39667 Minnesota Pollution Control Agency Request for Comments on PFAS in Products Currently Unavoidable Use Rule

Closed Mar 01, 2024 · Discussion · 155 Participants · 1 Topics · 172 Answers · 1 Replies · 24 Votes

155	1	172	1	24
PARTICIPANTS	TOPICS	ANSWERS	REPLIES	VOTES

SUMMARY OF TOPICS

SUBMIT A COMMENT

172 Answers · 1 Replies

Important: All comments will be made available to the public. Please only submit information that you wish to make available publicly. The Office of Administrative Hearings does not edit or delete submissions that include personal information. We reserve the right to remove any comments we deem offensive, intimidating, belligerent, harassing, or bullying, or that contain any other inappropriate or aggressive behavior without prior notification.

Lee Landstrom · Citizen · (Postal Code: unknown) · Jan 08, 2024 9:49 am
1 Votes

Revisor's ID Number R-4837. PFAS Products. I write in favor of strengthening and clarifying the regulation of pesticide-coated seeds. Currently, these products are NOT regulated like other pesticides. As demonstrated in Mead, Nebraska, piles of these seeds polluted ground water and nearby bee hives with this deadly runoff. There are NOT adequate safeguards for public health. Furthermore, if these seeds are treated with neonicotinoid pesticides, they have been shown to be a great danger to human and wildlife health. The treated seeds must be regulated as to their proper safe use, handling and especially disposal - for the benefit of our environment and human health.

Angela Ginsburg · Citizen · (Postal Code: unknown) · Feb 19, 2024 11:12 am
0 Votes

Comment in the link

Rose Thelen · Citizen · (Postal Code: unknown) · Feb 19, 2024 11:42 am
4 Votes

The MPCA must ensure that the "unavoidable use" rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products

that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.
MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.
MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Daniel Parnell McCarter · Citizen · (Postal Code: unknown) · Feb 19, 2024 12:33 pm
3 Votes

I would like to join others in calling for the following principles/actions to be followed, borrowing language from activists who have studied these issues:

- The MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.

- MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.

- MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.

- MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.

- MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Erin Enger · Citizen · (Postal Code: unknown) · Feb 19, 2024 12:52 pm
3 Votes

I too would like to join others in calling for the following principles/actions to be followed, borrowing language from activists who have studied these issues:

The MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.

MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.

MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.

MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.

MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Grant Thrall · Citizen · (Postal Code: unknown) · Feb 19, 2024 1:16 pm
2 Votes

Re: Revisor ID: R-4837
MPCA must prioritize public health over financial concerns. Therefore, a total ban of PFAs must be enforced. No exceptions. The "miracle" properties of PFAs have proven to be too good to be true. Any continued use of them prioritizes cost over health. Mining must find non-toxic, non-groundwater-polluting substitutes.

MATTHEW JOHNSON · Citizen · (Postal Code: unknown) · Feb 19, 2024 4:53 pm
4 Votes

Discussion: 39667 Minnesota Pollution Control Agency Request for Comments on
PFAS in Products Currently Unavoidable Use.
Revisor’s ID Number R-4837
I implore you to prioritize public health above ALL.
Nothing short of a total ban of PFAs must be put in place and more important - enforced.
No exceptions.
It is just that simple.
Mining must find non-toxic, non-groundwater-polluting substitutes or go without using anything.
My Health is at stake as is the health of fellow Minnesotan's.
REMEMBER: THESE CHEMICALS DO NOT GO WAY.
Think of the stacking effect increased exposure comes form adding more
PFA's (Forever Chemicals) into our environment.
It is a threat to ALL LIFE, ALL LIVING THINGS.
STOP IT NOW!

Sharon Coombs · Citizen · (Postal Code: unknown) · Feb 19, 2024 5:05 pm
3 Votes

As individuals we have the right to know what human-made materials enter our bodies when we eat, drink, and breath; therefore with respect to PFAS, MPCA rules must assure that information on the use of PFAS in products is readily available and easily usable by the public - no exceptions, not even for "trade secret formulas". I was most discouraged to learn that PFAS are in my rice krispie bars!! Had I known that earlier, I would not have bought them and hopefully others wouldn't as well, letting the market have some impact on the use of PFAS. Industries have access to knowledge that should enable them to use safe alternatives to PFAS. Products that allegedly can't be made without PFAS don't pass the test for use and should not be made.

The same principle applies to mining. Proposed mining facilities that would release PFAS should not be granted permits and existing and legacy mining sites should be evaluated for the presence of PFAS and means made available to mitigate the effects of PFAS already released or those with the potential to be released into the environment. The use of public monies to mitigate effects should be the last resort; polluters and their insurers should foot the bills.

Alternatives to mining exist or could exist with imagination and effort eg. mining landfills - there are lots of valuable materials in landfills. The MPCA must prevent further degradation of the environment and get rid of the idea of sacrifice zones. It's not acceptable to simply make degradation more inconvenient, or marginally more costly, or simply slower.

Don A. Zatroch · Citizen · (Postal Code: unknown) · Feb 19, 2024 5:23 pm
3 Votes

As a resident of New Brighton, Ramsey County, I am submitting the following points:

1. MPCA must ensure that the “unavoidable use” rule-making process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency;

2. MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses;

3. MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions do not become permanent loopholes;

4. MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS;

5. MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Very respectfully,

Betsy Blume · Citizen · (Postal Code: unknown) · Feb 19, 2024 6:08 pm
2 Votes

I believe based on the MPCA rules that must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses be noted in consideration of permitting of any industry that contributes to PFAS release into water resources.
Further, the MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.
MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.
Finally, MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.
Thank you for considering these comments on a very important public health concern.

Valerie Myntti · Citizen · (Postal Code: unknown) · Feb 19, 2024 8:52 pm
1 Votes

I too would like to join others in calling for the following principles/actions to be followed, borrowing language from activists who have studied these issues:
MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens.
MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.
MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.
MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Why is this crucial?
Mining is a potential source of PFAS release both to surface water and to groundwater. Exploratory drilling for minerals, use of tunnel boring machines, use of surfactants to

enhance metal recovery in the ore floatation process, ore leaching, acid mist suppression, and use of wetting agents are just some of the ways in which the mining industry can introduce PFAS to surface water and groundwater. Products containing PFAS may also be used in mines for fire suppression and firefighting activities.
Ore flotation processes—like the processing method proposed by PolyMet for the NorthMet mine—may use aqueous foams containing PFAS to lower surface tension and separate the metals from soil and rock. PFAS in the flotation process can be released to the environment through tailings seepage to surface and groundwater and in direct wastewater discharge to surface water.
Tunnel boring machines, like the one proposed by Talon Metals for the Tamarack mine may directly introduce PFAS to groundwater through use of lubricants, protection pastes, greases, foaming agents for rock tunnel boring, grouting additives, or fire resistant fluids containing PFAS.
Although there have been few efforts to monitor mines as potential sources of PFAS to, BHP’s Mount Whaleback Iron Ore Mine in Western Australia was recently identified as the source of PFAS impacts to groundwater with the potential to threaten a nearby drinking water supply.
Thank you for acting on these concerns.

Barbara Thomborson · Citizen · (Postal Code: unknown) · Feb 20, 2024 3:20 am
2 Votes

too risky to allow mining businesses near our water. Ore flotation processes—like the processing method proposed by PolyMet for the NorthMet mine—may use aqueous foams containing PFAS to lower surface tension and separate the metals from soil and rock. PFAS in the flotation process can be released to the environment through tailings seepage to surface and groundwater and in direct wastewater discharge to surface water.
Tunnel boring machines, like the one proposed by Talon Metals for the Tamarack mine may directly introduce PFAS to groundwater through use of lubricants, protection pastes, greases, foaming agents for rock tunnel boring, grouting additives, or fire resistant fluids containing PFAS.

Kevin LeVoir · Citizen · (Postal Code: unknown) · Feb 20, 2024 6:59 am
1 Votes

I want the rules to ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.

The MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.
Submitted by Kevin LeVoir Grand Marais MN

Sven Sorge · Citizen · (Postal Code: unknown) · Feb 20, 2024 7:15 am
0 Votes

Dear Sirs and Madams,

Mining is a potential source of PFAS release both to surface water and to groundwater.

Exploratory drilling for minerals, use of tunnel boring machines, use of surfactants to enhance metal recovery in the ore floatation process, ore leaching, acid mist suppression, and use of wetting agents are just some of the ways in which the mining industry can introduce PFAS to surface water and groundwater. Products containing PFAS may also be used in mines for fire suppression and firefighting activities.
Ore flotation processes—like the processing method proposed by PolyMet for the NorthMet mine—may use aqueous foams containing PFAS to lower surface tension and separate the metals from soil and rock. PFAS in the flotation process can be released to the environment through tailings seepage to surface and groundwater and in direct wastewater discharge to surface water.
Tunnel boring machines, like the one proposed by Talon Metals for the Tamarack mine may directly introduce PFAS to groundwater through use of lubricants, protection pastes, greases, foaming agents for rock tunnel boring, grouting additives, or fire resistant fluids containing PFAS.
Although there have been few efforts to monitor mines as potential sources of PFAS to, BHP's Mount Whaleback Iron Ore Mine in Western Australia was recently identified as the source of PFAS impacts to groundwater with the potential to threaten a nearby drinking water supply.

Janet Keough · Citizen · (Postal Code: unknown) · Feb 20, 2024 9:00 am
1 Votes

PFAS chemicals are toxic chemicals and pose real threats to human health and to ecosystems. Minnesota rules must include all industrial uses of PFAS including all the various uses in mining. Rules associated with PFAS chemicals must include the following:

MPCA must ensure that the "unavoidable use" rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
MPCA rules must make sure that any determination of "currently unavoidable use" must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don't become permanent loopholes.
MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.
MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Ali Ling · Citizen · (Postal Code: unknown) · Feb 20, 2024 10:51 am
0 Votes

Some comments addressing specific questions in the linked file.

Ginger Sanders · Citizen · (Postal Code: unknown) · Feb 20, 2024 11:19 am
0 Votes

I’m just going to be real here. The MPCA needs to stop giving polluters loopholes to pollute. I'm not sure why this is even a question, there shouldn't have been any past (allowable) PFAS's or any other pollutant in our air, land, water, or food. Furthermore, in 2024 we have alternatives that could be used in place of these deadly chemicals. The MPCA should be working on making laws to eliminate polluting industries and requesting alternatives to be used. Industrialized HEMP can do everything polluting industries do now and more, it's time to move away from polluters and do the real work.

Denise Tennen · Citizen · (Postal Code: unknown) · Feb 20, 2024 1:01 pm
0 Votes

The “unavoidable use” rulemaking process must protect Minnesota waters and the health of Minnesota citizens. Actually I question the very concept of unavoidable use. Dangerous chemicals should be banned outrigtht, no loopholes. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.
MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.
MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

thank you for your consideration
Denise Tennen

Samuel Choe · Citizen · (Postal Code: unknown) · Feb 20, 2024 2:08 pm
0 Votes

Please see the attached files.

Sam Engel · Citizen · (Postal Code: unknown) · Feb 20, 2024 5:15 pm
1 Votes

I would like you to make sure that the "unavoidable use" rule making process protects Minnesotans and the waters in the state. Big companies will try to find loopholes or avoid tranparency in such a subjective phrase. We are not big companies. We are people, Minnesotans. MPCA, do what you can to limit the power that these companies have to bend the rules, and please protect our waters!

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lisa bergerud · Citizen · (Postal Code: unknown) · Feb 20, 2024 6:38 pm
1 Votes

MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.
MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.
MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Annah Gardner · Citizen · (Postal Code: unknown) · Feb 20, 2024 11:27 pm
1 Votes

Please work to protect Minnesota’s precious water resources. It is vital that the MPCA ensures that the “unavoidable use” rulemaking process protects Minnesota's water resources from mining activities that can release PFAS. The rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes. MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS. MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Jane Hovland · Citizen · (Postal Code: unknown) · Feb 21, 2024 11:45 am
0 Votes

I would like to join others in calling for the following principles/actions to be followed, borrowing language from activists who have studied these issues:

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MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.

MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.

MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.

MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.
There is a reason these chemicals are lableled "forever"-- we don't know the extent of the damage they can do to inhabitants of earth who are exposed to them.

David Wilson · Citizen · (Postal Code: unknown) · Feb 21, 2024 3:50 pm
0 Votes

The Country looks to Minnesota for clean pristine water. We know now that it is teetering on the brink of being a finite resource. Security is having clean lakes, waterways and drinking supplies.
Our state is vulnerable to contamination due to an ever irresponsible mining industry and the representative withing our government who think nothing but for short term financial gain. Minnesota will be a poor state indeed if not for clean water and its recreational businesses.

Emily Thompson · Citizen · (Postal Code: unknown) · Feb 21, 2024 5:07 pm
0 Votes

I would recommend that "Unavoidable use" needs to be proven by the manufacturer, and that outcomes of not using PFAS should be demonstrated to be somehow worse than potential health effects of using them. Decreased yields or shareholder profits do not make the use of dangerous chemicals "unavoidable." Alternatives should also be regulated--they should not be closely related chemicals with different side chains that can be expected to have similar health effects. This will require careful definition of PFAS in the ban. There should perhaps be an independent group of chemists reviewing use of PFAS and alternatives, who have veto power over companies claiming unavoidable use. Companies using PFAS should be required to label their products and justify their continued use every few years, to prevent products from being grandfathered in after a viable alternative has been produced. They should not be able to protect themselves from transparency by claiming protection of trade secrets.

Pete McDonnell · Citizen · (Postal Code: unknown) · Feb 21, 2024 8:05 pm
0 Votes

As a resident of Beltrami County, I echo others comments who are pressing for common sense and environmentally sound practices regarding PFAS. To that end, I'd like to encourage the MPCA:
-To ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
-That MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
-That MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.
-That MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.
-That MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Respectfully,
Pete McDonnell

Michael Overend · Citizen · (Postal Code: unknown) · Feb 21, 2024 9:23 pm
0 Votes

Dear MPCA,
MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
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MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.
Thank You!

Michael Overend · Citizen · (Postal Code: unknown) · Feb 21, 2024 9:25 pm
0 Votes

Dear MPCA,

MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
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MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.
Thank you.

Kay Drache · Citizen · (Postal Code: unknown) · Feb 21, 2024 9:35 pm
0 Votes

MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
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MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

TOMOYOSHI SEGAWA · Citizen · (Postal Code: unknown) · Feb 21, 2024 10:44 pm
0 Votes

Dear MPCA,

There should be a standard of "essential for health, safety, or the functioning of society" to maintain the current standard of living, and that standard should be whether it contributes to people's lives and livelihoods. For example, manufacturing facilities related to social infrastructure (e.g., drinking water, water recycling, wastewater treatment), food, pharmaceuticals, and semiconductors that are essential to daily life meet the criteria of being "essential for health, safety, or the functioning of society".

Except as above comments, refer as attachment file.

Edward Best · Citizen · (Postal Code: unknown) · Feb 22, 2024 7:01 am
1 Votes

Dear MPCA,
Please find comments in the attached report.

Georganne Krause · Citizen · (Postal Code: unknown) · Feb 24, 2024 1:27 pm
0 Votes

Dear MPCA, Thank you for taking my comments. See Attachment.

William Thomas · Citizen · (Postal Code: unknown) · Feb 24, 2024 7:42 pm
0 Votes

MPCA must prioritize public health over financial concerns. Therefore, a total ban of PFAs must be enforced. No exceptions. There is no "unavoidable" use: mining companies must find or make alternatives. Any use of substances containing PFAs endangers ground water and public health. Mining must find non-toxic, non-groundwater-polluting substitutes.

Jeff Schatz · Citizen · (Postal Code: unknown) · Feb 26, 2024 2:46 pm
0 Votes

Dear MPCA,
Thank you for the opportunity to submit comments. Please see attached.

KUNIHIKO INAMURA · Citizen · (Postal Code: unknown) · Feb 26, 2024 8:39 pm
1 Votes

I am the secretary general of Battery Association of Japan (BAJ).
On behalf of the Japanese battery industry, I would like to give a comment about PFAS in battery products currently unavoidable use. Please refer to the attached file.

Response:

Steve Timmer · Citizen · (Postal Code: unknown) · Feb 27, 2024 6:27 pm
Perhaps then, Mr. Secretary General, you can apply for an exemption from a rule. And submit scientific evidence why. Your submission is NOT a reason not to have a rule. Not

to mention that you have eight years to figure out how to make batteries without PFAS.

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jacklyn janeksela · Citizen · (Postal Code: unknown) · Feb 27, 2024 12:01 pm
0 Votes

Last year, the Minnesota Legislature passed a statute (Minn. Stat. § 116.943) that would prohibit PFAS in many types of products unless their use in those products was "currently unavoidable." This was an important positive step to keep PFAS out of surface water and groundwater. Yeah! However, the MPCA is developing rules that will determine how the PFAS statute will be interpreted. The details will determine if Minnesota waters and human health are protected.

PFAS "forever chemicals" have a wide range of serious health consequences including cancers, liver damage, increased cholesterol and obesity, reduced immune response to fight infection, dangerous high blood pressure in pregnancy, reduced infant birth weight, and developmental delays in children.
PFAS "forever chemicals" are very toxic. PFAS exposure results in cancers, liver damage, reduced immune response to fight infection, increased cholesterol and obesity, dangerous high blood pressure in pregnancy, reduced infant birth weight, and developmental delays in children.

PFAS are not only found in cookware and cosmetics. Mining can release PFAS directly into surface waters and groundwater as a result of uses including drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression.

I hope speaking from my heart, my truth and offering these comments that I can encourage the reviewers and committee members to ignore pressure from special interests and listen to folks who don't have funds invested, but instead are invested with their hearts towards loved ones and our beautiful planet Earth. These are ways we can be good relatives and community members and honor our home and mother Earth. Thank you for letting me speak from my heart to yours in the hopes that I will awaken you from your slumber of the fossil fuel industry.

Joseph Salas · Citizen · (Postal Code: unknown) · Feb 27, 2024 1:06 pm
0 Votes

Letter of Support

I am the Product Compliance Manager of Smith Sport Optics who manufactures products used in the state of Minnesota, and I stand firmly behind efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. However, I express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. It's important to acknowledge that PFAS play a vital role in ensuring product functionality and meeting stringent safety standards.
In line with our commitment to finding balanced solutions, Claigan Environmental has developed a comprehensive Currently Unavoidable Uses (CUU) proposal, which is being submitted to the states of Minnesota. This proposal is founded upon rigorous laboratory testing and incorporates valuable insights gathered from diverse stakeholders. By engaging experts from various industries, Claigan Environmental has adopted a

collaborative approach to address this complex issue.
Smith Sport Optics actively participated in the consultation process and supports Claigan Environmental's submission. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS while mitigating adverse impacts on businesses, communities, and public health.

Best regards,
Joseph Salas

Steve Timmer · Citizen · (Postal Code: unknown) · Feb 27, 2024 4:13 pm
1 Votes

To: Minnesota Pollution Control Agency
From: Steven J. Timmer
Re: PFAS rulemaking
Date: February 27, 2024

Ladies and Gentlemen:

I am a retired Minnesota lawyer with forty-some years of private civil practice experience, including administrative law. I write today to urge rigorous protection of the citizens and the environment of the state from PFAS pollution. I write now specifically about rulemaking under the “currently unavoidable” provisions in Minn. Stat. § 116.943, subd. 5 (2023).

Any rule proposed and adopted by the MPCA must distinguish between things that are truly unavoidable versus merely inconvenient or marginally more expensive to manufacturer. There are also undoubtedly products where PFAS is unavoidable, but the product is of such marginal utility that it should be kept out of the stream of commerce and the bloodstreams of citizens or the waters and landfills in the state.

Advocates in many fields of endeavor have been known to shade the merely inconvenient or the marginally more expensive into the impossible to avoid or minimize regulation. I may have done it myself once or twice.

In order for legislators, citizens, and environmental watchdogs to have confidence in any administrative scheme of permitting “currently unavoidable PFAS use,” that scheme must be transparent enough to let these concerned parties check the MPCA’s work, and to do so without having to resort to frequent data requests, which are burdensome for everybody. Applications for exemption, and supporting documentation, ought to be published with a comment period for the public before any is granted. Since the rule won’t come into effect until 2032, there is plenty of time for industry to anticipate a period between application and possible grant of an exemption request.

All “currently unavoidable uses” must be time limited; the statute says “currently,” not “forever.” This is necessary, not only for the protection of citizens and the environment in the near term, but it will also incentivize industry to find PFAS-free solutions for their products. It would also prevent innovative competitors who find PFAS-free solutions being put at a competitive disadvantage.

It is not unfair to periodically test whether “currently unavoidable” has become “avoidable.”

I believe that it is also desirable to consider “distribution” under Subdivision 5 to include the activity of a party that purchases prohibited PFAS products out of state for use in-state, as for example, a mining company or its contractor that uses PFAS products in exploration or mining activities, or the flotation and precipitation of metals from ore.

Thank you,
Steven J. Timmer
5348 Oaklawn Avenue
Edina, Minnesota 55424

Jonathan Lee · Citizen · (Postal Code: unknown) · Feb 27, 2024 4:50 pm
0 Votes

Comments attached:

Avonna Starck · Citizen · (Postal Code: unknown) · Feb 27, 2024 5:10 pm
0 Votes

Comments attached.

Merlin Loblick · Citizen · (Postal Code: unknown) · Feb 27, 2024 5:14 pm
0 Votes

Please see the attached letter of support for the work that Claigan Environmental is doing on this very important topic

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Rebecca Myerly · Citizen · (Postal Code: unknown) · Feb 27, 2024 5:46 pm
0 Votes

Thank you for the opportunity to comment on the vital importance of ensuring that the “unavoidable use” rulemaking process for PFAs truly protects Minnesota waters and the health of all Minnesotans and others who live downstream. It is essential for MPCA to resist the pressure of special interests to find loopholes in the statute or escape transparency. Key to this protection are several essential actions and ongoing monitoring by MPCA, including

*Protecting Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.

*Making sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.

*Prioritizing public health and transparency, so that information on the use of PFAS in products is readily available and usable for members of the public.

*Working with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

All measures to discover, monitor, reduce, and eliminate PFAs will help increase the health and wellbeing of Minnesota and all who live here—and beyond. Thank you for your work focused on these priorities.

Julia Kloehn · Citizen · (Postal Code: unknown) · Feb 27, 2024 7:26 pm

0 Votes

MPCA must ensure that the "unavoidable use" rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.

MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.

MPCA rules must make sure that any determination of "currently unavoidable use" must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don't become permanent loopholes.

MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.

MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Wendy Willard · Citizen · (Postal Code: unknown) · Feb 27, 2024 9:40 pm

0 Votes

Please see the attached letter of support for the work that Claigan Environmental is doing

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Masatoshi Aimoto · Citizen · (Postal Code: unknown) · Feb 28, 2024 12:19 am

0 Votes

Please see the attached file.

Andreas Klemm · Citizen · (Postal Code: unknown) · Feb 28, 2024 2:24 am
0 Votes

Please see the attached letter of support for the work that Claigan Environmental is doing

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Miguel Gascon · Citizen · (Postal Code: unknown) · Feb 28, 2024 8:35 am
0 Votes

CommScope is requesting for CUU for:
1. PTFE as anti-dripping agent and flame retardant in thermoplastic materials that CommScope uses to produce indoor and outdoor telecommunication equipment.

Miguel Gascon · Citizen · (Postal Code: unknown) · Feb 28, 2024 8:36 am
0 Votes

CommScope is requesting for CUU for:
2. PTFE and PFA used by CommScope’s suppliers in the production of printed circuit boards.

Miguel Gascon · Citizen · (Postal Code: unknown) · Feb 28, 2024 8:37 am
0 Votes

CommScope is requesting for CUU for:
3. PTFE, FEP and PVDF used by CommScope in the production of coaxial antenna cables, category cables and optical fibre cables.

Diana Brainard · Citizen · (Postal Code: unknown) · Feb 28, 2024 9:38 am
0 Votes

MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.
MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.
MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Karl Bodenhoefer · Citizen · (Postal Code: unknown) · Feb 28, 2024 11:16 am
0 Votes

Dear MPCA, Thank you for the opportunity to submit comments. Please see attached

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Mark Herwig · Citizen · (Postal Code: unknown) · Feb 28, 2024 12:00 pm
0 Votes

Thank you for the opportunity to submit comments on the PFAS CUU Request for Comment. Please see attached files. Thank you.

Christa Ernst · Citizen · (Postal Code: unknown) · Feb 28, 2024 12:00 pm
0 Votes

Thank you to the Office of Administrative Hearings for accepting comments from the public on this topic.
I ask that the MPCA ensure that the “unavoidable use” rule making process protects Minnesota waters and the health of Minnesota citizens. Please resist the pressure of special interests to find loopholes in the statute or escape transparency.
MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.
MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.
MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.
Thank you for your time on this important issue,
Christa Ernst

Mark Herwig · Citizen · (Postal Code: unknown) · Feb 28, 2024 12:01 pm
0 Votes

Adding one additional supportive document to the above related comments and attachments.

Lonnie Hall · Citizen · (Postal Code: unknown) · Feb 28, 2024 2:45 pm
0 Votes

Thank you for the opportunity to provide comments. Please see attached.

Lonnie Hall · Citizen · (Postal Code: unknown) · Feb 28, 2024 2:47 pm

0 Votes

Thank you for the opportunity to comment. Please see attached.

Robert Hale · Citizen · (Postal Code: unknown) · Feb 28, 2024 3:09 pm

0 Votes

Thank you for the opportunity to comment on this important discussion.

I believe that MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.

MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.

MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.

MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.

MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Dawn Friest · Citizen · (Postal Code: unknown) · Feb 28, 2024 3:50 pm

0 Votes

Please see attached comments. Thank you.

Erica Corser · Citizen · (Postal Code: unknown) · Feb 28, 2024 4:07 pm

0 Votes

Please see attached Honeywell's comments regarding Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS); OAH Docket No. 71-9003-39667; Governor’s Revisor’s ID Number: R-4837

Kevin Wolfe · Citizen · (Postal Code: unknown) · Feb 28, 2024 4:35 pm
1 Votes

Please see attached Intel Corporation’s Comments on the MPCA’s Request for Comments on Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per- and Polyfluoroalkyl Substances (PFAS); OAH Docket No.71-9003-39667; Governor’s Revisor’s ID Number: R-4837

Kevin Wolfe · Citizen · (Postal Code: unknown) · Feb 28, 2024 4:42 pm
0 Votes

Please see attached Intel Corporation’s Comments on the MPCA’s Request for Comments on Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per- and Polyfluoroalkyl Substances (PFAS); OAH Docket No.71-9003-39667; Governor’s Revisor’s ID Number: R-4837

Kazuhito Oosumi · Citizen · (Postal Code: unknown) · Feb 28, 2024 8:19 pm
0 Votes

Japan Business Machine and Information System Industries Association (JBMIA) represents the global leading companies of business machines industry, and our main products are printers, copying machines, multifunction devices (MFDs), and their consumables, including toner.

JBMIA is also one of the organizations that make up the Japan Electrical Engineering and Electronics Association (JP4EE). As JP4EE, we are providing input to the request for comments regarding Minnesota's PFAS regulations. In Attachment 5, regarding Ref No. 15, 19 and 28 Functional materials used in printing process, it is recommended to refer to JBMIA's input for details.
We would like to submit the opinion that JBMIA submitted to the State of Maine regarding the use of PFAS compounds in Toner additives, Ink additives, and Developer additives as Functional materials used in printing process. Please consider this information when considering PFAS regulations in Minnesota.

Kazuhito Oosumi · Citizen · (Postal Code: unknown) · Feb 28, 2024 8:20 pm
0 Votes

Additional documentation is attached.

Japan Business Machine and Information System Industries Association (JBMIA) represents the global leading companies of business machines industry, and our main products are printers, copying machines, multifunction devices (MFDs), and their consumables, including toner.

JBMIA is also one of the organizations that make up the Japan Electrical Engineering and Electronics Association (JP4EE). As JP4EE, we are providing input to the request for comments regarding Minnesota's PFAS regulations. In Attachment 5, regarding Ref No.

15, 19 and 28 Functional materials used in printing process, it is recommended to refer to JBMIA's input for details.
We would like to submit the opinion that JBMIA submitted to the State of Maine regarding the use of PFAS compounds in Toner additives, Ink additives, and Developer additives as Functional materials used in printing process. Please consider this information when considering PFAS regulations in Minnesota.

Junko SUDO · Citizen · (Postal Code: unknown) · Feb 29, 2024 12:00 am
0 Votes

Regarding the Comments for CUU Determinations in Minnesota, we have prepared our comments as attached.

Masatoshi Tsuruoka · Citizen · (Postal Code: unknown) · Feb 29, 2024 12:04 am
0 Votes

Thank you for the opportunity to submit comments on the PFAS CUU Request for Comment. Please see attached files. Thank you.

Masatoshi Tsuruoka · Citizen · (Postal Code: unknown) · Feb 29, 2024 12:18 am
0 Votes

I add HTS-Code table. Please see attached file.

Emi Yamamoto · Citizen · (Postal Code: unknown) · Feb 29, 2024 1:06 am
0 Votes

The Japanese electric and electronic (E&E) industrial associations comment (1/3)
Our comment contains 7 attachments, so we are sending it in 3 comments.
This comment is No.1 in all 3 comments.

The Japanese electric and electronic (E&E) industrial associations – JEITA, CIAJ, JBMIA and JEMA (JP4EE)
have carefully and conscientiously examined the Request for comments on Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837, and would like to submit our comments and recommendations.
We would highly appreciate the MPCA would carefully consider our input.

Emi Yamamoto · Citizen · (Postal Code: unknown) · Feb 29, 2024 1:07 am
0 Votes

The Japanese electric and electronic (E&E) industrial associations comment (2/3)
Our comment contains 7 attachments, so we are sending it in 3 comments.

This comment is No.2 in all 3 comments.

The Japanese electric and electronic (E&E) industrial associations – JEITA, CIAJ, JBMIA and JEMA (JP4EE)
have carefully and conscientiously examined the Request for comments on Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837, and would like to submit our comments and recommendations.
We would highly appreciate the MPCA would carefully consider our input.

Emi Yamamoto · Citizen · (Postal Code: unknown) · Feb 29, 2024 1:08 am
0 Votes

The Japanese electric and electronic (E&E) industrial associations comment (3/3)
Our comment contains 7 attachments, so we are sending it in 3 comments.
This comment is No.3 in all 3 comments.

The Japanese electric and electronic (E&E) industrial associations – JEITA, CIAJ, JBMIA and JEMA (JP4EE)
have carefully and conscientiously examined the Request for comments on Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837, and would like to submit our comments and recommendations.
We would highly appreciate the MPCA would carefully consider our input.

Tomomitsu Muta · Citizen · (Postal Code: unknown) · Feb 29, 2024 3:07 am
0 Votes

Dear Minnesota Pollution Control Agency,

We, Japan Electric Measuring Instruments Manufacturers' Association (JEMIMA), would like
to express the gratitude of having the opportunity of stating our opinion to Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

We agree with The Japanese electric and electronic (E&E) industrial associations – JEITA, CIAJ, JBMIA and JEMA (JP4EE) on the comments for the questions1 to 6, 8 and 9. We would like to submit the attachment for the question 7. This is 1 out of 2 posts.
We are grateful if you could consider our comment.

Tomomitsu Muta · Citizen · (Postal Code: unknown) · Feb 29, 2024 3:07 am
0 Votes

Dear Minnesota Pollution Control Agency,

We, Japan Electric Measuring Instruments Manufacturers' Association (JEMIMA), would

like
to express the gratitude of having the opportunity of stating our opinion to Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

We agree with The Japanese electric and electronic (E&E) industrial associations – JEITA, CIAJ, JBMIA and JEMA (JP4EE) on the comments for the questions1 to 6, 8 and 9. We would like to submit the attachment for the question 7. This is the 2nd post out of 2 posts.
We are grateful if you could consider our comment.

YASUFU YAMADA · Citizen · (Postal Code: unknown) · Feb 29, 2024 5:17 am
0 Votes

Please see attached comments regarding Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number: R-4837

Louisa Mitchell · Citizen · (Postal Code: unknown) · Feb 29, 2024 5:53 am
0 Votes

Dear MPCA
Thank you for the opportunity to submit comments on the planned new rules governing determinations of currently unavoidable uses (CUU) of PFAS. I am submitting the attached document jointly prepared by members of BioPhorum, a global biopharmaceutical manufacturing industry collaboration comprising all major manufacturers and their key suppliers (over 150+ companies, representing > 98% of all biopharmaceuticals manufactured worldwide).

Our industry sector shares a responsibility to work with all relevant stakeholders to manage the transition away from materials of concern while maintaining our ability to ensure the safety and wellbeing of patients and the communities in which we operate. Any efforts to restrict usage and production of materials of concern by our industry must be pragmatically considered; the risk of drug shortages and therefore failure to supply medicines to patients must be evaluated against the risk the materials pose to the environment and to that very same population. We welcome the opportunity to participate in this process and respectfully ask you to review the attached response and contact me if you wish to further discuss the contents.
Thank you

Daniel Carey · Citizen · (Postal Code: unknown) · Feb 29, 2024 7:37 am
0 Votes

Dear MPCA,

Please find attached comments from Polaris Industries Inc., as you consider new rules pertaining to the currently unavoidable use (CUU) of products containing PFAS. Thank you very much for the opportunity to provide comments during this important process.

Francisco Hernandez · Citizen · (Postal Code: unknown) · Feb 29, 2024 8:30 am
0 Votes

Dear MPCA,
CHEMSERVICE, acting on behalf of
MTO Hose Solutions Inc. (214 Interchange Blvd., Newark, DE, 19711)
and
MTO Hose of Texas (3140 Commonwealth Dr. – Ste. 440, Dallas, TX, 75247)
which are part of the UNIGASKET Group, wants to provide the attached comments on Planned New Rules Governing CUU Determinations about products containing PFAS.
We remain at your disposal to answer any questions you may have regarding the information provided, as well as for the provision of additional documentation.

Callum Ross · Citizen · (Postal Code: unknown) · Feb 29, 2024 9:08 am
0 Votes

Dear MPCA,

Please find attached comments for your consideration from Steam Thermal Solutions (Spirax Sarco & Gestra). Thank you in advance for your consideration, both for your efforts to protect our environment and the attached CUU comments.

Ron Phillips · Citizen · (Postal Code: unknown) · Feb 29, 2024 9:25 am
0 Votes

Attached please find comments from the Animal Health Institute regarding CUU designations for products containing PFAS. Thank you for this opportunity.

Bruce Calder · Citizen · (Postal Code: unknown) · Feb 29, 2024 10:02 am
0 Votes

Attached is a combined submission of fifty-three (53) PFAS Currently Unavoidable Use (CUU) proposals. Each is an individual proposal, but listed in the attached excel file sequentially for your convenience.

These submissions were put together by Claigan Environmental in combination with over 50 companies across virtually all market spaces (consumer, professional, laboratory, life sciences, medical, safety, industrial, machinery, and IT). The data is backed up with 2022 to 2024 laboratory data from testing 1,000s of products for PFAS and PFAS salts.

Most of the included PFAS uses are very widespread and used in virtually every industry. These proposals can be broken out by industry, but that would expand the list to nearly 400 individual proposals which are really based on 53 uses.

Document 1 - PFAS Currently Unavoidable Uses Proposals Guidance Document - Feb 2024.pdf
Summary and guidance document on the currently unavoidable uses proposals being submitted. This document is a must read for anyone looking to regulate PFAS. It includes summaries and explanations based on the most recent data.

Guidance document
a). Explanation of the submission project and members
b). Definitions
c). Key findings / notes from the project (examples - over 500M products sold in the US each year contain PFAS, the forestry, life sciences, and fishing industries will be closed in the State of Minnesota if PFAS are banned, etc.)
d). Explanations of the few situations where fluoropolymers products products PFAS found in drinking water and humans. The data here is the most modern information available. There is nothing comparable to date.
e). A detailed review of an example US State (Kentucky) and the sources of PFAS in their drinking water in 2023. This is a map to determining sources of PFAS in drinking water for the State of Minnesota.
f) An detailed explanation of the criteria used to compare alternatives.

Document 2 - PFAS Currently Unavoidable Uses Proposals - Feb 2024.xlsx
A very detailed listing of each Currently Unavoidable Use, industries impacted, example products, essential use of product and of PFAS, comparison of alternatives, and potential for presence of PFOA / LC-PFCA.

This document is explained in detail in the Guidance Document (Document #1)

PFAS CUU Proposal document
a). List of each CUU with summary for each criteria
b). Secondary tabs for each use type with a detailed comparison of alternative materials

There is no comparable comprehensive listing, explanation, and justification of PFAS uses. These documents should be required reading for any PFAS regulator.

Kevin Farnam · Citizen · (Postal Code: unknown) · Feb 29, 2024 11:51 am
0 Votes

Please see the attached letter of support for the work that Claigan Environmental is performing.

Judi Sobecki · Citizen · (Postal Code: unknown) · Feb 29, 2024 11:55 am
1 Votes

Thank you for the opportunity to submit the attached comments regarding the planned new rules governing Currently Unavoidable Use (CUU) determinations about products containing PFAS, which are being submitted on behalf of Hitachi Energy.

Javaneh Tarter · Citizen · (Postal Code: unknown) · Feb 29, 2024 2:25 pm
0 Votes

Please find attached the comments of Lac-Mac Limited on MPCA's Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing PFAS, Revisor ID R-4837

Thomas Cortina · Citizen · (Postal Code: unknown) · Feb 29, 2024 2:39 pm
0 Votes

The Halon Alternatives Research Corporation, Inc. (HARC) appreciates the opportunity to provide information to the Minnesota Pollution Control Agency (MPCA) in response to its request for comments on planned new rules on currently unavoidable uses of PFAS. HARC is a non-profit trade association formed to promote the development and approval of halon alternatives that serves as an information clearinghouse and focal point for cooperation between government and industry on issues of importance to special hazard fire protection. HARC members encompass all levels of the fire protection industry including agent manufacturers, equipment manufacturers, distributors/installers, recyclers, and end-users.

The HCAs used for fire protection that meet the definition of PFAS in the Minnesota law are FK-5-1-12, HFC-227ea, HFC-125, HFC-236fa, 2-BTP and HCFC Blend B. While there are non-PFAS alternatives for HCAs that have been available for several decades and are widely used, we write to inform MPCA that there are important uses of HCAs in facility, aviation and military applications for which non-PFAS alternatives do not exist and are not currently in development. As such we expect there to be continuing uses of HCAs for fire suppression well beyond January 1, 2032.

Wendy Willard · Citizen · (Postal Code: unknown) · Feb 29, 2024 2:45 pm
0 Votes

Thank you for reviewing our comments attached.

Michelle Wegler · Citizen · (Postal Code: unknown) · Feb 29, 2024 2:50 pm
0 Votes

Thank you for the opportunity to comment on the vital importance of ensuring that the “unavoidable use” rulemaking process for PFAs truly protects Minnesota waters and the health of all Minnesotans and others who live downstream. It is essential for MPCA to resist the pr understanding and identifying a baseline for the term “reasonable” is critical for any future consideration of a viable PFAS alternative. ig companies will try to find loopholes or avoid transparency in such a subjective phrase. Big money and corporations think only with immediate bottom line, not the long term incentives for protecting our most valuable resource: our water. We the people, Minnesotans, want you to do what you can to limit the power that these companies have to bend the rules, and please protect our waters.

Denise Lee · Citizen · (Postal Code: unknown) · Feb 29, 2024 3:29 pm
0 Votes

Please see attached. Thank you!

Fran Groesbeck · Citizen · (Postal Code: unknown) · Feb 29, 2024 3:35 pm
0 Votes

The Cookware & Bakeware Alliance is a vital housewares trade association, delivering critical industry resources as a voice of authority and influence uniting the industry by setting engineering standards for product and consumer safety.

Attached are our PFAS Education Documents #1, #2 and #3 which we would like to submit regarding your request for information

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chris olson · Citizen · (Postal Code: unknown) · Feb 29, 2024 3:40 pm
0 Votes

Emphasize that MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.
MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.
MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Daniel Iverson · Citizen · (Postal Code: unknown) · Feb 29, 2024 3:47 pm
0 Votes

MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.
MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.
MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Joel Sherman · Citizen · (Postal Code: unknown) · Feb 29, 2024 4:04 pm
0 Votes

Please see the attached letter of support for the comprehensive/scientific research work that Claigan Environmental has provided to Minnesota for their consideration for PFAS in Products Currently Unavoidable Use Rule.

Katie Pelch · Citizen · (Postal Code: unknown) · Feb 29, 2024 4:16 pm
0 Votes

Please see the attached document and responses from the Natural Resources Defense Council.

John Roterman · Citizen · (Postal Code: unknown) · Feb 29, 2024 4:19 pm
0 Votes

I heard in my 1st semester back towards my bachelor degree that Earth is experiencing a mass-extinction. That was six years ago and I near my Master in Tribal Resources Environmental Sustainability Stewardship. (MTRES). Sadly, we have not improved our paradigm and it is in large part due to our own activities. Anthropocene era has been debated for decades whether we now qualify. We do. It is our activities that create our environment. It has become barren and toxic for Invertebrates and vertebrates and birds and mammals. Our "goals" of keeping our global carbon expiration and temperature low are still increasing.
"Unavoidable use" ???
please.
To stop this problem it will take doing the opposite of business as usual. We need Sustainability NOW. None of our current actions are unavoidable. We must simply stop doing them. Find a different way to accomplish our needs.
What did our ancestors do? That question sticks to me. I am of Anishinaabe-Ojibwe heritage and am a member of the Minnesota Chippewa Tribe (MCT).
Respectfully, I beg. Please do not allow business interests, whose sole existence is to profit for their small base. Please put the health and welfare of the Earth before any ill gain who continues to destroy Nature and the Natural process of life. Those bugs do more for us than we realize. The birds and fish, the mammals also contribute to healthy Ecosystems. Bioregions. Earth.
We are ALL connected.
As our pfas now is connected too. We are all exposed to this lethal agent who was released without regard for our health. There are technological advances and it may be possible to remove this toxin but it is still very expensive .. and who will pay?
Who will pay?
We all pay.
Water. Fresh Water. The basic essential to us.
Stop polluting and saying it's necessary. There are beautiful ways people existed and did maintain a paradise here once. We have been duped into submission to unnatural resources and maintaining a completely unsustainable lifestyle. We need to just stop.
Stop.
It's avoidable. And unnecessary. And wholly unsustainable.
And what do the local Native population think of it.
Consultation must be thorough. It has not been.

We can do better.
Stop pfas. Talon mine has unsustainable history forever. Don't let them turn this bioregion into an unlivable area and future Superfund site. There is no unavoidable, stop doing it.
Chi miigwech

Christopher Walsh · Citizen · (Postal Code: unknown) · Feb 29, 2024 4:59 pm
0 Votes

Please see my attached letter. Thank you for your consideration.

Lea Foushee · Citizen · (Postal Code: unknown) · Feb 29, 2024 7:45 pm
0 Votes

Mining can release PFAS directly into surface waters and groundwater as a result of uses including drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression.
PFAS contamination is ubiquitous. It is a suspected carcinogen and causes multiple health effects and is "persistent" in the environment. PFOS is commonly called the forever poison. Do not license (permit) more of this forever poison into our air, water, and soils of Minnesota.

Anne Morrison · Citizen · (Postal Code: unknown) · Feb 29, 2024 8:49 pm
0 Votes

I have submitted one email on the topic of MPCA rulemaking but wish to add some additional thoughts.

The MPCA is in the process of developing rules regarding the regulation of PFAS, which has been classified as a “forever” chemical.

PFAS are “forever chemicals” which will impact the health of Minnesota residents into perpetuity— for as long as people continue to reside in this state. They are known to cause cancer and liver damage; to suppress here deadly immune responses; to cause dangerously high blood pressures during pregnancy, endangering mothers and their unborn children; and to cause developmental delays in children. The Environmental Protection Agency has issued advisory warnings that even tiny amounts of some of PFAS chemicals found in drinking water may pose risks. Scientists are now finding PFAS in our soil, air, and drinking water. As a result, these deadly chemicals are now four in our food, wildlife, and even our own bloodstreams.

Although PFAS are frequently ingested through contaminated surface and groundwater, the research regarding the impacts of PFAS on animal life, and therefore, on the net effects of releasing PFAS into the environment is inadequate for understanding the broad environmental effects of PFAS. Little is known about the way the PFAS affect microorganisms, or about the ever-expanding effects of PFAS as they are ingested by microorganisms and re-ingested up the entire food chain —including, ultimately, by humans.

As a result, it is currently impossible to know how releasing carcinogens and toxins which can never be withdrawn from the environment affects environmental processes as a whole. However, it would be reasonable to presume that animal, like humans, experience significant effects, and that the release of PFAS into the environment has a broader and more significant effect on our environment than we can currently comprehend l

It is also significant that the waters of northern Minnesota drain into the Hudson Bay and Mississippi watersheds: toxic chemicals released into Minnesota waters will affect the environment across vast areas of the North American continent.

The MPCA faces regularly issues involving the release of chemicals, and often deadly chemicals, into the environment. In view of the facts that the effects of PFAS on humans or the environment are yet to be fully studied, that PFAS are currently known to cause serious health and reproductive issues, that PFAS travel up the food chain to eventually contaminate the entire environment, and that the release of PFAS into Minnesota water stands to affect vast portions of North America, it would be beyond unconscionable for MPCA or its employees to promulgate rules which prioritize short-term corporate profit over the vast and irreversible health and environmental effects of releasing additional PFAS into the environment.

For all of the above reasons, I urge the MPCA to ensure that rules promulgated regarding these issues prioritize the protection of Minnesota's water resources and human and environmental health over mining activities which release PFAS, into the environment. Such rules must include:

—The requirement that any manufacturer must prove the existence of a “currently unavoidable use”;

—that any exception which would allow the release of PFAS (there should be none!) have an end date to protect Minnesotans, and our environment, from the release of PFAS on an indefinite basis;

—provisions which mandate the disclosure of information regarding the creation and release of PFAS, so that such critical health information is made available to the public.

Thank you again for considering these additional thoughts and concerns.

Thomas Sullivan · Citizen · (Postal Code: unknown) · Feb 29, 2024 9:00 pm
0 Votes

MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.

MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.

Frank Janezich · Citizen · (Postal Code: unknown) · Feb 29, 2024 9:36 pm
0 Votes

Thank you for the opportunity to comment on this important discussion.

MPCA must ensure that the "Unavoidable Use" rule-making process protects Minnesota waters and the health of all the humans and wildlife using Minnesota waters. MPCA must resist the pressure of special interests to find loopholes in the statute or to escape transparency.

MPCA rules must protect Minnesota surface water and groundwater from all ways in which mining process have the potential to release PFAS by using products containing PFAS in any mining processes or process steps.

MPCA rules must ensure that any determination of "Currently Unavoidable Use" must be proved by the manufacturer and must be sunset by an agreed-upon date so that temporary exceptions do not become permanent loopholes.

MPCA rules must prioritize public health and transparency, such that information on use of PFAS in products is readily available and usable by members of the public. If manufacturers choose to protect their trade secret or proprietary formulas for their product, they must certify that their product Does Not Contain PFAS.

MPCA should work in cooperation with Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS; and the MPCA must investigate whether PFAS are present at existing and legacy mining facilities and sites.

Ian Choiniere · Citizen · (Postal Code: unknown) · Mar 01, 2024 12:43 am
0 Votes

Please see the attached comments from the Center for the Polyurethanes Industry regarding Currently Unavoidable Use (CUU) designations for Products Containing Per-and polyfluoroalkyl substances (PFAS). Thank you for the opportunity to comment.

Samuel Staehelin · Citizen · (Postal Code: unknown) · Mar 01, 2024 4:05 am
0 Votes

Subd. 5 (c) explicitly states that “the commissioner may not determine that the use of PFAS in a product is a currently unavoidable use if the product is listed in paragraph (a)”. One of the product groups listed in Subd. 5 (a) is “cookware” and from the perspective of a company producing electrical household appliances like e.g. coffee machines, this term needs some clarification. Subd. 1 (h) defines “cookware” as “durable houseware items used to prepare, dispense, or store food, foodstuffs, or beverages”. As an electrical coffee machine can in principle be described as a durable houseware item used to prepare and dispense a beverage (coffee), it seems to fall under the definition of cookware. However, all items listed as examples in Subd. 1 (h) – pots, pans, skillets, grills, baking sheets, baking molds, trays, bowls, and cooking utensils – are very simple objects and not at all comparable to electrical household appliances. An electrical coffee machine consists of hundreds, sometimes even thousands, of different components and a lot of the tubes and seals in such a machine are made of fluoropolymers, which fall under the definition of PFAS according to Subd. 1 (p), and it will be absolutely impossible to redesign all appliances that are currently in production or in development until January 1, 2025. Because of this, I have my doubts that such electrical appliances are actually targets of the restriction of PFAS in cookware. In any case, I would be happy about some definitive clarification.

Scott Armstrong · Citizen · (Postal Code: unknown) · Mar 01, 2024 4:41 am
0 Votes

Please see attached. Thank you.

Yuri Ikada · Citizen · (Postal Code: unknown) · Mar 01, 2024 5:11 am
0 Votes

Dear MPCA,
We, Japanese Federation of Medical Devices Association (JFMDA), would like to express the gratitude of having the opportunity of stating our opinion to Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor’s ID Number R-4837

Please see attached comments from JFMDA.
We would highly appreciate the MPCA would carefully consider our input.

Matthias Peters · Citizen · (Postal Code: unknown) · Mar 01, 2024 5:51 am
0 Votes

Dear Madam or Sir,

To begin we would like to thank the Minnesota Pollution Control Agency for the opportunity to contribute comments! Please find attached Trelleborg Sealing Solutions feedback to the planned New Rules Governing Currently Unavoidable Use Determinations about Products containing Per-and polyfluoroalkyl substances (PFAS), Revisor’s ID Number R-4837of the Minnesota Pollution Control Agency (MCPA).

With best regards,

Dr. Matthias Peters
Director Global Materials Compliance

Trelleborg Sealing Solutions

Best Technology · Citizen · (Postal Code: unknown) · Mar 01, 2024 7:25 am
0 Votes

Please see attached. We appreciate the MPCA consideration of unavoidable uses of PFAS which are critical to health, safety, and the functioning of society

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Catherine Palin · Citizen · (Postal Code: unknown) · Mar 01, 2024 8:30 am
0 Votes

Please find attached the comments of the Alliance for Automotive Innovation.

Philip Berdos · Citizen · (Postal Code: unknown) · Mar 01, 2024 8:57 am
0 Votes

Please see attached PFAS Member Support letter on behalf of Iwaki America. Thank You.

Robert Denney · Citizen · (Postal Code: unknown) · Mar 01, 2024 9:27 am
0 Votes

Please see attached comments submitted on behalf of the PFAS Pharmaceutical Working Group.

Warren Lehrenbaum · Citizen · (Postal Code: unknown) · Mar 01, 2024 9:34 am
0 Votes

Please see the attached comments submitted on behalf of AGC Chemicals Americas, Inc. and AGC America, Inc.

Andrew Bemus · Citizen · (Postal Code: unknown) · Mar 01, 2024 9:55 am
0 Votes

Please see the attached comment letter from the Sustainable PFAS Action Network (SPAN). Please contact SPAN with any questions or comments.

Ben Kallen · Citizen · (Postal Code: unknown) · Mar 01, 2024 10:28 am
0 Votes

On behalf of SEMI, the industry association serving the global semiconductor design and manufacturing supply chain, we write to offer comments on the regulations on per- and polyfluoroalkyl substances (PFAS) being developed by the Minnesota Pollution Control Agency (MPCA), as authorized in Minn. St. § 116.943 (Section 116.943). These comments discuss the MPCA's planned rulemaking governing currently unavoidable use (CUU) determinations for products containing intentionally added PFAS (the CUU Rule).

SEMI is committed to balancing the need for environmental protection and the sustainability of semiconductor manufacturing operations, which is a complex challenge. As such, SEMI is grateful for the opportunity to engage on the MPCA's planned CUU Rule and is available to meet at your convenience to further elaborate on the issues discussed in these comments. If you have any questions or would like to discuss our positions, please do not hesitate to contact us.

Marta Yuste Prieto · Citizen · (Postal Code: unknown) · Mar 01, 2024 10:50 am
0 Votes

NEMA- National Electrical Manufacturers Association, appreciates the opportunity to provide comments on the Planned New Rules Governing Currently Unavoidable Use (CUU) determinations about products containing PFAS that will be promulgated by the Minnesota Pollution Control Agency (the “MPCA” or the “Agency”) pursuant to Minnesota Statutes 116.943, subdivision 5(c)(“Amara’s Law”).
Please see attached a comment letter.

Ann Beane · Citizen · (Postal Code: unknown) · Mar 01, 2024 10:55 am
0 Votes

Keep PFAS from Mining out of Surface and Ground Water!

PFAS “forever chemicals” are toxic. PFAS exposure results in cancers, liver damage, reduced immune response to fight infection, increased cholesterol and obesity, dangerous high blood pressure in pregnancy, reduced infant birth weight, and developmental delays in children.

PFAS are not only found in cookware and cosmetics. Mining can release PFAS directly into surface waters and groundwater as a result of uses including drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression.

Christian Nelson · Citizen · (Postal Code: unknown) · Mar 01, 2024 11:06 am
0 Votes

PFAS is considered a "forever" chemical with demonstrated harm to humans and wildlife. No temporary project should ever release this chemical into our environment.

*The MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.

*MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.

*MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.

*MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.

*MPCA should work with the Minnesota Department of Health and the Minnesota

Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Joel Weisberg · Citizen · (Postal Code: unknown) · Mar 01, 2024 11:13 am
0 Votes

Re Revisor's ID Number R-4837, the "PFAS in Products Currently Unavoidable Use Rule"
I am a retired professor of physics and astronomy and the natural sciences at Carleton. While my background does not give me extra knowledge of the harms and benefits of PFAS and its regulation, it does mean that I deeply understand the scientific method. In addition, I have read articles for lay readers about PFAS for years. I write to make the following points:

PFAS does not easily break down into harmless chemicals over time. This fact is why it is called called a "forever chemical," and what marks it as a long-term pollutant, requiring strict and transparent rulemaking by MPCA, and avoiding carve-outs that would permit manufacturers, users, and other stakeholders to maneuver around the regulations. Furthermore the rule must regulate the environmental harms of PFAS production in any aspect of its being mined.

The final "unavoidable use" PFAS rules must offer a high level of protection for state waters, either under or on the surface, and prioritize Minnesotans' health. In addition, manufacuturers must not be allowed to cite "trade secrets" as a reason to avoid providing information necessary for regulation, since the dangers of this chemical are great.

MPCA must collaborate with other State agencies such as MN Department of Health and the MN DNR to ensure that no new mines emit PFAS into our waters, and to study whether PFAS chemicals are sitting in already-closed or existing mines.

The term "currently unavoidable use" should not lead to "forever use" without regular regulatory assessment. Therefore any currently unavoidable use permit must automatically die after a reasonable length of time, absent new assessments.

Thank you for listening to my comments.

Eric Morrison · Citizen · (Postal Code: unknown) · Mar 01, 2024 11:17 am
0 Votes

Perfluorinated substances must be taken extremely seriously, and the subject of "unavoidable use" categories for these chemicals must be very thoughtfully, publicly and transparently considered.

My comments are based on working with perfluorinated liquids at 3M (relevant to PFASs) and from being a member of Ecolab's ECOPAC political action committee (relevant to seeking special treatment).

My first assignment at 3M showed me how profound is the power of suggestion, particularly as it relates to chemical safety. I invented a one part epoxy coating for eyeglasses to be used in one hour lens crafting, and the epoxy was to be cured by steaming it over a boiling perfluorinated compound (US Patent 5,314,980 Epoxy coating compositions with metal-containing stabilizers). To even think of selling a device like that, one would need to be convinced that perfluorinated compounds are actually inert and safe, a common belief because of the stability of carbon – fluorine bonds. The stability of the fluorine carbon bond means that perfluorinated compounds will last forever – but they are not inert – other bonds change and the product perfluorinated compounds can be very dangerous. The well known example is decomposition of poly tetrafluoroethylene (Teflon) to give perfluoroisobutylene (which is a potential chemical warfare agent 10 times more toxic than phosgene). While chemical changes in PFAS may not be as dramatic as Teflon decomposing to perfluoroisobutylene, they must be understood and the risks must be managed. Someone high up at 3M wisely chose to end the one hour lens crafting scheme, and now we know very well that perfluorinated compounds are not inert, but I am still moved by the power of suggestion and the passion with which we believed otherwise when we were working with these compounds in the lab.

My experience at Ecolab leads me to view “unavoidable uses” with suspicion. What “unavoidable uses” means is the compound in question is really effective, but there are alternatives but they either cost much more or they don’t work as well. An example is phosphorous compounds (which cause eutrophication of lakes and rivers) for cleaning and lubrication. But even in cases where environmentally damaging compounds give much better results than other materials (such as fire fighting foams), there still needs to be a public, transparent treatment of risk vs benefit. Giving companies a get out of jail free card in terms of unavoidable uses is unnecessary and strictly oppositional to the public good.

MPCA must ensure that the "Unavoidable Use" rule-making process is transparent, public, and seriously weighs risks and benefits. Especially concerning are mining operations which have tremendous potential to release PFASs in large amounts in ways that are very opaque.

Thank you for the opportunity to comment and for your consideration.

Roman Ventura · Citizen · (Postal Code: unknown) · Mar 01, 2024 11:21 am
0 Votes

Datwyler Pharma Packaging USA, Inc. would like to express its appreciation for the opportunity to provide comment to the Minnesota Pollution Control Agency (MPCA) with regard to its planned new rules governing Currently Unavoidable Use (CUU) Determinations about Products Containing Per- and Polyfluoroalkyl substances (PFAS), Revisor’s ID Number R-4837. Datwyler hereby respectfully submits the responses contained within this attached submission for consideration.

Thank you for allowing us to provide these comments and for taking the time to consider these views during the rulemaking process. Datwyler admires the significant task being undertaken by the MPCA to balance environmental impacts of PFAS with maintaining essential functions of health, safety and a functioning society for all Minnesotans. Datwyler welcomes the opportunity to further engage with the MPCA in this process.

David Perlman · Citizen · (Postal Code: unknown) · Mar 01, 2024 11:25 am
1 Votes

The American Watch Association ("AWA") submits the following comments. The AWA is a trade association representing many of the major watch brands and companies in the United States. Watches use an extremely small amount of PFAS in a way where there is virtually no risk of consumer exposure. As such, the AWA believes watches pose an exceedingly remote risk of PFAS exposure to consumers. When watches are constructed, a solution called an epilame is added to certain movement parts inside of the watch to prevent oil from spreading and to ensure the lubricant remains in place and performs as intended. Effective epilame solutions contain a small amount of PFAS, and no technically or economically feasible PFAS-free alternatives currently exist. The eplilame is applied in small drops, of a thickness between 3 to 5 nanometers. Once applied, the epilame dries and is not volatile. The quantities of lubricants involved are extremely small. Between 1.5 mg and 6 mg of fluorinated lubricant is used per watch, each containing about 30% PFAS. As noted, there is no currently available substitute; the AWA anticipates that it would take 8-10 years to develop a possible substitute. The movements that are treated with the PFAS containing epilame solutions are assembled in other countries. They are then sealed in a watch case, which also takes place in other countries. Accordingly, when a watch enters this country, the PFAS containing eplilames are sealed away and therefore inaccessible to consumers. Indeed, consumers are discouraged from opening the watch case as the movement could easily be damaged. Furthermore, it is quite difficult to open a watch case without a specialized tool, manual dexterity, and technical skill. Therefore, there is virtually no risk of PFAS exposure to a consumer from the epilame coating a watch movement. The risk of PFAS exposure from watches in the waste stream is also remote. Watches are unlikely to enter the solid waste stream as they are generally high value items and designed to last for years. For example, analogue watches have a very long life and are often passed down across generations. Given the fact that relatively few watches containing PFAS are disposed of, and in light of the exceedingly small amount of epilame at issue, which is generally inaccessible to consumers, there is very little risk that the minimal PFAS in the epilame would be released and contaminate the environment.
We therefore respectfully request that such uses of PFAS containing eplilame solutions qualify as a currently unavoidable use.

Sincerely,

David B. Perlman
Executive Director
American Watch Association

Lawrence Culleen · Citizen · (Postal Code: unknown) · Mar 01, 2024 11:25 am
0 Votes

Please see attached which we submit on behalf of the Chemical Users Coalition for consideration by MPCA .

Emily Sobel · Citizen · (Postal Code: unknown) · Mar 01, 2024 11:39 am
0 Votes

MEMA, The Vehicle Suppliers Association respectfully submits these comments to the Minnesota Pollution Control Agency (MPCA) on its request for comments on planned new rules governing currently unavoidable use (CUU) determinations for products containing PFAS.

Lawrence Karnitz · Citizen · (Postal Code: unknown) · Mar 01, 2024 11:49 am

0 Votes

Emphasize that MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.
MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.
MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Ron James · Citizen · (Postal Code: unknown) · Mar 01, 2024 11:58 am

1 Votes

All water well drilling holes, and all mineral exploration drilling boreholes, utilize drilling fluids for lubrication. The Pollution Control Agency should insist that the manufacturers of these lubricants prove that there are no PFAS in their products. Currently, no one is testing these products to confirm they are PFAS free.

It is not good enough to rely on the National Sanitary Foundation's (NSF) recommendations, because even the NSF does not test their "drinking water treatment chemicals" for PFAS. The NSF list includes all of the biggest suppliers to the oil & gas exploration industry. These are the same chemicals used for drilling water wells and mineral exploration boreholes. None have been tested to confirm they are PFAS free. NSF 60 certified does not mean they are PFAS free!

The NSF list is here: https://info.nsf.org/Certified/PwsChemicals/Listings.asp?CompanyName=&TradeName=&ChemicalName=&ProductFunction=&PlantState=&PlantCountry=&PlantRegion=

It is also not good enough to rely on Safety-Data-Sheets that make no mention of PFAS content. All SDS's are written by the manufacturers and they never disclose 100% of the chemical content of their products. No manufacturer will disclose that their product contains PFAS on their SDS.

Please include in the rule making the requirement that all drilling fluids and drilling lubricants be tested to confirm they do not contain PFAS. If this requirement is not included, the PFAS contamination cycle will continue to start when water wells and mineral exploration boreholes are drilled.

Michael Blume · Citizen · (Postal Code: unknown) · Mar 01, 2024 11:59 am
0 Votes

Please see attached.

Joseph Dawley · Citizen · (Postal Code: unknown) · Mar 01, 2024 12:07 pm
0 Votes

On behalf of Waygate Technologies, a subsidiary of Baker Hughes Company, please find our attached comments for an unavoidable use determination for our non-destructive testing equipment, as further described below.   Many of our products are used for industrial asset monitoring to ensure the safe, reliable, and efficient operation of industrial equipment in power plants, transportation infrastructure, manufacturing plants, and other industrial operations. Please let me know if you have any problems opening the attached file or questions regarding our comments.

Best regards,

Joe

Joseph Dawley · Citizen · (Postal Code: unknown) · Mar 01, 2024 12:08 pm
0 Votes

To whom it may concern,

Baker Hughes, on behalf of our subsidiaries, Bently Nevada, Waygate Technologies, Panametrics, Druck, Reutor-Stokes, and Nuovo-Pignone, submits the following request for an unavoidable use determination for our compression, gas and steam turbine, and our condition monitoring equipment, as further described in the attached file named Baker Hughes UUD Product Request (1 March 2024).xlsx. Many of our products are used for industrial asset monitoring to ensure the safe, reliable, and efficient operation of industrial equipment in power plants, transportation infrastructure, manufacturing plants, and other industrial operations. Please let me know if you have any problems opening the attached file or questions regarding our comments.

Best Regards,

Joe

Kathleen Stuebner · Citizen · (Postal Code: unknown) · Mar 01, 2024 12:09 pm
0 Votes

I write using language of activists more familiar with the issues than I am, to emphasize that MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
In addition, MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.
MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.
MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Joseph Dawley · Citizen · (Postal Code: unknown) · Mar 01, 2024 12:20 pm
0 Votes

Baker Hughes, on behalf of our subsidiaries listed below, submits the attached request for an unavoidable use determination for our valve products. The Baker Hughes products that contain PFAS and are subject to these comments include Dresser valves and associated brands, including Consolidated, Masonelian, Becker and Mooney. Please let me know if you have any problems opening the attached file or questions regarding our comments.

Best regards,

Joe

Alex Gordon · Citizen · (Postal Code: unknown) · Mar 01, 2024 12:25 pm
0 Votes

Please see the attached comments of the Semiconductor Industry Association (SIA).

Bob McIntosh · Citizen · (Postal Code: unknown) · Mar 01, 2024 12:52 pm
0 Votes

Please find attached Georg Fischer Piping Systems' comments on the planned new rules on CUUs for PFAS in products. We appreciate the opportunity to participate in the rule making process and remain available to answer any further questions.

Kyle Thompson · Citizen · (Postal Code: unknown) · Mar 01, 2024 1:08 pm
0 Votes

In the attached comment letter Plumbing Manufacturers International (PMI) is requesting that all plumbing products utilized in residential and commercial construction, as well as those used in public infrastructure be designated as “currently unavoidable use”. In addition PMI recommends that MPCA use similar criterion as Maine DEP for PFAS (https://www.maine.gov/dep/spills/topics/pfas/PFAS-products/cuu.html) and requests that MPCA establish an ongoing process for granting CUU designations in the future so that manufacturers and industries that do not receive an initial CUU designation can apply in the future as more information on PFAS and its viable alternatives becomes available between now and 2032 when the state’s PFAS products ban goes into effect.

All the best,

Kyle Thompson
Plumbing Manufacturers International
Website: www.safeplumbing.org

Tony Kwilas · Citizen · (Postal Code: unknown) · Mar 01, 2024 1:11 pm
0 Votes

Attached are the Minnesota Chamber of Commerce comments.

Jason Malcore · Citizen · (Postal Code: unknown) · Mar 01, 2024 1:25 pm
0 Votes

Attached file are the comments from the Association of Equipment Manufacturers (AEM)

Lori Austino · Citizen · (Postal Code: unknown) · Mar 01, 2024 1:25 pm
0 Votes

Dear MCPA -
Thank you for the opportunity to provide comment on the CUU rulemaking. Please see attached document.

Jay Eidsness · Citizen · (Postal Code: unknown) · Mar 01, 2024 1:29 pm
0 Votes

Please see the attached comments from Minnesota Center for Environmental Advocacy and CURE.

Lawrence Culleen · Citizen · (Postal Code: unknown) · Mar 01, 2024 1:33 pm
1 Votes

Please see attached comments submitted on behalf of the Chemical Users Coalition concerning Currently Unavoidable Uses of PFAS.

Dan Barth · Citizen · (Postal Code: unknown) · Mar 01, 2024 1:47 pm
0 Votes

I have serious concerns that the ingredients list in drilling fluids may not be completely accurate. Both Pennsylvania and Colorado have found PFAS in drilling fluids and have taken action to stop their use. I urge a rule that requires PFAS testing on all drilling fluids prior to their approval for use. Water is too precious to take chances with.

Rebecca Poindexter · Citizen · (Postal Code: unknown) · Mar 01, 2024 1:48 pm
0 Votes

Please see attached comments submitted on behalf of Mozarc Medical.

Peter Lance · Citizen · (Postal Code: unknown) · Mar 01, 2024 2:00 pm
0 Votes

Please see the attached comments submitted on behalf of the Fluid Sealing Association concerning Currently Unavoidable Uses of PFAS.

Rick Van Arnam · Citizen · (Postal Code: unknown) · Mar 01, 2024 2:00 pm
0 Votes

Attached, please find the comments submitted on behalf of the Vision Council.

Heather Darrah · Citizen · (Postal Code: unknown) · Mar 01, 2024 2:18 pm
0 Votes

Please see the attached comments on behalf of the Power Tool Institute.

Heather Rhoderick · Citizen · (Postal Code: unknown) · Mar 01, 2024 2:26 pm
0 Votes

Please see the attached comments submitted on behalf of the Flow Control Coalition. Thank you for the opportunity to provide comments.

Peter Glessing · Citizen · (Postal Code: unknown) · Mar 01, 2024 2:27 pm
0 Votes

Please see attached public comment submission from Medical Alley.

John Keane · Citizen · (Postal Code: unknown) · Mar 01, 2024 2:40 pm
0 Votes

Please see the attached comments from Association of Home Appliance Manufacturers (AHAM).

Nichol Robinson · Citizen · (Postal Code: unknown) · Mar 01, 2024 2:47 pm
0 Votes

We appreciate the opportunity to collaborate with MPCA on this important issue. Please see attached document for comments.

Diana Rondeau · Citizen · (Postal Code: unknown) · Mar 01, 2024 2:48 pm
0 Votes

Attached, please find the comments for Currently Unavoidable Uses of PFAS submitted on behalf of IDEXX Laboratories Inc., and IDEXX's letter in support of the Claigan submission.

Ronald Shebik · Citizen · (Postal Code: unknown) · Mar 01, 2024 2:48 pm
0 Votes

Please see attached

Diana Rondeau · Citizen · (Postal Code: unknown) · Mar 01, 2024 2:49 pm
0 Votes

Attached, please find the comments for Currently Unavoidable Uses of PFAS submitted on behalf of IDEXX Laboratories Inc.

Daniel Mustico · Citizen · (Postal Code: unknown) · Mar 01, 2024 2:51 pm
0 Votes

Please see attached comment letter from the Outdoor Power Equipment Institute.

Amy Neal · Citizen · (Postal Code: unknown) · Mar 01, 2024 2:55 pm
0 Votes

Emerson would like to thank the Minnesota Pollution Control Agency for the opportunity to contribute comments. Please find attached our feedback to the planned New Rules Governing Currently Unavoidable Use Determinations about Products containing Per-and polyfluoroalkyl substances (PFAS).

Jay West · Citizen · (Postal Code: unknown) · Mar 01, 2024 2:56 pm
0 Votes

Please find attached comments from the American Chemistry Council's Performance Fluoropolymer Partnership.

Stacy Tatman · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:00 pm
0 Votes

Please find attached the Air-Conditioning, Heating, and Refrigeration Institute's comments. Please contact us if you have questions or need additional information. We appreciate the opportunity to work with MPCA on this important issue.

Andrea Murphy · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:01 pm
0 Votes

Please find attached comments on behalf of Panasonic Corporation of North America.

Paul Rivers · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:02 pm
0 Votes

Concerns over PFAS (perfluoro- and polyfluoro-alkyl substances) began when it was discovered that some fluorinated compounds were environmentally persistent, bioaccumulative and potentially toxic. In the more than two decades since then, the definition of fluorinated substance designated for concern has dramatically increased to now include any compound that contains a CF2 or CF3 group in its chemical structure. However, a comprehensive scientific assessment of volatile, hydrophobic fluorinated fluids demonstrates that these materials should not be grouped with the compounds of concern despite their inclusion in some PFAS definitions. While it is prudent for regulatory agencies to restrict some compounds designated as PFAS due to the hazards they present, not all materials that fall under the broad PFAS definition pose an unacceptable risk to human health or the environment. Considering all compounds which contain a CF2 or CF3 moiety as displaying the same inherent hazards is analogous to grouping all hydrocarbons as the same. Even small differences in chemical structure can have a profound effect on on properties. Consider the effect of one CH2 unit on the difference in toxicity of ethanol (CH3CH2OH) compared to methanol (CH3OH). One would never imply that these compounds exhibit the same hazards or present the same risks. Similarly, many in the scientific community have recognized the need to differentiate between the wide range of compounds now being encompassed in broad PFAS definitions (T. Wallington, et al., "The case for a more precise definition of regulated PFAS," Environmental Science: Process & Impacts, vol. 23, pp. 1834-1838, 2021. R. Andersen, et al., "Grouping of PFAS for human health risk assessment: Findings from an independent panel of experts," Regulatory Toxicology and Pharmacology, vol. 134, p. 105226, 2022.).
Nonafluoro-2-trifluoromethyl-3-pentanone is a fluoroketone used in a number of industrial applications and primarily in fire protection as a clean fire extinguishing agent. It performs a critical role in providing fire protection in applications where it is unsuitable to use water, an inert gas or dry chemical. The fluoroketone has chemical and toxicological properties which are vastly different from the PFAS compounds of concern. Despite containing fluorine, the fluoroketone is not a “forever chemical” since it degrades in the environment on a reasonable time scale, does not bioaccumulate and have been demonstrated through testing to be low in toxicity. The fluoroketone is not

found to be a contaminant in water or soil due to its very high volatility combined with extremely low water solubility which results in partitioning to the atmosphere. The fluoroketone then undergoes degradation in the atmosphere through natural processes (photolysis) resulting in an atmospheric lifetime of 1-2 weeks.
The largest degradant in terms of molecular weight resulting from atmospheric decomposition is trifluoroacetic acid (TFA). Several risk assessments have concluded that TFA does not pose an unacceptable risk to human health or the environment even at the projected environmental concentrations that could be generated from refrigerants and other large volume industrial compounds (J. Boutonnet, et al., "Environmental Risk Assessment of Trifluoroacetic Acid," Human and Ecological Risk Assessment: An International Journal, vol. 5, no. 1, pp. 59-124, 1999. K. Solomon, et al., "Sources, fates, toxicity, and risks of trifluoroacetic acid and its salts: Relevance to substances regulated under the Montreal and Kyoto Protocols," Journal of Toxicology and Environmental Health, Part B, vol. 19, no. 7, pp. 289-304, 2016. United Nations Environment Programme (UNEP), 2022 Assessment Report of the Environmental Effects Assessment Panel, Nairobi, Kenya, 2023. US EPA has designated TFA as a “well studied non-PFAS” and attempts to exclude compounds with TFA as the degradant from their PFAS definition (U.S. Environmental Protection Agency, National PFAS Testing Strategy: Identification of Candidate Per- and Polyfluoroalkyl Substances (PFAS) for Testing, 2021.).
The fluoroketone is recognized to have very low bioaccumulation potential. The high volatility (vapor pressure of 40 kPa at 25°C) combined with very low solubility in water (1 ppmw) results in a high Henry’s Law constant of 1.3x107 Pa.m3/mol, demonstrating extensive partitioning to the atmosphere. The physical properties also result in a low log KOW of 2.79 which is well below the threshold for concern with bioaccumulation.
The fluoroketone is low in toxicity based on a comprehensive set of tests. The fluid is low in acute and repeat-dose inhalation toxicity. It was also demonstrated as not mutagenic nor genotoxic based upon both in vitro and in vivo test protocols. Studies also established that the fluoroketone is not classified as hazardous for reproduction or development.
Data corroborating these properties and results can be found in the ECHA REACH database under E.C. Number 436-710-6.

Paula Maccabee · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:07 pm
0 Votes

The attached comments and Exhibits 1-4 pertaining to MPCA's "PFAS in Products Currently Unavoidable Use Rule" are submitted on behalf of WaterLegacy.

Craig Tangren · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:09 pm
0 Votes

Please find attached the Leech Lake Band of Ojibwe's comments on MPCA's Proposed New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS).

Anthony Price · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:21 pm
0 Votes

Minnesota Pollution Control Agency,

Thank you in advance for your time. I am Anthony Price, Manager of Government Relations at Whirlpool Corporation. Attached, you will find comments submitted on behalf of Whirlpool Corporation involving planned rules governing currently unavoidable use determinations.

Thank you for your consideration. Should you have any questions regarding our comments, please let us know.

King County Hazardous Waste Program · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:27 pm

0 Votes

Please see attached comments letter on behalf of the Hazardous Waste Management Program of King County, Washington.

Abbey Linsk · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:29 pm

0 Votes

American Chemistry Council submits the attached comments on MPCA's request for comment on PFAS in Products Currently Unavoidable Use Rule.

Riaz Zaman · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:30 pm

0 Votes

see attached

Daniel Moyer · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:30 pm

0 Votes

Please see attached for comments from the Consumer Technology Association and the Information Technology Industry Council

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James Votaw · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:35 pm

0 Votes

Ladies and gentlemen,
On behalf of Valmet, Inc. and Valmet Flow Control Inc., we appreciate the opportunity to submit the attached comments on considerations for developing proposed rules for determining when products should be exempt from the January 1, 2032, ban on distribution and sale of products containing intentionally added PFAS.
Enclosed are Valmet’s comments on the particular issues raised by the Agency in its Request for Comments document, together with detailed information on a number of Valmet’s products that contain PFAS (fluoropolymers and fluoroelastomers) for which Currently Unavoidable Use
(CUU) determinations would be warranted. Minnesota Statutes 116.943, subdivision 5(c).

The
comments include additional background on the Company’s products, the important role played
by fluoropolymers and fluoroelastomers in the listed CUU products, the particular challenges
and costs of attempting substitutions in complex equipment, and the societal impacts of the bans going into effect without appropriate CUU exemptions. Valmet’s comments also urge the Agency to interpret the scope of the products rule to be limited to consumer products and to exclude industrial products. Its comments demonstrate the impracticability and high cost of applying these rules to industrial products and the limited benefit.

Mark Chaffee · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:37 pm
0 Votes

Letter in support of the comments submitted by the Flow Control Coalition

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Andrew Brackbill · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:39 pm
0 Votes

Attached are the comments of the Extruded Polystyrene Foam Association - XPSA. We urge the MPCA to take the overly broad definitions of the statute into account when designing Minnesota's regulatory architecture around PFAS. We suggest that CUUs should be expeditiously granted for products (like XPS foam insulation) which rarely come into contact with human beings in situ, are made with chemicals of little toxicological concern, and cannot easily be replaced by alternative products available in the market today.

Thomas Wiensch · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:47 pm
0 Votes

PFAS causes cancer. I've had cancer. It's miserable - Much more miserable than being a car part maker who is has to do a bit of re-tooling in order to make parts without pfas in them. Please make a rule that is stringent in requiring darn good reasons for industry to get dispensations that allow them to use pfas. Above all, please do not allow mining companies to use pfas in drilling fluids, as they drill right through the water table - perhaps the most direct way to get pfas into our water supply and into us. We lived for a long time with out pfas-laden products. If it avoiding their use make corporations less profitable, so be it. How many people should have to die for corporate profits?

Juliann Rule · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:53 pm
0 Votes

I am commenting because I believe it is imperative that PFAS from mining be kept out of Minnesota surface and ground water.

PFAS, the forever chemicals, have a wide range of serious health consequences including cancers, liver damage, increased cholesterol and obesity, reduced immune response to fight infection, dangerous high blood pressure in pregnancy, reduced infant birth weight, and developmental delays in children.

MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.

MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.

MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.

MPCA rules must prioritize public health and transparency so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.

MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Rosanna Imholte · Citizen · (Postal Code: unknown) · Mar 01, 2024 3:56 pm
0 Votes

Please see attached comments submitted on behalf of Polar Semiconductor.

A.L. Goebel · Citizen · (Postal Code: unknown) · Mar 01, 2024 4:04 pm
0 Votes

I would like to comment on the
"Unavoidable Use" rule. This decision process must be transparent, and seriously consider the risks. The mining operations have the potential to release PFASs in large amounts.
I comment on this as a homeowner and parent that lives in a community with PFAS contaminated water. We are constantly told our levels are ‘safe’, but no level is safe. It is not really acceptable that it is even under discussion that these chemicals could be used. They need to be banned.

Scott Schloegel · Citizen · (Postal Code: unknown) · Mar 01, 2024 4:11 pm
0 Votes

Please find the attached comments from the Motorcycle Industry Council, Specialty Vehicle Institute of America, and the Recreational Off-Highway Vehicle Association.

Edith Nagy · Citizen · (Postal Code: unknown) · Mar 01, 2024 4:12 pm
0 Votes

Attached please find the comments from The Rechargeable Battery Association.

Michael Klug · Citizen · (Postal Code: unknown) · Mar 01, 2024 4:14 pm
0 Votes

MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.
MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.
MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Jesse McArdell · Citizen · (Postal Code: unknown) · Mar 01, 2024 4:23 pm
0 Votes

Please see the attached comments from the National Marine Manufacturers Association, the Watersports Industry Association, and the Marine Retailers Association of the Americas.

Debbie Allert · Citizen · (Postal Code: unknown) · Mar 01, 2024 4:25 pm
0 Votes

As a retired Minnesota physician, I would like to join others in calling for the following principles/actions to be followed, borrowing language from activists who have studied these issues:

The MPCA must ensure that the “unavoidable use” rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.

MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.

MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.

MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.

MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

Laurent Davis · Citizen · (Postal Code: unknown) · Mar 01, 2024 4:27 pm
0 Votes

Please see attached commentary from Wilo USA LLC

Jacob Carter · Citizen · (Postal Code: unknown) · Mar 01, 2024 4:27 pm
0 Votes

Please see the attached file for comments from the Window & Door Manufacturers Association.

Sophia Patane at March 01, 2024 at 4:43pm CST

Comment received prior to eComments manual closure at 4:31 pm on March 1, 2024.

If the Minnesota Pollution Control Agency is, in fact, committed to “ensuring that every Minnesotan has healthy air, sustainable lands, clean water, and a better climate,” then the MPCA must ensure that the rulemaking process around “PFAS in Products Currently Unavoidable Use Rule” protects Minnesota waters and the health of Minnesota citizens.

MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency. For decades after the development of PFAS in the 1940s, special industry interests hid the connection between exposure to PFOA, PFOS, and other PFAS to a huge—and heartbreaking—series of health impacts including reduced immune response, developmental delays in children, increased cholesterol and obesity, and cancer.

MPCA rules must also protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.

MPCA rules must make sure that any determination of “currently unavoidable use” must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don’t become permanent loopholes.

MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.

MPCA should also work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at existing and legacy mining sites.

My community in the east metro of the Twin Cities has been directly impacted by PFAS contamination in our water supply. The threat to our health from PFAS is real and ever-present. I ask that MPCA take this historic opportunity to create strong, enforceable rules that protect Minnesotans and the waters, wetlands, groundwater resources, and lands that we rely upon for life itself from toxic PFAS chemicals.

0 Reads

March 1, 2024

Melanie Loyzim, Commissioner
Maine Department of Environmental Protection
17 State House Station
Augusta, Maine 04333-0017
PFASProducts@maine.gov

Re: Request to Maine for a Currently Unavoidable Use Exemption for Complex Consumer and Durable Goods, their Components and Replacement Parts

Dear Commissioner Loyzim:

The Coalition of Manufacturers of Complex Products (Coalition) appreciates the opportunity to submit to the Maine Department of Environmental Protection (MDEP) this request for a currently unavoidable use (CUU) exemption pursuant to 38 M.R.S. §1614 for "complex consumer and durable goods, their components and replacement parts."

Coalition members manufacture equipment and products by assembling tens to hundreds or thousands of parts, components, and raw materials to provide, in many cases, critical services to society. These include commercial and consumer products such as appliances, vehicles, vessels, motors, heating, ventilation, air conditioning, refrigeration, and water heating equipment (HVACR-WH), electronics, and their replacement parts. Coalition members serve and support nearly every major sector in the nation, providing critical products and services for government agencies, the military, law enforcement, first responders, and public safety, food and agriculture (including commercial fishing and sea farming), energy, transportation and logistics (including for commuting and for island residents), public works and infrastructure support services, critical manufacturing, the defense industrial base, conservation, and life-saving climate control and ventilation in homes, hospitals, schools, and eldercare facilities, for food preservation and processing and for critical health and life sciences. Services dependent on refrigeration include everything from the prevention of dangerous food spoilage to life-giving medicines, vaccines, proteomics, therapeutics, blood plasma, and other temperature-dependent elements in the life sciences and pharmaceutical sectors. Collectively these products and services constitute a vital part of the economy, at all levels, including for public safety.

As explained below, in response to the criteria specified by MDEP for requesting a CUU exemption, Coalition members produce complex consumer and durable goods with internal components that may contain substances in the class of substances defined broadly as per- and polyfluoroalkyl substances (PFAS) at 38 M.R.S. §1614(1)(F). The use of PFAS in these applications warrants an exemption from both Maine's reporting program and 2030 ban. There is an exceptionally low or no likelihood of exposure to PFAS from using these products, and the process of identifying where PFAS are present, researching feasible alternatives, and implementing changes throughout these large and complex supply chains will take many years beyond January 1, 2030.

1. **Description of Individual Product Category.**

Maine's law is entitled "SALE OF CONSUMER PRODUCTS AFFECTING THE ENVIRONMENT". As written, the requirements of this law apply the more general concept of a "product," defined in 38 M.R.S. § 1614(1)(G) as:

> "an item manufactured, assembled, packaged or otherwise prepared for sale to consumers, including its product components, sold or distributed for personal, residential, commercial or industrial use, including for use in making other products."[1]

The inclusion in the definition above of items that are sold and distributed *for commercial and industrial use* extends well beyond items that are sold to individuals and households.[2]

Given its scope, the Coalition is extremely grateful that Maine's law offers a rational approach to product identification, and specifically allows manufacturers to supply information for categories of products, rather than for each individual product or product type.[3] According to 38 M.R.S. §1614(5)(C), the Department may "identify products by category or use that may not be sold" (emphasis added) and "prioritize the prohibition of the sale of product categories" (emphasis added). According to 38 M.R.S. §1614(5)(D), MDEP may "specify specific products or product categories in which it has determined the use of PFAS is a currently unavoidable use" (emphasis added).[4] Maine's website specifies that a separate proposal must be submitted for each individual product category. In these comments we explain how "complex consumer and durable goods" is an individual product category.

To make the expansive scope of this law rational and targeted so that it addresses Maine's concerns, and do so in an efficient manner, the Coalition respectfully urges Maine to think broadly in establishing exempt product categories. The definition of a CUU in the law offers support for

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1 Under subparagraph H, a "product component" is defined as an identifiable component of a product, regardless of whether the manufacturer of the product is the manufacturer of the component.

2 The expansive scope is echoed in the Frequently Asked Questions (FAQs) prepared by MDEP. In response to the question "What products must be reported? "DEP responds:

> "38 M.R.S. §1614 (1)(G) defines a product as "an item manufactured, assembled, packaged or otherwise prepared for sale to consumers, including its product components, sold or distributed for personal, residential, commercial or industrial use, including for use in making other products." The statute defines "product component" as "an identifiable component of a product, regardless of whether the manufacturer of the product is the manufacturer of the component."
>
> All products and product components sold in Maine for personal, residential, commercial, or industrial use are subject to this program. If a product is offered for sale in Maine for one of those purposes, the Manufacturer of the product must report the amount of PFAS in their product."

In response to the question "Are products that are sold for industrial or commercial use treated differently than those meant for personal or residential use?" MDEP responds:

> "No, under the law all products, regardless of whether they are sold for personal, residential, commercial, or industrial use are treated the same.
>
> The law also requires reporting for components of the final product and products that are sold to be incorporated into another product. (38 M.R.S. §1614(1)(G))."

3 38 M.S.C. 1614(2)(B).

4 MDEP, *PFAS in Products: Currently Unavoidable Uses* (Last visited February 29, 2024).

this approach, speaking in terms of "a use of PFAS" absence of a reference to a "product", "individual product category" or the term "industrial sector." It states:

> "a use of PFAS that the department has determined by rule under this section to be essential for health, safety or the functioning of society and for which alternatives are not reasonably available."[5]

Examples of the uses we ask to be exempt include, but are not limited to, HVACR-WH equipment, boats, marine vessels, automobiles, off-highway vehicles, farm equipment, personal assistive mobility devices, household appliances, consumer electronics, furniture, tools, industrial, commercial and consumer lighting installation equipment, sports equipment, and medical equipment. These items, when categorized as complex consumer and durable goods, qualify as a "product category" under the Maine law because the use of PFAS in all of these products is essential for the health, safety, or functioning of society.

Accordingly, the Coalition asks MDEP for a CUU determination for use in complex consumer and durable goods, their components and replacement parts. Complex consumer and durable goods are manufactured items that are sold and distributed for personal, residential, commercial, or industrial use. It is appropriate to treat them as a product category because of the high degree of complexity associated with identifying and requesting an exemption for each and every affected component.

A. Proposed Language for this Exemption

We request that the term "complex consumer and durable goods" be defined similar to the language found in the Toxic Substances Control Act (TSCA) § 6(c)(2)(D) to mean:[6]

> "electronic devices, mechanical devices, and manufactured goods composed of multiple components, with an intended useful life of 3 or more years, where the product is intended for consumer, commercial, or industrial use and is typically not consumed, destroyed, or discarded after a single use, and for which the components would be impracticable to redesign or replace."

Pursuant to 38 M.R.S. §1614(1)(B), we offer the following language to describe the exemption:

> "Complex consumer and durable goods, their components, and replacement parts, including but not limited to:
>
> a. Cooling, heating, ventilation, air conditioning and refrigeration equipment.
> b. Vehicles, including watercraft and marine vessels, automobiles, off-highway vehicles, farm equipment, personal assistive mobility devices, e-scooters, and e-bikes.
> c. Solid state and LED industrial, commercial and consumer lighting and system installations and smart home systems.
> d. Consumer electronics and communication devices.

5 38 M.R.S. §1614(1)(B).

6 15 U.S.C. § 2605(6)(c)(2)(D).

e. Medical devices."

The Coalition does not think Maine's law requires the use of brick codes or HTS codes to implement CUU exemptions. We do not support requiring their use as a condition for qualifying for a CUU exemption.

The Coalition's proposed approach is the kind of pragmatic thinking Maine needs to address such a critical issue. Instead of having to review and sign off on hundreds or more individual product exemptions, MDEP can address all of them under the sole product category of complex consumer and durable goods. This idea has been adopted by the federal government under TSCA.[7]

If MDEP chooses another approach, then the Coalition supports all requests in that regard for the products listed above as well as others. Additionally, the Coalition suggests that a product category can be a group of chemicals, such as fluoropolymers or refrigerants. For manufacturers of these chemicals, the fluoropolymers and refrigerants are their products. They are manufactured from other chemical components and packaged and sold for commercial and industrial use to manufacture other products and components, including complex consumer and durable goods. If MDEP permits an exemption for a product, product category, or use based on a request by a single manufacturer (or a group of manufacturers), the Coalition urges Maine to ensure that the exemption applies to all manufacturers of those products or uses.[8] Ultimately, the Coalition believes that the number of requests that Maine may receive to exempt various kinds of complex consumer and durable goods will highlight the need for a complex consumer and durable goods category as the most effective way to ensure that Maine will not be deprived of essential goods when the 2030 ban becomes effective.

2. Use Information In Complex consumer and durable goods That Are Essential For The Health, Safety, and Functioning of Society.

Complex consumer and durable goods are essential to the safety and functioning of critical domestic infrastructures such as defense, aerospace, communications, indoor climate control, cooling systems, transportation, communications, and construction. These products are used in security systems, lighting, life-saving medical devices, military equipment, and for transitioning to a clean energy-based economy. Coalition members serve and support nearly every major sector in the nation, providing critical products and services for government agencies, the military, law enforcement, first responders, and public safety, food and agriculture (including commercial fishing and sea farming), energy, transportation and logistics (including for commuting and for island residents), public works and infrastructure support services, critical manufacturing, the defense industrial base, conservation, and life-saving climate control and ventilation in homes, hospitals, schools, and eldercare facilities, for food preservation and processing and for critical health and life sciences. Services dependent on refrigeration include everything from the prevention of dangerous food spoilage to life-giving medicines, vaccines, proteomics, therapeutics, blood plasma, and other temperature-dependent elements in the life sciences and

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7 For example, EPA is proposing to exempt wire harnesses and semiconductors from the PIP 3:1 product ban. Decabromodiphenyl Ether and Phenol, Isopropylated Phosphate (3:1); Revision to the Regulation of Persistent, Bioaccumulative, and Toxic Chemicals Under the Toxic Substances Control Act (TSCA),88 Fed. Reg. 82287 (Nov. 24, 2023).

8 The Coalition does not support granting CUU determinations that exclude other market participants. Such a determination would be contrary to 38 M.R.S. §1614(5)(C) and (D)which refer to products by category or use, not by manufacturer or groups of manufacturers.

pharmaceutical sectors. Collectively, these products and services constitute a vital part of the economy, at all levels, including for public safety. Put in the context of MDEP's proposed definition of "essential for health, safety or the functioning of society,"[9] a ban on complex consumer and durable goods could disrupt normal societal functions and jeopardize the health and safety of Maine citizens.

PFAS chemicals are on the minds of every lawmaker at the local, state, federal and international level. Exposure to these PFAS must be addressed with expediency and pragmaticism. Unfortunately, getting caught up in the Maine law meant to regulate PFAS are many products that we rely on every day that present low or no potential for exposure. These products could be outright banned by 2030 if Maine's current approach does not shift toward a more inclusive and pragmatic version. Right now, any manufacturer who sells a product in Maine will be required by 2025 to report to the state if the product contains one of nearly 8,000 chemicals designated as PFAS. By 2030, the PFAS needs to be out of the product, or they must stop selling them in the state.

Complex consumer and durable goods are necessary to maintain current lifestyles. We all have systems in our house that have PFAS enclosed in them. Thermal insulation, heating, wiring, and lighting systems are examples. Think about your refrigerator, microwave, car, computer, and most starkly, heat pumps. Heat pumps are designated as energy efficient to cool and heat homes, and Maine goes so far as to give rebates to its citizens for putting them in their homes. Under the current law, they will be banned by 2030 because the refrigerants in them contain PFAS. The refrigerants are in a closed system, and these are the kind of products that maintain their integrity.

Another example is commercial and recreational boats. The supply chain for these complex products is fragmented, with around 3000 boat builders in the US. All electrical components, tubing, speakers, electronics, fuel systems, vents, dispensers, nozzles, all ordered from a catalogue and there is a lot of customization. A typical boat has over 1000 components and each item has in turn several parts. There are parts (*e.g.* coolers, ignition box) assembled into the boat that are separate complex consumer or durable goods themselves.

Banning PFAS in all complex consumer and durable goods six years from now would have unprecedented national security consequences. The U.S. Department of Defense (DOD) issued a Report in August 2023 to explain these consequences. DOD classifies the use of PFAS as critical for several, common complex consumer and durable goods.[10] This report shows how complex consumer and durable goods are central to the functioning of all fundamental infrastructures that are essential to the functioning of society. Again, these include our defense capabilities, public safety, food and agriculture, energy, education, medical care, transportation, and logistics.

As the Maine Legislature stated in the preamble to Public Law 2021 c. 477, the purpose of Maine's law is "to phase out the sale of certain nonessential products containing PFAS."[11] The Coalition submits that there are no complex consumer or durable goods that are nonessential, and the failure to exempt complex consumer or durable goods as a category will inevitably result in

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9 MDEP, *PFAS in Products: Currently Unavoidable Uses* (Last visited February 21, 2024).

10 Department of Defense, *Report on Critical Per- and Polyfluoroalkyl Substance Uses, Pursuant to Section 347 of the James M. Inhofe National Defense Authorization Act for Fiscal Year 2023 (Public Law 117-263)* (August 2023).

11 Public Law 2021, c. 477, An Act To Stop Perfluoroalkyl and Polyfluoroalkyl Substances Pollution (LD 1503, 130th Legislature).

spending more resources on CUU determinations, not to mention depriving the state of products that are essential to safety and health and functioning of society.

3. **The Specific Use of PFAS Essential for Products to Function. If this use of PFAS is required by federal or state law or regulation, provide citations.**

The Coalition supports a risk-based approach to regulation of the broad category of PFAS chemicals. Such an approach aligns with the directive in 38 M.R.S. §1614(5)(C) for MDEP to "prioritize the prohibition of the sale of product categories that, in the department's judgment, are most likely to cause contamination of the State's land or water resources if they contain intentionally added PFAS." The components containing PFAS are bound or encased within complex consumer and durable goods. Therefore, there is little to no likelihood of human exposure or release to the environment during the useful life of the product.[12] Many types of PFAS that can be found in complex consumer and durable goods have not yet been sufficiently studied to confirm whether they exhibit the persistent, bioaccumulative and toxic characteristics found in the most common PFAS that were studied. Less than 1% of known PFAS are currently monitored by targeted analysis.[13] Yet, Maine's sweeping definition that captures around 8,000 PFAS would ban them indiscriminately in spite of the significant differences in characteristics among the substances that fall into that category.

In some cases, the use of PFAS in complex consumer and durable goods can be essential due to their unique properties under extreme conditions (*e.g.*, elevated or freezing temperatures, high pressure, and exposure to aggressive chemicals) and electrical and thermal insulation. They are used as neat chemicals as regulated refrigerant gases, foam blowing agents, specialty fluids, aerosol propellants, and heat transfer fluids. In cases where substitutes can be identified, the replacement process for complex consumer and durable goods often takes many years.

A. <u>Applicable Federal Laws and Regulations</u>

38 M.R.S. §1614 subsection 4A states that "[a] product for which federal law governs the presence of PFAS in the product in a manner that preempts state authority" is out of the scope of the law. There are numerous examples of federal laws that govern complex consumer and durable goods. For instance, the list below provides examples of some of the federal laws already governing HVACR-WH products:

- EPA's Significant New Alternatives Program (SNAP) under the Clean Air Act;
- EPA's new chemicals and significant new uses program under Section 5 of TSCA;
- EPA's American Innovation and Manufacturing (AIM) Act Technology Transitions Final Rule for the Phase down of HFC's;
- Drugs, medical devices, biologics, and diagnostics and equipment authorized under the Food and Drug Act (FFDCA); and
- Devices subject to regulation under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) (i.e. air purifiers).

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[12] The Coalition would like to continue to see Maine regulate the disposal of PFAS-containing products through the state's waste management laws, rather than through a law instituting a PFAS ban.

[13] Nicolas Humez, Prevention of PFAS pollution & Monitoring of PFAS environmental releases, OECD Webinar (Dec. 10, 2023).

4. **Whether There Are Alternatives For This Specific Use Of PFAS Which Are Reasonably Available.**

Maine's law mandates that the manufacturers report on PFAS and remove PFAS by 2030, but in most cases the manufacturers of complex consumer and durable goods are not the origin of the PFAS ingredient. For example, the components of a heat pump are made by multiple suppliers for assembly by the manufacturer of the heat pump. The component suppliers are not normally required to provide detailed information on the ingredients they use. Due to the sheer number of parts and suppliers, it is extremely difficult to find out if and where PFAS is used.

Determining the presence of PFAS in complex international supply chains, finding potential suitable alternatives, and performing rigorous testing, reformulation, and other steps involved in implementation can easily take twenty years or more. The process begins with a preliminary screen for possible alternatives, evolves to a more in-depth analysis on performance and economic feasibility of suitable candidates, and finally results in the need for adequate performance testing to ensure safety, reliability, performance, and quality control parameters are met. Moreover, due to the myriad and diverse products which qualify as complex consumer and durable goods, there is no single time limit that would be suitable for an exemption for these products. MDEP can and should avoid the need to spend more resources to re-engage with industry and undertake additional rulemakings to extend specific product exemptions.

5. **Contact Information For The Submission.**

The Coalition thanks MDEP for consideration of this request for CUU. For more information on this request, please contact:

Martha Marrapese, Partner
Wiley Rein LLP
2050 M Street, N.W.
Washington, D.C. 20036
(202) 719-7156
mmarrapese@wiley.law

RECEIVED
By: OAH on 2/19/2024

The Minnesota Pollution Control Agency (MPCA) is planning new rules governing determinations of currently unavoidable uses of per- and polyfluoroalkyl substances (PFAS) in products. The organic statute, located in Chapter 60 of the 2023 Minnesota Session Laws, at 116.943(5)(c) says that

> Beginning January 1, 2032, a person may not sell, offer for sale, or distribute for sale in this state any product that contains intentionally added PFAS, unless the commissioner has determined by rule that the use of PFAS in the product is a currently unavoidable use. The commissioner may specify specific products or product categories for which the commissioner has determined the use of PFAS is a currently unavoidable use. The commissioner may not determine that the use of PFAS in a product is a currently unavoidable use if the product is listed in paragraph (a).

The MPCA has requested public comments to specifically answer eight questions and to provide any other feedback.

Before I address the eight questions, I would like to make a few points regarding the detrimental effects of PFAS and putting the regulation in context with Amara's Law.

First, PFAS are "a group of thousands of human-made chemicals known to be toxic that do not break down in the environment." PFAS in Minnesota. Colloquially they are known as "forever chemicals." We have not studied the effects of these chemicals on their effects on humans and our environment, yet they "have been found in groundwater and surface waters throughout Minnesota and have seeped into some drinking water systems." *Id.*

Second, I would like to point out that Minnesota regards PFAS as hazardous substances and should seek to address the issue as soon as possible and as effectively as possible.

MPCA has requested comments on eight question, to which my responses are below:

1) Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

For context, this question is addressing 116.943(1)(j), the section that defines "currently unavoidable use."

> "Currently unavoidable use" means a use of PFAS that the commissioner has determined by rule under this section to be essential for the health, safety, or the functioning of society and for which alternatives are not reasonably available.

Defining criteria for the terms “essential for health, safety, or the functioning of society” is not necessary because the Commissioner should have broad authority to determine this finding. Subsection (c) specifically grants the Commissioner this authority: “The commissioner may specify specific products or product categories for which the commissioner has determined the use of PFAS is a currently unavoidable use.” However, the Commissioner could issue guidance, specifically on what he/she believes is essential to the functioning of society, since this element could be construed as the vaguest and perhaps broadest part of the definition.

2) Should costs of PFAS alternatives be considered in the definition of “reasonably available”? What is a “reasonable” cost threshold?

The costs of PFAS alternatives could be considered in this definition. These are some ideas to consider:

- Adding the costs of PFAS alternatives could possibly reduce litigation costs because the term “reasonably” is very ambiguous.
- Listing actual numbers is a potentially bad idea because of the costs of inflation.
- A better way to clarify is to use percentages. Perhaps “reasonably available” might include PFAS alternatives that cost 15% or less than the fair market value of PFAS products.
- However, I think the State should consult with experts in economics to determine the proper percentage.

3) Should unique considerations be made for small businesses with regards to economic feasibility?

Small businesses make up 95% of MN’s businesses and employ over 1.3 million workers, or 47% of the workforce. This is a large sector of the State’s economy but special consideration should not be given because the State has funding opportunities to help small businesses.

Care should be taken to prevent job loss, which the State has already done with PFAS source reduction grants. These grants provide “financial assistance to businesses and local governments for reducing or eliminating the use or release of PFAS.” Therefore, I don’t believe the rule needs to specifically address small businesses.

5) How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided? Should significant changes in available information about alternatives trigger a re-evaluation?

These determinations, as prescribed by 116.943(5)(c), should be valid for 10 years. This length of time allows for stability and it's not so frequent as to deplete resources by forcing reconsideration too often.

As to the question of whether significant changes in available information about alternatives trigger re-evaluation, MPCA and the Commissioner should re-evaluate currently unavoidable use determinations. The name itself seems to mandate it–if there is new information regarding the ***currency*** of an alternative, the Commissioner must re-evaluate in order to ensure that the product is ***currently*** an unavoidable use.

6) How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

The MPCA could conduct evidentiary hearings for the most fairness. The drawback of this option is the administrative costs to the State could be high. However, this would likely be considered to be an adjudication, so Due Process could possibly require a hearing. To determine what kind of hearing is necessary, the MPCA should consider the *Eldridge* factors when crafting a rule on this topic.

7) In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

The products that are considered currently unavoidable uses should be strictly limited. However, here is a brief list of each element:

- ***Health***:
  - Medical equipment such as single-use tubes, syringes, catheters, etc
  - Items for medical research
- ***Safety***:
  - Protective apparatus for workers
- ***Functioning of Society***:
  - Some building materials

My list is short because I would not like to see this rule, and Amara's law diluted with exceptions. These exceptions need to be limited in order to ensure greater incentive for companies to eliminate truly unnecessary PFAS usage.

8) Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

As long as it is the Commissioner making such determinations and as long as the determinations are purely legislative determinations, the MPCA should make some determinations. Doing so would help clarify the statute for companies to ensure better compliance. And, when the MPCA conducts hearings on the matter for individual companies, providing this guidance early could potentially reduce these adjudications and the costs from them.

9) Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

In this section, I simply wish to stress the importance of limiting the number of products that are part of a currently unavoidable use. While the costs to the companies conducting business in MInnesota are important, I believe that the costs to our health and environment strongly outweigh financial costs to companies. On this point, "essential to the functioning of society" should not be treated as a "junk-drawer" for the Commissioner to allow certain products with PFAS to poison our waters because what will truly allow for the functioning of society is eliminating PFAS to the maximum extent possible.

Thank you for your consideration,

Concerned Citizen of Minnesota

RECEIVED
By: OAH on 2/20/24
Ali Ling Attachment

Comments submitted by Ali Ling, 2/20/2024

These comments are meant to address specific questions posed by the MPCA under "PFAS in products: Currently unavoidable use" (Revisor ID: R-4837)

1) Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

I think "essential for health, safety, or the functioning of society" should be defined as providing more long-term benefit to society than harm. The total benefits of using it (the direct benefits minus long-term environmental and health impacts of PFAS resulting from use) to the total benefits of not using it (long-term benefits of environmental and health impact reduction minus the cost and drawbacks of not using it). Since some PFAS uses have demonstrated, effective, widely available, non-PFAS alternatives, (See this Royal Society publication as one source), I suggest developing a list of these uses and designating them as "non-essential" regardless of economic situation.

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

In the long-term, costs of PFAS alternatives should be compared to the costs of a.) the remediation costs of removing those PFAS from the environment once released, b.) the potential future public health burden of those PFAS once released, or a combination of the two. A primary issue with ongoing PFAS use is long-term accumulation in the environment (due to their environmental persistence), so consideration of immediate replacement costs should be weighed against future health risks and remediation costs.

3) Should unique considerations be made for small businesses with regards to economic feasibility?

Some exceptions could be made in the short-term to protect businesses, especially small local businesses, for specific applications while additional PFAS-free alternatives are developed. In the meantime, research into those types of alternatives should be accelerated (I'm not sure by whom). However, the list of non-essential uses described above should be held to, even for small businesses.

I think the state could benefit from a technical assistance program to help small businesses identify and implement readily available alternatives. This could be operated through the MPCA but supported by any number of other organizations.

4) What criteria should be used to determine the safety of potential PFAS alternatives?

Safety judgement should be based on a combination of environmental persistence and demonstrated toxicity, if available. ZeroPM is doing some good work in this sector using "cheminformatics" to predict the environmental persistence of anthropogenic chemicals.

5) How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

"Currently unavoidable" use determinations should be valid for no more than five years, with re-evaluation triggered by changes in available information and products.

6) How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

Stakeholders should request "currently unavoidable use determination" from the MPCA. Information in requests for currently unavoidable uses should include:

- Specific use and specific PFAS
- Mass rates of PFAS used and final fate
- Projected future remediation cost of PFAS emissions
- Projected future health costs of PFAS emissions
- Projected "future" cost of replacing the PFAS (discount-adjusted to account for different time frames, i.e. cost savings now resulting in larger future risks)

RECEIVED
By: OAH on 2/20/2024
Samuel Choe Attachment 1

Manufacturer: Honda

Product Category: Motor Vehicles

Submission Date: February 20, 2024

1. Provide a brief description of the type of product including, if applicable, the Global Product Classification (GPC) brick category and code, or if GPC is not applicable than the Harmonized Tariff System (HTS) code.

   GPC brick code: 10005232

   GPC brick title: Batteries (Automotive)

2. Describe the intended use of the product and explain how it is essential for health, safety or the functioning of society.

   PVDF (Polyvinylidene fluoride), a type of PFAS, serves as a binder for electrode active materials in lithium-ion batteries, and there is no alternative material for PVDF. If PVDF cannot be utilized, the widespread of electric vehicles could be significantly hindered, potentially accelerating global warming.

   Furthermore, the battery cells are sealed, and the cells are additionally protected by an envelope when integrated into the product. PVDF is used inside these sealed cells, so there is no potential exposure to the end user that may lead to health risk.

3. Describe how the specific use of PFAS in the product is essential to the function of the product. If this use of PFAS is required by federal or state law or regulation, provide citations to that requirement.

   Currently, PVDF is the sole option as a binder for electrode active materials in lithium-ion batteries, and no alternative materials have been identified. Therefore, the use of PVDF as a binder is crucial for the production of lithium-ion batteries.

4. Describe whether there are alternatives for this specific use of PFAS which are reasonably available.

   Currently, there is no suitable alternative.

5. Provide contact information for the submission.

Attn: Samuel Choe
Manager
Emissions & Fuel Economy Certification & Compliance Dept.
Product Regulatory Office
American Honda Motor Co., Inc.
1919 Torrance Blvd, Torrance, CA 90501
(310) 783-3218
samuel_choe@na.honda.com

RECEIVED
By: OAH on 2/20/2024
Samuel Choe Attachment 2

Manufacturer: Honda

Product Category: Power Products

Submission Date: February 20, 2024

1. Provide a brief description of the type of product including, if applicable, the Global Product Classification (GPC) brick category and code, or if GPC is not applicable than the Harmonized Tariff System (HTS) code.
   - ➔ Please refer to Table 1.

2. Describe the intended use of the product and explain how it is essential for health, safety or the functioning of society.
   - ➔ PFAS is used on generators, lawn mowers, marine engines, cultivators, etc. These products are indispensable to society in agriculture and outdoor activities.

3. Describe how the specific use of PFAS in the product is essential to the function of the product. If this use of PFAS is required by federal or state law or regulation, provide citations to that requirement.
   - ➔ Please refer to Table 2.

4. Describe whether there are alternatives for this specific use of PFAS which are reasonably available.
   - ➔ Currently, there is no suitable alternative for the parts listed.

5. Provide contact information for the submission.
   - ➔ Attn: Samuel Choe
     Manager
     Emissions & Fuel Economy Certification & Compliance Dept.
     Product Regulatory Office
     American Honda Motor Co., Inc.
     1919 Torrance Blvd, Torrance, CA 90501
     (310) 783-3218
     samuel_choe@na.honda.com

Table 1

GPC Code	Products
10003166	Rings/Grommets
10003168	Springs
10003170	Bearings/Bushings
10003173	Tubing
10003254	Hoses
10005256	Fuel Pumps (Non-Powered)
10005258	Gas Fuel Bottles/Canisters (Empty)
10005412	Light/Motion/Sound Sensors
10001472	Switchboxes
10003387	Lawn Mowers/Rakers (Non-Powered)
10003397	Cultivators/Tillers (Non-Powered)
10003404	Garden Carts (Non-Powered)

And so on...

Table 2

Products	Function
Valve stem seal	high temperature durability
Piston	low friction property
Cam chain tensioner	low friction property
Gasket	high temperature durability, avoid sticking
Cam chain tensioner lifter	low friction property
Connected rod bearing	high temperature durability
Water pump shaft bearing	high temperature durability
Oil seal	high temperature durability
Head cover gasket	high temperature durability
Reed valve comp	high temperature durability
OUTER, CLUTCH	low friction property
CENTER, CLUTCH	low friction property
PLATE, CLUTCH PRESSURE	low friction property
GEAR, M-2 18T	low friction property
WASHER, SPECIAL	low friction property
PLATE, CLUTCH LIFTER CAM	low friction property

SHAFT A, SHIFT FORK	low friction property
OIL SEAL, COUNTER SHAFT	high temperature durability
NIPPLE, SPOKE	low friction property
PIPE COMP, BRK	corrosion resistance (Brake Fluid resistance)
CALIPER, ASSY L FR	low friction property
CALIPER, ASSY L FR	low friction property
HOSE COMP B, FR BRK	Fuel resistance
FORK ASSY, R FRONT	low friction property
FORK ASSY, R FRONT	low friction property
TUBE, OUTER	low friction property
BUSH, GUIDE	low friction property
CUSHION ASSY, REAR	low friction property
DAMPER COMP, REAR	low friction property
STATOR COMP AC Gen. (Heat-resistant wire)	high temperature durability
STATOR COMP AC Gen. (Heat-resistant wire)	high temperature durability
STATOR COMP AC Gen. (Heat-resistant wire)	high temperature durability
SUB CORD, ENG (Heat-resistant wire)	high temperature durability
WINKER Assy FR (Ventilation filter)	water repellency
LIGHT Assy LICENSE (Ventilation filter)	water repellency
SW Assy START STOP (Rotating sliding part)	low friction property
SW Assy START WINKER (Electrical terminals)	Electrical contact stability
SENSOR AIR FUELRATIO R (Sealing rubber)	high temperature durability
SENSOR Assy OXYGEN (Sealing rubber)	high temperature durability
VLV Assy EX-AI	high temperature durability
SOL VLV PURGE CONT. (O-ring)	Fuel resistance
SENSOR, WHEEL SPEED.RR (Heat-resistant wire)	high temperature durability
RUBBER PROTECTOR MOUNT	high temperature durability
RUBBER PROTECTOR MOUNT	high temperature durability
Injector O ring	Fuel resistance, high temperature durability
Injector O ring (High pressure)	Fuel resistance, high temperature durability
PACKING, FUEL PUMP	Fuel resistance, EVAPO EM
High pressure plastic hose	Fuel resistance, EVAPO EM
High pressure rubber hose	Fuel resistance, EVAPO EM
Fuel rubber tube	Fuel resistance, EVAPO EM
O-RING, INLET PIPE	Fuel resistance, high temperature durability

O-RING, THROTTLE BODY	Fuel resistance, high temperature durability
Fuel cock diaphragm	Fuel resistance, EVAPO EM
Fuel cock o ring	Fuel resistance, EVAPO EM
SEAL, BREATHER	Fuel resistance, EVAPO EM
Main stand stopper	high temperature durability
Lithium-ion battery	Binder
Cable (Waterproof heat-shrinkable tube such as brake cable)	Waterproof

And so on...

RECEIVED
By: OAH on 2/20/2024

Manufacturer: Honda

Product Category: Powersports Products

Submission Date: February 20, 2024

1. Provide a brief description of the type of product including, if applicable, the Global Product Classification (GPC) brick category and code, or if GPC is not applicable than the Harmonized Tariff System (HTS) code.
   - ➔ Please refer to Table 1.

2. Describe the intended use of the product and explain how it is essential for health, safety or the functioning of society.
   - ➔ PFAS is used on many products for transportation, logistics transportation, sports, competitions such as Motorcycles, ATVs, SxS (Side-by-Side), etc. These products are indispensable to society in transportation and outdoor activities.

3. Describe how the specific use of PFAS in the product is essential to the function of the product. If this use of PFAS is required by federal or state law or regulation, provide citations to that requirement.
   - ➔ Please refer to Table 2

4. Describe whether there are alternatives for this specific use of PFAS which are reasonably available.
   - ➔ Currently, there is no suitable alternative for the parts listed.

5. Provide contact information for the submission.
   - ➔ Attn: Samuel Choe
     Manager
     Emissions & Fuel Economy Certification & Compliance Dept.
     Product Regulatory Office
     American Honda Motor Co., Inc.
     1919 Torrance Blvd, Torrance, CA 90501
     (310) 783-3218
     samuel_choe@na.honda.com

Table 1

GPC Code	Products
10003031	Headlights (Automotive)
10003038	Driving Lights
10003084	Electrical Other (Automotive)
10003166	Rings/Grommets
10003168	Springs
10003170	Bearings/Bushings
10003173	Tubing
10003254	Hoses
10005232	Batteries (Automotive)
10005256	Fuel Pumps (Non-Powered)
10005258	Gas Fuel Bottles/Canisters (Empty)
10005412	Light/Motion/Sound Sensors
10001472	Switchboxes

And so on...

Table 2

Products	Function
Valve stem seal	high temperature durability
Piston	low friction property
Cam chain tensioner	low friction property
Gasket	high temperature durability, avoid sticking
Cam chain tensioner lifter	low friction property
Connected rod bearing	high temperature durability
Water pump shaft bearing	high temperature durability
Oil seal	high temperature durability
Head cover gasket	high temperature durability
Reed valve comp	high temperature durability
OUTER, CLUTCH	low friction property
CENTER, CLUTCH	low friction property
PLATE, CLUTCH PRESSURE	low friction property
GEAR, M-2 18T	low friction property
WASHER, SPECIAL	low friction property
PLATE, CLUTCH LIFTER CAM	low friction property

SHAFT A, SHIFT FORK	low friction property
OIL SEAL, COUNTER SHAFT	high temperature durability
NIPPLE, SPOKE	low friction property
PIPE COMP, BRK	corrosion resistance (Brake Fluid resistance)
CALIPER, ASSY L FR	low friction property
CALIPER, ASSY L FR	low friction property
HOSE COMP B, FR BRK	Fuel resistance
FORK ASSY, R FRONT	low friction property
FORK ASSY, R FRONT	low friction property
TUBE, OUTER	low friction property
BUSH, GUIDE	low friction property
CUSHION ASSY, REAR	low friction property
DAMPER COMP, REAR	low friction property
STATOR COMP AC Gen. (Heat-resistant wire)	high temperature durability
STATOR COMP AC Gen. (Heat-resistant wire)	high temperature durability
STATOR COMP AC Gen. (Heat-resistant wire)	high temperature durability
SUB CORD, ENG (Heat-resistant wire)	high temperature durability
WINKER Assy FR (Ventilation filter)	water repellency
LIGHT Assy LICENSE (Ventilation filter)	water repellency
SW Assy START STOP (Rotating sliding part)	low friction property
SW Assy START WINKER (Electrical terminals)	Electrical contact stability
SENSOR AIR FUELRATIO R (Sealing rubber)	high temperature durability
SENSOR Assy OXYGEN (Sealing rubber)	high temperature durability
VLV Assy EX-AI	high temperature durability
SOL VLV PURGE CONT. (O-ring)	Fuel resistance
SENSOR, WHEEL SPEED.RR (Heat-resistant wire)	high temperature durability
RUBBER PROTECTOR MOUNT	high temperature durability
RUBBER PROTECTOR MOUNT	high temperature durability
Injector O ring	Fuel resistance, high temperature durability
Injector O ring (High pressure)	Fuel resistance, high temperature durability
PACKING, FUEL PUMP	Fuel resistance, EVAPO EM
High pressure plastic hose	Fuel resistance, EVAPO EM
High pressure rubber hose	Fuel resistance, EVAPO EM
Fuel rubber tube	Fuel resistance, EVAPO EM
O-RING, INLET PIPE	Fuel resistance, high temperature durability

O-RING, THROTTLE BODY	Fuel resistance, high temperature durability
Fuel cock diaphragm	Fuel resistance, EVAPO EM
Fuel cock o ring	Fuel resistance, EVAPO EM
SEAL, BREATHER	Fuel resistance, EVAPO EM
Main stand stopper	high temperature durability
Lithium-ion battery	Binder
Cable (Waterproof heat-shrinkable tube such as brake cable)	Waterproof

And so on...

RECEIVED
By: OAH on 2/21/2024
Tomoyoshi Segawa Attachment

AsahiKASEI
microza
https://www.asahi-kasei.co.jp/membrane/microza/en/

Comments on Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

Date: February 25, 2024
To: State of Minnesota Office of Administrative Hearings, Minnesota Pollution Control Agency

In response to the request for comments on the currently unavoidable use determinations about products containing PFAS, we would like to comment as follows:

1) **Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?**
   There should be a standard of "essential for health, safety, or the functioning of society" to maintain the current standard of living, and that standard should be whether it contributes to people's lives and livelihoods. For example, manufacturing facilities related to social infrastructure (e.g., drinking water, water recycling, wastewater treatment), food, pharmaceuticals, and semiconductors that are essential to daily life meet the criteria of being "essential for health, safety, or the functioning of society".

2) **Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?**
   Raw materials such as super engineering plastics, which are equivalent to PFAS in performance, are several times more expensive than PFAS and are sometimes in short supply. For products that are essential for health, safety, or the functioning of society, the cost of PFAS alternatives should be comparable to PFAS to preserve people's lives and livelihoods. (e.g., Compared to typical PFAS, PES is 1.5 times more expensive, and PEEK is 5 to 10 times more expensive.)

3) **Should unique considerations be made for small businesses with regards to economic feasibility?**
   The same standards should be established for all businesses, regardless of company

size, that handle products that contribute to people's lives and livelihoods.

4) **What criteria should be used to determine the safety of potential PFAS alternatives?**
Raw materials that contain as starting materials substances of concern for human health or environmental hazards under TSCA, California's Proposition 65, or EU-REACH's SVHC must not be substituted. In addition, general-purpose polymers, which have the potential to decompose and generate microplastics after prolonged exposure to pressure or chemicals, should not be used in water, food, and pharmaceuticals that enter the human body, nor in the semiconductor field, where even the smallest particulate contamination is unacceptable. In the case of products related to drinking water facilities, the product should be considered safe if it can be issued a certificate of safety, such as that it adheres to the proposed National Primary Drinking Water Regulation (NPDWR) which was announced by EPA on March 14, 2023, and Minnesota's drinking water standards. [NPDWR URL: https://www.epa.gov/sdwa/and-polyfluoroalkyl-substances-pfas]

5) **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?**
It should remain in effect until alternatives are found that are equal to or better than the current product, both technically and economically. We expect the MPCA to continue its investigation of suitable raw materials for substitution and to compile a list of alternatives. The validity period can be considered again when the survey and list of alternative substances is completed. We agree with the idea that a reassessment should be made when there is a significant change in the available information on alternatives.

6) **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?**
There should be an opportunity for public comment on whether to decide on products for unavoidable uses of PFAS.
In support of the request, we believe the following information should be submitted.
・Information on the intended use of the product and whether it is essential for health,

safety, or social function

・Intended use of PFAS in products

・Anticipated impact on people and society if PFAS is no longer available

・Information on alternatives (Multifaceted information on performance, safety, economy, etc.)

・Certification to standards or regulations, if those standards or regulations have been established for the application

7) **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.**

Hollow fiber filtration membrane modules mainly used in the following fields:

1. Drinking water, wastewater treatment, and water recycling

In the field of drinking water production, hollow fiber filtration membrane modules have the following characteristics and are used in water purification facilities in Minnesota and the United States.

- Stable water quality can be maintained over a long period of time: the size of impurities that can be removed is clearly defined.
- No need to dispose of coagulant or sludge: no need for specialized technology such as coagulant control and easy maintenance.
- Space saving of water purification facilities.

The change to water purification methods other than hollow fiber filtration membrane modules will result in deterioration of water quality, an increase in industrial waste, and an increase in the area required for facilities, which will affect people's lives and livelihoods by making it impossible to produce water at the same level as at present.

2. Food production

Membrane modules are used, for example, to remove lees from wine and have the following features:

- No industrial waste is generated: Conventional filtration using diatomaceous earth requires the disposal of a large amount of industrial waste, including filtration aids.

- Automation and simplification of the separation process
- CO2 emission reduction: In the case of diatomaceous earth filtration, the calcination of diatomaceous earth before use emits a large amount of CO2. Membrane modules do not require calcination.
- Stable quality: Membrane modules perform filtration without heat, so the flavor of the product is not compromised.

The change in manufacturing methods to methods other than hollow fiber filtration membrane modules is expected to increase industrial waste, increase CO2 emissions, and degrade food quality.

3. Pharmaceutical manufacturing

The membrane module is suitable for long-term continuous culture of high-density cells. The membrane module is suitable for long-term continuous culture of high-density cells. Compared to the conventional batch method (centrifugation), continuous culture produces higher antibody production per day and enables the production of pharmaceuticals with higher production efficiency. Continuous operation lowers the risk of contamination and can contribute to improved safety of drug quality, increased drug production, and cost containment. Others have been used for many years in the process of producing water for injection, which consumes less energy than distillation and reduces CO_2 emissions. (In a case study of 1.8 m3/hr of water for injection, data shows that the membrane method can reduce running costs by 40%.)

4. Semiconductor manufacturing

Membrane modules are used to produce ultrapure water for cleaning wafer. The semiconductor cleaning process is an important process that accounts for 30% of semiconductor manufacturing, and requires a very high level of cleanliness for semiconductors because even the smallest particle contamination can affect semiconductor performance. Currently, there is no process that can produce ultrapure water at the same level as organic membranes. If the quality of ultrapure water deteriorates, problems will arise, such as the inability to manufacture semiconductors in sufficient quantities and the difficulty of manufacturing electronic devices due to the rising price of semiconductors. There is ample potential for significant interruption of the daily functions on which society relies.

8) Should MPCA make some initial currently unavoidable use determinations as part

of this rulemaking using the proposed criteria?

As indicated in Item 7, regulating all PFAS would have significant social and environmental impacts. Considering the social and environmental impact, instead of regulating all PFAS, regulation should begin with PFAS that have already been identified as hazardous.

9) **Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.**

We request that the process be determined by considering the following.

- It is necessary to examine the impact on people's lives and livelihoods.
- The hazards of individual PFAS should be considered. Regulations should be implemented for substances with known hazards to human health or the environment or with known thresholds of toxicity.

We thank you for this opportunity to contribute to the rule making for currently unavoidable uses of per- and polyfluoroalkyl substances (PFAS) in products. If you have any questions, please let us know.

Sincerely,

Tomoyoshi Segawa, Manager
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By: OAH on 2/22/2024
Edward Best Attachment

Currently Unavoidable Uses of Per- and polyfluoroalkyl substances (PFAS) in Watson-Marlow Fluid Technology Solutions Products

Issue: 1
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Contents

Executive Summary

Watson-Marlow Fluid Technology Solutions (WMFTS) fully supports the restriction of specific, hazardous PFAS that pose a danger due to bioavailability, bioaccumulative and toxic properties. However, fluoropolymers (a group of polymers within the class of PFAS) meet the Organisation for Economic Co-operation and Development (OECD) criteria for polymers of low concern and are essential for various applications across multiple industries. WMFTS uses fluoropolymer materials in many products because of the very strong C-F bond as they are critical to achieve the chemical, heat and mechanical resistance required for the applications and industries that they are intended to support.

This report outlines the products and applications where WMFTS uses PFAS within its products for specific properties or performance characteristics, and the availability and feasibility of alternative materials.

For the majority of these applications, there are currently no alternative materials. To the extent there are apparent alternatives, they are not sufficiently evaluated or approved for these applications, creating concerns on performance and safety, that can impact medical procedures and drug products, aerospace, transport and food industries, amongst others. For these reasons, the products listed in this report and their associated applications should be considered Currently Unavoidable Uses (CUU).

WMFTS thanks the Minnesota Pollution Control Agency (MPCA) for the opportunity to share information on where and why fluoropolymers are used in our products and their specific applications, and where there are currently no suitable, available alternative materials that can meet the required performance characteristics. We look forward to the future opportunity mentioned in the MPCA Request For Comments communication to provide more detailed information on each of the products and applications mentioned in this report.

Sectors and applications

Information is provided for the following industry sectors and applications within this report and submission as shown in Table 1:

Sector	Application
Transport – Aerospace	PTFE lined flexible high-pressure hoses to convey critical Hydraulic fluids and Jet 1-A fuel whilst in-flight
Transport – Transport Vehicles	Use of PFASs in applications affecting the proper functioning related to the safety of transport vehicles, and affecting the safety of operators, passengers or goods
Chemical Manufacturing Industry	Transfer of chemicals for the general industrial and fine chemicals industries
Pharmaceutical Manufacturing	PTFE lined flexible hose assemblies used to transfer solvents, active pharmaceutical ingredients (API) and cleaning media
Biopharmaceutical Industry	Pump, tubing and connection components for assemblies used for the transfer of fluids for upstream processing, downstream processing, fill/finish and dosing applications
Cosmetics Industry	Fill finish applications for dosing fragrances and cosmetic products such as creams and lotions
Water and Wastewater	Use of pumps, tubing and connection components for water treatment applications including dosing of emulsion polyacrylamides, disinfection, flocculation and pH
Medical Devices	Tubes and catheters
	Support components for medical devices and laboratory testing
Lubricants	Lubricants containing PFASs required for use in harsh conditions and/or for safe functioning or safety of equipment
Petroleum and Mining	Used in pipelines, valves, gaskets, O-rings, seals, cable and wiring insulation, as well as in major equipment components, storage and transportation of products.
Food & Beverage	Pump, tubing, hoses and connection components for assemblies used for the transfer of fluids for Food & Beverage manufacturing

Table 1: Sectors and applications included in this report

A summary of the key industry processes and the impact and availability of alternative materials is shown below. Further detail is provided for each sector and application in dedicated sections of this report.

Aerospace Industry

PTFE-lined high pressure flexible hose assemblies are used to convey critical hydraulic fluids and Jet 1-A fuel whilst in-flight. PTFE is required due to the required wide temperature range of -55°C to +232°C, chemical resistance against key fluids and the flexibility and fatigue resistance. Alternative materials to PTFE for use in aerospace duty hose assemblies are not yet available. The impact of restriction will be the inability for aircraft, both commercial and military, to be able to fly.

Transport Vehicles

PTFE lined hose assemblies are used for fluid transfer applications within the proper functioning of transport vehicles including brake lines, turbo oil feed, hydraulic suspension systems, oil suction and scavenging systems. The operating temperature range of PTFE (-73°C to 260°C) is a key property required for these applications as well as chemical resistance with specific fluids such as brake fluids and hydraulic fluids. The flexibility and high fatigue resistance are also essential requirements. Alternative materials are available, but have significant limitations compared to PTFE including higher risk of failure which reduces the safety of the vehicle.

Chemical Manufacturing Industry

PTFE-lined flexible hose assemblies are used to transfer fluids and chemicals during chemicals manufacturing. PTFE is needed for the wide operating temperature of -73°C to 260°C as well as resistance against a wide range of chemicals. Hydrophobicity, flexibility, fatigue resistance and melt strength are also key properties required for use within chemical manufacturing. A number of alternative materials are considered in section 6, however there are no suitable materials that meet all of the required properties that PTFE offers. The impact of restriction will be a significant disruption to chemical manufacturing, where certain processes may no longer be possible. This will have significant impact of various industries that the chemical manufacturing industry serves.

Pharmaceutical Manufacturing

PTFE-lined flexible hose assemblies are used to transfer solvents, active pharmaceutical ingredients (API) and cleaning media. Corrosion resistance and chemical compatibility are key to the use of the hose assemblies within the industry to maintain purity and reduce the risk of contamination to the pharmaceutical drug products. A wide operating temperature range of -73°C to +260°C, hydrophobicity, flexibility, fatigue resistance and melt strength are also key properties. Suitable alternative materials have limited applications and where any changes that are possible by replacing parts with non-fluoropolymer alternatives, this would require development, qualification, validation, registration and approval. This could see a reduction in sector's growth and the slowing of the development and manufacture of life-saving drug products as companies will need to allocate significant resource to refocus on substituting, revalidating and recertifying processes, equipment, designs and controls.

Biopharmaceutical Industry

Pump, tubing and connection components for assemblies used for the transfer of fluids for upstream processing, downstream processing, fill/finish and dosing applications. Pump components include seals, gaskets, diaphragms and other pump components, where assembly components include tubing, connectors, elements, cartridges and filters. High mechanical strength, flexibility and chemical compatibility are key properties required for these applications. The impact of restriction could potentially lead to unavailability of critical medicines, health and safety hazards associated with the manufacturing processes, as well as significantly increasing manufacturing costs. Any changes by replacing parts with non-fluoropolymer alternatives would require development, qualification, validation, registration and approval. This could see a reduction in sector's growth as companies will need to allocate significant resource to refocus on substituting, revalidating and recertifying processes, equipment, designs and controls. These revalidation and registration activities associated with changing to alternative materials would be a huge regulatory undertaking for the whole biopharmaceutical industry and would divert focus and resources away from developing new therapies for life-threatening diseases for which there is currently no cure.

Cosmetics Industry

Fluoropolymers are used in surfactants, semi-automatic fill finish machines for development and small-scale production, transfer of products such as creams and lotions and packaging. The chemical resistance and inertness property of fluoropolymers means they can be used with various chemicals such as oils, hydrocarbons and solvents that are used prominently in cosmetics manufacturing, but are known to problematic due to their nature. Fluoropolymer cased pumps and tubing can be used in the transferring of various products e.g., creams, lotions, etc. at various product temperatures from - 10°C up to 100°C and allow for sterilisation up to 140°C. A considerable number of companies within the cosmetics industry would be affected by the restriction of fluoropolymer products as there are currently no significant alternatives available for critical applications in this sector.

Water and Wastewater

Error! Reference source not found.. The chemical resistance, hydrophobicity and non-stick characteristics make fluoropolymers an excellent repellent to many chemicals found in wastewater such as oils, fats, hydrocarbons, solvents and acids. Fluoropolymer membranes are the current standard in this sector as most membranes used in key composting solution for the treatment of organic waste (green waste, food waste, source separated organics, biosolids etc.) contain ePTFE. Most of these treatment facilities will have to replace a lot of integral equipment and components containing fluoropolymers, which could become very costly and could lead to some facilities shutting down. It may be possible to use alternative materials for certain specific applications within this industry, but there are no known alternatives that can be used exclusively for all required processes.

Medical Devices

Fluoropolymers are used in medical device tubing as well as in pump components, lubricants and tubing used for laboratory scale manufacturing and routine laboratory testing. Medical device tubing is used for a range of purposes such as port-catheters, angiographic catheters, epidural catheters, feeding tubes, infusion tubes and dialysis tubes. These medical device tubing applications often contain fluoropolymers such as ePTFE. Fluoropolymers provide products that are strong yet mouldable, flexible and yet porous, and most importantly are very biocompatible. These characteristics are very important for medical devices such as catheters and tubes that transfer fluids containing human cells or are inserted into the human body. There are limitations with available alternative materials in terms of their biocompatibility and the resistance to mechanical and physical stress leading to concerns over safety and likelihood of failure after a relatively short time. Cased pumps are used in laboratory scale manufacturing and routine laboratory testing as they are designed for dynamic conditions. Fluoropolymers are required for various components such as seals, pipes, plugs, fittings, liners, membranes for their ability to withstand various pressures and are highly chemically resistant. There are no alternative materials that can match the mechanical and chemical resistance properties of these fluoropolymer components. The impact of this restriction would result in critical medical devices being unavailable or significantly impacting the safety of these devices.

Lubricants

Fluoropolymer lubricants are used in lubricant oils and hydraulic fluids to reduce surface tension to allow effective working of pumps and assemblies. The chemical compatibility of these lubricants is a key characteristic in reducing the risk of violent reactions should they mix with aggressive media. Their low coefficient of friction is also important to reduce wear and tear and facilitate performance and prevent the generation of excessive heat when operating at high speed and pressures. Alternative lubricants exist, but they do not possess the same equivalent chemical compatibility creating a risk of reactions within the pumps resulting in a building of pressure, ignition and potentially violent explosions within the pumpheads. Fluoropolymer-based lubricants are used for various applications across numerous industries. The total number of affected companies and markets is unknown.

Petroleum and Mining

Fluoropolymers and fluoropolymer components are used in pumps and piping used for petroleum manufacture and mining applications. They can be found in pipelines, valves, gaskets, O-rings, seals, cable and wiring insulation, as well as in major components used in equipment, storage and transportation of products. The key functional properties that make fluoropolymers like PVDF and PTFE important in this sector are their durability, mechanical strength, corrosion resistance and rapid gas decompression resistance under the extreme environments found in mining e.g. high temperature, high pressure, presence of steam and harsh chemicals. There are currently no suitable alternatives available for critical applications in this sector. The impact of restriction would see a significant negative impact on the safety within this industry, as well as a considerable increase in cost for the development and transition to viable alternative materials. This cost is likely to be passed on to consumers, who have already seen substantial rises in their prices recently may result in energy prices becoming unfeasible for many people.

Food & Beverage

Fluoropolymers and fluoropolymer components are used in pumps and tubing for food and beverage manufacture. Fluoropolymers offer the high purity and sterile requirements that the food and beverage industry requires. Fluoropolymer materials are used to line valves, piping, tubing, filters, seals, gaskets and other standard fluid contact components as they are inert and therefore avoid chemical reactions and leaching into the food that it comes in contact with, thereby reducing the risk of contamination. Alternative materials could be used for certain, specific applications, but are not suitable for all conditions. As these alternatives don't meet all the requirements provided by fluoropolymers, this would mean multiple variations of materials would be needed for specific uses and for different regulatory requirements. This increases the risk of using the wrong material for the wrong application. The impact of restriction could potentially lead to significant increases in manufacturing costs. Ensuring proper systems is a critical feature in the food and beverage industry, failure in these systems could result in contamination of food and beverages or the release of hazardous materials, which could pose a risk to workers, consumers and the environment.

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By: OAH on 2/24/2024

1. MPCA must ensure that the "unavoidable use" rulemaking process protects Minnesota waters and the health of Minnesota citizens. MPCA must resist the pressure of special interests to find loopholes in the statute or escape transparency.
2. MPCA rules must protect Minnesota surface waters and groundwater from the many ways in which mining processes have the potential to release PFAS by using products that contain PFAS for drilling, tunnel boring, flotation processing, fugitive dust control, and fire suppression among other uses.
3. MPCA rules must make sure that any determination of "currently unavoidable use" must be proved by the manufacturer and must sunset after a specific time so that temporary exceptions don't become permanent loopholes.
4. MPCA rules must prioritize public health and transparency, so that information on use of PFAS in products is readily available and usable for members of the public. If manufacturers want to protect their trade secret formulas for products, they should use safer alternatives to PFAS.
5. MPCA should work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to prevent new mining facilities that release PFAS and to investigate whether PFAS are present at
6. Exploratory drilling for minerals, use of tunnel boring machines, use of surfactants to enhance metal recovery in the ore floatation process, ore leaching, acid mist suppression, and use of wetting agents are just some of the ways in which the mining industry can introduce PFAS to surface water and groundwater. Products containing PFAS may also be used in mines for fire suppression and firefighting activities.
7. Ore flotation processes—like the processing method proposed by PolyMet for the NorthMet mine—may use aqueous foams containing PFAS to lower surface tension and separate the metals from soil and rock. PFAS in the flotation process can be released to the environment through tailings seepage to surface and groundwater and in direct wastewater discharge to surface water.
8. Tunnel boring machines, like the one proposed by Talon Metals for the Tamarack mine may directly introduce PFAS to groundwater through use of lubricants, protection pastes, greases, foaming agents for rock tunnel boring, grouting additives, or fire resistant fluids containing PFAS.
9. Although there have been few efforts to monitor mines as potential sources of PFAS to, BHP's Mount Whaleback Iron Ore Mine in Western Australia was recently identified as the source of PFAS impacts to groundwater with the potential to threaten a nearby drinking water supply.

Jeff Schatz Attachment RECEIVED
By: OAH on 2/26/2024

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March 1, 2024
Minnesota Pollution Control Agency
520 Lafayette Road N
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RE: Request for Comments-PFAS in Products Currently Unavoidable Use Rule OAH Docket No. 71-9003-39667

Thermo Fisher Scientific (Thermo Fisher) appreciates the opportunity to submit comments in response to the Minnesota Pollution Control Agency's (MPCA) request for comments on PFAS in Products Currently Unavoidable Use Rule.

Thermo Fisher is the world leader in serving science. Our mission is to enable our customers to make the world healthier, cleaner, and safer, whether our customers are accelerating life sciences research, solving complex analytical challenges, increasing productivity in their laboratories, improving patient health through diagnostics or the development and manufacture of life-changing therapies, we are here to support them.

Thermo Fisher appreciates the opportunity to provide the following comments and applauds MPCA's commitment to robust public engagement. We offer brief comments below in response.

MPCA Question (1): ***Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?***

Despite the apparent risks from the full lifecycle of continued uses of PFAS, its use at this time, is largely irreplaceable across products and applications within the Life Sciences, Bioproduction, and Laboratory sectors. The unique chemical properties conveyed by PFAS are essential in plastics used in every academic and clinical laboratory and in the manufacture of devices, diagnostic, and tools for research and development. The equipment used in these and other critical sectors such as mining, chip manufacturing, and in environmental monitoring and testing also uniformly and unavoidably rely on PFAS starting with basic components such as semiconductors and capacitors, displays, wiring/cabling insulations, and batteries as well as tubing and connectors where aggressive chemicals are used. In fact, every type of analytical equipment used in detecting PFAS have a critical reliance on components which themselves contain PFAS. While not every form of electrical or electronic equipment (EEE) are reliant upon PFAS, specific exclusions for PFAS used in components EEE are certainly necessary to maintain market access to critical monitoring, control and measurement equipment as well as medical devices and diagnostics instruments.

Given the complexities of a global supply chain with varying regulations impacting PFAS and other substances of concern and the unique and near existential reliance on the physical-chemical properties conveyed by PFAS substances, it is realistic to believe full elimination of PFAS throughout the global supply chain for all products will take more time that current legislation foresees. Therefore, a means to ensure the good functioning of society while invention, development, and market introduction of new chemicals advances is necessary.

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In order to provide industry with clarity and certainty over new product development and market access, a means and criteria to enable a self-declaration of essentially is needed. This is already addressed in a limited manner in SubDivision 8 of the Rule, providing for exemptions for drugs, devices, and medical applications as well as for fire-fighting foams and food packaging. We believe this list should be expanded according to essentiality for the health, safety or the functioning of society and offer 3 aligned proposals according to product use and industry sector:

Health

i. Inclusion in any product which enables the manufacture of any drugs, medical devices, and diagnostic products (human and veterinary).
ii. Inclusion in any product sold to support or enable research on human health or the environment.

Safety

iii. Inclusion in any primary packaging used to ensure safety from spills/leakage of aggressive or otherwise hazardous chemicals or has functional use in primary packaging of drugs, devices, or diagnostic products.
iv. Inclusion in any product for analysis, testing, monitoring, or measurement relating to human health and environmental pollution.

Functioning of Society

v. Inclusion in products used for academic, governmental, or industrial research.
vi. Any product which depends on PFAS for safe operation per established standards and building codes.

Secondarily, because the lifespan of industrial/professional monitoring, control and measurement equipment is intentionally designed for long-lasting and reliable performance with lifespans of up to 40 years, it is vital that Amara's law be amended to enable placing spare parts onto the market in keeping with commonplace objectives of a circular economy.

Where the regulation may require a case-by-case determination for Currently Unavoidable Use (CUU), the MPCA must establish criteria for:

a) A methodology for analysis of alternatives including hazard assessment in conjunction with risk management measures for control of exposure and environmental releases – accommodating standards for best available science and adaptation as new information becomes available; and
b) A socio-economic methodology to determine proportionate and economic feasibility for implementing alternatives which factors the broad value of use as well as cost to the citizens of Minnesota where the product is removed from the market. We also recommend that these determinations be time-bounded allowing for renewal to account for scientific and technical progress.

MPCA Question (2): ***Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?***

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A "reasonable" cost threshold is not easily defined as a single value or as a cost/benefit ratio – rather it is an inexact science relating to perceived value of continued use and risk of potential harm. Moreover, we recognize the fully realized cost of any risk reduction measures relating to PFAS use must be established to determine if those measures are proportionate.

Ooserhius et al have estimated the cost of substitution, emission control, and remediation associated with 8 persistent, bioaccumulative and toxic substances. Their data showed a high variation in the reported data ranging from approximately €50/kg to an extreme of €1.2M/kg and with PFOA and PFOS remaining the highest at €1.5K/kg and €7.7K/kg, respectively, when ranked to median estimates.[1] However, this report did not factor-in the broader socio-economic impact where an alternative is not feasible, leading to the product becoming unavailable on the market.

The market cost of implementing an alternative PFAS will include not only the development of the novel chemistry, but also the cost associated with converting that novel chemistry into an intermediate product along with validating and recertifying the alternative into an end-use product. Under a realistic scenario of no universal PFAS alternative, the socio-economic model turns to societal costs of a non-use scenario. This would include costs related to plant closures or down-sizing as well as the broader impact to the Minnesota economy if the products would become unavailable.

We ask the MPCA to require consideration of a comprehensive socio-economic analysis of the costs directly associated to implementing an alternative to PFAS as well as, alternatively, the cost associated with a non-use scenario where implementing an alternative is not possible or immediately practicable.

MPCA Question (3): ***Should unique considerations be made for small businesses with regards to economic feasibility?***

No Response.

MPCA Question (4): ***What criteria should be used to determine the safety of potential PFAS alternatives?***

Any component recognized as:

- Category 1A or 1B Carcinogen, Mutagen or Reproductive Toxicants
- Substances that are Persistent, Bioaccumulative and Toxic,

[1] Oosterhuis F, Brouwer R, Janssen M, Verhoeven J, Luttikhuizen C. Towards a proportionality assessment of risk reduction measures aimed at restricting the use of persistent and bioaccumulative substances. Integr Environ Assess Manag. 2017 Nov;13(6):1100-1112. doi: 10.1002/ieam.1949. Epub 2017 Jun 24. PMID: 28548694.

- Substances which are very Persistent and very Bioaccumulative,
- Substances which are Persistent, Mobile and Toxic
- Substances which are very Persistent and very Mobile
- Substances recognized as Endocrine Disruptors for human health or the environment

should be regarded as an undesirable alternative unless there are mechanisms to manage the risk of used of those substances than what is afforded with PFAS (e.g., adequate hazardous waste incineration capacity).

MPCA Question (5): ***How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?***

To avoid costly and unpredictable interruptions to the market, a reasonable period must be afforded to each CUU determination. Furthermore, a reasonable transition time must be provided to allow for a petitioning for renewal or for market withdraw following denial of an applied for CUU determination.

We recommend, particularly for professional/industrial use products which have longer design cycles than more traditional higher volume consumer products, that an initial CUU determination period of at least 12 years be granted with provisions to allow renewal applications within two years of the date of termination of the determination period. Where a renewal is not granted, there must be a further transition period of two years from renewal denial allowing for market withdraw. A shorter CUU determination period of seven years would be appropriate after the first determination. This is particularly required given the broad scope of products potentially impacted by the market restriction and limitations in technical resources to redesign broad portfolios without compromising ongoing portfolio innovation.

The ability of industry to adopt to 'significant changes' in alternatives is highly dependent on factors the MCPA are unable to assess (such as a business' ability to make critical capital investments to re-tool or to re-obtain regulatory approvals). Therefore, it is critical that the determination period be honored in full and consideration of the reasonableness of the alternatives be factored in any renewal petition.

MPCA Question (6): ***How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?***

In addition to our proposal for expanding the exemption for industry sectors in SubDivision 8, we envision a process by which a party may submit an application for a CUU determination to MPCA for consideration. The application to MPCA would be constructed according to the provisions outlined in the eventual rule and submitted via a secure portal established by the

MPCA. A further provision regarding confidential business information regarding content of the application would be necessary. It would be advisable that this process be publicly transparent. Where a sectorial use exemption is not provided under subdivision 8, the CUU application should contain information on an analysis of alternatives, human and environmental exposure scenarios, as well as broader socio-economic data regarding implementation of any possible alternative and the corollary non-use implications.

MPCA Question (7): ***In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.***

Professional and industrial use products containing PFAS within the Life Sciences, Bioproduction, and professional/industrial monitoring, control and measurement equipment sectors as well as professional and industrial use stationary refrigeration equipment are low-volume/high-mix as compared to portfolios intended for consumer markets (e.g. domestic appliances) are high-volume/low-mix. As a result, the actual number of impacted products would be high – though containing a very small fraction of the PFAS currently emitted into the environment.
Non-inclusive list of impacted products:

- Electrical and electronic equipment used in laboratories and industrial facilities
- Environmental monitoring and test equipment
- Filtration devices used in manufacturing and bioproduction
- Laboratory apparatus (e.g., Fluorinated plastics)
- Laboratory consumables (e.g., pipete tips, fluorinated containers, semi-rigid tubing, etc.)
- Packaging of high purity chemicals, reagents and standards used in manufacture of drugs and devices as well as for sensitive laboratory applications.

MPCA Question (8): ***Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?***

We believe MPCA should make an affirmative initial CUU determination for the sectorial uses described as points i-vi in response to Q1.

MPCA Question (9): ***Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.***

A) Please clarify definition of “Intentionally Added” as it relates to PFAS inclusion in component parts of a complex article where the end-product manufacturer did not specify inclusion of PFAS; however, an upstream supplier did intentionally may have intentionally added the PFAS unknown to the downstream user of the component?

   <u>Example Scenario:</u> *Party A (based in Minn) owns the functional specifications of a wire-harness assembly which is used as a component part of a complex article (e.g., a Mass-*

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Spectrometer). Party A purchases this component from Party B (based in the US) who is a distributor for a supplier (Party C). Party C (based in Asia) creates and owns the performance specifications for the insulating plastic used in co-extrusion of the wire (e.g., a specific frictional coefficient; however, they do not stipulate the performance must be enabled by PFAS Party D (based in the EU) provides the plastic resin which meets the frictional coefficient specification through formulating the PFAS into the resin. Would Party A have the obligation to file for CUU as 'intentionally adding' the PFAS into their complex article?

B) How does MCPA envision communicating decisions on CUU Determination and renewals (if any)?

C) What standard will MCPA make in determining if alternatives are or are not reasonably available <u>and</u> qualified for end applications?

D) How does MCPA foresee enabling the circular economy by facilitating equipment repair with PFAS containing spare parts when the equipment has been placed on the market before any restriction set forth by this rulemaking?

Conclusion

Again, Thermo Fisher appreciates the chance to provide these comments in response to this proposed rulemaking. We welcome the opportunity to further engage with the MPCA to answer questions and serve as a resource.

Kind Regards,

Jeff Schatz
Director, Product Legislation Compliance
Thermo Fisher Scientific
Jeff.Schatz@thermofisher.com

Kunihiko Inamura Attachment RECEIVED
By: OAH on 2/26/2024

BAJ BATTERY ASSOCIATION OF JAPAN

2024/02/27

Battery Association of Japan

Kikai Shinkokaikan Building, 3-5-8, Shiba-koen,
Minato-ku, Tokyo 105-0011, Japan
contact: Kunihiko Inamura (email: inamura@baj.or.jp)

Battery Association of Japan's Observation about the PFAS restriction

Battery Association of Japan (BAJ) represents Japanese primary and rechargeable battery manufacturers. We are aware that sales of any product containing intentionally added PFAS will be prohibited in Minnesota from 2032 if it has not been determined by rule that the use of PFAS in that product is a "currently unavoidable use". However, not a few PFAS materials are used in both primary and rechargeable batteries, playing vital roles. Here we would like to explain the reason briefly why PFAS use in batteries should be a "currently unavoidable use".

What we can point out are typical PFAS materials used in batteries, their roles and potential threats caused by their ban as follows:

1. Examples of PFAS used in batteries (no guarantee that all PFAS in batteries are covered)

abbreviation	PFAS substance	CAS RN
PVDF	polyvinylidene fluoride	24937-79-9
PTFE	Polytetrafluoroethylene	9002-84-0
PFA	Perfluoroalkoxyalkane	26655-00-5
ETFE	tetrafluoroethylene-ethylene copolymer	25038-71-5
LiTFSI	lithium bis (trifluoromethanesulfonyl) imide	90076-65-6
LiTFS	lithium trifluoromethanesulfonate	33454-82-9
TEE-FP copolymers	poly(propylene-co-tetrafluoroethylene)	27029-05-6
FEP	tetrafluoroethylene hexafluoropropylene copolymer	25067-11-2

2. PFAS materials above are used as:

   a) binder of active material and electric collector to support electrode structure in lithium batteries (primary and rechargeable), nickel metal-hydride batteries, nickel cadmium batteries and alkaline button batteries.
   b) composing element of electrolyte in lithium batteries (primary and rechargeable)
   c) material for sealing parts in lithium rechargeable batteries
   d) catalyst for nickel metal-hydride batteries
   e) water-repellent membrane in zinc air batteries for hearing aid

   PFAS materials are essential for performance and safety in above batteries. After years of research battery manufacturers have finally reached the present material balance. At the moment there are no alternatives of PFAS with equivalent characteristics and costs.

3. If PFAS use in batteries is banned:

   Battery manufacturers will not be able to supply the market with lithium, nickel cadmium, nickel metal-hydride, zinc air and alkaline button batteries. Hearing aid users cannot go without zinc air batteries, and above all, the modern life without lithium-ion batteries is unimaginable. If production of lithium-ion batteries were stopped, it would have significant consequence, inevitably leading to great delay in electric vehicle promotion.

4. Conclusion

   As mentioned above, PFAS materials are widely used and irreplaceable for batteries.
   We will propose that the use of PFAS in battery is a "currently unavoidable use."

RECEIVED
By: OAH on 2/27/2024
Jonathan Lee Attachment

Claigan Environmental Inc.
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Letter of Support

ResMed Pty Ltd stands firmly behind efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. However, we express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. It's important to acknowledge that PFAS play a vital role in ensuring product functionality and meeting stringent safety standards.

In line with our commitment to finding balanced solutions, Claigan Environmental has developed a comprehensive Currently Unavoidable Uses (CUU) proposal, which is being submitted to the states of Maine and Minnesota. This proposal is founded upon rigorous laboratory testing and incorporates valuable insights gathered from diverse stakeholders. By engaging experts from various industries, Claigan Environmental has adopted a collaborative approach to address this complex issue.

ResMed Pty Ltd actively participated in the consultation process and supports Claigan Environmental's submission. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS while mitigating adverse impacts on businesses, communities, and public health.

J. Lee

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RECEIVED
By: OAH on 2/27/2024
Avonna Starck Attachment

CLEAN WATER ACTION
PEOPLE • ACTION • JUSTICE

March 1, 2024

Thank you for the opportunity to comment on the **"**Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837**".**

Clean Water Action has worked in Minnesota since 1982, focusing on finding solutions to health, consumer, environmental, and community problems; developing strong, community-based environmental leadership; and working for policies that improve lives and protect water. Our focus includes supporting environmental justice; protecting and restoring the Great Lakes for Minnesota; and ensuring safer chemicals for use in our homes and daily lives, as well as source and toxics reduction in plastics and other forms of waste. All our work culminates in the overarching goal of protecting the water we drink for generations to come.

The use of PFAS in consumer products, from firefighting foam to clothing to cosmetics, has caused extensive contamination of drinking water, wildlife, food, and people. We must turn off the tap of new PFAS entering into the waste stream by having strict rules around what is considered essential for the health, safety, and functioning of society while approaching both decision making and the ongoing quest for safer alternatives with a hazard-based approach. A strong rule is urgent and necessary to protect public health, drinking water, and the environment.

1. **Continuous quest for safer alternatives –** MCPA should adopt a clear framework for determining "safer" alternatives.

    - The state of Washington has been implementing a framework for making "safer alternative" regulatory decisions for five years and can serve as a model for Minnesota to build upon. Key elements of this framework include: 1) using a hazard approach with criteria based on EPA's Safer Choice and Design for Environment (DfE) programs, and the GreenScreen® for Safer Chemicals Hazard Assessment Guidance (GreenScreen®); 2) using a class-based approach; and, 3) including safer alternatives as alternative products or processes.

        - **Hazard- Based Approach:** When implementing the PFAS ban, it is important to have a hazard approach with an established set of criteria.

          The GreenScreen hazard criteria and its assessment tool are reliable. ChemForward is another tool based on similar hazard criteria that can be used to assess chemical alternatives.

          Both GreenScreen and ChemForward are used by both governments and companies. ChemForward partners include Nike, Sephora, Apple, Google, Levi's, H&M, HP, Credo, Method, Cradle to Cradle, Steelcase, HBN, Environmental Defense Fund, Target, and ZDHC. Many industry associations such Green Chemistry Council, Phosphorus, Inorganic, and Nitrogen Flame Retardants Association, and Textile Sector: Zero Discharge of Hazardous

Chemicals, already use the GreenScreen for Safer Chemicals system to find safer alternatives to hazardous chemicals, including PFAS. There are also GreenScreen certification standards for firefighting foam, textile chemicals, furniture and fabrics, cleaners and degreasers in manufacturing, food service ware, medical supplies and devices, and reusable food packaging, service ware, and cookware.

Researchers and chemical formulators alike rely on GreenScreen, which uses an open and transparent standard for assessing chemicals. The goal of GreenScreen is to avoid the use of chemicals that have negative impacts whenever possible and, when it isn't possible, to commit to continuous improvement and reduce harm as much as possible.

- **Class-Based Approach:** For too long, chemicals have been regulated one at a time, forcing regulators to play whack-a-mole when one toxic chemical is substituted for another. Further, it is unreasonable to wait for the federal government to act on chemical policy reform when the threat of PFAS exposure is impacting Minnesota in such a negative way. The intent of Amara's Law is to take a meaningful class-based approach and regulate all PFAS since all PFAS that have been studied persist in the environment, cause harm to biological systems, and endanger public health.

- **Safer Solutions:** It is vital that the agency define safer alternatives to include alternative processes, materials, and removing the chemical all together. With PFAS in particular, removing the chemical altogether or using a different material or process to achieve the function of the product is important to evaluate.

  In the process of continually searching for safer substitutions for PFAS, Minnesota works with other states, uses a process such as GreenScreen to prevent regrettable substitutions, and is holding industry accountable for consistent evaluation of ensuring they are using the safest chemicals possible in place of toxic PFAS.

2. **Process for determining "currently unavoidable"** –
It is clear from the definition of "currently unavoidable" that the MCPA must determine by rule whether a use of PFAS in a product is currently unavoidable. It should not be left to the industry to determine this and regulate itself.

Amara's Law uses "*currently unavoidable*" as the standard, and is defined as, "a use of PFAS that the commissioner has determined by rule under this section to be essential for health, safety, or the functioning of society and for which alternatives are not reasonably available." There is a difference between "currently unavoidable" and "essential" – "currently unavoidable" use, in and of itself, does not necessarily mean that the use is *essential* to the health, safety, or functioning of society - it simply means the use is temporarily unavoidable in a particular product. Therefore, a "currently unavoidable" determination should only be a temporary exemption granted by rules that requires both a demonstration that there are no reasonable available alternatives AND the use of PFAS in the product is essential to the health, safety, or functioning of society.

The use of PFAS must be essential to the functioning of the product in a way that supports the functioning of society. Evaluation of the need for PFAS must include questioning whether the presence of PFAS is essential to the function of the product and whether the product still functions as it was intended without the presence of PFAS. For example, the function of a couch is to sit. Adding PFAS to resist stains does not change the function of the couch, therefore PFAS is not an essential function of the couch. Removing PFAS still allows the couch to serve its function, which is sitting. Stain resistance for the couch is an added benefit, not a core function of its existence and society isn't harmed if stain resistance is a benefit that is eliminated in order to protect the public from PFAS.

The rules must only provide time-limited exemptions that have a clear schedule for re-evaluation for the products where PFAS use is "currently unavoidable," because safer alternatives are being developed rapidly for many product sectors as states and countries set bans on PFAS in products. Ongoing evaluation of PFAS use in products exempted as "currently unavoidable" is vital to the success of the program and the quality of our water and human health. We recommend that exemptions be granted for no more than 5 years and that the agency establishes a process for re-evaluation of exemptions similar to the process established to review initial exemption claims.

We recommend the following process be used to evaluate claims of "currently unavoidable" use:

- Upon petition from the manufacturer of a product, the department shall review and determine, by rule or regulation, whether the use of PFAS in the product is a currently unavoidable use.

- The manufacturer in its petition must provide all of the following:

    - Identification of the alternatives that have been evaluated and considered as replacements for PFAS. Alternatives can mean either a chemical replacement or a change in process or material. If the only alternative being considered is a chemical alternative, petitioners must provide evidence of a chemical alternative's hazard profile demonstrating that the alternative is not safer. Hazard assessment tools including Green Screen, Chem Forward or other similar tools can be utilized to demonstrate hazard profiles of alternatives; and,

    - evidence from an independent source that demonstrates the absence of safer alternatives. Independent source in this context means a source of information that has no perceived or actual financial conflict of interest; and,

    - evidence that the function of the PFAS is necessary for the product to work for its stated purpose; and,

    - evidence that the use of PFAS in the product is critical for health, safety, or the functioning of society; and,

    - any additional information requested by the department to assist in making the determination.

- In making an unavoidable use determination, the department should:

- Adopt the state of Washington definition of “safer” when considering whether there are no reasonably available alternatives and require non-chemical alternatives and process changes to be evaluated; and,
- consider other credible sources of information. Credible sources of information should include, but not be limited to a report or publication that has been scientifically peer reviewed; published in a report of the United States National Academies; or published in a report by an international, federal, or state agency or body that identifies safer alternatives or implements laws governing chemicals. Information considered should include availability of safer alternatives for the product category or the function of PFAS in that product.
- Consider bans on the sale and use of PFAS in the product or product category in another state or states within the United States or in other countries; and,
- make the determination in relation to a category of PFAS use or a type of product rather than for each individual use or product.

Finally, for the program to function effectively, the department must uphold existing laws with respect to confidential business information (CBI) claims from manufacturers seeking exemptions, particularly when it comes to disclosing the use of alternative chemistries. The agency must have full knowledge of the chemistries used in products to evaluate if an alternative to PFAS is actually safer. And, to carry out rulemaking to exempt certain product categories, the agency must be able to provide the rationale to the public so that they can have the information to comment. Additionally, it should be the policy of the state that the presence of PFAS in a product, or any other chemical known to cause harm, not be granted CBI protection. The public health interest of knowing the ingredients of a product outweighs any business’ need to keep information about the use of harmful ingredients secret.

3. **Healthy, Safety and Functioning of Society** - While opponents of this law claim that Minnesotans will lose access to products in key sectors, it is important to remember a key provision of the law includes exemptions for products for which there are no safer alternatives and for products that are necessary for the health, safety and functioning of society. It is important that the department establish guidelines for what would constitute a product that is essential for the health, safety and functioning of society.

   Fortunately, the statute has some guidance for the department to follow. Amara’s Law has clear exemptions for “a product for which federal law governs the presence of PFAS in the product in a manner that preempts state authority; (2) a product regulated under section 325F.072 or 325F.075; or (3) the sale or resale of a used product. (b) Subdivisions 4 and 5 do not apply to a prosthetic or orthotic device or to any product that is a medical device or drug or that is otherwise used in a medical setting or in medical applications regulated by the United States Food and Drug Administration.”

   Products necessary for health and safety will likely be easier for the MPCA to identify; however, it is critical that the agency develop a rubric to determine if a product is necessary for society to function. For example, products required to meet Federal Aviation Administration or corresponding foreign aviation regulatory authority, including the European Union Aviation Safety Agency and the Transport Canada Civil Aviation or

National Aeronautics and Space Administration may receive time limited exemptions by rule.

Ultimately, no matter what decision-making framework is used, it is critical for the MPCA to only offer time-limited exemptions as a way to spur the search and use of safer alternatives. Additionally, it is important to include complex products (those with several component parts) in the regulation. First, since the law doesn't exempt these products, the legislature clearly intended for these to be included. Second, while many manufacturers claim that PFAS may only be found in the internal components of a product and therefore exposure is limited, we argue that no matter where PFAS is in a product, it endangers health and the environment.

Even though the average person might not encounter the internal component containing PFAS in complex appliances or vehicles, repair technicians do. Many of these technicians are not informed about the presence of PFAS in a complex product like appliances and therefore do not know about appropriate measures to protect themselves and the customers they are serving. Moreover, products at the end of their life cycle likely end up in landfills and in Minnesota, 98 out of our 101 landfills are leaching into the groundwater. Putting products on a timeline to be reevaluated for safer alternatives will keep Minnesota moving forward in terms of the end of toxic PFAS exposure for our community.

Thanks to an MPCA study, we know that the cost of removing PFAS from wastewater could cost Minnesota taxpayers up to $20 billion over the next 20 years. We also know that even one life lost due to an illness linked to toxic chemical exposure is too high of a cost to pay. Strong rules defining what essential use is will put Minnesota on a path towards meaningful cleanup and lives saved.

Minnesota is a national and global leader. Nearly 30 states have adopted policies to protect the public from PFAS but none are as comprehensive as Minnesota's policy. By supporting rules in Minnesota that will spur the use of safer alternatives, create a clear process for exemptions and offer time-limited exemptions, Minnesota will be taking the lead and setting an example for what can, and must, be done to eliminate the threat from PFAS.

Sincerely,

AStarck

Avonna Starck
Clean Water Action
Minnesota State Director

RECEIVED
By: OAH on 2/27/2024

SANMINA

Sanmina Corporation
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San Jose, California 95134

27Feb2024

Letter of Support

Viking Enterprise Solutions, a division of Sanmina Corp. stands firmly behind efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. However, we express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. It's important to acknowledge that PFAS play a vital role in ensuring product functionality and meeting stringent safety standards.

In line with our commitment to finding balanced solutions, Claigan Environmental has developed a comprehensive Currently Unavoidable Uses (CUU) proposal, which is being submitted to the states of Maine and Minnesota. This proposal is founded upon rigorous laboratory testing and incorporates valuable insights gathered from diverse stakeholders. By engaging experts from various industries, Claigan Environmental has adopted a collaborative approach to address this complex issue.

Viking Enterprise Solutions, a division of Sanmina Corp. actively participated in the consultation process and supports Claigan Environmental's submission. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS while mitigating adverse impacts on businesses, communities, and public health.

Merlin Loblick

Merlin Loblick
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By: OAH on 2/27/2024

PCB PIEZOTRONICS
AN AMPHENOL COMPANY

AS9100:2016 QMS Certified by DQS, Inc.
ISO 9001:2015 QMS Certified by DQS, Inc.
ISO 17025 Accredited

Letter of Support

PCB Piezotronics stands firmly behind efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. However, we express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. It's important to acknowledge that PFAS play a vital role in ensuring product functionality and meeting stringent safety standards.

In line with our commitment to finding balanced solutions, Claigan Environmental has developed a comprehensive Currently Unavoidable Uses (CUU) proposal, which is being submitted to the states of Maine and Minnesota. This proposal is founded upon rigorous laboratory testing and incorporates valuable insights gathered from diverse stakeholders. By engaging experts from various industries, Claigan Environmental has adopted a collaborative approach to address this complex issue.

PCB Piezotronics actively participated in the consultation process and supports Claigan Environmental's submission. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS while mitigating adverse impacts on businesses, communities, and public health.

Wendy Willard

Regulatory Affairs Specialist & Product Certification Specialist

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RECEIVED
By: OAH on 2/28/2024

Feb.28.2024
Pacific Industrial CO.,LTD.
ENGINEERING DEPT.

APPROVED	VERIFIED	PREPARED
M. Yamamoto	M. Hirose	M. Aimoto

PFAS Public Comment

1.HTS Codes

Please refer to the table on the right.

Products		HTS Codes
Tire Valve	Valve Core	8481.90.1000
	Swivel Valve	8481.80-13.00
	Valve Extension	8481.80-13.00
Relief Valve		8481.40.000
Check Valve		8481.30.100
Hot Gas Switching Valve		8481.80-13.00
Electric Expansion Valve		8481.80-13.00
TPMS (Tire Pressure Monitoring System)		9026.20.4000

2. The intended uses of the products.

PFAS are widely used in cars and motorcycles, etc.
These products are indispensable to society in transportation and outdoor activities.

3. How the specific uses of PFAS in the products are essential to the function of the products.

・As an example, regarding the valve core, we must also consider the possibility that the valve core may come into contact with gasoline.
PTFE, which has excellent fuel oil resistance, heat resistance, and wear resistance, is indispensable for valve cores.
This is evident from the fact that PTFE is used in almost all valve cores, including those manufactured by other companies.

・Other products are also essential for reasons such as improved flame-resistance, heat-resistance, and sliding properties.

4. Whether there are alternatives for this specific uses of PFAS which are reasonably available.

・There is no substitute material for PFAS, and there is no prospect of a substitute.
In fact, we have considered using rubber for some products in the past, but it was not possible to replace it due to poor setting properties.

・These are essential parts for maintaining airtightness inside automobile parts such as tires, and if they are replaced with sealants of inferior performance, the safety and reliability of the vehicle will not be ensured over the long term.
In addition, the economic burden increases due to the increased frequency of parts replacement.

・Furthermore, since these products are used not only in automobiles but also in motorcycles, construction machinery, agricultural machinery, industrial vehicles, etc., the negative impact is expected to be even greater.

・In all of these industries, PFAS are used in harsh environments to ensure safety, just as in automobiles, so switching to them is impossible unless there is an alternative material with comparable performance.

5. Contact

Name of the Representative : Masahiko Yamamoto
Position of the Signatory : Senior Project Manager, Engineering Dept.
E-mail : msyamamo@pacific-ind.co.jp

RECEIVED
By: OAH on 2/28/2024
Andreas Klemm Attachment

SPXFLOW®

LETTER OF SUPPORT

To whom it may concern :

Safety and Regulatory Compliance of our products are of highest priority to SPX FLOW. Consequently, we support efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. However, we express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions in the undifferentiated way these restrictions apply to all PFAS. In markets and applications we serve, PFAS play a vital role in ensuring product functionality whilst meeting stringent safety standards and protecting human health.

In line with our commitment to finding balanced solutions, Claigan Environmental has developed a comprehensive Currently Unavoidable Uses (CUU) proposal, which is being submitted to the states of Maine and Minnesota. This proposal is founded upon rigorous laboratory testing and incorporates valuable insights gathered from diverse stakeholders. By engaging experts from various industries, Claigan Environmental has adopted a collaborative approach to address this complex issue.

SPX FLOW actively participated in the consultation process and supports Claigan's Environmental submission. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS while mitigating adverse impacts on businesses, communities, and public health.

Andreas J. Klemm, Andreas
Compliance Program Manager

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RECEIVED
By: OAH on 2/28/2024
COMMSCOPE®
Miguel Gascon Attachment 1

Request for Proposal Seeking Current Unavoidable Uses (CUU)

Use of Polytetrafluoroethylene (PTFE) Powder and Concentrates Used in Thermoplastic Materials of Construction for Telecommunication Equipment to Meet Flammability Standards.

CONTENT

1. INTRODUCTION TO COMMSCOPE AND THE RELEVANT EQUIPMENT

CommScope is a manufacturer of communications technology. We design, manufacture, install and support hardware infrastructure and software intelligence that enable our digital society to interact and thrive. Working with customers, CommScope advances broadband, enterprise and wireless networks to power progress and create lasting connections.

This document is CommScope's request for Currently Unavoidable Uses (CUU) of polytetrafluoroethylene (PTFE, Teflon) CAS # 9002-84-0 as powder, which is categorized in the Harmonized Tariff Schedule (HTS) with the code 3904.61.0000; or as pellets, categorized as 3904.61.0010; or in any other form, categorized as 3904.61.0090.

PTFE, as solid powder, is a commonly used by plastic manufacturers as anti-dripping agent and flame retardant because it forms fibrils in the polymeric matrix,[1,2] furnishing thermoplastic materials with increased extensional viscosity, improving the fire safety of polymers used in construction for any indoor or outdoor telecommunication equipment. When the telecommunication equipment is attached to a domicile, it is required by law to comply with flammability standards to ensure safety and adequate functionality throughout their lifespan.

PTFE powder fibrillates, compounded into thermoplastic resins, help molten plastic bead up and extinguish, rather than dripping and spreading a flame. The standards related to fire hazard testing of electrotechnical products require no drip. Standard UL 94, the Test for Flammability of Plastic Materials for Parts in Devices and Appliances, determines the material's tendency to either extinguish or spread the flame once the specimen has been ignited. Additionally, Standard UL 723, the Safety Test for Surface Burning Characteristics of Building Materials, determines the material's propensity to burn rapidly and spread flames.

2. SEPECIFIC USE OF PTFE IN THE ARTICLE

PTFE, as a thermoplastic material, is necessary to retard dripping (usually at less than 0.5 wt.% loading). CommScope, as a downstream user of thermoplastic materials, determines the required properties of plastic pellets that are used in manufacturing of telecommunication equipment, used in the construction of telecommunication infrastructures. However, CommScope is dependent on the expertise of suppliers and polymer manufacturers for the formulation of thermoplastic materials.

PTFE can form a fibril structure due to high shear forces during compounding. This fibril structure together with the strength of the carbon=fluorine bond, creates a very stable structure and helps molten plastic bead up and extinguish rather than dripping and spreading a flame.

Polytetrafluoroethylene (PTFE), as an additive with anti-dripping properties, plays a safety-critical role and its use is essential to achieve compliance with strict UL 94 and the National Electrical Code (NEC/NFPA 70).

3. INTENDED USE OF THERMOPLASTIC MATERIAL OF CONSTRUCTION IN TELECOMMUNICATION EQUIPMENT

Plastic construction materials for any indoor or outdoor telecommunication equipment, attached to a residential dwelling, are required by law (electrical code) to comply with UL94 V0 at the design thickness. Relevant equipment includes fiber optic (FO) splice and connector housings (closures, boxes, cabinets) and associated components for fiber management, FO connectors and adapters, fiber optic cable and cable attachments, enterprise (ethernet/twisted pair copper) cables, jacks, and plugs. The quantity of PTFE powder annually used by CommScope, as anti-dripping agent, we have estimated to be in the range of 10 to 20 metric tons globally.

Use case - Tunnel application for mission-critical communication:
Due to safety requirements in tunnels longer than five hundred meters, materials need to be used during their construction that guarantees mission-critical communication amongst the emergency response forces, such as fire-brigade, police, first response and medical personnel. Communication is usually done with an active Distributed Antenna System (supplied by CommScope) where RF signals from Base Stations outside of the tunnel are received at a Head End, converted into optical signals, and distributed intelligently over fiber to Remote Units which are installed inside the tunnels. These are then reconverting the optical signals into RF, amplifying the RF signals, and serving these radiating cables. Certain flammable requirements for the DAS and the radiating cables are set and can only be met when a FR resin (containing PTFE) is used for the outer insulating layer (jacket) of the cable.

A recent review, published by the Society of Environmental Toxicology and Chemistry (SETAC) in 2023,[3] states that emissions to the environment of PTFE are negligible during the use phase of final products. PTFE is bound within the polymer. PTFE does not release any chemical substances of toxicological or environmental concern. In addition, PTFE is one of the most thermally stable plastic material and there are no appreciable decompositions at ambient temperatures.

When articles containing PTFE, as anti-dripping additives, reach the end of their lifecycle, various waste pre-treatment methods are commonly practiced by the industry, such as recycling, re-use, landfilling and incineration.

For example, during **incineration,** PTFE thermally degrades completely without formation of non-polymeric PFAS at combustion temperatures higher than 850 °C and then residues are removed when the flue gases are cleaned. This fluoropolymer is mineralized by breaking all C-F bonds and generating hydrofluoric acid, which is scrubbed to calcium fluoride. On the other hand, no fluorine-containing products of incomplete combustion are produced above background levels under commercial Waste-to-Energy (WtE) incineration operating conditions.

The RIVM report[4] affirmed that PTFE is the most stable fluorine-containing polymer. When users of PTFE opt for **recycling/reusing** and **landfilling** an article or a complex object, PTFE remains as a fluoropolymer, which is not water soluble or mobile., These articles or complex objects do not decompose into non-polymeric PFAS presenting a risk to the environment by the non-polymeric PFAS. There is considerable data demonstrating that PTFE do not release substances of toxicological or environmental concerns at ambient temperatures in any climate. In contrast to non-polymeric PFAS, PTFE being a polymeric material is chemically, thermally, and biologically stable and therefore is not expected to transform to dispersive nonpolymeric PFAS if it was disposed of in **landfill**.

4. ANALYSIS OF ALTERNATIVE POLYMERS

A low concentration of PTFE solid powder is formulated with other polymers to produce different grades of thermoplastic material, which is supplied to CommScope as pellets, ready for injection molding. CommScope, is a downstream user of PTFE and relies on the expertise of suppliers and manufacturers of these materials.

Some of our suppliers have conducted a thorough analysis of the latest available flame-retardant and anti-dripping technology for polycarbonate, via a patent and literature review, as well as their own in-house technical expertise based on decades of experience with plastics.

There are no known alternative polymers to PTFE used as an anti-dripping agent and flame retardant in thermoplastic materials of construction for indoor or outdoor telecommunication equipment with equivalent flammability, electrical, impact, weathering, and other properties and application performance. It is known that additives used as anti-dripping agents and flame retardants are costly and present processing challenges such as non-homogeneous dispersion due to poor mixing.[5,6]

There are no other technologies that provide adequate flame-retardant properties without significantly degrading impact resistance or other mechanical properties.

5. CONTACT PERSON

Miguel Gascón
Senior Manager, Product Compliance

6. REFERENCES

(1) Amran Bin Md Ali, M.; Nobukawa, S.; Yamaguchi, M. Morphology Development of Polytetrafluoroethylene in a Polypropylene Melt. Pure Appl. Chem 2011, 83 (10), 1819–1830. https://doi.org/10.1351/PAC-REP-11-01-10.
(2) Huang, A.; Peng, X.; Turng, L.-S. In-Situ Fibrillated Polytetrafluoroethylene (PTFE) in 29 Thermoplastic Polyurethane (TPU) via Melt Blending: Effect on Rheological Behavior, Mechanical Properties, and Microcellular Foamability. Polymer (Guildf). 2018, 134, 263–274. https://doi.org/10.1016/j.polymer.2017.11.053.
(3) Abstract Book, SETAC Europe 33RD Annual Meeting, 30 April – 4 May 2023, Dublin, Ireland, online "Data-Driven Environmental Decision-Making"
(4) Bakker, J.; Bokkers, B.; Broekman, M. Per- and Polyfluorinated Substances in Waste Incinerator Flue Gases, Report to the Ministry of Health, Welfare and Sport (RIVM report 2021-0143).
(5) Dhanumalayan, E.; Joshi, G. M. Performance Properties and Applications of Polytetrafluoroethylene (PTFE)-a Review. Adv. Compos. Hybrid Mater. 2018, 1, 247–268. https://doi.org/10.1007/s42114-018-0023-8.
(6) Ghanbari, A.; Heuzey, M.-C.; Carreau, P. J.; Ton-That, M.-T. Morphological and Rheological 30 Properties of PET/Clay Nanocomposites. Rheol. Acta 2013, 52 (1), 59–74. https://doi.org/10.1007/s00397-012-0667-1.

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Miguel Gascon Attachment 2

Request for Proposal Seeking Current Unavoidable Uses (CUU)

Use of polytetrafluoroethylene (PTFE) and perfluoroalkoxy alkanes (PFA) in printed circuit boards (PCBs) for telecommunication applications.

CONTENT

1. DESCRIPTION OF PRINTED CIRCUIT BOARDS (PCBS)

CommScope is a manufacturer of communications technology. We design, manufacture, install and support hardware infrastructure and software intelligence that enable our digital society to interact and thrive. Working with customers, CommScope advances broadband, enterprise and wireless networks to power progress and create lasting connections.

This document is CommScope's request for Currently Unavoidable Uses (CUU) of polytetrafluoroethylene (PTFE) CAS # 9002-84-0 and perfluoroalkoxy alkanes (PFA) in printed circuit boards (PCBs), which are categorized in the Harmonized Tariff Schedule (HTS) with the code 8534.00.0020. CommScope's telecommunication equipment and many other apparatuses require PCBs to function. These products are categorized in the Harmonized Tariff Schedule (HTS) with the 45 codes listed in Appendix 1. Some of the most representative HTS codes are: 8504.90.6500 and 8536.30.8000.

Printed Circuit Boards (PCBs) are crucial in base station antennas, active distributed antenna systems, and small cell solutions for indoor and outdoor use. They are all critical components of wireless communication systems like cellular networks. PCBs are used in these antenna systems for various purposes, contributing to the functionality, efficiency, and performance. The PCBs used by CommScope in base station antennas have a two-layer board, 0.76 mm, or 1.53 mm thick plastic substrate with 1OZ copper trace on one side and 1OZ copper ground on the other side.

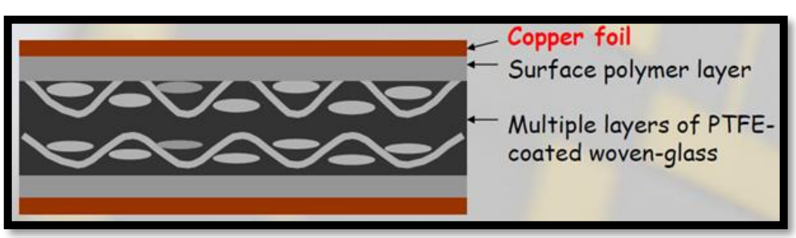

Figure 1. A printed circuit board containing multiple layers of PTFE.

2. SPECIFIC USE OF FLUOROPOLYMERS IN PCBS

Fluoropolymers are used in printed circuit boards (PCBs) for a variety of reasons due to their unique properties. Some common uses of fluoropolymers in PCBs include:

1. **Dielectric Materials:** Fluoropolymers such as polytetrafluoroethylene (PTFE) and perfluoro alkoxy (PFA) are excellent dielectric materials with high electrical insulation properties. They are used as insulating layers between conductive traces and layers in multilayer PCBs. Their low dielectric constant and low dissipation factor help maintain signal integrity and reduce signal loss at high frequencies.

2. **Thermal Stability:** Fluoropolymers have remarkable thermal stability and can withstand high temperatures without undergoing significant degradation maintaining high strength and toughness. This property is essential in PCBs, especially those used in high-power applications where components might generate a lot of heat.

3. **Chemical Resistance:** Fluoropolymers exhibit exceptional chemical resistance, making them suitable for use in harsh environments where exposure to corrosive chemicals or moisture is a concern. This is crucial in protecting PCBs from environmental factors that could lead to deterioration or failure.

4. **Radio Frequency (RF) and Microwave Applications:** The high-frequency performance of fluoropolymers, coupled with their low signal loss characteristics, makes them valuable for RF and microwave applications in PCBs. These applications include antennas, RF filters, and other components used in wireless communication systems.

5. **Impedance Control:** Fluoropolymers' consistent electrical properties make them useful in maintaining controlled impedance in transmission lines on PCBs. Impedance control is crucial for high-speed digital and RF circuits to minimize signal reflections and maintain signal integrity.

6. **Environmental Sealing:** Some fluoropolymers are used for environmental sealing and encapsulation of sensitive components on PCBs. This helps protect these components from moisture, dust, and other contaminants that could lead to performance degradation or failure.

The unique combination of electrical, thermal, chemical, and mechanical properties exhibited by fluoropolymers makes them versatile materials for various aspects of PCB design and manufacturing, especially in applications that demand high-performance characteristics.

3. INTENDED USE OF PCBS IN TELECOMMUNICATION EQUIPMENT

Base station antennas, active distributed antenna systems (DAS), and small cell solutions serve crucial roles in indoor and outdoor wireless communication networks. Some essential uses for these technologies:

Base station antennas facilitate high-speed data transmission, enabling users to connect to the network for voice, data, and messaging services. They help in increasing the capacity of a cellular network by serving as access points for many mobile devices, allowing for more simultaneous connections in each area. Base station antennas are essential for emergency services, providing reliable communication for first responders and emergency personnel during critical situations.

Active Distributed Antenna Systems (DAS) are used to improve cellular coverage and capacity in large indoor spaces like stadiums, shopping malls, airports, and office buildings, where signal penetration can be challenging. They can support multiple carriers, making them suitable for venues where different wireless providers need to provide coverage. In critical environments like hospitals, active DAS ensures reliable wireless communication for medical staff and patients, supporting emergency response and patient care. DAS systems can be scaled up or down to accommodate changes in the number of users or the layout of a venue, making them flexible for various applications.

Small Cell Solutions are deployed in densely populated urban areas to boost capacity and improve network performance where traditional microcells may be insufficient. They are used indoors to provide reliable cellular coverage in places like shopping centers, airports, hotels, and corporate offices where indoor signal penetration may be weak. Small cells play a critical role in the rollout of 5G networks, as they provide the necessary capacity and low latency required for high-speed 5G data services. In rural and underserved areas, small cell solutions can extend network coverage to provide connectivity in locations where traditional infrastructure is limited. Small cells can be deployed for private cellular networks in various industries, including manufacturing, logistics, and healthcare, to support IoT devices and mission-critical applications.

These technologies collectively contribute to ensuring reliable and high-quality wireless communication services for both indoor and outdoor environments, addressing the growing demand for mobile connectivity in a wide range of scenarios.

4. ANALYSIS OF ALTERNATIVE MATERIALS

Currently, alternative polymers that can match the unique properties, performance, and reliability of PTFE and PFA are not available in the supply chain. In our pursuit of alternatives, we rely on the expertise of our suppliers to develop innovative materials. Some of these suppliers have started investigations to find alternative polymers but they are in an early stage to confirm if a suitable alternative will be made available in the future. The process of creating a viable substitute for even a single application demands substantial investments of time and resources. Currently, there is no certainty if polymer manufacturers will identify a viable replacement.

CommScope's experts have compared two PCBs currently available on the market, PCB 1 hydrocarbon based (free of fluoropolymers) and PCB 2 made of PTFE. PCB 1 is not currently used in those pieces of equipment that require printed circuit boards of the properties of PCB2.

	PCB 1	PCB 2
	Made of hydrocarbon	Made of PTFE
Dielectric Loss Tangent @10GHz	0.004	0.0018
Dielectric Constant (Permittivity) @10Hz	3.5	2.94
Peel Strength	1.22 N/mm	2.1 N/mm

If PCB1 was used instead of PCB 2 in some equipment, we would observe a significant increase of electricity consumption and lower performance of our equipment due to the higher dissipation factor of PCB 1. The equipment reliability will be compromised by using PCB 1 due to the Peel Strength and Dielectric Constant not meeting the current expectations. Existing PCB 1, hydrocarbon-based, will need new designs, further testing, and verifications prior to be used in those applications where PCB 2 is currently used.

For manufacturers of PCBs, the main reason for choosing PTFE as based material is its lower insertion loss and stable dielectric constant. An alternative material based on hydrocarbons can be displayed similar properties, but they cannot achieve the same level of insertion loss. It has been also observed with the use of alternative materials that the peel strength of the copper trace will be degraded. In addition, manufacturers of PCBs highlight that the use of alternative materials will be increased the cost of PCBs by 40%.

The complexity of the challenge is heightened by the fact that the existing material is widely employed across diverse electronic applications. This complicates the search for a universal solution and makes it less likely that a single replacement material can effectively replace the current fluoropolymer across all applications. There is no certainty that a viable replacement can be identified at all.

5. CONTACT PERSON

Miguel Gascón
Senior Manager, Product Compliance

APPENDIX 1. LIST OF HTS CODES FOR PRINTED CIRCUIT BOARDS AND CONTAINING PCBs

8414901080	Air or vacuum pumps, air or other gas compressors or recycling hoods
8414909180	Air or vacuum pumps, air or other gas compressors or recycling hoods
8421990180	Centrifugal dryers
8504312000	Electrical transformers
8504408500	Static converters
8504409570	Static converters
8504409580	Static converters
8504906500	Printed circuit assemblies
8504907500	Printed circuit assemblies
8504909650	Printed circuit assemblies for transformers
8504909690	Printed circuit assemblies for transformers
8517620090	Machines for the reception, conversion and transmission or regeneration of voice, images or other data, including switching and routing apparatus:
8517690000	Aerials and aerial reflectors of all kinds; parts suitable for use therewith
8517790000	Aerials and aerial reflectors of all kinds; parts suitable for use therewith
8531909001	Electric sound or visual signalling apparatus (for example, bells, sirens, indicator panels, burglar or fire alarms)
8532240020	Electrical capacitors, fixed, variable or adjustable (pre-set)Electrical capacitors, fixed, variable or adjustable (pre-set)
8534000020	Printed circuits
8534000040	Printed circuits
8534000070	Printed circuits
8534000080	Printed circuits
8534000095	Printed circuits
8536308000	Electrical apparatus for switching or protecting electrical circuits
8536509020	Electrical apparatus for switching or protecting electrical circuits
8536509031	Electrical apparatus for switching or protecting electrical circuits
8536509040	Electrical apparatus for switching or protecting electrical circuits
8536509050	Electrical apparatus for switching or protecting electrical circuits
8536509065	Electrical apparatus for switching or protecting electrical circuits
8536694010	Electrical apparatus for switching or protecting electrical circuits
8536694040	Electrical apparatus for switching or protecting electrical circuits
8536694051	Electrical apparatus for switching or protecting electrical circuits
8536698000	Electrical apparatus for switching or protecting electrical circuits
8536904000	Electrical apparatus for switching or protecting electrical circuits
8536908585	Electrical apparatus for switching or protecting electrical circuits
8537109170	Boards, panels, consoles, desks, cabinets
8538903000	Parts suitable for use solely or principally with the apparatus of heading 8535, 8536 or 8537
8538908140	Parts suitable for use solely or principally with the apparatus of heading 8535, 8536 or 8537
8538908180	Parts suitable for use solely or principally with the apparatus of heading 8535, 8536 or 8537
8541410000	Semiconductor devices (for example, diodes, transistors, semiconductor-based transducers); photosensitive semiconductor devices
8544200000	Insulated (including enamelled or anodised) wire, cable (including coaxial cable) and other insulated electric conductors
8544429090	Insulated (including enamelled or anodised) wire, cable (including coaxial cable) and other insulated electric conductors
8544700000	Insulated (including enamelled or anodised) wire, cable (including coaxial cable) and other insulated electric conductors
8547200000	Insulating fittings for electrical machines, appliances or equipment, being fittings wholly of insulating material apart from any minor components of metal
9025198085	Hydrometers and similar floating instruments, thermometers, pyrometers, barometers, hygrometers and psychrometers,
9030902500	Parts and accessories for oscilloscopes, spectrum analysers and other instruments and apparatus for measuing or checking electrical quantities
9030908940	Parts and accessories for oscilloscopes, spectrum analysers and other instruments and apparatus for measuing or checking electrical quantities
9032906180	Parts and accessories for autormatic regulating or controlling instruments and apparatus

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Request for Proposal Seeking Current Unavoidable Uses (CUU)

Use of PFAS in Coaxial Antenna Cables, Category Cables, and Optical Fiber Cables in High-Speed Communication Networks Enabling Rapid Data Exchange

CONTENT

1. DESCRIPTION OF COAXIAL ANTENNA CABLES, CATEGORY CABLES AND OPTICAL FIBER CABLES

CommScope is a manufacturer of communications technology. We design, manufacture, install and support hardware infrastructure and software intelligence that enable our digital society to interact and thrive. Collaborating with customers, CommScope advances broadband, enterprise and wireless networks to power progress and create lasting connections.

This document is CommScope's request for Currently Unavoidable Uses (CUU) of polytetrafluoroethylene (PTFE) and fluorinated ethylene propylene (FEP) in coaxial antenna cables, which are categorized in the Harmonized Tariff Schedule (HTS) with the code 8544.20.0000. Products in this category code are described as insulated (including enameled or anodized) wire or cable (including coaxial cable) and other insulated electric conductors, whether or not fitted with connectors. Coaxial cables are used in high-speed communication networks and are made of four essential components:

1. Central Conductor: Constructed from highly conductive metals like copper or aluminum, it is the pathway through which high-speed data signals travel at elevated frequencies.

2. Dielectric Layer: The dielectric material surrounding the central conductor plays a critical role in maintaining signal integrity in high-speed communication networks. Advanced dielectric materials with low dielectric constants are employed as insulator to ensure efficient signal transmission and minimize signal loss and distortion. Antenna cables, also known as RF (Radio Frequency) cables, utilize polytetrafluoroethylene (PTFE), fluorinated ethylene propylene (FEP) or similar fluoropolymers as dielectric material due to their properties.

3. Metallic Shield: It serves as a guard against electromagnetic interference that could compromise signal quality.

4. Outer Insulating Layer: This layer provides mechanical protection and insulation, ensuring the cable's durability and safety.

Figure 1 – coax cable

This CommScope request for Currently Unavoidable Use (CUU) also includes polyvinylidene fluoride (PVDF) and fluorinated ethylene propylene (FEP) when used in category cables, which are categorized in the Harmonized Tariff Schedule (HTS) with the code 8544.49.1000.

Products in this category are described as insulated (including enameled or anodized) wire, cable (including coaxial cable) and other insulated electrical conductors, whether or not fitted with connectors; for voltage not exceeding 80V, and of a kind used for telecommunications.

Category cables use FEP as tape separators and copper wire insulators. Vinylidene fluoride-hexafluoropropylene polymer, also known as polyvinylidene fluoride (PVDF) is also used to make the jackets as a dielectric layer around a central conductive material like copper. The cross-shaped isolator, which can be found in some category cables, also could be made with FEP for CMP rated cables, in addition to the pair insulation being made with FEP.

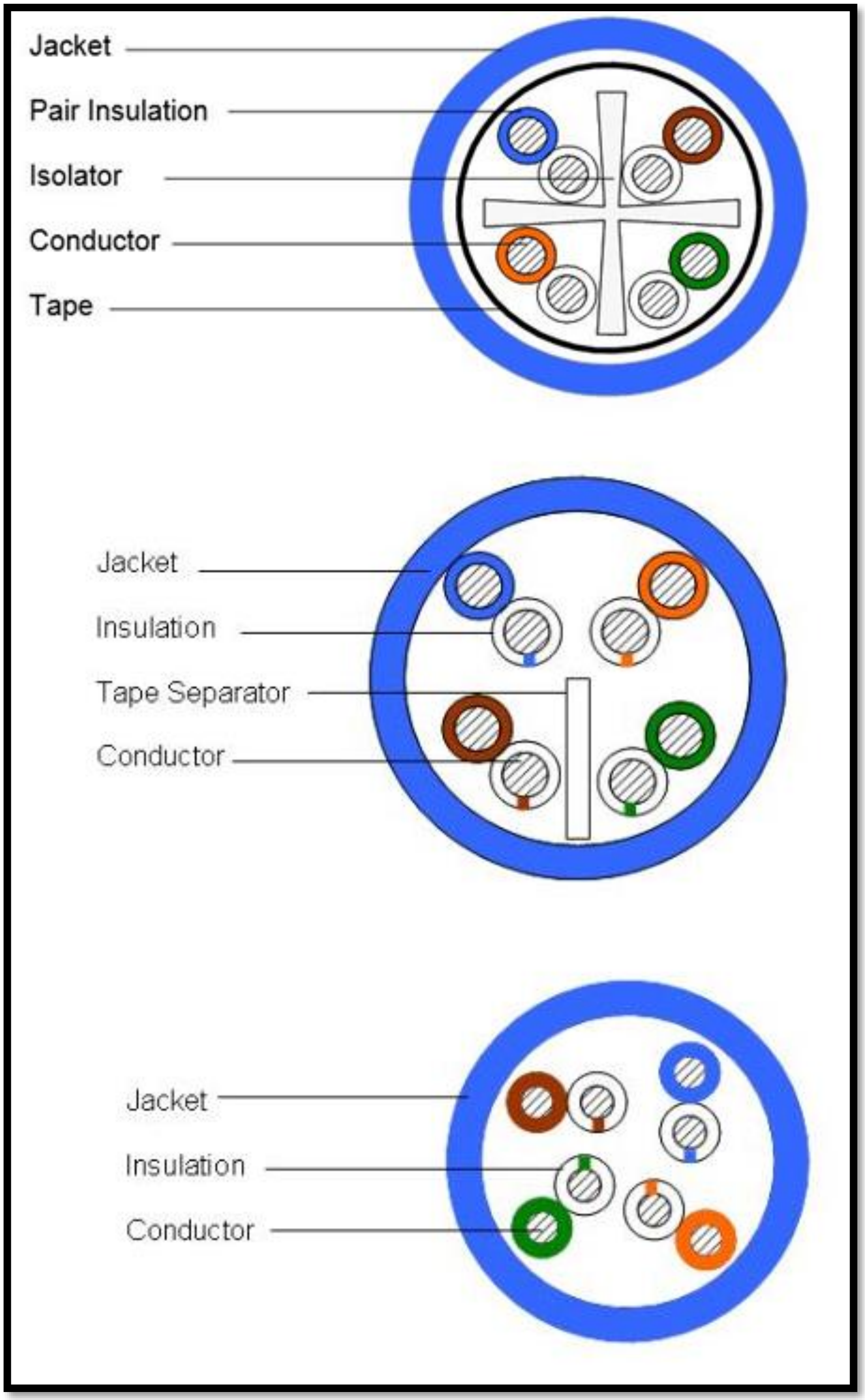

Figure 2 – Category cable

This CommScope request for Currently Unavoidable Use (CUU) also includes polyvinylidene fluoride (PVDF) and fluorinated ethylene propylene (FEP) when used in category and optical fiber cables, which are categorized in the Harmonized Tariff Schedule (HTS) with the code 8544.70.0000.

Polyvinylidene difluoride (PVDF) or the copolymer poly(vinylidene fluoride-co-chlorotrifluoroethylene) (PVDF-CTFE) are commonly used in fiber optic cables, which must be Plenum rated for outdoors use. On the other hand, Plenum-rated cables for indoor use typically use highly filled PVC (polyvinyl chloride) jackets only to pass Plenum flame test NFPA-262 Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces. However, it is widely known that Plenum PVCs can crack when exposed to mechanical stresses at outdoor temperatures less than -20ºC (-4ºF). All indoor/outdoor rated cables at CommScope are tested to cable standard ICEA 696 Indoor-Outdoor Optical Fiber Cable, which requires Cold Temperature Bend at -30ºC (-22ºF) and Temperature Cycling and Cable Aging between -40ºC (-40ºF) and +70ºC (158ºF). This same cable standard requires a complete dissection of the cable after Cold Impact and Low Temperature Bend testing, and any cracks in the cable jacket and/or buffer tubes constitute a failure.

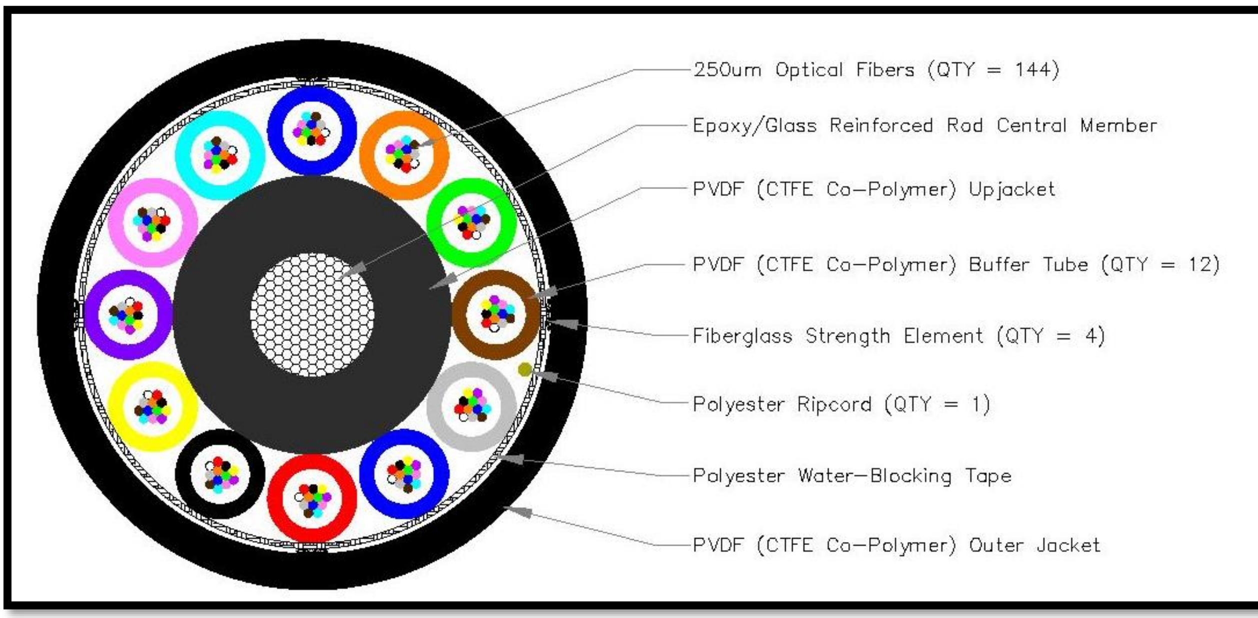

Figure 3. Optical Fiber Cable

2. INTENDED USE OF COAXIAL ANTENNA CABLES, CATEGORY CABLES AND OPTICAL FIBER CABLES

The primary intended use of coaxial antenna cables is to transmit signals with minimal distortion and interference. The design of coaxial antenna cables minimizes the impact of external electromagnetic radiation and reduces signal loss, allowing for higher data transmission rates and improved signal quality compared to other transmission media. Coaxial cables facilitate rapid and reliable data exchange over considerable distances, which is an essential function in nowadays society.

Coaxial antenna cables face extreme environmental conditions and customer demands for signal transmission quality. The ability to achieve low transmission loss in this environment requires unique material properties derived from the molecular structure of fluoropolymers and is impossible to achieve with any other polymer.

Current coaxial cables are essential components of high-speed communication networks, which have a wide range of applications in various sectors and industries. Examples of the most essential applications for the functioning of society are:

1. **5G networks**: While 5G networks rely heavily on wireless technologies, coaxial cables maintain their significance by providing reliable, high-speed connections for antenna feedlines, backhaul, fronthaul, small cell deployments, in-building coverage and more. Their ability to offer low-latency, high-quality connections and their compatibility with various deployment scenarios make them a crucial component in the evolving 5G landscape.
2. **Telecommunications and Internet Connectivity**: High-speed communication networks are the backbone of modern telecommunications and the internet. They enable fast and reliable data transfer, video conferencing, voice-over-IP (VoIP) services, and seamless browsing experiences.
3. **Cloud Computing and Data Centers**: Cloud computing relies on high-speed networks to provide on-demand access to computing resources and storage. These networks ensure quick data transmission between users and remote data centers, enabling efficient deployment of virtual machines, storage, and applications.
4. **Smart Cities and Internet of Things (IoT)**: High-speed communication networks play a crucial role in creating smart cities and powering IoT devices. These networks enable real-time data collection, analysis, and control of various urban systems, such as transportation, energy management, and public safety.
5. **Streaming and Online Entertainment**: Services like video streaming, online gaming, and interactive entertainment heavily depend on high-speed networks to deliver high-quality content and low-latency experiences to users. These networks ensure minimal buffering, lag, and latency issues.
6. **Telemedicine and Remote Healthcare**: High-speed communication networks are essential for telemedicine and remote healthcare applications. They facilitate real-time video consultations, remote patient monitoring, and the exchange of medical data between healthcare professionals and patients, regardless of their geographical locations.
7. **Radiating cable**: A special form of a coaxial cable is a radiating cable, which is used as an antenna in tunnel applications. Due to safety requirements in long tunnels (>500 m), these cables are critical for communication among emergency response teams, fire-brigades, police, and emergency medical teams. Communication in long tunnels is usually done with an active Distributed Antenna System (supplied by CommScope) where RF signals from Base Stations outside of the tunnel are received at a Head End, converted into optical signals, and distributed intelligently over fiber to Remote Cable Units, installed inside the tunnels.

These applications are an illustration of the critical role that high-speed communication networks play in shaping the digital landscape and driving innovation across various sectors.

As technology continues to evolve, coaxial cables remain an asset, underpinning the seamless flow of data in the era of rapid information exchange.

3. SPECIFIC USE OF PFAS IN COAXIAL ANTENNA CABLES CATEGORY CABLES AND OPTICAL FIBER CABLES

Fluoropolymer dielectric insulator properties are crucial for efficient signal transmission and overall antenna performance:

1. **Low Dielectric Constant**: Fluoropolymers have low dielectric constants, which enable the propagation of RF signals with minimal signal loss and reduced phase distortion. This characteristic is crucial for maintaining the integrity of high-frequency signals, especially in applications where signal clarity and accuracy are paramount, such as in wireless communications.

2. **Low Dielectric Loss**: Fluoropolymers also exhibit low dielectric loss, which means they absorb minimal energy from the RF signals passing through the cable. This property contributes to higher efficiency in signal transmission, reduced heat generation, and improved overall signal quality.

3. **Stable Performance Across Frequencies**: Antenna systems operate over a wide range of frequencies, and the dielectric material used should maintain consistent electrical properties across the spectrum. Fluoropolymers offer stable performance over various frequencies, which is crucial for maintaining signal quality in broadband communication systems.

4. **High Power Handling Capability**: Some antenna applications require the handling of high-power levels, such as in broadcasting or radar systems. Fluoropolymers can withstand higher power levels due to their low dielectric loss and excellent insulating properties, reducing the risk of signal degradation or insulation breakdown.

5. **Temperature Stability**: Antenna cables are frequently exposed to a wide range of temperatures, from extreme cold to high heat. Fluoropolymers exhibit excellent temperature stability, maintaining their electrical properties across the entire range of temperatures. This stability is essential to ensure consistent antenna performance under varying environmental conditions.

6. **Chemical Resistance**: Fluoropolymers have strong resistance to chemicals, moisture, and environmental contaminants. This resistance prevents degradation of the dielectric material over time, ensuring long-term reliability and consistent signal transmission.

7. **Mechanical Durability**: Antenna cables can be subject to mechanical stress during installation, bending, and movement. Fluoropolymers offer good mechanical strength and durability, reducing the risk of cable damage and maintaining signal integrity even under physical strain.

8. **Non-Stick Surface**: PTFE is known for its non-stick surface properties, which can make cable installation and handling easier and more efficient.

The dielectric layer in coaxial antenna cables, category cables and optical fiber cables are made of the fluoropolymers listed below:

PTFE	CAS No.9002-84-0	(Polytetrafluorethylen)
FEP	CAS No.25067-11-2	(Fluorionated ethylene propylene)

PVDF CAS No.24937-79-9 (Polyvinylidene difluoride)

The ability to achieve efficient signal transmission and overall antenna performance is a unique property derived from the molecular structure of fluoropolymers and is with the current state of technology impossible to achieve the same properties with any other polymers.

4. ANALYSIS OF ALTERNATIVES

The key function of fluoropolymers as the dielectric material in coaxial antenna cables is to be a good dielectric insulator that provides flexibility and low friction for the cable. Additionally, the fluoropolymers provide these cables with temperature stability and remarkable mechanical durability. These cables can today only achieve the performance prescribed by industry standards with a fluoropolymer dielectric material.

The use of fluoropolymers in category cables allow them to meet the North American Cable Fire Safety Ratings – Plenum. A space in building that handles HVAC or other supply air (air you might breathe) is called a plenum. Plenum cable is the highest rated fire-proof/smoke-proof cable available in North America.

Standards that set performance requirements for coaxial, category and optical fiber cables:

IEC 61196	Coaxial communication cables
IEC 60966	Radio frequency and coaxial cable assemblies
ICEA S-104-696	Indoor – Outdoor optical fiber cables
UL 444	Safety communication cables
ANSI/TIA-568.2-D	Copper cabling standards basis
NFPA 70	National electrical code (NEC)

CommScope is a downstream user of dielectric materials. We specify, based on the relevant standards and customer demands, the required properties but CommScope depends on our suppliers for the exact chemical composition of these materials. Currently, we have not identified viable dielectric materials, PFAS free, capable of meeting international standards and customer demands.

Investigations for substitution of PFAS-based dielectric materials have been performed, however the results have not been positive. Additional research work will be required by polymer manufacturers to identify potential alternatives and to conduct associated development, testing, as well as the implementation into markets. Based on the current investigation, we believe that it will take more than a decade to conclude if suitable alternatives to the existing dielectric materials will be available in the future.

Industrialization is a long and complex step-by-step methodology followed to implement a qualified material or process throughout the manufacturing, supply chain and maintenance operations, leading to the items' final certification. This includes renegotiation with suppliers, investment in process implementation and the final audit to qualify the new process throughout the supply chain. Any change in the process or in the components concerned can take a number of years to requalify and ensure that the level of performance achieved is as good as the previous one.

5. CONTACT PERSON

Miguel Gascón
Senior Manager, Product Compliance

Karl Bodenhoefer Attachment
RECEIVED
By: OAH on 2/28/2024

TECAN.

Tecan US, Inc.,
9401 Globe Center Dr, Suite 140
Morrisville, NC 27560
United States

Minnesota Pollution Control Agency
Resource Management and Assistance Division
520 Lafayette Road N
St. Paul, MN 55155-4194

February 27, 2024

Dear Madam/Sir.

Tecan is submitting this input upon Agency's request to manufacturers to inform on currently unavoidable uses of PFAS rule, OAH Docket No. 71-9003-39667, before March 1, 2024.

Tecan Group stands firmly behind efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. However, we express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. It's important to acknowledge that PFAS play a vital role in ensuring product functionality and meeting stringent safety standards.

In line with our commitment to finding balanced solutions, Claigan Environmental has developed a comprehensive Currently Unavoidable Uses (CUU) proposal, which is being submitted to the states of Maine and Minnesota. This proposal is founded upon rigorous laboratory testing and incorporates valuable insights gathered from diverse stakeholders. By engaging experts from various industries, Claigan Environmental has adopted a collaborative approach to address this complex issue.

Tecan Group actively participated in the consultation process and supports Claigan Environmental's submission. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS while mitigating adverse impacts on businesses, communities, and public health.

The Tecan Group of companies is a global supplier of laboratory automation products that specializes in complex laboratory automation workflow solutions for clients in the medical device, biotechnology, research, and pharmaceutical industries. Our products include highly specialized sample preparation, detection and liquid handling laboratory equipment with applications in research and clinical diagnostics as well as components (i.e., pumps) for this type of equipment.

Information about our products is accessible from our website: https://www.tecan.com

Tecan US, Inc.,
9401 Globe Center Dr, Suite 140
Morrisville, NC 27560
United States

The company headquarters are located in Männedorf, Switzerland, which are the owner/operator of the legal entities in the United States, Austria, Germany, and Malaysia. The entity responsible for importation and sales of Tecan's products in the United States is the Tecan US, Inc. subsidiary, which is located in Morrisville, North Carolina.

Any questions regarding this letter may be addressed to my attention; I am available by email, karl.bodenhoefer@tecan.com or by telephone, +41 44 922 8433.

Sincerely,

DocuSigned by:

Karl Bodenhöfer

Signer Name: Karl Bodenhöfer
Signing Reason: I am the author of this document
Signing Time: 2024-02-27 | 9:24:45 AM CET
230854A25CF04F43856D534EA728034E

DocuSigned by:

laura nea

Signer Name: laura nea
Signing Reason: I have reviewed this document
Signing Time: 2024-02-27 | 10:37:02 AM CET
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Dr. Karl Bodenhöfer
Manager Product environmental Compliance, Tecan Trading

Laura Nea
Vice President, Quality & Regulatory Affairs Management, Tecan US

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State of Minnesota, Minnesota Pollution Control Agency (MPCA), Request for Comments to proposed rulemaking identifying Currently Unavoidable Uses (CUUs) pursuant to Minnesota Statute 116.943

RTX Submission in response to Request

Introduction

Thank you for providing the opportunity to respond to the State of Minnesota, Minnesota Pollution Control Agency ("MPCA"), request for comments on it's proposed rulemaking referred to as **PFAS in Products Currently Unavoidable Use ("CUU") Rule** required under the State's Amara's Law. Specifically, MPCA is inviting comments to assist it in identifying those PFAS uses that are considered to be CUUs because they are essential for the health, safety, or functioning of society and where alternatives are not reasonably available.

As more fully described below and in the attachments, RTX Corporation ("RTX"), as part of the global aerospace and defense industry, has critical dependencies upon certain PFAS in the manufacture, maintenance, repair and overhaul of products and equipment that are indeed essential for the safe, orderly, and efficient functioning of society, including, but not limited to, national security.

While RTX and its peers in the aerospace and defense ("A&D") sector are actively engaged in an analysis of PFAS dependencies and potentially available alternatives, the unique demands of our uses and that of our customers, are often such that there are no immediate drop-in replacements available for many end use applications. PFAS are chemically stable and provide necessary resistance to heat and other extreme and critically important application conditions required of products produced in the A&D sector. Accordingly, RTX asks the MPCA to accept A&D uses as a whole, and further described in these comments and attachments, as CUUs in its rulemaking process thereby excluding such uses from the 2032 ban.

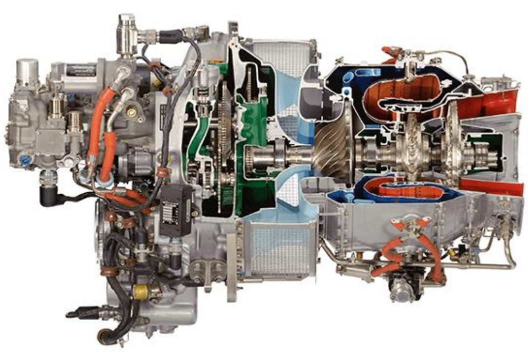
About RTX (www.rtx.com)

RTX is the world's largest A&D company. With more than 180,000 global employees, RTX pushes the limits of technology and science to redefine how we connect and protect our world. Through industry-leading businesses – Collins Aerospace, Pratt & Whitney, and Raytheon – we are advancing aviation, engineering integrated defense systems for operational success, and developing next-generation technology solutions and manufacturing to help global customers address their most critical challenges. In particular, RTX provides products, integrated systems, and services for commercial, military and government customers across the globe. Such products and services support marine, land-based, aviation and space customers.

Our Collins Aerospace business specializes in advanced structures, avionics, connected aviation solutions, interiors, mission systems, and power and control systems that serve customers across the commercial, regional, business aviation and military sectors. Pratt & Whitney designs, manufactures, and services the world's most advanced aircraft engines and auxiliary power systems for commercial, military and business aircraft. Lastly, our Raytheon business specializes in next-generation defense solutions that are smarter, faster, and better than previously thought possible, including integrated air and missile defense, advanced sensors, space-based systems, hypersonics, effectors and cyber solutions.

Our businesses have a special and longstanding distinct relationship with Minnesota and its residents and have invested in the success of the Minnesota economy. The following are a few examples of how RTX's businesses rely on certain PFAS:

Collins Aerospace's Burnsville, MN facility hosts a unique wind tunnel testing laboratory and clean fabrication space for commercial and defense aerospace products. This campus produces proprietary components for critical external aircraft systems and sensors while the wind tunnel simulates the high speeds and high altitudes at which the sensors operate. PFAS containing materials are typically present in such products to repel moisture, prevent corrosion, and handle extreme fluctuations in temperature and pressure.



PW-200

Pratt & Whitney is a global leader in propulsion systems, powering the most advanced aircraft in the world, and we are shaping the future of aviation. Our engines help connect people, grow economies and defend freedom. The PW-200 series engine is used in a variety of missions including emergency medical services, security and defense, utility, business, and other operations in Minnesota. Certain of the engine components and connections require use of fluoropolymer containing materials.

The Raytheon Company RAIVEN product, an electro-optical intelligent-sensing device and capability, which enables operators (e.g. pilots) to have faster and more precise identification, may be sold into the State of Minnesota. RAIVEN can identify objects optically and spectrally simultaneously in real-time. Similar to the two examples above, certain fluoro-based materials are present in the finished product.

RTX Response to MPCA Questions

RTX appreciates the opportunity provided by the MPCA to submit comments in response to questions being considered by the MPCA for its CUU rulemaking. We note that while we have attempted herein to provide brief answers to Agency questions, our ability to satisfy some of the more detail-oriented questions on or before March 1, 2024, is unworkable given the short notice provided.

Question 1: Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

RTX Answer: RTX appreciates that this could be very difficult to complete given broad market interests and characterizations of "essentiality". However, we point MPCA to the following language that has been considered in the State of Maine for inclusion in its rulemaking: **"Essential for Health, Safety or the Functioning of Society"** means products or product components that if unavailable would result in a significant increase in negative healthcare outcomes, an inability to mitigate significant risks to human health or the environment, or significantly interrupt the daily functions on which society relies. Products or product components that are Essential for Health, Safety or the Functioning of Society include those that are required by federal or state laws and regulations. Essential for the Functioning of Society includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, and construction.

Question 2: Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

RTX Answer: This term is also very difficult to characterize. Similar to above, the State of Maine has considered the following: **"Reasonably available"** to mean a PFAS alternative which is readily available in sufficient quantity and at a comparable cost to the PFAS it is intended to replace and performs as well as or better than PFAS in a specific application of PFAS in a product or product component. One of the most significant challenges in this regard to the A&D sector, as expressed in much detail in the attachments, is that it can take a very long time (years if not decades) to qualify, test and obtain other regulatory agency (e.g. FAA) approvals/certifications as well as that of customers, including military and defense customers. PFAS as a category of materials do not today have simple alternative options that will perform as well or better than what is currently in place. Reducing performance capability for the types of products in A&D is not an option due to the criticality of things like flight safety, airworthiness, and defense capability. Costs are always a consideration for any change that may occur, but it in and of itself should not be the main criteria for deciding what is possible. It should, however, be one of many considerations in alternatives / product design options analysis.

Question 3: Should unique considerations be made for small businesses with regards to economic feasibility?

RTX Answer: This question is best left to those of small businesses and their respective associations such as the Small Business Administration of MN.

Question 4: What criteria should be used to determine the safety of potential PFAS alternatives?

RTX Answer: There are a plethora of quality, acceptability, accessibility, performance, and physical/chemical criteria differing typically for each intended end use application. There is no "one-size fits all" in the A&D sector. Each application must be evaluated individually to be certain all criteria for that end use application are met or exceeded. There are further specific references to the types of performance attributes needed for A&D within the details of the attached documents for your further review.

Question 5: How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided? Should significant changes in available information about alternatives trigger a re-evaluation?

RTX Answer: The response here is similar to that of Question 4. For some end use applications, maintaining an open-ended CUU may be the only option enabling the continuation of essential uses as previously defined. Others may be suitable for re-evaluation following an extended period of time for the A&D sector. It is difficult to pinpoint what time period this should be, but we suggest that allowing 10-12 years before re-evaluation occurs is reasonable given the complexity and time it takes to implement change in our sector.

Question 6: How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

RTX Answer: If CUU determinations are adopted through rulemaking at a high-level (e.g. on a sectoral basis), the need for, and frequency of, new requests for CUUs should be kept to a minimum. If on the off chance an "intentionally added PFAS product" is not somehow already covered within the higher-level CUU groups, MPCA rulemaking should occur to allow for a submission to be considered for CUU designation. In the case of any CUU rulemaking, there should be time parameters around the length of time that it takes so that impacted parties have an idea of when the CUU determination will be made and can plan around it with customers and suppliers. RTX discourages MPCA from inserting language to allow parties to petition for a use to be "disqualified" as a CUU. Information should be submitted that sufficiently supports the broader definition provided above in answer to Question 1.

Question 7: In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and product you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

RTX Answer: The types of products and criticalities of PFAS uses for the A&D sector that warrant CUU coverage discussed above in this document but are more fully detailed in the enclosed documents.

Question 8: Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

RTX Answer: Yes.

Question 9: Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

RTX Answer: RTX appreciates the MPCA's efforts to solicit comments regarding CUU rulemaking and work with companies like RTX that have critical PFAS dependent products and uses to ensure that PFAS restrictions or bans do not unintentionally undermine critical aerospace and defense products and processes for the essentiality and importance of the health, safety, and societal interests that such products serve. We welcome the opportunity to answer any questions about these comments or PFAS as it relates to the RTX businesses. To this end, I invite you to contact Mark Herwig of my staff at (203) 224-0713 or mark.herwig@rtx.com for further discussion if it would assist the MPCA in its efforts.

Thank you for your time and consideration of these comments.

Respectfully submitted,

Annette McNeely

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VP, Environment, Health & Safety

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Attachments:

US NDAA DoD
Office of the Assistant Secretary of Defense for Energy, Installations, and Environment
Office of the Assistant Secretary of Defense for Industrial Base Policy
Report on Critical Per- and Polyfluoroalkyl Substance Uses

EU Aerospace, Security and Defence Industries Association (ASD)
COMMENTS ON THE ANNEX XV RESTRICTION REPORT FOR PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS)

Aerospace Industries Association of America, Inc. (AIA)
IMPACT OF THE PROPOSED EU REACH PFAS RESTRICTION ON THE AEROSPACE AND DEFENSE SECTOR

RECEIVED
By: OAH on 2/28/2024
Mark Herwig Attachment 2

Report on Critical Per- and Polyfluoroalkyl Substance Uses

Pursuant to Section 347 of the James M. Inhofe National Defense Authorization Act for Fiscal Year 2023 (Public Law 117-263)

August 2023

Office of the Assistant Secretary of Defense for Energy, Installations, and Environment

Office of the Assistant Secretary of Defense for Industrial Base Policy

The estimated cost of this report or study for the Department of Defense is approximately $83,000 in Fiscal Year 2023. This includes $47,900 in expenses and $45,100 in DoD labor.
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Table of Contents

Figure

Appendix

Acronyms

AFFF	Aqueous film forming foam
AIM Act	American Innovation and Manufacturing Act of 2020
CMRMP	Chemical and Material Risk Management Program
DoD	Department of Defense
ECTFE	Ethylenechlorotrifluoroethylene
EPA	U.S. Environmental Protection Agency
EU	European Union
F3	Fluorine-free foam
FY	Fiscal Year
HFCs	Hydrofluorocarbons
HFOs	Hydrofluoroolefins
Li-ion	Lithium-ion
MCMEU	Mission-critical military end use
MilDep	Military Department
NDAA	National Defense Authorization Act
NDT	Non-destructive testing
OASD(IBP)	Office of the Assistant Secretary of Defense for Industrial Base Policy
ODASD(E&ER)	Office of the Deputy Assistant Secretary of Defense for Environment and Energy Resilience
OECD	Organisation for Economic Co-operation and Development
PA&T	Policy, Analysis, & Transition
PFA	Perfluoroalkoxy alkanes
PFAA	Perfluoroalkyl acid
PFAS	Per- and polyfluoroalkyl substances
polyFAA	Polyfluoroalkyl acid
PTFE	Polytetrafluoroethylene
PVDF	Polyvinylidene fluoride
SOTA	State-of-the-Art
SOTP	State-of-the-Practice
U.S.	United States
USS	United States Ship
UV	Ultraviolet

I. Introduction

Section 347(a) of the James M. Inhofe National Defense Authorization Act (NDAA) for Fiscal Year (FY) 2023 (Public Law 117-263) directs the Secretary of Defense, in consultation with the Defense Critical Supply Chain Task Force (i.e., the Office of the Assistant Secretary of Defense for Industrial Base Policy (OASD(IBP))) and the Chemical and Material Risk Management Program (CMRMP) of the Office of the Assistant Secretary of Defense for Energy, Installations, and Environment (OASD(EI&E)), to submit to the Committees on Armed Services of the House of Representatives and the Senate a report outlining the uses of per- and polyfluoroalkyl substances (PFAS) that are critical to the national security of the United States. This report focuses on critical uses in the sectors outlined in the February 2022 Department of Defense (DoD) report titled *Securing Defense-Critical Supply Chains* and sectors of strategic importance for domestic production and investment to build supply chain resilience.

PFAS are common chemicals used across DoD. Most weapons platforms incorporate PFAS, and PFAS are found throughout the defense industrial base in roles supporting mission critical component production and supply. PFAS uses may be direct, where a PFAS is a constituent in a consumable item or is incorporated into an article (e.g., end item), or indirect, where a PFAS is used to formulate another chemical or is part of a manufacturing process. These uses and processes are necessary to the production of key components of the defense industrial base, such as microelectronic chips and lithium-ion (Li-ion) batteries.

PFAS are chemically quite stable, and many are water and oil repellent, heat resistant, and/or stain resistant, often leading to non-stick surfaces on various materials. Examples of applications of PFAS are in plastics, o-rings, gaskets, lubricants, coolants, and fabrics. DoD is reliant on the critically important chemical and physical properties of PFAS to provide required performance for the technologies and consumable items and articles which enable military readiness and sustainment. Losing access to PFAS due to overly broad regulations or severe market contractions would greatly impact national security and DoD's ability to fulfill its mission, and impact domestic defense industrial base manufacturing and supply.

This report provides details on what is currently known about direct and indirect mission critical PFAS uses that could impact mission readiness if the substances are no longer available. It also highlights the challenges and costs related to finding and qualifying equal or improved performing alternatives to existing PFAS materials in sectors of strategic importance to DoD. It is important to note that the information contained in this report is limited to what was available at the time of its drafting. As such, the information presented represents a fraction of the mission critical PFAS uses due to a lack of knowledge of the complete chemical composition in consumables and articles (e.g., end items)[1]. In addition, there is significant uncertainty regarding

[1] A consumable is defined as "an item of supply or an individual item (except explosive ordnance and major end items of equipment) that is normally expended or used up beyond recovery in the use for which it is designed or

the presence of PFAS in products that make up a complex value chain. A more complete understanding of PFAS essential uses would require an extensive and complex evaluation of the market, a gap analysis of current requirements for manufacturer-provided product information, and illumination of the value chain of products.

II. Definitions

For purposes of this report, the terms used within section 347(a) of the NDAA for FY 2023 are defined in the following sub-sections.

II.1 Per- and Polyfluoroalkyl Substances

There is currently no consensus definition of PFAS as a chemical class.[2] Congress did not define PFAS within section 347(a) of the NDAA for FY 2023 for purposes of this report.[3] While there is no consensus definition, regulators in the European Union (EU) and the United States have proposed, but not yet adopted, different chemical-structure-based (rather than hazard- or risk-based) definitions. In anticipation of the most stringent future regulatory actions, DoD used the definition put forward by the Organisation for Economic Co-operation and Development (OECD) in its 2021 report, *Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance*,[4] for collecting data and developing this report. OECD states "The term 'PFASs' is a broad, general, non-specific term, which does not inform whether a compound is harmful or not, but only communicates that the compounds under this term share the same trait for having a fully fluorinated methyl or methylene carbon moiety." OECD cautions that this definition should not be used in deciding how to group and manage PFAS in regulatory actions; however, future PFAS legal and regulatory frameworks may disregard the OECD caution and seek to restrict the use of PFAS based on chemical structure.

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intended. An end item is the "final combination of end products, component parts, or materials that is ready for its intended use, e.g., ship, tank, mobile machine shop, or aircraft." *DoD Supply Chain Terms and Definitions* (February 21, 2023). https://www.acq.osd.mil/log/LOG_SD/.policy_vault.html/DoD_Supply_Chain_Terms_and_Definitions.pdf.

[2] *Per- and Polyfluoroalkyl Substances (PFAS) Report: A Report by the Joint Subcommittee on Environment, Innovation, and Public Health*, Per- and Polyfluoroalkyl Substances Strategy Team of the National Science and Technology Council, March 2023.

[3] Congress previously defined PFAS in the NDAA for FY 2021 for purposes of establishing the interagency working group to coordinate federal activities related to PFAS research and development. Section 332(g)(1) defines PFAS broadly as (A) man-made chemicals of which all of the carbon atoms are fully fluorinated carbon atoms; and (B) man-made chemicals containing a mix of fully fluorinated carbon atoms, partially fluorinated carbon atoms, and nonfluorinated carbon atoms. William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, Pub. L. 116-283 (2021).

[4] "PFASs are defined as fluorinated substances that contain at least one fully fluorinated methyl or methylene carbon atom (without any H/Cl/Br/I atom attached to it), i.e., with a few noted exceptions, any chemical with at least a perfluorinated methyl group (–CF3) or a perfluorinated methylene group (–CF2–) is a PFAS." OECD, *Reconciling Terminology of the Universe of Per- and Polyfluoroalkyl Substances: Recommendations and Practical Guidance* (Series on Risk Management No. 61), July 9, 2021. https://one.oecd.org/document/ENV/CBC/MONO(2021)25/En/pdf.

The figure below provides an overview of the PFAS groups based on the OECD definition. This very broad definition encompasses more than 38,000 individual PFAS chemicals.[5] DoD uses are represented in each major category of PFAS (i.e., perfluoroalkyl acids (PFAAs) and polyfluoroalkyl acids (polyFAAs)), PFAA precursors, and other PFAS (e.g., fluoropolymers, fluoroelastomers).

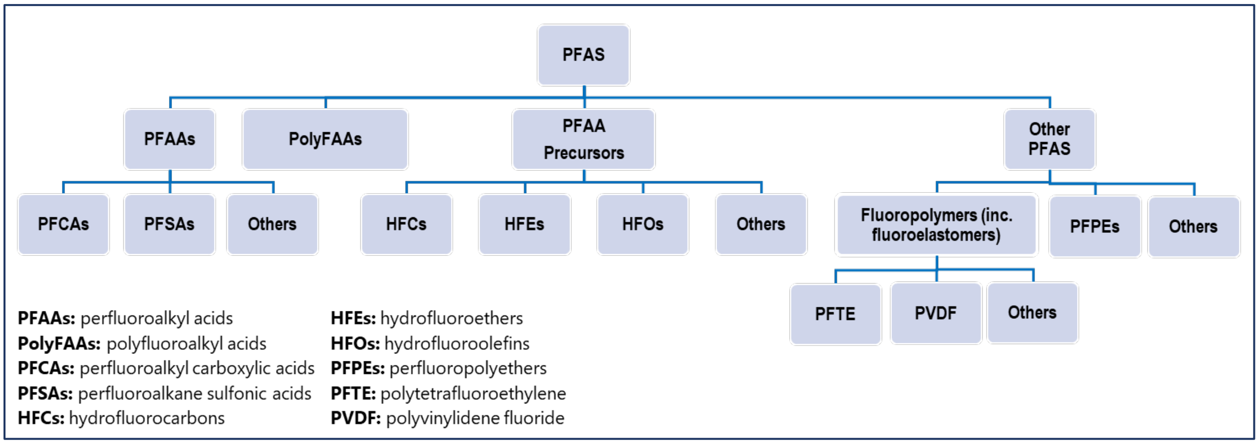

Figure: Overview of PFAS Groups (refined from OECD 2021)

II.2 Critical to the National Security

Congress did not define "critical to the national security of the United States" within section 347(a) of the NDAA for FY 2023. The term "mission-critical military end use (MCMEU)," however, is defined in regulations promulgated by the U.S. Environmental Protection Agency (EPA) under the American Innovation and Manufacturing Act of 2020 (AIM Act).[6] The AIM Act addresses the phasedown of production and consumption of hydrofluorocarbons (HFCs) (e.g., regulated substances). MCMEUs are "[t]hose uses of regulated substances by an agency of the Federal Government responsible for national defense that have a direct impact on mission capability, as determined by the U.S. Department of Defense, including, but not limited to uses necessary for development, testing, production, training, operation, and maintenance of Armed Forces vessels, aircraft, space systems, ground vehicles, amphibious vehicles, deployable/expeditionary support equipment, munitions, and command and control systems."[7]

The MCMEU definition focuses on *regulated substances*. As with HFCs, PFAS are undergoing increased regulation. But in addition to regulation, market forces can directly impact mission capability by limiting DoD's ability to source and use PFAS and PFAS-containing

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[5] Williams, et al. 2022. Assembly and Curation of Lists of Per- and Polyfluoroalkyl Substances (PFAS) to Support Environmental Science Research. *Front. Environ. Sci*. 10:850019. doi:10.3389/fenvs.2022.850019.
[6] 42 U.S. Code 7675.
[7] See 40 Code of Federal Regulations 84.3, "Phasedown of Hydrofluorocarbons" (October 5, 2021).

products. The most recent example is 3M's decision to phase out production of PFAS and PFAS-containing products by 2025.[8]

For purposes of data collection and report development, DoD used the MCMEU definition with the recognition that both market forces and increased regulation can have a direct impact on mission capability.

II.3 Sectors Considered

Section 347(a) of the NDAA for FY 2023 directs DoD to focus this report on critical PFAS uses in the four focus areas identified in DoD's February 2022 report *Securing Defense-Critical Supply Chains.*[9] The four focus areas—kinetic capabilities, energy storage and batteries, microelectronics, and castings and forgings—have critical supply chain vulnerabilities posing the most pressing threats to national security. In addition, this report focuses on semiconductors—a sector of strategic importance for domestic production and investment to build supply chain resilience—and strategic and critical minerals. These areas are described as:

- **Kinetic capabilities**: Current missiles systems and advanced and developing missile capabilities, including hypersonic weapons technology, as well as directed energy weapons.
- **Energy storage and batteries**: High-capacity batteries, with a particular focus on lithium batteries.
- **Microelectronics and semiconductors**: State-of-the-Practice (SOTP) and legacy microelectronics, State-of-the-Art (SOTA) microelectronics, and semiconductors.
- **Castings and forgings**: Metals or composites developed into key parts and manufacturing tools through high-intensity processes.
- **Strategic and critical minerals**: Minerals to supply U.S. military, industrial, and essential civilian national emergency needs, with emphasis on those that are not produced in sufficient quantities in the United States.

III. Data Collection Methodology

Data collection efforts for this report were led by the CMRMP of the ODASD(E&ER) and the OASD(IBP) and included engagement with the DoD Components and Military Departments (MilDeps), industry, and industry associations.

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[8] "3M to Exit PFAS Manufacturing by the End of 2025" (December 20, 2022). https://news.3m.com/2022-12-20-3M-to-Exit-PFAS-Manufacturing-by-the-End-of-2025.

[9] Securing Defense-Critical Supply Chains: An Action Plan Developed in Response to President Biden's Executive Order 14017 (February 2022). https://media.defense.gov/2022/Feb/24/2002944158/-1/-1/1/DOD-EO-14017-REPORT-SECURING-DEFENSE-CRITICAL-SUPPLY-CHAINS.PDF.

III.1 CMRMP Data Call

In March 2023, the CMRMP asked the DoD Components and MilDeps to provide information about its critical uses of PFAS, to include use of neat PFAS, use of PFAS-containing products, the functionality provided by the PFAS, specific uses and applications, and availability of alternatives (if known).

III.2 Additional Industry Engagement

The CMRMP held engagement sessions with various industries and industry associations to obtain information about the PFAS and PFAS-enabled products that they (or their member industries) manufacture and how DoD uses those products. The CMRMP shared this information with the DoD Components and MilDeps to inform their data collection efforts.

III.3 OASD(IBP) Industry Sector Data Collection Process

The Kinetic Capabilities Team at Policy, Analysis, & Transition (PA&T), OASD(IBP), engaged with PA&T Industry Sector leads and their industry partners to identify PFAS uses that are critical to U.S. national security. These sectors include Kinetic Capabilities, Energy Storage and Batteries, Microelectronics and Semiconductors, Castings and Forgings, and Strategic and Critical Materials. The Sector leads identified PFAS uses in industry, operation, manufacturing, processes, components, parts, and materials. They also discussed how and where losing access to PFAS could have significant mission readiness impacts and what they could do or are doing to mitigate those impacts.

IV. Results

DoD's known critical uses of PFAS are summarized in the following sub-sections, organized by focus area, and in the Appendix. The complexities in dissecting the defense industrial base value chain and supply chain dependencies, in addition to the lack of transparency in chemical and material content data, prevented the CMRMP from gathering comprehensive data on all critical PFAS uses.

Critical PFAS uses were identified in almost every major weapon system category including but not limited to fixed wing aircraft (trainers, fighters, bombers, transports, refuelers, ground support, unmanned, and associated support equipment); rotary wing aircraft (attack, transports, heavy lifts, search-and-rescue, and associated support equipment); surface ships (combat, destroyers, aircraft carriers, cutters, landing crafts); submarines; missiles (air-to-air, ground-to-air, air-to-ground, ballistic); torpedo systems; radar systems; and battle tanks, assault vehicles, and infantry carriers.

IV.1 Kinetic Capabilities

Kinetic capabilities represent a direct use of PFAS, as PFAS are found in a variety of applications across the DoD munitions portfolio. About a dozen fluoropolymers, including fluoroelastomers, are ingredients in polymer bonded explosives, pyrotechnics, and propellant components used in munitions, decoy flares, and chaff. They serve as high temperature resistant binders and resins. These uses, which represent some of the few purely military PFAS applications, include:

- Unique binder materials specifically developed for use in the energetic portion of conventional and strategic weapons platforms.
- Fluoroelastomers, such as Viton™, used as a binder in explosive and booster charge formulations integrated into many DoD munitions.
- Fluoropolymers, such as Teflon™, used in pyrotechnics and as a material used in the manufacture of munitions for a variety of missile systems.

PFAS are used in a variety of applications during energetics processing and testing. Currently, non-PFAS alternatives do not exist for most of these applications, and the likelihood of developing alternatives for these uses is estimated to range from moderate to almost impossible. If available, alternatives require multi-year processes and cost program offices millions of dollars to requalify every missile system that used the material, even if products are similar.

IV.2 Energy Storage and Batteries

Impacts to national security from PFAS applications in energy storage and battery applications are indirect. Manufacturers use fluoropolymers (e.g., polytetrafluoroethylene (PTFE)) and polyFAAs in multiple subcomponents in modern Li-ion batteries. They serve as heat transfer materials or insulation and provide weather resistance and ultraviolet (UV) light resistant functionalities to final components. Military applications rely on Li-ion battery technologies that are largely innovated in the civilian sector. Manufacturers use PFAS in the electrolyte solutions, cathode binders, and separator coatings; and, to a lesser extent, PFAS are found in casing materials and gaskets due to their deterioration resistance properties.

PFAS materials also play an important role in battery manufacturing. Filters and other components of manufacturing equipment are essential to battery production. The battery industry's ability to make products for a broad range of commercial and military applications would be greatly impacted if PFAS were no longer available for use in these components. The significant time and money needed to identify and qualify alternatives as replacements would cause ripple effects throughout the economy as consumers and users absorb the additional cost.

Fully eliminating PFAS from energy storage in the U.S. economy would likely take more than 10 years. Energy storage is a broad issue for U.S. industrial competitiveness as well as an important part of Federal initiatives around combating climate change. DoD is not the primary consumer of batteries in the United States, but battery supply chain issues would impact the ability to produce missiles and field military vehicles that increasingly rely on batteries.

IV.3 Microelectronics and Semiconductors

The semiconductor industry produces the chips that drive modern electronic devices. The microelectronics packaging and assembly industry integrates these chips into the electronic products used every day across the defense enterprise. In the semiconductor industry, fluoropolymers, fluoroelastomers, polyFAAs, and other fluorochemicals are used in a number of applications and at every stage of semiconductor fabrication. These uses include etching materials (photoresists), etching coolants, masks in photolithography processes, packaging materials that provide heat dissipation for the chip, and cleaning gases at various stages in the microchip production process. Examples of specific PFAS in the semiconductor industry include polyvinylidene fluoride (PVDF; a fluoropolymer), ethylenechlorotrifluoroethylene (ECTFE; a fluoropolymer), FKM/FFKM (fluoroelastomers), and perfluoroalkoxy alkanes (PFAs).

One significant use of PFAS in semiconductor manufacturing is during the photolithography process, where the patterns that define the microchip circuitry are developed onto bare silicon surfaces. Manufacturers use photolithography specialty formulations containing fluorinated compounds in various steps of this process to ensure final chip quality and reduce the probability of defects. PFAS are ideal for these purposes due to their low surface tension and compatibility with other chemicals. The PFAS materials used in these processes are typically no longer present in the finished product, except in some specific applications, such as imaging chips used in cameras, displays, and some medical devices.

Similar to the energy storage industry, PFAS are essential for semiconductor manufacturing equipment and factory infrastructure. The exceptional combination of heat and chemical resistance and chemical inertness allows fluoropolymers to be used both in equipment components (e.g., tubing, gaskets, containers, filters) and lubrication (e.g., various oils and greases). These same properties are also needed to ensure the functioning of the surrounding infrastructure.

In wider microelectronics applications, PFAS remain key industrial materials in applications that integrate microchips into electronic products, such as printed circuit boards. PTFE and PFA base laminate materials are currently used in many radio frequency (RF) and microwave circuits, as they provide unique properties related to isolating RF and microwave signals. Identifying and qualifying potential replacement materials will require significant time, particularly for use in fielded systems. There currently are no available drop-in replacement materials for a PTFE designed printed board. Lack of access to PTFE laminate will necessitate the redesign and requalification of the printed board, the assembly, and potentially the system.

Several PFAS-containing vapor phase soldering and flux removal products are used in the manufacture of printed circuit boards. Vapor phase soldering is used primarily for printed board assembly when there is a high thermal mass, in combination with advanced technologies such as fine-pitch features, or when there are temperature sensitive components used. Alternative materials are not currently identified and would need to be evaluated for performance and safety. New equipment may be required to implement new vapor phase soldering liquids. PTFE cable jackets are used in printed circuit board and other electronic systems in connectors and wire. PTFE has unique properties as a wire insulator including fire, smoke, and chemical resistance to mitigate the risk of wire exposure in harsh environments. PTFE can withstand 450°C and is used widely in products that have been developed to meet MilSpec applications. Manufacturers also use fluoropolymers as electronics sealants and encapsulants to protect microelectronic components from degradation due to environmental, chemical, or UV-light exposure. Vapor degreasing solvents, used in a variety of cleaning processes during microelectronics production, contain hydrofluorocarbons (HFCs) and hydrofluoroolefins (HFOs), which, in many cases and in the broadest sense, are defined as PFAS. These materials impart fire suppression properties to the degreasing solvent, creating safer manufacturing environments for workers.

Currently, no alternatives to PFAS have been identified that can provide the functional properties required for photolithography or some applications in semiconductor manufacturing equipment. Even if alternative chemicals and technologies were discovered today, due to the extremely complex qualification process throughout the value chain, it would take another 15 years to deploy them in high-volume manufacturing. Therefore, continued access to PFAS is a prerequisite for high-volume and advanced semiconductors. Lack of continued access to PFAS could lead to an inability to produce and supply semiconductor manufacturing technology.

Replacing most PFAS uses in semiconductor fabrication would require industry-wide re-tooling and other process innovations, at a minimum. Some might be achievable within 10 years, but many would not. As stated above, there are some PFAS uses for which no alternatives are known. For these uses, it may be necessary to invent novel chemistries and processes. Replacing PFAS in semiconductor fabrication could be a 25-year effort and may not succeed in all respects if alternatives cannot be identified or qualified at the microchip level.

Consideration must also be given to the resultant impact on DoD programs. It is highly probable that manufacturers would need to change semiconductor manufacturing processes to accommodate PFAS replacements. This change has the potential to result in the costly requalification of specific components. For example, radiation hardened microelectronics applications typically mandate requalification if a manufacturer substantively alters the fabrication process, which can easily exceed $10 million; many programs lack intrinsic funding for requalification.

IV.4 Castings and Forgings and Strategic and Critical Minerals

Specialty fluorochemical gases and fluids are used for advanced metalworking, casting, and fabrication due to the temperature and wear resistance functionalities they provide. These gases and fluids are used in the production of advanced metal parts throughout U.S. industry, including military-specific parts. Requiring a move to PFAS-free alternatives in under 10 years may make construction using certain alloys impossible and require returning to previous methods of construction leading to lower performance, shorter life, and higher weight of constructed parts.

In both the casting and forging and strategic and critical minerals industries, loss of access to PFAS is an indirect threat to national security and a potential source of significant disruption to supply chains vital to the DoD mission. These industries depend on PFAS in products used during normal business operations. A product used as a liquid cold spray in castings and forgings or coolant in drilling operations for critical minerals may contain PFAS, but the product user would not know that PFAS are present until the product is discontinued. Both industries are at risk of losing critical capabilities with little warning, as there are limited requirements for companies to provide composition information for the materials used to create the products they sell to DoD or on the commercial market. The risk for these industries is particularly high, even if the probability is low, because there may be no warning for critical product obsolescence and no ability to develop and qualify alternatives in a timely fashion.

PFAS are also contained in mold release chemicals and release films typically used in composite manufacturing processes. Loss of access of PFAS would impact the commercial composites manufacturing industry and, indirectly, the DoD who is reliant on the commercial industry for applications.

Mold release chemicals are applied to mold hardware to prevent the composites from strongly adhering to the mold hardware during cure. The mold release chemicals typically contain PFAS chemicals or a PTFE polymer spray. Peel plies are used to prevent attachment of vacuum bag materials and other disposable molding materials to the composite part and to impart a textured surface to the molded component to improve adhesion in secondary bonding or painting. Peel plies are typically made of non-PFAS polymers, such as polyamides and polyesters; however, to prevent adhesion of the composite to the peel ply, PFAS modification (most commonly) or silicone modification is done to the fabric. Additionally, if high cure temperatures are required, PTFE and PVDF peel plies are typically used. Polymer release films are similar to peel plies but are generally used with composite resins that need to release gasses during cure. Many of these release films are polyethylene, polypropylene, or other polyolefins and work well for many applications; however, certain applications (typically higher temperature curing systems) require use of fluoropolymers, such as PTFE, PVDF, and others. Pre-preg release film is used to keep individual layers of pre-pregs (e.g., fabrics that are pre-impregnated with a fully curable, mixed resin system during manufacture) separated from each other within the rolls of materials that are prepared and transported for use in composites manufacturing facilities. Fluoropolymer release films are generally used to ensure the releasability of the release film during composite layup. Silicones are also useable for this application but are generally not used because of the low rigidity of silicone films.

IV.5 Additional Mission Critical PFAS Uses

Mission critical PFAS uses extend beyond the five industries discussed to this point. DoD identified a range of additional critical uses for which the potential risk of supply chain disruption would undercut not only mission readiness but the U.S. economy. These uses are discussed in more detail in the following sub-sections.

IV.5.1 Refrigeration and Air Conditioning, Cooling, and Electronics Thermal Control

Most refrigerants used in civil and military cooling and refrigeration applications can be classified as PFAS. Many next-generation refrigerant alternatives adopted by U.S. industry (and U.S. households) between now and the end of 2025 are also PFAS. Under the AIM Act and EPA technology transition regulations, the U.S. economy is in the process of switching from one set of PFAS-classified refrigerants (e.g., HFCs) to a new generation of refrigerants (e.g., HFOs), which are also, in the broadest definitions, considered to be PFAS. Known non-PFAS alternatives (e.g., hydrocarbon or ammonia alternatives) pose flammability, toxicity, or high-pressure concerns. The same PFAS that are used in quantities of several hundred million pounds per year throughout the U.S. economy for cooling applications are used in much smaller quantities (i.e., a fraction of one percent) for military cooling and military thermal control of all kinds.

IV.5.2 Fire Suppression in Naval Vessels, Aircraft and Ground Combat Vehicles

Fluorochemical specialty gases are used in “clean agent” fire suppression in naval vessels, aircraft, and ground combat vehicles. Most known clean agent, low-corrosion, low-weight, low-toxicity alternatives will likely be classified as PFAS, broadly defined.

Since the advent of regulations against halogenated agents, Naval vessels commonly utilize an HFC clean agent in compartments subject to flammable/combustible liquid fuel fires such as engine modules and hazardous material storage spaces. For new U.S Naval ship designs, the Navy continues to move to alternate fire suppression technologies (e.g., water mist) where suitable, however limited use of HFC remains for those spaces where the alternatives are not appropriate. For existing ship HFC uses, there is no “drop-in” replacement for these HFC agents.

Well over 10 million pounds of PFAS fire suppressants are installed in civil aircraft engine, cargo compartment, and lavatory fire suppression systems, and in hand-held aircraft fire extinguishers, worldwide. This includes halons (which meet PFAS definitions but are frequently excluded from draft PFAS regulations because they are separately covered by ozone depleting substance regulations) and all currently implemented aviation replacements for halons. In 2022, Working Paper 96 presented at the 41st Assembly of the International Civil Aviation Organization recommended considering PFAS use in aircraft fire suppression an essential use in prospective PFAS regulations to maintain progress in replacing halons.[10]

[10] International Civil Aviation Organization (ICAO), Working Paper 96: Aircraft Halon Replacement, A41-WP/96, 28 July 2022. https://www.icao.int/Meetings/a41/Documents/WP/wp_096_en.pdf.

IV.5.3 Aqueous Film Forming Foam

Mission critical ocean-going vessels employed by DoD and the Military Services continue to use aqueous film forming foam (AFFF) containing PFAS for combating Class B (flammable/combustible liquid) fuel spill fires. U.S. Navy ships are required to use AFFF qualified to MIL-PRF-24385. MIL-PRF-24385 qualified AFFF provides the capability to rapidly control and extinguish shipboard fires. AFFF is critical for fire emergencies on flight decks where aircraft movement, fueling, launch/recovery, and weapons loading occur, and substantial risk exists for loss of aircraft, ship, and life if a fire is not rapidly controlled and extinguished.

Past flight deck fires, such as those that occurred on the United States Ship (USS) FORRESTAL, USS ENTERPRISE, and USS NIMITZ, all demonstrate the potential for such catastrophic events to occur. The risk of devastating loss of life and warfighting capability in incidents such as these, and the more recent fire emergency which resulted in the loss of the USS BONHOMME RICHARD, necessitates the use of the most effective firefighting agents available.

Beyond the potential for the immediate loss of life and impacts to operational capability that can result from an uncontrolled fire on a warship, the defense industrial base has limitations with respect to repairing or delivering replacement national security assets, including ordnance, aircraft, and ships. It could take a decade or longer to replace large amphibious assault ships and aircraft carriers.

Currently available fluorine-free foams (F3s) have significant limitations compared to AFFF that preclude their use on DoD ocean-going vessels, including the U.S. Navy fleet. Those limitations include reduced firefighting performance; chemical and physical properties that make them unsuitable for use with existing ship firefighting foam storage and delivery systems; and cross-agent compatibility issues. There are currently no equivalent, fully performing firefighting alternatives to AFFF for shipboard use.

DoD continues to sponsor research and development for F3 technologies to address these limitations, with the goal that continued technology improvements will support efforts toward a future path for use on ships. To date, DoD has invested approximately $45.8M since 2017 toward the development and qualification of F3 technologies.

Until such time that a capable F3 alternative is found, the safety and survivability of naval ships and crew from shipboard fires depends on the continued availability of MilSpec AFFF products and their PFAS-containing constituents, which were formulated, tested, qualified, and implemented in order to save lives and military assets.

IV.5.4 Lines, Hoses, O-Rings, Seals and Gaskets, Tapes, and Cables and Connectors

Dozens of different fluoropolymers (e.g., PVDF, ECTFE, PTFE) and fluoroelastomers (e.g., FKM/FFKM) are critical to modern UV-resistant, ozone-resistant, weather-resistant, temperature-resistant, high pressure-resistant, chemical-resistant "rubberized" fuel lines. They are also key materials in hoses, tubing, hydraulic system lines, O-rings, seals and gaskets, tapes, and cables and connectors widely used in civil and military aircraft, space systems, vehicles, weapon systems, utility systems, and other applications. Alternatives are not as resistant to embrittlement and break-down and have a much shorter useful life, leading to more frequent part replacement, which is not feasible for space or satellite uses.

IV.5.5 Electronic/Dielectric Fluids

Fluorochemicals are found in electronic and dielectric fluids that are used in civil and military radars and high-power electronics and electrical system/utility system components because of their dielectric and heat transfer properties. Industry and DoD have repeatedly investigated alternatives for these applications. Known alternatives have high global warming potential (e.g., sulfur hexafluoride) or may pose health/environmental risks (e.g., the polychlorinated biphenyls banned by the U.S. Toxic Substances Control Act and the Stockholm Convention on Persistent Organic Pollutants). Examples of PFAS-containing electronic/dielectric fluids used by DoD include 3M™ Fluorinert™ Electronic Liquids FC-40, FC-72, FC-770, and FC-3283.

IV.5.6 Advanced Oils, Greases, Fluids, and Lubricants

PFAS are used in many advanced turbine engine oils, greases, fluids, and lubricants due to their wear- and heat-resistant properties. These uses are common throughout the most demanding applications in the U.S. civil transportation, industrial, and space sectors. Analogous PFAS-containing oils, lubricants, and fluids are used in military critical ground, sea, air, and space applications. Previous generations of oils, fluids, and lubricants approached, but did not equal, the performance of PFAS additives that have become more prevalent in high performance oils, greases, fluids, and lubricants over the past 20 years.

Castrol Braycote 640AC is an example of a PFAS-containing grease, designed to be oxidizer and propellant compatible for use in aerospace vehicles, spacecraft, rocket and aircraft engines, and associated ground support equipment, oxygen equipment, and transport equipment. Braycote 640AC is typically used to lubricate threaded fasteners, connectors, valves, gaskets, elastomers, and bearings. Perfluorinated greases, in general, exhibit excellent shelf lives due to their intrinsic inertness.

Two additional examples of PFAS-containing greases used by DoD (and original equipment manufacturers and the maintenance, repair, and overhaul industry) are NYCO GREASE GN25013 and NYCO GREASE GN617. PTFE is used as a thickener in both products and perfluoropolyether is used as the base stock for GN617.

IV.5.7 Precision Cleaning Fluids

Fluorochemicals are used in precision cleaning applications, including the cleaning of sensitive oxygen systems in civil and military aerospace.

IV.5.8 Degreasing/Cleaning Fluids

The MilDeps reported the use of PFAS-containing degreasing/cleaning products and contact cleaners (e.g., 3M™ Novec™ Engineering Fluids, 3M™ Novec™ Contact Cleaners, 3M™ Novec™ Contact Cleaner/Lubricant) in vapor degreasing and flux removal.

The Army reported the use of FCC2 Enhanced Fiber Connector Cleaner and Preparation Fluid, which contains butane, 1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxy, for cleaning fiber optic connectors in secure link manager assemblies and primary modem assemblies.

The MilDeps reported the use of fluorinated non-destructive testing (NDT) solvent cleaner/remover for precleaning before NDT and for removing excess surface penetrant from an inspection area before applying developer during liquid penetrant testing.

The MilDeps also reported that PFAS-containing degreasers are used to effectively remove grease, oil, tar, and other substances from military equipment to increase its operating efficiency. These degreasers leave no residue, have no flash or fire point, and serve as an alternative to legacy solvents (e.g., n-propyl bromide, trichloroethylene, tetrachloroethylene).

IV.5.9 Adhesives

The MilDeps reported the use of the following adhesives, which contain PFAS: 3M™ Super Foam Fast Spray Adhesive 74-Orange, 3M™ Hi-Strength Spray Adhesive 90 (aerosol), and 3M Scotch-Weld Epoxy Adhesive DP420 Off-White, Part A.

IV.5.10 Insulation and Foam Blowing

Fluorochemicals are components of insulation and foam blowing products used in civil and military aircraft and space vehicles/rocket motors.

IV.5.11 Resins for Specialty Materials

Fluoropolymers are used in resins for specialty high-temperature or weather-/UV-resistant composites due to their temperature-, pressure-, wear-, and chemical-resistance properties. Fluoropolymers are also used in high cleanable, high weathering and chemical resistant coatings for military assets. Many aircraft topcoats contain fluoropolymer resins due to their UV and chemical resistance properties. PFAS are not actually in the coatings themselves but are used in fluoropolymer resin manufacturing.

Moving to alternatives in under 10 years may require a return to previous methods of parts construction which produced shorter life and higher weight composites with lower performance characteristics.

IV.5.12 Specialty Filters and Membranes

Fluoropolymers are used in specialty filters and membranes (e.g., aviation filters) due to their temperature-, pressure-, and wear-resistance properties. PFAS are also found in several air filtering masks and air filtering respirators used by DoD.

IV.5.13 Fabrics, Fabric Liners, and Fabric Barriers

A variety of textiles used in uniform clothing and footwear items, tents, and duffle bags are treated with PFAS to repel water and oils while providing durability to laundering, UV light exposure, and temperature cycling. The main PFAS used on textiles are fluoropolymers, such as PTFE and short chain PFAS, known as C6 or C4 chemistries. PFAS can be incorporated as an additive mixed into individual fibers or sprayed as a coating onto finished fabrics during manufacturing or after sale and are present in/on textiles in two forms: a non-polymerized compound that can be washed out or evaporated or as a molecule integrated into a fluorine free polymer network via covalent bonds. The MilDeps reported the use of PFAS in chemical, biological, radiological, and nuclear protective equipment (the Uniform Integrated Protection Ensemble Family of Systems) and in a number of uses within health care communities.

Coretech, the biological protective fabric lining used on the Joint Biological Agent Decontamination System, includes a barrier layer for biological protection during the decontamination of aircraft. The barrier layer contains PFAS.

IV.5.14 Customized Applications

Customized applications like gyroscope suspension fluids and analytic gases and fluids for thermometric and other sensors use specialty fluorochemicals because of their pressure-resistant, wear-resistant, and temperature control properties. These applications require very small quantities of specialty PFAS and are particularly susceptible to disruptions in PFAS supply chains due to challenges in attracting manufacturers to develop low-volume commodities.

V. Conclusions

This report summarizes known direct and indirect uses of PFAS that are critical to the national security of the United States, but it is not comprehensive. Also highlighted are the challenges and costs related to finding and qualifying alternatives to existing PFAS materials in sectors of strategic importance to DoD. The information contained in this report is limited to what was available at the time of its drafting. As such, the information presented represents a fraction of the mission critical PFAS uses due to a lack of transparency in the chemical composition in consumables and articles. In addition, there is significant uncertainty regarding the presence of PFAS in products that make up a complex value chain. A more complete understanding of PFAS essential uses would require an extensive and complex evaluation of the market, a gap analysis of current requirements for manufacturer-provided product information, and illumination of the value chain of products.

PFAS are critical to DoD mission success and readiness and to many national sectors of critical infrastructure, including information technology, critical manufacturing, health care, renewable energy, and transportation. DoD relies on an innovative, diverse U.S. industrial economy. Most of the structurally defined PFAS are *critical to the national security of the United States*, not because they are used exclusively in military applications (although a few are) but because of the civil-military commonality and the potentially broad civilian impact. This report provides details on what is currently known about direct and indirect mission critical PFAS uses that could impact mission readiness if the substances are no longer available.

Emerging environmental regulations focused on PFAS are broad, unpredictable, lack the specificity of individual PFAS risk relative to their use, and in certain cases will have unintended impacts on market dynamics and the supply chain, resulting in the loss of access to mission critical uses of PFAS. These market responses will impact many sectors of U.S. critical infrastructure , including but not limited to the defense industrial base. Collectively, international and U.S. regulatory actions to manage PFAS' environmental impacts and identify and eliminate PFAS from the market, and the resulting market changes, pose risks to DoD operations and the defense industrial base supply chain. In addition, impacts to the global PFAS supply chain will present risks to the DoD Foreign Military Sales program and to North Atlantic Treaty Organization interoperability.

The Department will continue to oversee coordinated lines of effort to expeditiously identify essential uses of PFAS, prioritize actions according to vulnerabilities to national security, and address mission readiness associated with the potential loss of access to PFAS. Actions include:

- Implementing DoD PFAS policy directing the DoD Components and MilDeps to determine the PFAS content in DoD weapon systems, to the extent feasible, and enabling continued access to mission critical uses, while encouraging safe use by DoD personnel and adoption of PFAS-free alternatives.
- Engaging with industry to identify PFAS content in other materials commonly used within the DoD to assess potential obsolescence risks and potential PFAS alternatives.
- Engaging with industry and federal agencies during routine meetings to assess obsolescence risks, mission criticality, and potential PFAS alternatives.
- Investing in research, development, and qualification efforts required to demonstrate conformance with Military Standards or Specifications.
- Collaborating across the Federal Government to develop a long-term research plan for the most challenging applications where it will take a decade or more to find viable replacements.
- Investing in research to support advanced manufacturing approaches by improving purification, deconstruction technologies, scale-up of sustainable materials design and manufacturing, and circularity for the most critical and irreplaceable PFAS.

Concurrent with efforts to identify essential uses of PFAS, the Department is phasing out non-essential and non-critical PFAS uses in accordance with NDAA requirements where there is no mission impact (e.g., in food packaging, cookware, furniture, personal protective firefighting equipment). Additionally, per the 2023 U.S. Government Accountability Office (GAO) recommendations,[11] the Department is developing an approach to implement the April 2023 prohibition for military exchange resale procurements. The Department is also updating DoD Instruction 4105.72, *Procurement of Sustainable Goods and Services*, to include procedures specifically targeted to implementing the provisions of Executive Order 14057, *Catalyzing Clean Energy Industries and Jobs Through Federal Sustainability*, with respect to limiting the procurement of items containing PFAS.

Eliminating PFAS from non-essential uses is an important step toward addressing public concerns and protecting human health and the environment. Mission critical PFAS uses provide significant benefits to the framework of U.S. critical infrastructure, and national and economic security. DoD will consider future policy actions to manage non-essential and essential PFAS uses and will implement these actions with the intent of protecting human health and the environment while ensuring no adverse impacts to U.S. critical infrastructure and national security.

If future PFAS legal and regulatory frameworks ignore the OECD caution on the use of its PFAS definition and seek to broadly restrict the use of PFAS based on chemical structure, there could be extensive economic, industrial competitiveness, and quality-of-life impacts to U.S. society. The PFAS universe is structurally and physiochemically diverse and subgroups of PFAS may be more or less stable, persistent, and/or bioaccumulative compared to well-studied PFAS such as perfluorooctane sulfonate and perfluorooctanoic acid.[12] Congress and the Federal regulatory agencies should avoid taking a broad, purely "structural" approach to restricting or banning PFAS. It is critical that future laws and regulations consider and balance the range of environmental and health risks associated with different individual PFAS, their essentiality to the U.S. economy and society, and the availability of viable alternatives.

[11] U.S. Government Accountability Office (GAO). Persistent Chemicals: Actions Needed to Improve DoD's Ability to Prevent the Procurement of Items Containing PFAS. GAO-23-105982. April 2023.
[12] EPA Framework for Estimating Noncancer Health Risks Associated with Mixtures of Per- and Polyfluoroalkyl Substances (PFAS) (Public Review Draft), EPA-822-P-23-003 (March 2023).

Appendix: Summary of Known Mission Critical PFAS Uses

PFAS	Application	Functionality	Availability of Alternatives	Time Frame / Cost to Develop and Qualify Alternatives*
Kinetic Capabilities				
Fluoropolymers (e.g., Teflon™) Fluoroelastomers (e.g., Viton™)	Ingredients in binders and resins used in PBX, pyrotechnics, and propellant components that are used in a variety of applications across the DoD munitions portfolio.	High temperature resistance	NA*	NA
PFAS	Used in energetic slurry processing.	Enables high levels of mixing between key energetic components.	NA	NA
Fluorinated performance fluids (e.g., 3M™ Fluorinert™ fluids)	Enable energetics laboratory research. Are critical for developing and transitioning new energetic materials.	NA	NA	NA
Energy Storage and Batteries				
Fluoropolymers (e.g., polytetrafluoroethylene (PTFE)) Polyfluoroalkyl acids (PolyFAAs)	Multiple subcomponents in modern Li-ion batteries: electrolyte solutions, cathode binders, separator coatings, casing materials, and gaskets.	Serve as heat transfer material or insulation. Provide weather-resistance, UV light-resistance, and deterioration-resistance properties.	NA	Fully eliminating PFAS from energy storage in the U.S. economy would likely take 10+ years.
PFAS	Battery manufacturing: filters and other components essential to production.	NA	Possibly available	Time and cost to identify and qualify alternatives would be significant and have ripple effects throughout the economy.
Microelectronics and Semiconductors				
Fluoropolymers Fluoroelastomers PolyFAAs Other PFAS	Semiconductor fabrication: etching materials and masks in photolithography processes; cleaning gases.	Dielectric, heat transfer, and insulation functionalities.	Currently no alternatives to PFAS for photolithography.	NA

Appendix: Summary of Known Mission Critical PFAS Uses

PFAS	Application	Functionality	Availability of Alternatives	Time Frame / Cost to Develop and Qualify Alternatives*
Fluoropolymers	Semiconductor manufacturing equipment and factory infrastructure: equipment components (e.g., tubing, gaskets, containers, filters) and lubrication (various oils and greases).	Heat and chemical resistance, and chemical inertness.	Currently no alternatives for some applications in semiconductor manufacturing equipment. Replacing most PFAS uses in semiconductor fabrication would require industry-wide re-tooling and other process innovations. Some might be achievable within 10 years, but many would not.	Development of alternatives for some uses may require the invention of novel chemistries and processes. Due to the extremely complex qualification process, it would take another 15 years to deploy alternatives, once developed, in high-volume manufacturing. Replacing PFAS in semiconductor fabrication could be a 25-year effort and may not succeed in all respects if alternatives cannot be identified or qualified at the microchip level. Replacing PFAS has the potential to initiate costly requalification of specific components. Example: radiation hardened microelectronics applications typically mandate requalification if a manufacturer substantively alters the fabrication process, which can easily exceed $10 million.

Appendix: Summary of Known Mission Critical PFAS Uses

PFAS	Application	Functionality	Availability of Alternatives	Time Frame / Cost to Develop and Qualify Alternatives*
PTFE PFA	Microelectronics applications: base laminate materials used in many RF and microwave circuits.	Provide unique properties related to isolating RF and microwave signals. Used in radar, antenna, guidance systems, 5&6 G infrastructure, and other network/ transmission applications.	There is no drop in alternative material. Any material replacement for fielded systems would require redesign of the printed board and potentially the electronic system to account for material property differences. Fielded systems that have been redesigned may require requalification.	Developing and or identifying suitable alternative materials and qualifying them could be a forward-looking action for all future DoD systems. This however does not address sustainment of existing systems. There will continue to be a need to have PTFE laminate materials available for system sustainment until all systems currently designed with PTFE are retired.
PFAS	Manufacture of printed circuit boards (PCBs): vapor phase solder and flux remover products.	Vapor phase soldering process is used for PCB assemblies with high thermal mass, fine-pitch structures, and temperature-sensitive components to minimize risk to materials, structures and components. The material stability and flame retardant qualities are well suited for the enclosed high temperature operation of the process.	It is unknown if there are suitable materials that can be used, however it is likely that current equipment may need to be replaced or modified to accommodate the replacement materials.	Developing and evaluating new materials could take 5 years or more. Equipment replacement would add time and have a cost impact.
PTFE	PCBs: cable jackets used in PCB connectors.	Used because it has excellent fire, smoke, and chemical resistance. Wide temperature range -200 to 260C constant use and up to 450C for peak exposure.	It is unknown if there are suitable replacement materials for all of the applications for PTFE wire jacket material. PTFE is higher cost than some other wire jacket materials. When it is selected for use there are typically no other suitable replacement materials.	Qualification of alternatives will be both costly and time consuming. Many materials will require new UL or other certification body approval before they can be implemented. Many current products are MilSpec certified.

Appendix: Summary of Known Mission Critical PFAS Uses

PFAS	Application	Functionality	Availability of Alternatives	Time Frame / Cost to Develop and Qualify Alternatives*
Castings and Forgings and Strategic and Critical Minerals				
Specialty fluorochemical gases and fluids	Advanced metalworking, casting, and fabrication processes used in the production of advanced metal parts throughout U.S. industry, including military-specific parts.	Temperature and wear resistance.	NA	Moving to alternatives in under 10 years may require returning to previous construction methods and may make construction using certain alloys impossible.
PTFE, PVDF, other PFAS	Mold release chemicals and release films typically used in composite manufacturing processes.	Prevent composites from strongly adhering to mold hardware.	NA	NA
Refrigeration and Air Conditioning, Cooling, Electronics Thermal Control				
HFOs	Next-generation refrigerant alternatives (to HFCs) used in civil and military cooling and thermal control applications.	NA	Known non-PFAS alternatives (e.g., hydrocarbon or ammonia alternatives) pose flammability, toxicity, or high-pressure concerns.	NA
Fire Suppression in Aircraft and Ground Combat Vehicles				
Fluorochemical specialty gases	"Clean agent" fire suppression in aircraft and ground combat vehicles.	NA	Most known clean agent, low-corrosion, low-weight, low-toxicity alternatives will likely be classified as PFAS, broadly defined.	NA
Aqueous Film Forming Foam (AFFF)				
PFAS	AFFF use to combat Class B (flammable/combustible liquid) fuel spill fires on mission critical ocean-going vessels employed by DoD and the Military Services.	MIL-PRF-24385 qualified AFFF provides the capability to rapidly control and extinguish shipboard fires.	Current F3s have significant limitations compared to AFFF that preclude their use on DoD ocean-going vessels, including the U.S. Navy fleet.	NA

Appendix: Summary of Known Mission Critical PFAS Uses

PFAS	Application	Functionality	Availability of Alternatives	Time Frame / Cost to Develop and Qualify Alternatives*
Lines, Hoses, O-Rings, Seals and Gaskets, Tapes, and Cables and Connectors				
Fluoropolymers (e.g., PVDF, ECTFE, PTFE) Fluoroelastomers (e.g., FKM/FFKM)	Critical to modern "rubberized" fuel lines. Key materials in hoses, tubing, hydraulic system lines, O-rings, seals and gaskets, tapes, and cables and connectors widely used in civil and military aircraft, space systems, vehicles, weapon systems, utility systems, and other applications.	Functionalities include UV-resistance, ozone-resistance, weather-resistance, temperature-resistance, high pressure-resistance, and chemical resistance.	Alternatives are not as resistant to embrittlement and break-down and have a much shorter useful life, leading to more frequent part replacement, which is not feasible for space or satellite uses.	NA
Electronic/Dielectric Fluids				
Fluorochemicals	Used in electronic and dielectric fluids used in civil and military radars, high-power electronics, and electrical system/utility system components.	Provide dielectric and heat transfer properties.	Industry and DoD have repeatedly investigated alternatives in these applications. Known alternatives have high global warming potential (e.g., sulfur hexafluoride) or may pose health/environmental risks (e.g., the polychlorinated biphenyls).	NA
Advanced Oils, Greases, Fluids, and Lubricants				
PFAS	Used in many advanced turbine engine oils, greases, fluids, and lubricants common throughout the U.S. civil transportation, industrial, and space sectors. Analogous oils, lubricants, and fluids are used in military critical ground, sea, air, and space applications.	Wear- and heat-resistant properties. Perfluorinated greases exhibit excellent shelf lives due to their intrinsic inertness.	Previous generations of oils, fluids, and lubricants approached, but did not equal, the performance of PFAS additives that have become more prevalent in high performance oils, greases, fluids, and lubricants over the past 20 years.	NA

Appendix: Summary of Known Mission Critical PFAS Uses

PFAS	Application	Functionality	Availability of Alternatives	Time Frame / Cost to Develop and Qualify Alternatives*
Precision Cleaning Fluids				
Fluorochemicals	Precision cleaning applications such as cleaning of sensitive oxygen systems in civil and military aerospace.	NA	NA	NA
Degreasing / Cleaning Fluids				
PFAS	Degreasing/ cleaning products and contact cleaners used in vapor degreasing and flux removal.	NA	NA	NA
	Non-destructive testing solvent cleaner/remover used for precleaning and for removing excess surface penetrant before applying developer during liquid penetrant testing.	NA	NA	NA
	Degreasers used to effectively remove grease, oil, tar, and other substances from military equipment to increase its operating efficiency.	Leaves no residue, has no flash or fire point, and serves as an alternative to chlorinated solvent-based cleaners (e.g., 1,1,1-trichloroethane).	NA	NA
Butane, 1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxy	Connector cleaner and preparation fluid used for cleaning fiber optic connectors in secure link manager assemblies and primary modem assemblies.	NA	NA	NA
Insulation and Foam Blowing				
Fluorochemicals	Components of insulation and foam blowing products used in civil and military aircraft and space vehicles/rocket motors.	NA	NA	NA

Appendix: Summary of Known Mission Critical PFAS Uses

PFAS	Application	Functionality	Availability of Alternatives	Time Frame / Cost to Develop and Qualify Alternatives*
Resins for Specialty Composites				
Fluoropolymers	Resins for specialty high-temperature or weather-/UV-resistant composites.	Temperature-, pressure-, wear-, and chemical-resistance properties.	NA	Moving to alternatives in under 10 years may require a return to previous methods of parts construction and an acceptance of lower performance, shorter life, and higher weight composites.
Specialty Filters and Membranes				
Fluoropolymers PFAS	Used in specialty filters and membranes (e.g., aviation filters); and in air filtering masks and air filtering respirators used by DoD.	Temperature-, pressure-, and wear-resistance properties.	NA	NA
Fabrics, Fabric Liners, Fabric Barriers				
PFAS	• Fabrics used in a variety of uniform clothing and footwear items, tents, and duffle bags. • Reported use in chemical, biological, radiological, and nuclear protective equipment. • Used in the biological protective fabric lining used in the Joint Biological Agent Decontamination System.	Water and oil repellency.	NA	NA
Customized Applications				
Specialty fluorochemicals	Used in customized applications like gyroscope suspension fluids and analytic gases and fluids for thermometric and other sensors.	Pressure-resistant, wear-resistant, and temperature control properties.	NA	NA

* NA = no information provided through data collection efforts.

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Mark Herwig Attachment 3

Aerospace, Security and Defence Industries Association of Europe (ASD) COMMENTS ON THE ANNEX XV RESTRICTION REPORT FOR PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS)

Reference: ECHA Public Consultation on the Annex XV restriction report of 22 March 2023 for Per- and polyfluoroalkyl substances (PFASs)[1]

This is the joint contribution of the Aerospace, Security and Defence Industries Association of Europe (ASD) – to the ECHA Public Consultation on the Annex XV restriction report of 22 March 2023 for PFAS.

We are submitting detailed information specifically for Q6 including case studies to illustrate PFAS usage by this sector.

[1] Available at https://echa.europa.eu/restrictions-under-consideration/-/substance-rev/72301/term.

1 Summary

Who we are: ASD is the voice of European Aeronautics, Space, Security and Defence Industries, directly and indirectly representing around 3,000 companies. It has 22 major European companies as direct members and 23 National Associations active in 18 European countries. ASD members together employed 879,000 people and generated a turnover of €238 billion in 2021. See our webpage for more details: https://www.asd-europe.org/.

In this document, we submit our input to Q6. We provide information on identified uses of PFAS chemicals in A&D products, the types of PFAS and our assessment of how these uses have been considered by the dossier submitters in the proposed restriction and the extent to which they are in scope of proposed/potential derogations.

Table 1 gives details of the uses reported by ASD members with details of the PFAS type and a best guess assessment of which of the application areas described in the restriction report they may be assigned to. For each reported use, we then assessed whether they may be in scope of a proposed/potential derogation (details given in Annex 1). From this assessment, we see that while some of the A&D uses were assessed, a very significant number of uses were not assessed and not unsurprisingly are also not covered by any derogation. We also see that in principle, some of our uses were assessed but the dossier submitters did not include them in the proposed/potential derogations.

In terms of the derogation periods given in the proposed restriction, we also see that the maximum time period is 12 years. In the assessment of available alternatives for the uses assessed (Annex E of the restriction report), we can also see that the dossier submitters did not consider the specificities of our sector when determining the time needed for substitution.

In this report, we provide details of these specificities (chapter 2.2) and show that when they are taken into account, the impact risk option proposed (RO2) would be catastrophic both for our sector and the wider functioning of the EEA in terms of aviation and defence capability (chapter 2.3).

PFAS chemicals and in particular fluoropolymers are integral to the production, operation and MRO of A&D products. A given product may have many 1000's of PFAS containing parts integrated into the components, sub-systems, systems, etc. that make up the product. The driver for their use is their high performance in harsh/extreme operating conditions that underpin the safety and reliability of A&D products. Due to the formal quality management processes in place to ensure safety and reliability, substitution is lengthy even when potential alternatives are available. There are no potential alternatives available that can fulfil the performance requirements. Maintenance of in-service A&D products must also be done with spare parts as per the original approved design over the entire product service. Depending on the product, this can be 40+ years (e.g. aircraft) or longer (e.g. naval vessel). Changes in the production of the spare parts would trigger the need for requalification and recertification and likely redesign before the part could be taken into use. This is lengthy and it can also be that redesign is not technically feasible.

Due to the ubiquity of PFAS (primarily fluoropolymers) in the production, operation and MRO of A&D products, the scale of the substitution requirement that would be triggered by the proposed restriction has no precedent. The dossier submitters' assessment did not consider the specificities of the A&D sector and the derogations as given are inadequate both in coverage and duration. Due to the complexity of A&D products and the formal quality management systems in place, non-availability of even a limited number of parts will stop production of new products and scheduled maintenance of in-service products. This means that the impact of the restriction would be felt already 18 months after the entry into force as all uses are not covered by a derogation. The impact would be quite simply catastrophic. The restriction as proposed does not have a plausible non-use scenario when our sector is included.

We ask the dossier submit to revise their proposal to include our sector; specifically

- Exclude fluoropolymers (and the precursor chemicals necessary for their manufacture) from the scope of the restriction given their ubiquity in A&D products and the absence of alternatives that fulfil the performance requirements for reliability and safety
- Include a sector derogation for the use of PFAS chemicals necessary for the production and operation of A&D products with a review clause to allow for an extension/renewal of the derogation if needed due to the non-availability of suitable alternatives
- Exclude the use of PFAS chemicals on their own, in formulations and in articles that are necessary for the MRO of existing products
- Include a time-unlimited derogation for specific PFAS chemicals used fire suppression systems (see case study 5 in Annex 2)

We also note that the reporting requirements on manufacturers and importers of PFAS or PFAS containing articles as well as formulators of PFAS containing mixtures relying on derogations (paragraphs 7 & 8) did not consider the specificities of our sector. Due to both the complexity of our products and our global supply chains (see chapter 2.2), it is not possible to collect, compile and report the information required under paragraph 7 within 18 months of the entry into force. The site specific management plans requirements given in paragraph 8 also cannot be implemented within 18 months of entry into force as the users will be need to collect information from all tiers of their supply chain and map PFAS in the 1000's of parts, components, systems etc. that make up A&D products. At least 5 to 10 years would be needed to be compliant with such requirements.

In addition, we highlight that the restriction refers to ppb levels in articles (paragraph 2) – the challenges associated with complying with the requirement were not considered by the dossier submitters as apriori to verify this, we would need to test all articles. This is not feasible for A&D products as 1000's of parts/components would need to be tested. In addition, standard test methods are not available for the range of articles that would need testing with this level of detection.

Contents

List of Figures

List of Tables

List of abbreviations

2-BTP	Bromotrifluoropropene
A&D	Aerospace And Defence
ADCR	Aerospace And Defence Chromates Reauthorisation (REACH authorisation consortium)
AoA	Analysis Of Alternatives
APU	Auxiliary Power Unit
ASD	Aerospace, Security And Defence Industries Association Of Europe
CBRNE	Chemical, Biological, Radiological, Nuclear, And High Yield Explosives
Cr(VI)	Hexavalent Chromium
CRES	Corrosion Resistant Steel
EASA	European Aviation Safety Agency
ECHA	European Chemicals Agency
EEA	European Economic Area
EoL	End Of Life
ESA	European Space Agency
ETFE	Ethylene Tetrafluoroethylene
EU	European Union
FAA	Us Federal Aviation Administration
FEP	Fluorinated Ethylene Propylene
FEPM	Tetrafluoroethylene Propylene
FFKM	Perfluorelastomers
F-Gas	Fluorinated Gas
FKM	Family Of Fluorocarbon-Based Fluoroelastomer Materials
FMQ, FVMQ	Fluorosilicone Rubber
FP	Fluoropolymer
FPG	Fluoropolymers Product Group
GCCA	Global Chromates Consortium For Aerospace (REACH authorisation consortium)
Halon 1211	Bromochlorodifluoromethan
Halon 1301	Bromotrifluoromethane
HFC	Hydrofluorocarbons
HFC R-134a	1,1,1,2-Tetrafluoroethane
HFC-125	Pentafluoroethane
HFC-236	Hexafluoropropane
HFE	Hydrofluoroether
MEA	More Electric Aircraft - A Term For Next Generation Aircraft Power
MoD	Ministry Of Defence
MRL	Manufacturing Readiness Level (1-10); Market Acceptance Readiness Level (11-15)
MRO	Maintenance Repair & Overhaul
NASA	National Aeronautics And Space Administration (US)
NOVEC 1230	Perfluoro(2-Methyl-3-Pentanone)
ODS	Ozone Depleting Substances
OEM	Original Equipment Manufacturer

PCB	Printed Circuit Board
PEBHF	Phosphate-Ester Based Hydraulic Fluids
PEMFC	Proton-Exchange Membrane Fuel Cells
PFA	Perfluoroalkoxy Alkane
PFAE	Perfluoroalkylether
PFAS	Per- And Polyfluoroalkyl Substance
PFPE	Perfluoropolyether
PSI	Pounds Per Squre Inch
PTFE	Polytetrafluoroethylene
PVDF	Polyvinylidene Fluoride
PVF	Polyvinyl Fluoride
R-1234yf	2,3,3,3-Tetrafluoropropene
REACH	Registration, Evaluation, Authorisation And Restriction Of Chemicals (Regulation (EC) No 1907/2006)
RO	Restriction Option
SEA	Socio-Economic Analysis
TFE	Tetrafluoroethylene
TRL	Technology Readiness Level
TULAC	Textiles, Upholstery, Leather, Apparel And Carpet
U.S.	United States
UK	United Kingdom
US DoD	US Department Of Defence

2 Overview of PFAS usage by the A&D sector

2.1 Use identification and assessment of derogation suitability

A soon as the restriction proposal was available on the ECHA website, ASD members initiated new activity to identify any further PFAS uses and to understand the impact of the proposed restriction on their sector and the extent of coverage of the proposed (5a-5t, 6a-6f) and potential (5u-5ee, 6h-6o) derogations. As outlined in our reply to Q2, PFAS chemicals are integral to the production, operation and MRO of A&D products. For example, a given product (e.g. a commercial airliner) will contain many 1000's of individual fluoropolymer parts/components integrated to subsystems, systems and assemblies.

A questionnaire with pre-defined questions was circulated between ASD members, with fields for free text answers. ASD members completed the questionnaires based on their current knowledge of where PFAS chemicals are used in the products and supply chains. Due to the limited time available, it was not possible to complete an exhaustive supply chain investigation. The aim was to collect a sector-wide first understanding of uses and to map coverage by the proposed and potential derogations as a first step in determining the impact of the proposed restriction. This exercise is not intended to be exhaustive or definitive. It was done solely in the scope of the restriction proposal and considering the applications identified by the dossier submitters (Annex A to the restriction dossier).

The questionnaire had fields to report uses by "application area/main use", the type of PFAS used and their understanding of whether each identified use may be covered by a proposed/potential derogation. ASD members reported uses in the "application area/main use" fields according to their products.

The completed questionnaires from each member were compiled to yield a wide dataset covering uses of ASD members and their supply chains. Duplicates for "application area/main use" were merged. An external contractor used expert judgement to assign reported uses to the use categories defined by the dossiers' submitters in Annex A of the proposed restriction dossier. The dataset was then used to extract details of the types of PFAS chemicals reported for each application area/main area. The contactor used expert judgement to categorise the PFAS reported in use by ASD members to particular groups; fluoropolymers, fluorinated gases, unspecified PFAS, fluorinated alkene or fluorinated organic fluids). The assignment of the reported PFAS to a PFAS type is given in Annex 1. The reported PFAS for each application area were grouped by types given in Table 1. The responses to the questionnaire depend on the products made by the member (e.g., aircraft, engines, landing gear, defence systems). There are many commonalities between the products since fluoropolymer PFAS are ubiquitous material for seals, gaskets, sleeves, tubing, cables, hosing, bearings, bushings and as components of lubricants, sealants and hydraulic fluids.

From Table 1, it can be seen that a very extensive set of application areas/main areas have been reported across the sector and that many of these cannot be assigned to a restriction use category included in Annex A by the dossier submitters. These are reported as "miscellaneous" in the Table. It can also be seen that fluoropolymers are the most common PFAS type. Note that the assignment of an A&D reported use to a restriction use category was a best guess based on current understanding of Annex A of the restriction report. The sub-uses given in Annex A for "transport" are not extensive and "defence industry" sub-uses are not given.

Some uses which have been categorised under "Applications of fluorinated gases" use 2-bromo-3,3,3-trifluoroprop-1-ene (CAS 1514-82-5, EC 627-872-0), which is a liquid at room temperature and pressure, but due to its low boiling point and high vapour pressure, is considered a gas in use. The fluorinated alkene reported was TFE (tetrafluoroethylene, CAS 116-14-3, EC 204-126-9). It is expected that this will be in the polymeric form in its final use but was reported separately by ASD members.

Table 1. Alignment of use categories as stated by the dossier submitter (Annex A) with those reported by ASD members for each PFAS type

Possible restriction Use Category (& sub-use) (Annex A)	Sub use identified by ASD members	Fluoropolymer	Fluorinated Alkene (non polymeric)	Fluorinated organic fluids (non polymeric)	Fluorinated gases	Unspecified PFAS
Applications of fluorinated gases	Cooling agents			x		
	Refrigerants			x	x	
	Refrigerants for air conditioning in military vehicles				x	
	Handheld fire extinguishers			x		
	Lavatory fire extinguishing systems				x	
	Cargo fire extinguishing systems			x		
	Engine and APU fire extinguishing systems			x	x	
	Fire extinguishers			x		
	Anti-corrosion products				x	
Transport* (Body-, hull- and fuselage construction)	Fire resistant bulkhead	x				
	Cellular materials	x				
	Housing	x				
	Radomes	x				
	Welding					x
Applications of fluorinated gases; solvents (Cleaning agents)	Specialist cleaning fluids			x		x
	Cleaning fluids				x	
	Cleaning agents			X		
	Cleaning solvents			X		
	Contact cleaners			X		
	Degreasing solvents			X		
	Precision cleaners			x		
Transport* (Coating and finishings)	Fan blade wear strips	x				
	Anti-slip paint	x				
	Abrasion resistant coatings	x				
	Varnish for electronics	x				
	Electrical coil varnish	x				
	Coatings	x				
	Paints	x				x
	Varnish	x				

Possible restriction Use Category (& sub-use) (Annex A)	Sub use identified by ASD members	Fluoropolymer	Fluorinated Alkene (non polymeric)	Fluorinated organic fluids (non polymeric)	Fluorinated gases	Unspecified PFAS
	Lacquers					x
	Chemically resistant coatings	x				
	Anti-foul paints					x
Electronics and semiconductors	Cable insulation	x	x			
	Electronic displays and touch screens	x				x
	Semiconductors					x
	Vapor phase soldering	x		x		
	Cables	x				
	Soldering	x				
	Protection sleeves					x
	Batteries	x				x
	Printed circuit boards	x				x
	Connectors	x				
	Optical fibre accessories	x				
	Harness insulation	x				
	Shrink sleeves	x				
	Components					x
	Lead-free soldering					x
	High frequency connectors	x				
	Coaxial cables	x				
	Dielectrics	x				
	Soldering fluxing agent	x				
	Sleeves	x				
	Flexible sleeves	x				
	Solder sleeves	x				x
	Conformal coatings	x				
	Boots	x				
	Tubing	x				
	Electronics					x
	Metal-plated wires	x				
	Loom guides	x				
	Looms	x				
	Pin carriers	x				
Energy sector	Proton exchange membrane (PEM)	x				
	Covering foils	x				

Possible restriction Use Category (& sub-use) (Annex A)	Sub use identified by ASD members	Fluoropolymer	Fluorinated Alkene (non polymeric)	Fluorinated organic fluids (non polymeric)	Fluorinated gases	Unspecified PFAS
Food contact materials and packaging** (Foils[2])	Foil heaters	x				
	Identification tape	x				
	Wrap for engine casings	x				
Food contact materials and packaging	Potable water systems					x
Transport* (Hydraulic fluids)	Hydraulic fluids	x		x		x
	Anti-corrosion liquids (hydraulics)			x		
Laboratory equipment	Diagnostic tests	x				
	Calibration of measurement instruments	x		x		x
	Calibration standard	x				
	Chemical detectors for military applications	x				
Lubricants	High temperature greases	x		X		
	Release agents	x		X	x	x
	Dry film lubricants	x		x		
	Perforated and non-perforated fluorocarbon release films					x
	Ammunition release agents	x				
	Bearings	x				
	Bushings	x				x
	Piston bearings		x			
	Thread lubricants	x				
	Lubricating oils	x				
	Lubricants	x		x		
	Anti-friction coatings	x		x		
	Solid lubricants	x				
	Self-lubricating coatings	x		x		x
	Chemically resistant greases	x				
	Greases for military applications	x				
	Greases	x	x			
	Release foils	x				
	Moulding	x				
	LVDT lubricants	x				

[2] See reply #8.1 in the ECHA Q&A from the webinar available at https://echa.europa.eu/documents/10162/2156610/230405_upfas_webinar_qa_ds_en.pdf

Possible restriction Use Category (& sub-use) (Annex A)	Sub use identified by ASD members	Fluoropolymer	Fluorinated Alkene (non polymeric)	Fluorinated organic fluids (non polymeric)	Fluorinated gases	Unspecified PFAS
	PTFE sheet for cabin emergency trap sealing	x				
	Sliding pads	x				
	PTFE and graphite filled polyamideimides	x				
Metal plating and manufacture of metal products	Nickel PTFE coating	x				
	Metal coatings					x
	Lamellar zinc surface treatments					x
	Metal plating	x				
	Lamellar zinc plating	x				
Pyrotechnics	Plastic bonded energetic material	x				
	Igniters	x				
	Relays	x				
Transport* (Sealing applications)	Seals	x		x		x
	Sealants	x				
	Adhesives	x				x
	O-rings	x				
	Gaskets	x				
	Backup rings	x				
	Tapes	x				
	Insulation tapes	x				
	Pressure-sensitive tapes	x				
	Adhesive sheets	x				
	Adhesive fabrics	x				
	Grommets	x				
	Hydraulic system seals	x				
	Slipping rings	x				
	Drive train seals	x				x
	Interlay sealants	x				
	High temperature sealants	x				
	Overcoating	x				
	Aircraft window gaskets	x				
	Wedge	x				
	Adhesive tapes	x				
	Pellet and strip locking	x				
	Bellows	x				

Possible restriction Use Category (& sub-use) (Annex A)	Sub use identified by ASD members	Fluoropolymer	Fluorinated Alkene (non polymeric)	Fluorinated organic fluids (non polymeric)	Fluorinated gases	Unspecified PFAS
	Valve seats	x				
	Grand plates (washer)	x				
	Shutters	x				
	Collar trim	x				
	Primary ring adapters	x				
	Washers	x				
TULAC	Anti-g suits	x				
	Cover vehicle seats					x
	Fire resistant glass cloth	x				
	Coated Fabrics for Rafts or Canopy					x
	Camouflage nets	x				
	Lacing ties	x				
	Coated yarns	x				
	Yarns	x				
Miscellaneous (not assignable)	Tank liners	x				
	Thermal insulation	x				x
	Filters	x				
	Pipes	x				
	Hoses	x				
	3D-Printing agents					x
	Heat transfer fluids					x
	Polyimide plastic					x
	Hydraulic hoses	x				
	Pumping rings	x				
	Tooling	x				
	Membranes	x				
	Oil level accessories	x				
	Half shells for anti-rotation coils	x				
	Cushion clamps	x				
	Mechanical parts	x				
	Rubber mats					x
	High performance polymeric membrane (filter)	x				
	Anti-vibration parts	x				
	Cable ties	x				
	Carriers	x				

Possible restriction Use Category (& sub-use) (Annex A)	Sub use identified by ASD members	Fluoropolymer	Fluorinated Alkene (non polymeric)	Fluorinated organic fluids (non polymeric)	Fluorinated gases	Unspecified PFAS
	Duct oil	x				
	Dyes	x				
	Elastomeric components	x				
	Extruded profiles	x				
	Flex	x				
	Friction devices		x			
	Fuel hose assemblies	x				
	HAD process surface treatments					x
	Holders	x				
	Liners	x				
	Markings	x				
	Fuel tank membranes	x				
	Oil hose assemblies	x				
	Packing	x				
	Pin holders	x				
	Critical foam packaging	x				
	Plastic for interiors					x
	Pneumatic assemblies	x				
	Rubber strips	x				
	Shock absorbers	x				
	Site glass	x				
	Special rubbers	x				
	Low friction thermoplastics	x				
	Process equipment	x				x
	Heat Transfer fluids (polymeric)	x				
	Heat transfer fluids for brazing furnace			x		

* "transport" does not cover many defence and security products (weapons, munitions, launchers)
** The assignment was a best guess focussing on "packaging" – details in Annex A are quite limited

Derogation assessment: Information on possible derogation coverage was then extracted from the dataset. In this context, "coverage" solely means that the contractor could make a link between the reported use and a derogation (i.e. the use may be in scope of the derogation). The contractor used the information reported by ASD members in their completed questionnaires and expert judgement based on the content of the dossier and the Q&As from the ECHA webinar. Expert judgement/best guess was used to assign each application area as "unassessed" or "assessed/partially assessed" by the dossier submitter and to determine where applications could perhaps fall under a proposed/potential derogation.

Note that as the dossier submitters did not include aerospace, defence and security as application areas in their assessment, coverage is very limited and open to interpretation.

Details of the derogation assessment are given in Annex 1. In terms of A&D areas assessed by the dossier submitters and possibly covered by a proposed derogation, 5-k, 5-m and 5-s were the most assigned (see Table 15). Of the ASD application areas considered to be "partially assessed" by the dossier submitters, the potential derogation 6-o "transport" was the more assigned by the contractor (see Table 16). Note that this is using a very wide interpretation of "transport" – many defence and security uses are not "transport" and they will not be covered. For two ASD application areas that were assessed by the dossier submitters, release agents and release foils, it is open to interpretation if they are covered by the proposed derogation 5-s "*lubricant*". The contractor assigned these two applications separately as "5-s?" – see Table 17. However, a **significant number of ASD application areas** were considered to be **either fully or partially assessed** by the dossier submitters but **not assignable to** either **a proposed/potential derogation** (see Table 18). A **significant number of ASD application areas** were **not assessed** by the dossier submitters and are mostly **not assignable to a proposed or potential derogation** (see Table 19 (red)).

From this investigation into ASD member uses, ASD has further confirmed that PFAS chemicals are ubiquitous in the production, operation and MRO of A&D products. Fluoropolymers are the most widely reported PFAS type as articles (seals, cables, etc.), integrated into articles (paints, coatings, sealants, etc.) or components of mixtures (e.g. lubricants, cleaning agents) across all A&D products. When assessing identified ASD member uses of PFAS against the scope of the proposed/potential derogations, it is clear that that there is insufficient coverage for the vast majority of its application areas.

From the use and derogation assessment, it is clear that if the restriction (RO2) came into force as proposed, the impact on the sector would be significant and would already be apparent within the 18 month transition period, since ca. half of the PFAS uses identified to date would not be covered at all by either a proposed or potential derogation. For those uses that could be covered by a proposed/potential derogation, and assuming these uses could even viably continue in the absence of the non-covered uses, the A&D sector would need to rely on a scattered and incomplete set of derogations, with expiry dates that do not consider the challenges and specificities for developing and introducing alternatives in the sector.

Such a situation, where some A&D uses are not derogated for and others are sporadically covered by multiple non-A&D specific derogations with short (12 years and less) expiry periods would lead to non-use scenarios being realised. Even if one PFAS-reliant component or formulation, critical to manufacture or MRO of an A&D product is no longer available (e.g. due to lack of clear derogation), the product manufacture and in-service support would cease. Taking civilian aviation as an example, this would mean grounding of aircraft. We see that this has not been considered by the dossier submitters.

In terms of derogation periods, particularly for fluoropolymers (which may never be replaced with less 'persistent/resilient' alternatives), 5 or even 12 years is inadequate for the A&D sector, even if there were potential alternatives available, due to the strict qualification and certification requirements that have to be met before a new alternative can be safely introduced and the long product service lives together with the associated need for spare parts/legacy spare parts to be available for decades. It would take decades for a full phase out if suitable alternatives could even be developed. The substitution requirement would impact thousands of parts, components, sub-systems etc. in all A&D products on a scale that has no precedent for this sector.

2.2 Specificities of ASD products

As outlined in our reply to Q1, PFAS chemicals are used in the production, operation, and maintenance of A&D products and/or in the manufacture of component parts (articles), sub-assemblies and formulations (mixtures) in A&D supply chains. This means that the impact of the restriction needs to consider production, operation and MRO activities.

2.2.1 High performance in harsh/extreme operating conditions is a key requirement for safety and reliability of A&D products

From our use identification to date, it is already clear that PFAS chemicals are ubiquitous in A&D products. Fluoropolymers in particular are integrated at every level of the supply chain relating to the production, use and maintenance, repair and overhaul (MRO) of A&D products. Due to their unique combination of properties (chemical inertness, thermal stability over a wide temperature range, non-stick and low friction properties, electrical insulation, weather and UV resistance, high resistance to corrosive liquids and gases,, mechanical strength and durability) they are used in seals, sealants, gaskets, lubricants, bearings, bushings, etc. the parts, components and systems that make up A&D products. The drivers for their ubiquitous use stem from their high performance in harsh/extreme operation environments that underpin the safety and reliability of A&D products. They have been integrated into A&D products due to their performance and an A&D product will have 1000’s of PFAS containing parts integrated into components and systems. There are formal quality management systems in place to qualify and certify/approve A&D production, operation and MRO. This means that once a product is approved, there are formal change management protocols that must be followed for any change. This means that a substitution requirement to change all current PFAS containing parts has to follow the quality management systems in place to ensure continued safety and reliability of A&D products.

2.2.2 Complexity in terms of number of parts

A&D products are generally very complex assemblies of parts, components, sub-systems and systems. For example, a single product such as a tank or air defence system contains many thousands of parts, utilising an exceptionally wide range of materials and technologies in the engines, structure, wheels, radio communications, controls, fuel system, lubrication systems, hydraulic systems, munitions, CBRNE protection, etc.. Hydraulic systems will have PFAS containing hydraulic fluids, hoses, seals, gaskets, filters and cables. In an aircraft such hydraulic systems are then used in braking systems, landing gear, wing flaps, flight-control surfaces, engine pumps, air turbines, and many other area. A single major platform such as a ship or aircraft can have millions of parts, many of which are complex assemblies. Figure 1 illustrates that products like commercial aircraft are assembled from parts that are themselves made up of thousands of parts. It has been estimated that around 400,000 - 500,000 PFAS-containing components are likely to be present in a smaller short-haul commercial aircraft, whilst in larger aircraft the number of PFAS-containing components will likely be in excess of 1 million.

2.2.3 Illustrative examples of the diversity of A&D uses of PFAS in a diversity of A&D products

20 case studies are given in Annex 2 illustrating the use of PFAS in A&D products, and providing a thorough explanation on the reasons/ needs and the status of alternatives. These examples are not exhaustive and many other uses of PFAS chemicals are also still required. Some highlights are given below.

For example, a **commercial airliner** will have many thousands of integrated fluoropolymer seals, gaskets, sealants, coatings, cables, connectors in its gas turbine engines, landing gear, fuel systems, brake systems and electronic systems. Fluoropolymer seals are used in various critical applications within gas turbine engines, such as sealing combustion chambers, fuel systems, lubrication systems, hydraulic systems, and other high-temperature and high-pressure components. The specific choice of fluoroelastomer seal depends on the operating conditions, fluid compatibility, and temperature requirements of the engine component (see case studies 3, 14). **Gas turbines engines** in turn have applications in a very broad range of fields – the major ones are aviation, oil and gas, marine propulsion, power generation and industrial applications. PFAS containing lubricants and hydraulic fluids are integral to the functioning of safety critical components like aircraft gas turbines (jet engines), including actuators, flight control systems and landing gear systems, maritime gas turbine, combustion engines (see case studies 7, 14) .

Lubricants are another example. Fluoropolymers are very widely used as lubricants for bearings, valves, actuators, regulators, gears and gearboxes, gear chains, mechanical devices (like hatch opening) and fasteners in general. **Electronic systems** also have integrated fluoropolymer components due to their inertness, light weight, mechanical strength, and durability (see case study 18). **Energy sources** like Li-ion batteries and hydrogen fuel cells also have integrated fluoropolymer components (see case study 6).

Non-polymeric PFAS are used in the operation of A&D products. For example, commercial airplanes, military vehicles, naval vessels including aircraft carriers and submarines use **clean agent fire suppression systems**. Clean fire suppression systems are designed to rapidly extinguish the fire without leaving residues that damage equipment or cause harm to humans breathing them in. PFAS gases have generally replaced or are about to replace halon as the fire suppression agent. Halon was banned under the F-gas Regulation and Ozone Depleting Substances (ODS) regulations. It was also banned for non-essential uses since 2003 and banned for essential uses by 2040. For aircraft fire extinguishers systems and other A&D uses, the replacement of halon (as required by the Montreal Protocol and associated regulations) has been staged over time, some systems being already addressed/retrofitted, some others on track for approval in 2024 - in most of the cases, the halon replacements are PFAS chemicals (see case study 5).

PFAS chemicals are also used as heat-transfer fluids in **refrigerant systems**. For example, in defence platforms, including jet fighters, surveillance platforms, transports, helicopters, naval ships, submarines and land vehicles, they are used in weapon systems to cool high output electrical and electronic equipment in addition to air conditioning, general equipment cooling and food preservation. In commercial aircraft, refrigerant systems are used for cabin air conditioning, avionics cooling, galley cooling, cargo hold cooling and equipment cooling (see case study 4).

Other PFAS chemicals are used in operation and maintenance activities to modify surfaces to repel rain and dirt. For example, they are used as rain repellent agents in fluids applied to windscreens in aircraft, military aircraft canopies, defence platforms like aircraft carriers, etc. They impart water repellence to windscreen surfaces ensuring good visibility under all weather conditions. They are also used in cleaning fluids to prevent rainwater sticking to surfaces leading to ice formation at high altitudes and changes to the weight and balance of the aircraft during flight. Another example of their use is in the technical textiles coating mainly used in the land defence vehicles and tanks, aircrafts, etc. for their fire and smog resistance properties and as water and oil repellence at the same time.

More details are given in Section 2.3.

2.2.4 Very long service lives and availability of spare parts and materials for operation and MRO

Products typically have decades long service lives meaning that a continuous supply of parts and material must be available for their operation and also in maintenance, repair and overhaul (MRO) until the end of service life. The latter also particularly relates to ships and submarines including for lay-up prior to decommissioning. All spare parts and materials are generally required to be as per the original design specification in all key attributes including physical, chemical, surface wear, life, reliability and compatibility with adjacent materials and components.

2.2.5 Complex multi-tiered supply chains

Due to the complexity of the products, each OEM will deal with hundreds of suppliers for each product/platform type. For some suppliers, production will be based on customer (OEM) drawings. Others will have their own designs and supply chains using a variety of custom and off-the-shelf commercial components. A simplified two region supply chain diagram is given in Figure 2 to illustrate the complex interrelationships and many levels of the global supply chain.

Figure 1. Illustration of the complexity of A&D products (adapted from Figure 8 in the ASD Sectoral Guidance for WFD/SCIP implementation[3])

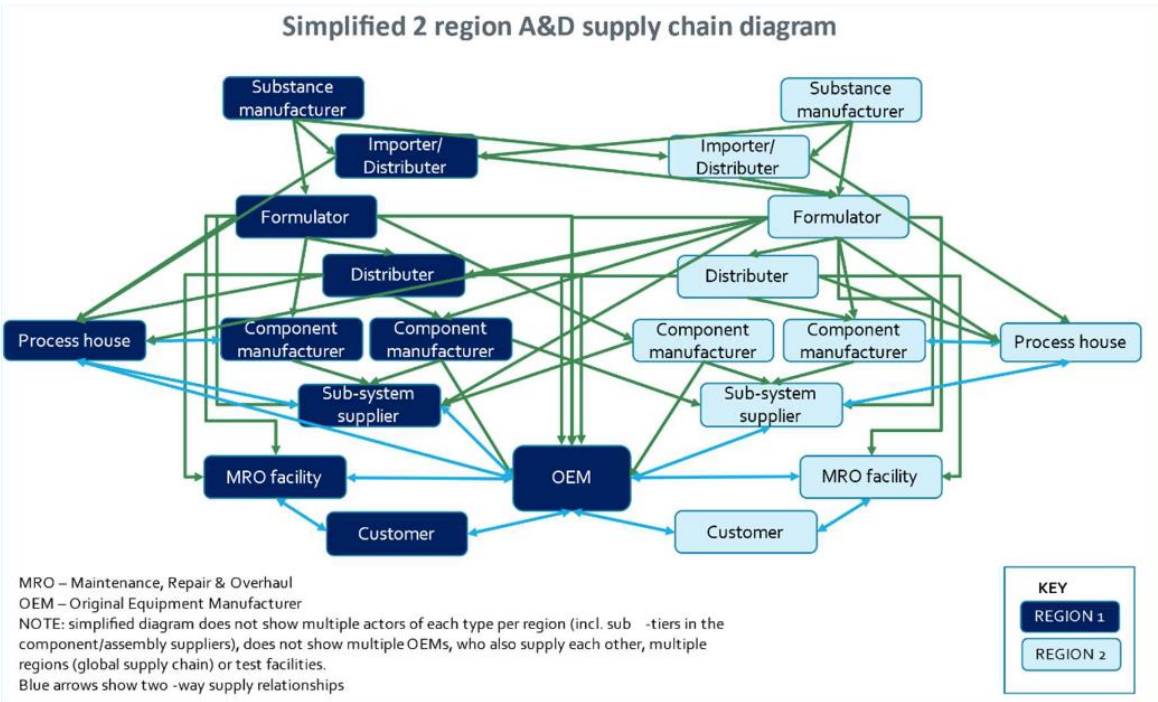


Figure 2. Simplified 2 region A&D supply chain showing the interdependences between the different tiers (reproduced with permission from the ADCR authorisation applications4 for CrVIs for the A&D sector)

[3] ASD Sectoral Guidance for WFD/SCIP implementation available at https://www.asd-europe.org/sites/default/files/2022-08/ASD%20Sectoral%20Guidance%20for%20WFD-SCIP%20implementation0505.pdf

[4] ADCR application for authorisation for continued use of hexavalent chromates; Application ID 0327-01 "*Chemical conversion coating using chromium trioxide, sodium dichromate and/or potassium dichromate in aerospace and defence industry and its supply chains*" available on the ECHA website at https://echa.europa.eu/en/applications-for-authorisation-consultation/-/substance-rev/74108/term

2.2.6 Formal quality management systems in place to ensure safety and reliability of A&D products

A&D products are subjected to some of the most aggressive environments around the world. They must operate successfully in extremes, not limited to altitude, temperature, pressure, and precipitation, while having to fulfil the highest possible technical reliability and safety requirements. Formal quality management systems are in place to ensure safety and reliability of A&D products throughout their service lives. For example, to ensure aircraft safety, comprehensive airworthiness regulations[5] have been in place in the European Union (as well as around the world) for decades. These regulations require qualification of all materials and processes according to a systematic and rigorous process to meet stringent safety requirements that are ultimately subject to independent certification and approval. Such rigorous testing and qualification processes are required to assure that any changes do not compromise the integrity of the affected components or the safety of the product as a whole.

Parallel requirements[6] are in place to ensure airworthiness for defence systems in Europe. Ground and sea-based defence systems are subject to similar rigorous qualification requirements. They operate in extreme environments over many years. In the defence sector, many national, European and NATO standards are obligatory and must be reached to be compliant with the NATO requirements settled by the allies in the international agreements. Space systems must also meet the highest specifications for consistent reliability and performance in extreme environments over many years, since repair or maintenance is practically impossible once the technology is launched.

This means that every alternative for an existing use must be successfully qualified (evaluated and tested) in the context of the whole system/sub-system. This has to be demonstrated for every existing use to be replaced, even if the alternative is the same. Once qualified, the system must be revalidated to maintain certification of the product (aircraft, vessel, vehicle, etc.). Certification is strictly controlled by regulatory bodies in the EU and other jurisdictions, in both the civil aerospace and military domains (European Aviation Safety Agency (EASA), the US Federal Aviation Administration (FAA) and their military counterparts).

Alternatives can only start to be used once they have successfully passed the qualification and certification stages. This means that substitution is a lengthy process. The specificities of the substitution process for the A&D sector are described in detail in the ADCR authorisation applications – see for example chapter 3.1.2 of the AoA-SEA report of the application requesting authorisation for continued use of hexavalent chromates in conversion coatings[4].

The scale of the substitution effort that would be required, if new materials are ever developed to replace PFAS (but in particular fluoropolymers), has no precedent. Thousands of formulations, parts, components, systems etc. across all A&D products would be affected.

Note that one of the challenges is to find suitable substitutes that fit with the existing product design. These are more or less frozen as they are tied to the type certification, making substitution technically and/or economically impractical. The "form, fit, function" requirements, that alternatives have to comply with, may mean that a complete redesign could be needed, which may in turn impact on product characteristics such as weight and adversely impact environmental performance. Retrofitting in-service

[5] E.g. European Union (EU) Regulation No 216/2008 and the EASA CS-25 and EASA CS-E in the EU

[6] The European Aviation Requirements (EMARs) established by the European Defence Agency (EDA) Airworthiness Authorities (MAWA) Forum

products also has temporal, logistical & economic challenges. For example, one OEM has design responsibility for a customer fleet of 12000 in-service civilian aircraft.

2.3 A&D uses of PFAS chemicals (Missing uses (Q6))

Based on the use mapping reported in section 2.1, ASD see that the specificities of their A&D sector have not been considered by the dossier submitters (variety of different A&D products concerned, number of parts and products concerned, strict qualification/certification requirements, long service life requiring parts to be available for decades, complex supply chains). To be clear, the potential derogation “transport” (6-o) is not adequate for the A&D sector as not all uses would be covered and the time limit of 12 years is insufficient.

For this reason, ASD provide information on A&D sector uses of PFAS in its reply to Q6 and request A&D to be considered as a sector in its own right, when determining derogations.

2.3.1 Tonnage and emissions – PFAS uses by the A&D sector (ECHA Q6a)

ASD members are typically OEMs and system integrators and the PFAS will generally be used by the members but also throughout their upstream suppliers (parts, components, systems, sub-systems providers), service providers (MRO providers) and customers (airline companies, defence forces and their service providers). It is therefore very challenging to estimate likely tonnages and emissions.

Types of PFAS: Based on the identification of PFAS uses by ASD members to date, polymeric PFAS are the most widely used PFAS type and are integrated to the parts and components that are ultimately assembled into the A&D products. Ca. 80 % of the reported uses (by count) given in Table 1 refer to polymeric PFAS and most refer to articles. As downstream users of fluorpolymers, ASD members do not have access to emissions data relating to their manufacture and end-of-life (EoL). We refer the dossier submitters to information submitted by the Fluoropolymers Product Group (FPG)[7] on manufacture and to the Conversion report on fluoropolymer waste[11]. The remaining 20 % of reported uses cover all non-polymeric PFAS.

Intentional release during use phase: For emissions, ASD have no reliable estimates at this time. Looking at the types of PFAS and where they are used in practice, ASD can differentiate between those where there is intentional release during the use and those where there is not and it is clear that there are only a few cases with intentional releases.

For polymeric PFAS integrated to parts/components in seals, gaskets, cables, sleeves, tubing, linings, and similar, there is no intentional release to the environment during use. The inertness and durability of polymeric PFAS is the driver for their use in these kinds of products.

For non-polymeric PFAS, there will be intentional release where that is intrinsic to the functioning of the system (e.g., as the fire suppression agent on the rare occasions they are used for purposes of safety (confirmed or suspected fire), this has been estimated to be ca. 4 tons per year (with +3% increase – i.e. ca. 0.150 metric tonnes - as per forecasted fleet growth – see case study 5) and no intentional release for uses as refrigerants, heat transfer fluids and hydraulic fluids.

Manufacturing stage: Due to the length and complexity of supply chains for the many parts affected it is not possible to provide additional information at this time regarding emissions during parts manufacture.

[7] Fluoropolymer Product Group (FPG) website available at https://fluoropolymers.plasticseurope.org/index.php/about-us

We refer the dossier submitters to the comments submitted by the FPG (#6418) on "*Health and Safety Directive (OHS) together with the implementation of responsible manufacturing and EoL risk-management practices*" for the position of the manufacturers. Our understanding is that for fluoropolymers in particular where there is no expected release during service life, it could be considered that any risks in the manufacturing and waste phases be addressed through the Industrial Emissions Directive and occupational health and safety measures.

A supplier of fluoropolymer seals and other parts for aerospace engines shared their estimates for emissions from the manufacture of their fluoropolymer parts used in aerospace engines at their site. The emissions are very low (< 0.3 kg /year to water and negligible to air during manufacture). These emissions can be effectively regulated under the Industrial Emissions Directive (see comments submitted by DuPont[8]).

Table 2. Preliminary estimates for breakdown of PFAS use by type and potential for emission during use from the use assessment

	Polymeric PFAS	**Non-polymeric PFAS**
% of PFAS type in A&D uses (estimate*)	Ca. 80 %	Ca. 20 %
Intentional releases to the environment during use	No, for most uses where the polymer is integrated to a part/component– there is no release for the service life of the part.	Yes, for some uses where release is a required function (fire suppression – see details in case study 5 in Annex 2 No, for other uses (e.g., refrigerant systems with leak controls)

* by count from the preliminary use mapping done – see Table 1

Emissions at end-of-life stage: Emissions depend on the type of PFAS and the specific use. The following details are based on civil aviation practices. Similar processes are anticipated in military equipment such as military aircraft in such cases where there is end of life disposal. It should be noted that the end-of-life management of military equipment is a highly sensitive subject for national security reasons and no information is provided on that in this report.

End-of-life A&D products e.g. aircraft, defence vehicles are valuable assets due to the parts and materials contained even after service life measured in decades. See for example the information on recycling of specific aircraft on OEM websites[9] and providers who specialise is aircraft recycling.[10] Dismantling includes decontamination/depollution steps to separate out hazardous waste including all chemicals and fluids which are then sent to appropriate hazardous waste treatment facilities. Some of these will include PFAS. As shown in the sectoral use mapping (Table 1), fluoropolymers are the dominant PFAS type and are generally integrated in articles such as seals, O-rings, fluid systems, cables and structures, etc.. As outlined in the Conversio report on fluoropolymer waste, the focus of aircraft dismantlers and recyclers is to extract valuable and reusable parts as well as recovery of metal fractions such as skeleton and cladding.

[8] Socio-Economic Impact Assessment for the use of PFAS within the Aerospace Supply Chain, Final Report prepared for DuPont by RPA, submitted via the webform on 09.08.2023
[9] https://aircraft.airbus.com/en/newsroom/news/2022-11-end-of-life-reusing-recycling-rethinking
[10] https://www.tarmacaerosave.aero/aircraft-recycling

Non-recyclable materials are mainly incinerated for energy recovery operations. Only a small share of plastics, incl. a small share FP materials, is landfilled, e.g., in the UK or in France.[11]

Aircraft storage, recycling and disposal is a specialised activity and is managed as a service.

Land defence vehicles storage, recycling and disposal is a specialised activity and is managed as a service with MoDs.

Emissions at end-of-life from the decommissioning of fire suppression equipment are extremely low as most of the agent is recovered and reused to service other equipment.

2.3.2 Key functionalities driving the use of PFAS chemicals in A&D products (ECHA Q6b)

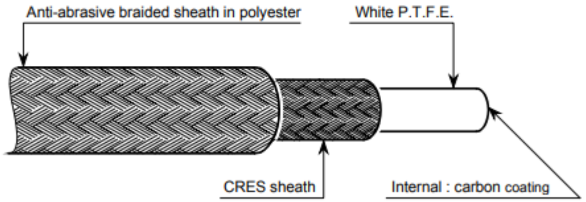
The key functionalities will depend on the driver for using the PFAS chemical in parts, components, sub-systems, assemblies and products. ASD members differentiated between polymeric PFAS and non-polymeric PFAS in their description of key functionalities requirements. Depending on the A&D product, their key functionalities are determined by the operating environment and conditions of use of the affected formulation or article within a product.

To illustrate the diversity and complexity of PFAS use across A&D products, some examples are given in Table 3. (typical fluoropolymer articles), Table 4 (formulations containing fluoropolymers) and Table 5 (non-fluoropolymer uses). As A&D products were generally not considered by the dossier submitters in their assessment, the examples aim to explain the where and why for PFAS usage.

[11] Fluoropolymer waste in Europe 2020, End-of-life (EOL) analysis of fluoropolymer applications, products and associated waste streams Conversio report 2022-07-19 available at https://www.ft.dk/samling/20222/almdel/euu/spm/49/svar/1951975/2698345.pdf

Table 3.Overview of typical fluoropolymer parts used in the production and MRO of A&D products, the drivers for the use and examples

Common fluoropolymer components	Description	Driver for why it is made from a fluoropolymer	Examples of fluoropolymer parts integrated to components/systems
Bearings and Bushings	Parts in mechanical systems that allow free rotation between a shaft and surrounding structure with minimal axial or radial movement.	- Higher thermal capabilities; - Reduced friction and wear, - life extension and performance i.e., lower friction less power losses Bearings in aircraft control levers are given an illustrative example. In an aircraft environment, where heat and chemical resistance as well as excellent wear characteristics are required, PTFE containing bearings or PTFE containing films are used at the interfaces of moving parts where low friction is required and other methods such as lubricants which require associated regular maintenance are not feasible. For example, the flap lever controls the high-lift system during take-off and landing. In addition to various sensors in the wings and redundant computer systems, the high-lift system is controlled manually by the pilot. The necessary, so-called Flaps Lever is situated in the cockpit and is the man-machine interface of the system. The Flaps lever is mounted in its pivot point in bearing shells, containing polytetrafluorethylene (PTFE) thus to minimize friction of the bearing. Due to the fact that the adhesive and the gliding friction are equally low with PTFE, the so-called stick-slip-effect is prevented, which is crucial for precise operation of the Flaps lever by the pilot.	 Use of PTFE bearings in aircraft control lever These parts are used at every intentionally moving interface. In aircraft this includes, flaps, slats, rudders, ailerons, doors, landing gear, fire escapes, switches, levers etc. In other products, these includes drive trains, turrets, anchorage and mooring systems, missile loading systems, cargo management, cranes. Exact material choices depend on operating conditions. See case Table 11. 12 and case study 8 in Annex 2.
Hydraulic hoses	Flexible pipes that allow transfer pressure through an incompressible fluid, with minimal expansion or flexing under extremely high fluid pressures	Performances related to aging (aeronautical requirement related to lifetime) - large range of temperature (-55°C to 232°C) - large range of pressure: full vacuum to 10 000 PSI - Compatibility with almost all fluid (fuel, hydraulic, …) - Compatibility with oxygen system (breathable) - mechanical performance mix: flexibility & tensile/ pressure properties - All specifications (standard and customer) require PTFE for hose construction As a specific example from the aviation sector, hoses in the aircraft are used to contain and convey hydraulic fluids, oils, fuel, greases, lubricants, anti-icing and de-icing agents, cleaning agents, oxygen, extinguishing agents and multiple other flight safety critical substances.	 Schematic of aircraft fuel and hydraulic systems

Common fluoropolymer components	Description	Driver for why it is made from a fluoropolymer	Examples of fluoropolymer parts integrated to components/systems
		Hydraulic hose lines act as links to ensure the transmission of energy in hydraulic systems. If they fail, the entire system is affected and machine failures are the result. Certification co-dependencies: as of today certification requirements make it so hydraulic fluids are phosphate ester based for fire resistance. As a result, hydraulic hoses must be resistant to phosphate ester.	 Schematic of CRES (corrosion resistant steel) hose material structure/layers Every hydraulic system has integrated hydraulic hoses. Hydraulic controls are used for high-force mechanical actuation for wing and rudder controls, thrust reverser movement, landing gear, gun turret and torpedo operating systems, crane and mooring systems. See Table 11 and case study 2 in Annex 2.
Seals (including O-rings and gaskets)	**Gasket**: Packing material between two relatively static surfaces to prevent leakage. **O-Ring**: A circular seal or gasket preventing liquids or gases from mixing or escaping to atmosphere	**Seals**: Use in aggressive environment: fluids (e.g. engine oil), space (extreme temperature and pressure) **Gaskets:** Chemical resistance (oils, greases, fuels) Thermal resistance (205°C / continuous) Resistance to ozone and oxygen For example**,** fluorocarbon and PTFE seals used in multiples parts of gas turbines. There are no alternatives that met the temperature and material compatibility requirements. Fluorocarbon and fluorosilicone seals are standard for fuel system sealing. There are no alternatives that have temperature and compatibility capability. Inability to use fluorocarbon seals would additionally prevent the use of sustainable fuels where the biggest compatibility challenges exist. Aircraft and other A&D products are required to operate in a wide temperature range of -56 to 80°C, in some areas the temperature may go up 220°C (engine fuel feed lines and recirculation). Seals and sealing solutions have to be suitable for use under these extreme temperatures. In particular, fuel seals and fittings must remain pliable at the coolest temperatures, to cope with flexure in the airframe from air movements and aircraft manoeuvres to avoid leaks. They also need to be oxygen, ozone, fuel and	 Photos of O-rings and parts with fitted seals

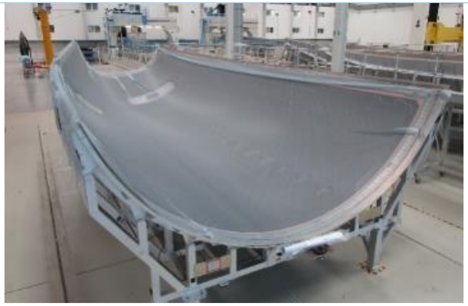
Common fluoropolymer components	Description	Driver for why it is made from a fluoropolymer	Examples of fluoropolymer parts integrated to components/systems
		oil resistant. Due to very specific technical requirements and extreme operating conditions, there are only two fluorinated rubbers which can offer the properties and characteristics needed to be used for aircraft seals and sealings solutions: Fluorinated silicones (FMQ) and fluorinated carbon rubbers (FKM). All the main groups of fluorinated rubbers possess very enhanced properties over traditional oil resistant rubbers, the key ones being the high resistance to swelling and mechanical strength. Fluorinated silicone rubbers (FKM) have a very extended temperature range -45 to +225°C and consequently extreme resistance to long term oxidation, aging and perishing.	Seals are used in gas turbines compressors and turbines to separate primary gas flows and cooling air, in air bleed valves, oil pumps, fuel pumps. oil and fuel filters, fuel delivery systems, fuel and oil temperature or pressure transducers, every fuel or oil pipe joint, shut-off valves, control valves, gearboxes. Across aircraft systems, seals are used through the hydraulic system including hydraulic pumps, pipe joints, filters, actuators for landing gear, flaps, rudders and ailerons. Seals are found around cargo doors and passenger doors, windows, electrical connectors, access panels. In other applications seals are used to protect all kinds of marine systems from sea water entry, and for the integrity of all manner of systems including fuel, lubrication, and hydraulic systems and to protect electronic and other systems from corrosion. See Table 11 and case study 3 in Annex 2
Sleeves	A protective tube that fits over a wire, pipe or other part to protect it from abrasion or to prevent electrical short circuits.	**Shrink sleeves:** - Heat and chemical resistance; - Insulation - Dielectric properties - Thermal resistance - Fire resistance - Mechanical protection - Chemical resistance **Sleeves:** - Excellent mechanical strength and toughness, stiffness, - high dielectric strength, - abrasion resistance, - creep resistance, - high purity, - chemical inertness, - low flammability & low moisture absorption.	Sleeves in electrical wiring provide insulation and protection for individual wires in electrical joints. Electrical and electronic systems are everywhere in modern A&D equipment, with many thousands of electrical joints per product system. Sleeves may also be used around oil or fuel pipes wherever there is a risk of rubbing and abrasion to protect against leaks or fire.
Sealants, adhesives and tapes	Adhesives and sealants stick to surfaces and may be used for a range of purposes including prevention of fluid	**Sealants**: PFAS contribute to the high temperature stability and fuel resistance (high chemical stability) of fluorocarbon sealants. **Adhesives**: High Strength, Chemical, thermal, water, and electrical resistance (insulating and dielectric properties), low coefficient of friction, chemically inert, high wearability and adhesion strength, cohesion (drip-resistant)	These products may be used in complex assemblies at joints or mating surfaces where there is a risk of air or fluid leaks and where disassembly is not needed, including in electronic assemblies, fuselage structures and wing structures.

Common fluoropolymer components	Description	Driver for why it is made from a fluoropolymer	Examples of fluoropolymer parts integrated to components/systems
	leakage between parts and mating surfaces. Tapes comprise a surface material together with an adhesive to provide a protective surface.	**Tapes**: protect parts from dust and aggressive chemicals (e.g., lubricants, fuels, electrolytes) thus ensuring functionality and reducing service intervals; prevent leakage, resistant against heat, pressure and corrosive chemicals and also have a low friction coefficient For A&D products, fluoropolymers are crucial in ensuring that high-performance sealants, mastics and resins, and gaskets and moulded products: - Provide reliable sealing over the long lifetime of A&D products (can be 40+ years) operating in hostile environments. - Seal pressurised cockpits and cabins in aircraft subjected to rapid changes in pressure differentials, noting that the pressure differential is especially great at high altitude - thus maintaining a safe environment for crew and passengers. - Prevent leakage of fuels, oils, coolants from high-pressure systems subject to high stress environments/vibration, extreme temperatures and rapid temperature fluctuations. - Prevent ingress of fluids, dirt and debris to A&D products operating in hostile/extreme environments. - Withstand exposure to fuels, engine oils, hydraulic fluids and chemicals that may cause deterioration in sealing properties upon contact. For example, sealants are used to seal airframes, panels, and other structures both in civil and military aircraft. Aerospace sealants have a significant impact on airframe functionality, operational performance, and maintainability. Tapes increase aircraft surface life because they effectively protect aircraft panels from vibration, corrosion, aggressive fluids, and more.	See Table 11 and case study 3 in Annex 2.
Cables and connectors	Electrical cables together with electrical connectors which connect electronic devices with each other and to key sensors and actuators.	**Cable insulation**: Combination of safety requirements: - temperature resistance (55°C to 260°C); - chemical resistance; - Resistant to fungal attack - mechanical resistance (abrasion, cut-through); - flexibility; - excellent dielectric properties; - arc tracking resistance;	Cables provide a nervous system-like network of reliable signal transmission within all A&D products to control communications, safety, and mission critical systems, such as flight controls, radar, and survivability equipment (depending on the product). For example, a single aircraft, satellite, or vehicle will have numerous cables and cable assemblies, each with unique performance requirements based on its specific use in a complex system.

Common fluoropolymer components	Description	Driver for why it is made from a fluoropolymer	Examples of fluoropolymer parts integrated to components/systems
		- flame Retardant **Co-axial cables**: - Resistance to soldering operations; - good resistance to solvents; - low moisture absorption; - uniform electrical properties over frequency For examples, specifically for cables in civilian airliners, ca. 50 000 km of cable are mounted each year in aircrafts by one OEM. All of these cables contain PFAS. More than 95 % of this volume (up to 49 000 km) are specified by the European standards EN2267-009, EN2267-010 and EN2714-013. Those specifications require the cables to be able to operate in temperatures between -55°C and 260°C. Fluoropolymers, and especially PTFE is the only currently known material to be able to operate efficiently cable insulation and flexibility in those temperature ranges during the whole lifecycle of the aircraft (40 years and up). Cables also need to be resistant to external contamination in case of failure of another system (fuel for example). Failure in the electrical system could lead to severe consequences and those requirements are thus essential to be met for safety and certification of the Aircraft.	 As a specific example, aircraft signal, power wires and cables systems are used all over the aircraft. The schematic shows the complex and wide electrical structure of the aircraft (engines are excluded in the schematic). Electrical system include communications, flight controls, engine controls, land controls, radars, weapon systems, power supplies, entertainment systems, lighting, flight recording systems (“black box”), telemetry and sensing systems, actuators. See Table 11 and case study 1 in Annex 2.

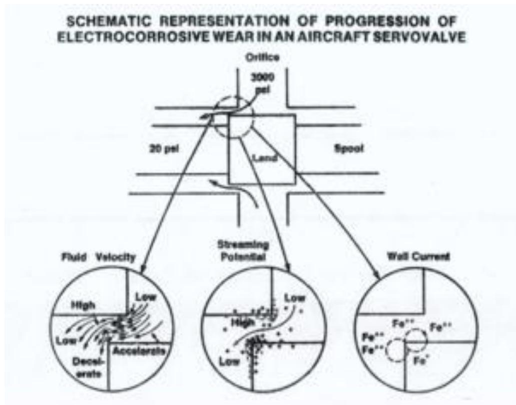
Table 4. Common polymeric PFAS containing mixtures used in the production, operation and MRO of A&D products, the drivers for the use and examples

Common fluoropolymer containing mixtures	description	Driver for why fluoropolymers are included	Examples of A&D uses
Lubricants	Materials and liquids which reduce friction between rubbing surfaces	Temperature resilience; chemical inertness; very low friction coefficient; resistance to harsh environment; Low outgassing; Lubricant operating with oxygen - Inert to oxygen; Key functions relate to the lubricant as a whole, not just to the PFAS component and include temperature stability and lifetime. It must retain its coefficient of friction over the full temperature range. Many components use these products to ensure that safety critical features are maintained. In A&D products, lubricants are used in production, operation and MRO to prevent sticking of surfaces in all use conditions. Aerospace applications have some of the most demanding requirements when it comes to lubrication. Compared to automotive applications, for example, the temperature ranges where a single lubricant must perform are considerably broader. Military aerospace applications can involve even greater extremes, in addition to other requirements, such as long storage life. Component failures in aerospace applications can be catastrophic, not only in terms of the capital costs of the parts themselves, but also because of the ancillary costs of repair and safety risks they engender.	Aircraft gas turbines (jet engines), including actuators Aircraft flight control systems Aircraft landing gear Maritime gas turbines Combustion engines Bearings – plain, roller, sliding Valves, actuators, regulators Gears, gearboxes Chains Friction reduction in various mechanical devices Door / hatch / window opening mechanisms Fasteners – screws, bolts, nuts, etc. See Table 11 and case study 10 in Annex 2.
Coatings	A coating that modifies the surface to give specific properties e.g. non-stick, corrosion resistance, abrasion resistance	Surface modification to prevent foreign particles sticking to the surface in all conditions of use For example, the requirements for coatings used in military aircraft systems, specifically in protecting aircraft parts, radomes and leading edges from abrasion and rain erosion during flight, are highly demanding. Operating in mission environments characterized by supersonic speeds, high altitudes, rain, UV-radiation and friction-induced high temperatures, military aircraft face significant challenges. Sprayable coatings are essential for providing effective protection against rain erosion and abrasion, aerodynamic heating, thermal flash exposure, and weathering. PFAS, particularly in the form of FKM (fluoroelastomers) and PTFE (polytetrafluoroethylene), play a critical role in meeting the functional requirements of these coatings. They possess unique properties such as heat resistance exceeding 200°C, wear resistance, lubricating properties, elasticity for shock absorption, and excellent aircraft fluid resistance, making them indispensable for military aircraft applications.	 naval carrier with a radome Weather-resistant structures, marine systems subject to salt water attack, hydraulic pumps and actuators. See Table 11. 1 and case studies 11 and 19 in Annex 2

		In defence products, for example the surface protection system used in rail launchers is essential to their performance and longevity. The current state-of-the-art solution involves hard anodizing-based protection with a PTFE sealing to reduce wear. This combination provides a range of exceptional properties that are critical to meeting the demanding requirements of rail launcher applications.	
Release films	Release films allow for the removal from the composite part of other process materials such as breather fabric and flow media.	ETFE, PTFE, and FEP-based mold release films play a vital role in aircraft and aerospace craft manufacture, offering the cleanest, most consistent release performance possible. The molding of composite structures is essential in improving the ratio of strength-to-weight and resistance to corrosion and fatigue. For example PTFE coated fibreglass fabric is used in various composite manufacturing processes. It is applied directly to the mold and product allowing for an easy and clean release after the curing process of aircraft composite.	 Photo of aircraft composite part with release film Composite parts are superior to traditional metals, including aluminum, due to higher strength, lower weight, and excellent resistance to flex fatigue and exposure to environmental extremes such as heat, cold, humidity, and pressurization. Release films are used in the manufacture of aircraft composited components like helicopter rotor blades, satcom and weather radomes, structural components like tail sectors, wire harness protective insulation.
Pyrotechnic mixtures	Pyrotechnics play a crucial role in defence by providing various effects, including illumination, signalling, and smoke generation	Fluoropolymers are used in pyrotechnic flares as their complex chemistry provides spectral output which can mimic the heat signatures of the aircraft jet exhaust.	Pyrotechnic flares used as anti-missile countermeasures for aircraft are essential to mission capability, and PFAS polymers help produce the required spectral output to decoy missiles away from the aircraft. The fluoride ions from the PFAS increase the brightness of the signal, to reach the specific illuminating effect.
Energetic materials	An energetic material, often referred to as an explosive	Certain fluoropolymers are included in energetic compositions because they provide functionality to the materials. A number of explosive compositions include	Polymer-bonded explosives in military weapons and munitions (see case study 20 in Annex 2)

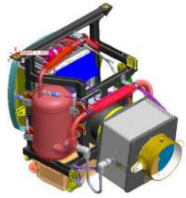
	material, is a substance that contains a large amount of stored energy that can be released rapidly in the form of an explosion. These materials are designed to release this energy when subjected to certain stimuli such as heat, shock, friction, or electrical impulses. Energetic materials are used in various applications, including military and industrial uses, mining and propulsion systems.	fluoropolymers which act as a binder for pressed pellets,-the high-density coating enables an effective energy transfer within the explosive material. The chemical stability of the binder also ensures dimensional stability and performance of the explosive composition over time.	

Table 5. Uses of non-polymeric PFAS in A&D products, the drivers for the use and examples

Non-polymeric PFAS uses	Description	Driver for PFAS use	Examples of A&D uses
Hydraulic fluids	Incompressible liquids which transfer force through hoses to actuators driving flight surfaces or other mechanisms, operating at high pressure.	- Anti-corrosion; - temperature resilience; - chemical stability; An example case study for aviation related hydraulic systems is given in the appendix and summarised in Table 11. Aviation hydraulic systems are used to control many parts of an aircraft. This includes the aircraft brakes and landing gear, the movement of flight control surfaces, pitch and yaw to move the aircraft up, down, left, and right, and parts of the wings for controlling lift and speed. All these systems are operated and lubricated by a common oil, which is a fire-resistant phosphate-ester based hydraulic fluid (PEBHF). PEBHFs are hydraulic system lubricants based on the esters of phosphoric acid. They have been the exclusive hydraulic fluid used for commercial aircraft for many decades because of their unique combination of fire resistance and low-temperature performance. The fire resistance properties are required to provide aircraft and passenger safety. The low-temperature performance properties are needed to ensure trouble-free operation of aircraft hydraulic systems, such as steering, under cold atmospheric conditions. Because of their chemical and electrical properties, phosphate ester fluids in high-pressure hydraulic systems without the use of a corrosion inhibitor additive can lead to rapid electrochemical erosion and ultimately failure of precision hydraulic system components, disrupting aircraft control. To prevent these failure modes, corrosion inhibitors for PEBHFs must increase the electrical conductivity of the phosphate ester fluid by dissociating into ionic charge carriers. The use of fluorinated compounds decreases the association energy of the ions and permits this to happen. Critically, the erosion inhibitor must be stable under harsh service conditions. Non-fluorinated erosion inhibitors were attempted many decades ago, and all	Aircraft flight control systems, actuators for flying surfaces Aircraft landing gear Actuators in defence systems. These include, but are not limited to steering mechanisms, munitions loading systems, turrets.  See case Table 11 and case study 7 in Annex 2

Non-polymeric PFAS uses	Description	Driver for PFAS use	Examples of A&D uses
		showed poor performance even in older, less severe system designs. Over 200 alternatives to PFAS have been tested in PEBHFs over 3 decades, and all have had challenges in one or more areas. To date, no potential replacement has been identified.	
Fire suppression clean agent	A clean agent is a gaseous fire suppressant that is electrically non-conducting and that does not leave a residue upon evaporation. This is ideal when protecting high value items like historical artifacts or sensitive electronic equipment. The umbrella term "clean agents" includes both halocarbon agents and inert gas agents.[12]	Fire suppression without residues (which can damage equipment in ways that can compromise safety); Chemical stability; Fire suppression at low concentration - Safe to breathe in - replacement for halon Fire extinguishers in aircraft are given as an example. Aircraft fire extinguisher systems are currently composed of build-in systems protecting four areas: - propulsion system (engines) - auxiliary power unit (APU – small gas turbine and aimed at providing energy for function other than propulsion) - cargo - cabin lavatories, plus, cabin & cockpit areas that are fitted with portable fire extinguishers The fire suppression agents have been HFCs regulated under Ozone Regulation and Montreal Protocol and substitution efforts to phase out banned HFCs has been ongoing for decades. However all substitutes are PFAS chemicals as the only alternatives that fulfil the level of safety required for airworthiness.	 Cockpit fire extinguisher Fire extinguishers are used in aircraft cockpit/passenger areas, cargo holds, and around engines and auxiliary power units. They are also used in Submarine / ship use due to confined spaces? See case Table 11 and case study 5 in Annex 2.
Refrigerant agent	Heat transfer fluids, or refrigerants, are used in refrigerant systems to absorb heat in the evaporator, release heat in the condenser, and facilitate the heat exchange process between various components. They undergo phase changes from gas to liquid and vice	- chemically inert; - non-flammable; - high dielectric strength and electrical resistivity; - evaporate without leaving residues;	

[12] https://www.gaseousfireextinguishers.com/

Non-polymeric PFAS uses	Description	Driver for PFAS use	Examples of A&D uses
	versa, allowing for efficient heat transfer and enabling the cooling or heating effect desired in the system	- broad operating temperature range; As a specific example of an A&D use, use in aircraft cooling systems is included as an illustrative case study (Table 11) HFC refrigerants are used in equipment specifically designed for use on aircraft installations and have an operation envelope to meet high safety and reliability standards. A basic principle of aircraft systems design is to avoid by design any event that could impose a risk to the safe operation of the aircraft. HFC refrigerant R-134a, which is used on aircraft, is non-toxic, non-flammable and thus intrinsically safe. Airworthiness certification of equipment is based on non-flammability classification of the refrigerant.	Galley Cooling - Air Chiller  Supplemental Cooling -Vapor Cycle Refrigeration Unit See case Table 11 and case study 4 in Annex 2.

Examples of key functionalities for specific A&D uses are given in Table 6, Table 7 and Table 8 together with information on the availability of alternatives. The details are taken from case studies given in Appendix 1 and from information available from suppliers (see summaries in Table 11). Due to their unique combination of properties that make them ideally suited to uses in harsh environments with high reliability requirements, there are generally no suitable alternatives available for fluoropolymer uses. Prior to this restriction proposal, there was no concern relating to the use of fluoropolymers in A&D and no driver to develop substitutes apart from their high costs. For non-polymer PFAS uses in fire suppression systems and refrigerants, PFAS chemicals substitute earlier HFC gases that are regulated under the Montreal Protocol and Ozone Regulation. However due to the qualification and certification requirements and the long service life of A&D products, substitution is still ongoing.

Details of what substitution would involve in practice in terms of identification of alternatives, qualification and certification are given in the next section.

2.3.3 Companies/parties in the sector impacted by the proposed restriction (ECHA Q6c)

A&D supply chains are complex and multi-tiered. The proposed restriction impacts hundreds of thousands of parts and components at all tiers of the supply chain, since if a qualified part is not available, it has a knock-on effect for each subsequent tier upstream. The non-availability of qualified parts would impact production of new products and maintenance of existing products in the EEA. It would also impact A&D customers from commercial airlines to Ministries of Defence in terms of the operability of A&D products in the EEA and their maintenance in terms of availability of spare parts and legacy spare parts. It would impact 3rd party MRO service providers who would not be able to source components containing PFAS in the EU. It would impact air transport (passengers, cargo) and the operational readiness of EEA defence forces as products and spare parts would not be available in the EEA and would also not be able to be sourced from outside the EEA.

Table 6. General key functionalities of polymeric PFAS and examples for specific uses

Polymeric PFAS	General	Seal in a gas turbine engine	Cable insulation in A&D products	Valves & seals in the manufacture of explosives	Printed circuit boards and assemblies integrated into electronic systems	Coating for the radome housing communication and weather antenna
Key functionalities	Durable, stable and mechanically strong in harsh conditions in a variety of sectors including but not limited to automotive, aerospace, environmental controls, energy production and storage, and electronics, stable in air, water, sunlight, chemicals and microbes; Chemically inert, Non-wetting, non-stick, and highly resistant to temperature, fire and weather	Provide thermal stability and resistance to vibration and to chemicals that may cause deterioration in sealing properties upon contact. e.g., PTFE lip seal Tight sealing, even under high pressure in excess of 35 Bar; Ability to run at temperatures far above or below elastomer rubber lip seals (with typical temperature ranges from -53 °C to 232 °C); Elastomer coatings on the seal's outer diameter make for easy installation without damaging mating hardware; Available in custom designs and a wide range of sizes and materials; Inert to most chemicals; Withstands high speed between moving surfaces in excess of 35 metres per second;	High performance over the long lifetime of A&D products (can be 40+ years), particularly where reliable, high-volume data transmission in harsh environments is essential; Low dielectric constant confers excellent electrical insulation; Flexible, resistant to cracking/degradation when subjected to high stress environments/ vibration; Allows wires in wiring harnesses to slide against each other and against harness fasteners, thus reducing stress/chafing when exposed to vibration or during maintenance; Resistant to high temperature environments and rapid temperature fluctuations; flame retardant; UV resistant.	Be chemically inert having a high strength whilst retaining elasticity, and with a relatively long life when exposed to chemicals	Low dielectric constant confers excellent electrical insulation; Heat resistance; Chemical resistance; Non-stick and low frictional properties; Resistant to water, oil and chemicals; See case study 18 in Annex 2.	Transparency to radio waves at relevant wavelengths; Weather resistance: Electrical insulation; Mechanical strength and durability; Chemical resistance. Specific example: Active Phased Array Radar in Naval applications operate in harsh and challenging environmental conditions. To protect the array, a radome is required that protects the radar system and withstands all environmental loads while also being transparent for X-band microwaves. The short wavelengths of X-band are needed for high resolution imaging for target identification. These short wavelengths require specific radome materials. See case study 19 in Annex 2.

Polymeric PFAS	General	Seal in a gas turbine engine	Cable insulation in A&D products	Valves & seals in the manufacture of explosives	Printed circuit boards and assemblies integrated into electronic systems	Coating for the radome housing communication and weather antenna
		Low friction and ability to address rotating equipment and vibration for longer life; Compatible with most lubricants and able to run in dry or abrasive media.	Resistant to water, oil and chemicals;			The only material that combines these conflicting properties is a fibre reinforced fabric with PTFE.
Availability of alternatives	There are no general alternative for fluoropolymers that have a comparable range of key functionalities. Note it is uncertain if alternatives can ultimately be innovated that would not be equally "persistent" as durability and inertness are technical performance requirements for operation in harsh/extreme conditions of use to ensure safety and reliability of A&D products.	There are no alternatives that fulfil the performance requirements. See Table 11. and case study 3 in Annex 2. The requirements for the A&D sector were not considered by the dossier submitters in the assessment of alternatives (Table E.113 in Annex E) under the "transport" use.	Currently no alternatives are available or known to be able to operate under the harsh conditions and over such a long lifecycle. See case Table 11. and case study 1 in Annex 2 This use (Annex A) and the availability of alternatives (Annex E) was not considered by the dossier submitters in their assessment.	Currently there are no viable alternatives to the fluoropolymer-based valves and seals used on equipment used in the manufacture and processing of explosives which provides the resilience and relative inertness to corrosive high temperature chemicals, and enables a high level of safety for processing of explosives and in the manufactured ammunition. See case Table 11 and case study 11 in Annex 2 This use and the availability of alternatives was not considered by the dossier submitters in their assessment (Annex A and Annex E).	There are no alternatives available that have the range of properties required for applications with high performance requirements in terms of safety and reliability. The requirements for the A&D sector were not considered by the dossier submitter in the assessment of alternatives (Table E.218 in Annex E)	No alternatives available with the range of properties needed. For the specific example of naval carriers, due to the environment and reliability requirements, materials in naval radar construction have to undergo and pass extensive qualification and testing. No alternative to PTFE coated fiber reinforced fabric is available to date for X-band radome material with required phased array radar performance which meets Naval environmental requirements. This use (Annex A) and the availability of alternatives (Annex E) was not considered by the dossier

Polymeric PFAS	General	Seal in a gas turbine engine	Cable insulation in A&D products	Valves & seals in the manufacture of explosives	Printed circuit boards and assemblies integrated into electronic systems	Coating for the radome housing communication and weather antenna
						submitters in their assessment.

Table 7. General key functionalities of non-polymeric PFAS uses in fire suppression and refrigerants with examples for specific uses

PFAS-gases	General	Aircraft fire suppression systems in 4 areas (engines, auxiliary power unit, cargo, cabin lavatories plus cabin & cockpit areas that are fitted with portable fire extinguishers)	Refrigerant HFC R-134a in aircraft installations	Heat Transfer Fluid Galden® HT in supplemental cooling system aircraft
Key functionalities	Chemically inert over a broad range; non-flammable; evaporates without leaving residues; Broad operating temperature range; Safe for humans to breathe at the concentrations used; Dielectric properties	Fire suppression without residues (which can damage equipment in ways that can compromise safety); Chemical stability; Fire suppression at low concentration - Safe to breathe in - replacement for halon Certified for use on aircraft according to airworthiness regulations See case study 5 in Annex 2	HFC refrigerant R-134a, which is used on aircraft, is non-toxic, non-flammable and thus intrinsically safe. Airworthiness certification of equipment is based on non-flammability classification of the refrigerant. Certified for use on aircraft according to airworthiness regulations See case study 4 in Annex 2	Galden® HT is used as heat transfer fluid in order to remove heat from the galleys and avionics. The physical properties of Galden® HT, being non-flammable, non-conductive and non-toxic in this application, make it intrinsically safe for use on aircraft applications. Certified for use on aircraft according to airworthiness regulations See case study 4 in Annex 2.
Availability of alternatives	Substitution for HFCs covered by the F-gas regulation has been ongoing for more than 20 years – however many of the substitutes are PFAS	PFAS are alternatives for Halon 1301. Halon 1301 (Bromotrifluoromethane) is the most effective fire extinguishing agent, but because of its high ozone depleting potential, the production of Halon 1301 was banned in 1994 as part of the Montreal Protocol. Most Halon 1301 alternatives (HFC-125 (Pentafluoroethane), 2-BTP (bromotrifluoropropene), NOVEC 1230 (Perfluoro(2-methyl-3-pentanone), CF3i	Alternatives for R-134a are available in the market for stationary and domestic applications as well as for vehicles and ground transport. These alternatives are either HFC (e.g. R-1234yf), natural (flammable) fluids like propane, isobutane, or Carbon Dioxide (CO_2). These are not currently suitable for aerospace / aircraft applications. Replacing the current refrigerant is extremely difficult in the short and mid-term refrigerant	Alternatives for use on aircraft are available. In fact, Galden® HT is not used anymore, in new aircraft types. For example in the A350 system a water-based Propylene-Water Glycol mixture is used, mainly due to weight reasons. However, additional design precautions are needed mainly due to the electrical conductivity, which could result in a risk in the case of leakages.

PFAS-gases	General	Aircraft fire suppression systems in 4 areas (engines, auxiliary power unit, cargo, cabin lavatories plus cabin & cockpit areas that are fitted with portable fire extinguishers)	Refrigerant HFC R-134a in aircraft installations	Heat Transfer Fluid Galden® HT in supplemental cooling system aircraft
		(Trifluoroiodomethane)) and all Halon1211 (Bromochlorodifluoromethane) alternatives (2-BTP and HFC-236 (Hexafluoropropane)) are PFAS. Assuming a non-PFAS Halon alternative is selected, a minimum of 15-20 years would be required for a complete transition. See Table 11. and case study 5 in Annex 2 The alternatives listed in Appendix E.2 to Annex E are not suitable for these uses.	on certified aircraft as no suitable refrigerants are on the market that have the same behaviour in terms of physical properties, e.g., are neither toxic nor flammable. It is technically possible to design, develop and build new equipment using natural refrigerants like propane and isobutane. However, the OEM needs to demonstrate the same safety level as today considering the flammability classification of the equipment. It may be possible that additional design precautions or means need to be installed on aircraft to enable safe operation of the equipment. This includes ventilation of installation areas, protection of electrical equipment, or relocation of the equipment. See Table 11 and case study 4 in Annex 2. The alternatives listed in Appendix E.2 to Annex E are not suitable for these uses.	Replacing Galden® HT on in-service aircraft is not possible, since extensive changes are needed on the equipment. If it can not be used, in-service aircraft will be grounded. See Table 11 and case study 4 in Annex 2 The alternatives listed in Appendix E.2 to Annex E od the restriction report are not suitable for these uses.

Table 8. General key functionalities of other non-polymeric PFAS and examples for specific uses

	Component of hydraulic fluid in aircraft hydraulic systems
Key functionalities	Corrosion inhibition in all conditions of use; fire resistant Aviation hydraulic systems are used to control many parts of an aircraft. This includes the aircraft brakes and landing gear, the movement of flight control surfaces, pitch and yaw to move the aircraft up, down, left, and right, and parts of the wings for controlling lift and speed. All these systems are operated and lubricated by a common oil, which is a fire-resistant phosphate-ester based hydraulic fluid (PEBHF). PEBHFs are hydraulic system lubricants based on the esters of phosphoric acid. They have been the exclusive hydraulic fluid used for commercial aircraft for many decades because of their unique combination of fire resistance and low-temperature performance. The fire resistance properties are required to provide aircraft and passenger safety. The low-temperature performance properties are needed to ensure trouble-free operation of aircraft hydraulic systems, such as steering, under cold atmospheric conditions.
Availability of alternatives	Over 200 alternatives to PFAS have been tested in PEBHFs over 3 decades, and all have had challenges in one or more areas. To date, no potential replacement chemistry has been identified with adequate stability to survive in phosphate esters in aircraft service. See Table 11 and case study 7 in Annex 2 Table E.133 in Annex E states that there are no non-PFAS alternatives available and that more than 10 years are needed for substitution. However, the assessment did not consider the specificities of the A&D sector.

2.3.4 Availability of suitable alternatives to PFAS chemicals in the A&D sector (ECHA Q6d)

PFAS chemicals are integral to the production, operation and MRO of A&D products due to their high performance in harsh/extreme operating conditions that underpin the safety and reliability of A&D products. Their high performance stems from their unique combination of properties and there are generally no suitable alternatives available that fulfil the performance requirements. Due to the formal quality management systems in place to ensure product safety, alternatives that fulfil the performance requirements would need to be identified and then taken through the strict qualification and approval processes before taking them into use. Scheduled maintenance and repair also requires the availability of spare parts that are produced as per the approved product over its entire service life. This can be decades depending on the product (e.g. 40+ for an aircraft, 40+ for a naval vessel). Any changes in the production of the spare parts also need to follow a requalification and recertification process before they can be taken into use. A redesign is likely to be needed meaning it is very lengthy as it would involve retrofitting all in-service products.

One of the key challenges with this proposed restriction is the scale of the substitution requirement it would trigger. As can be seen from the Tables above, fluoropolymers in particular are ubiquitous in A&D products. Substitution efforts would need to be balanced against all other ongoing R&D activities and substance replacement workstreams. It would also impact ongoing activities like the transition from internal combustion engines to hydrogen, as fluoropolymers are integral to the hydrogen transition (see contribution from Hydrogen Europe[13]) and MEA (more electric aircraft). Additionally fluoropolymers are necessary for the transition to sustainable aviation fuel, which would also be impacted.

The dossier submitters included an analysis of alternatives for the application areas and sub-uses they considered in their assessment. Defence and security was not included in their assessment and defence use are not generally covered in Annex A or Annex E of the dossier or if they are covered (e.g. lubricants), the specificities of defence products were not considered in the availability of alternatives or the time

[13] https://hydrogeneurope.eu/wp-content/uploads/2023/02/Hydrogen-Europe-position-paper-on-PFAS-ban_v12_FINAL.pdf

needed for substitution. For other A&D products, a limited number of uses could be under the scope of "transport". However, the dossier submitters concluded for uses under "transport " in Table E.121 in Annex E

> […] *that a 12 year derogation could be appropriate for PFAS use in transport (including automotive, aircraft, rail, marine, and aerospace industries) where the substances are affecting the proper functioning related to the safety of transport vehicles, and affecting the safety of operators, pasengers or goods. Shorter transition periods would not reflect the current state of the industry with respect to PFAS use, with many uses having no satisfactory identified alternatives at the present time.*
>
> *In light of the broad use scope and the weak evidence base to narrow down the scope for a derogation, such a derogation is not proposed at this point but marked for reconsideration. A derogation might be proposed at a later stage if additional information on (e.g.) the rationale for continued PFAS use in specific applications and the quantities of PFAS used in those applications is provided*. […]

We highlight that the dossier submitters did not consider the specificities of our sector where there are no alternatives that fulfil the performance requirements needed for safety and reliability of A&D products. 12 years is not adequate to develop new materials and subsequently phase out all the uses of fluoropolymers in A&D products. Noting that it is not currently foreseen that alternatives, that are not also considered persistent, may ever be found for fluoropolymer applications, since reliability/durability is a primary reason they are used in A&D applications.

Taking lubricants and hydraulic fluids that are ubiquitous in A&D products as illustrative examples, reformulation requires identification of alternatives that fulfil the performance requirements for **each use**. The testing of each lubricant and fluid, followed by qualification and certification for use across each application in all A&D products may take from 3 to 10+ years per formulation, depending on complexity, **after** a reformulated alternative has been developed by formulators. It is important to note that if reformulated lubricants and hydraulic fluids do not meet performance specifications and pass qualification testing, they cannot be used. In ASD's earlier submission in the call for evidence in 2021, an ASD member highlighted the risk of incompatibility between lubricants. Two incompatible greases were used in the same aircraft system and as a consequence, the mixed greases solidified and the system seized. This highlights the criticality of ensuring that even changes that may seem 'minor' at the formulation level, are adequately tested and qualified prior to being allowed to be used for A&D products.

Taking an example of ongoing substitution efforts, the A&D sector has been working for more than 30 years to replace hexavalent chromium compounds. The challenges faced with alternatives development for this sector was summarised by the Global Chromates Consortium for Aerospace (GCCA)[14] as follows (related to their application for authorisation to continue use of these chemicals after the given sunset dates):

> *"Aerospace and defence products operate and carry people in extreme environments over extended timeframes, while having to fulfil extremely challenging technical, reliability, and safety requirements. To ensure the safety and reliability of aerospace products, comprehensive*

[14] "Aerospace & Defence Qualification Process Impacts on Ability to Substitute Cr(VI) Substances" from Global Chromates Consortium for Aerospace (GCCA) available at https://www.ramboll.com/-/media/files/reh/GCCAAerospaceDefenceQualificationProcessImpactsonAbilitytoSubstituteCrVISubstanceswhitepaper

airworthiness regulations have been in place globally for decades. These regulations require a systematic and rigorous framework to be in place to qualify all materials and processes to meet stringent safety requirements that are subject to independent certification and approval through EASA and other agencies requirements. Air, ground and sea-based defence systems, and also space systems, are subject to similar rigorous qualification requirements. Changes to Aerospace and Defence hardware offer unique challenges that are not seen in other industries."

The illustration given in Figure 3 (adapted from the GCCA paper[14] in the ADCR authorisation applications[4]) provides a simplified overview of alternatives development steps and typical timelines. Note that as PFAS chemicals, in particular fluoropolymers, are ubiquitous in A&D products, **the substitution challenge is far more complex as substitution impacts multiple chemicals, multiple parts integrated into multiple components that are in turn integrated into the sub-systems and systems that make up the products**. An illustration of the testing requirements going from components to subsystems to systems from the ADCR authorisation application reports[4] is given in Figure 4.

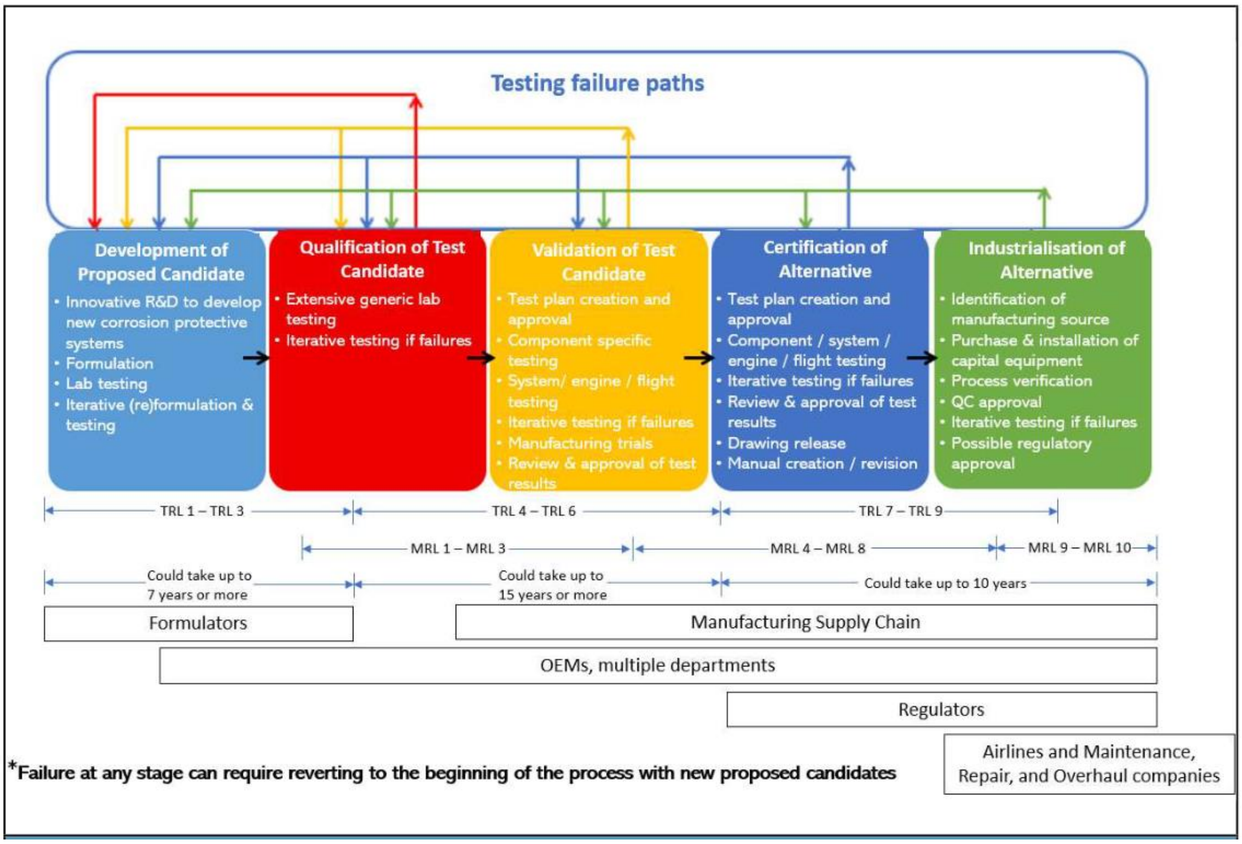


Figure 3. Schematic showing the key phases of the substitution process; Typical TRLs and MRLs associated with each stage, and the entities involved in each stage, are also shown. Note that failure of a proposed candidate at any stage can result in a return to a preceding stage including TRL 1. Note that failures may not become apparent until a late stage in the process. – adapted from the GCCA paper on Aerospace & Defence Qualification Process Impacts on Ability to Substitute Cr(VI) Substances & Joint Analysis of Alternatives and Socio-Economic Analysis, Authorisation application 0203-0242 (reproduced from ADCR authorisation application[4])

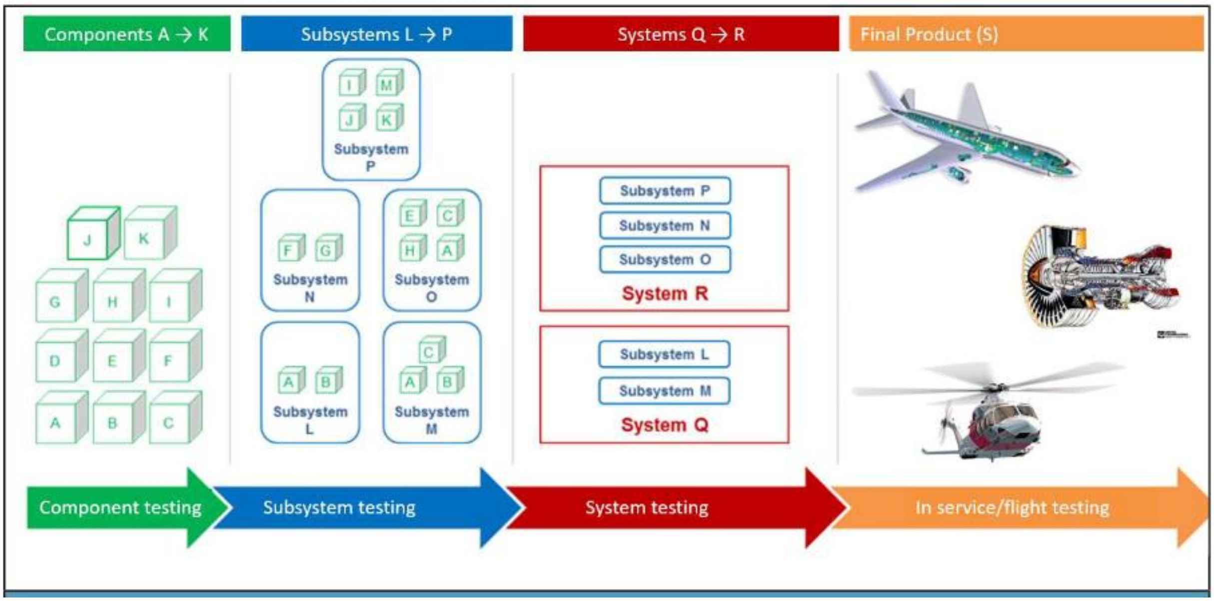


Figure 4. Assessment requirements in the implementation of alternatives (reproduced from the ADCR authorisation application[4] and based on the GCCA paper on "Aerospace & Defence Qualification Process Impacts on Ability to Substitute Cr(VI) Substances"[14]

When looking to qualify new alternatives to replace undesirable substances used in formulations and materials e.g., adhesives, sealants, resins, lubricants etc., A&D companies must ensure that the functional requirements performed by the formulation are met. The focus when determining the necessary requirements for alternatives is not typically driven by the function of any individual constituent substance per se, but on the function of the formulation as a whole in which those substances are being used (for the case where PFAS is a component of a formulation).

Thus, when providing information on the technical functions that are necessary for any alternative, information that may be provided from A&D companies is often focused on the required functions for a replacement formulation rather than a replacement substance. Furthermore, this will vary according to the different OEMs, products and parts where a replacement needs to be used, even for the same formulations. A schematic illustration of the path to successful reformulation of a formulation certified for use in commercial aircraft from the ADCR 2023 authorisation application[4] for A&D uses of CrVI compounds is given in Figure 5.

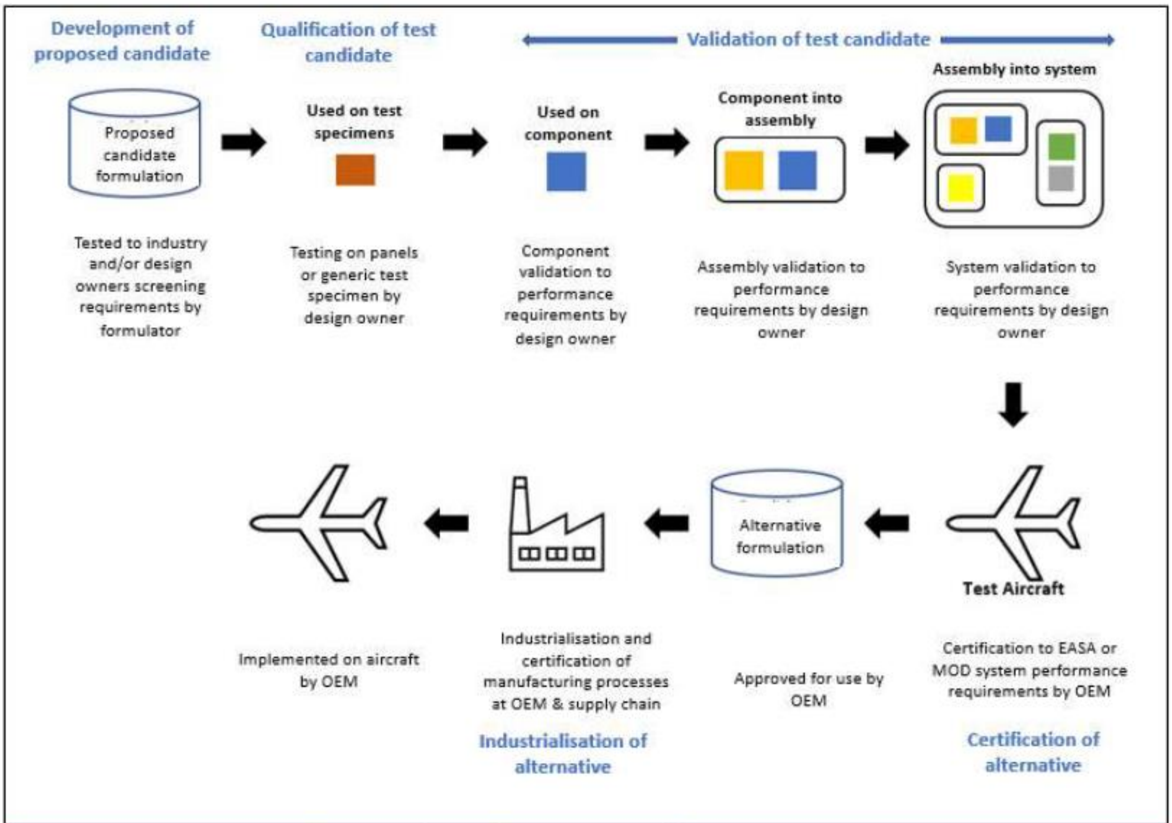


Figure 3-4: Process to Certify a Formulation for use on Aircraft
Formulations used in production have completed this process. New or reformulations must follow same process for use in production.
Source: ADCR member

Figure 5. Overview from the ADCR authorisation application[4] illustrating the complexity of reformulation must consider the overall functioning of the formulation and not solely the component substituted.

Note that with alternatives development and qualification, success is not guaranteed. If alternatives fail any part of the testing criteria, the process restarts, substitution timelines will exceed any originally anticipated timeline. Resource constraints can prevent testing/trialling multiple alternatives simultaneously (since whilst the cost/resource is less for performing multiple trials than if done separately, it is still higher than if one trial is done and it works)

An additional aspect specific to the A&D sector is the long lifetime of the products. This means that spare parts made according to the approvals in place at the time an A&D product was certified must be used in MRO, unless a replacement is qualified and certified under an exhaustive and robust process. This means that spare parts must be available for decades and also legacy spare parts must be available to support operation after the aircraft ends production. This also means storage facilities for such spares must be in place (and of adequate environmental/ cleanliness standards and maintain suitable QC standards). Non-availability of a sufficient number of spare parts means that the aircraft is grounded. The ADCR consortium authorisation applications for continued use of CrVI for various surface treatments illustrate the impact of the non-availability of parts on the ability to produce an aircraft[4] (see Figure 6).

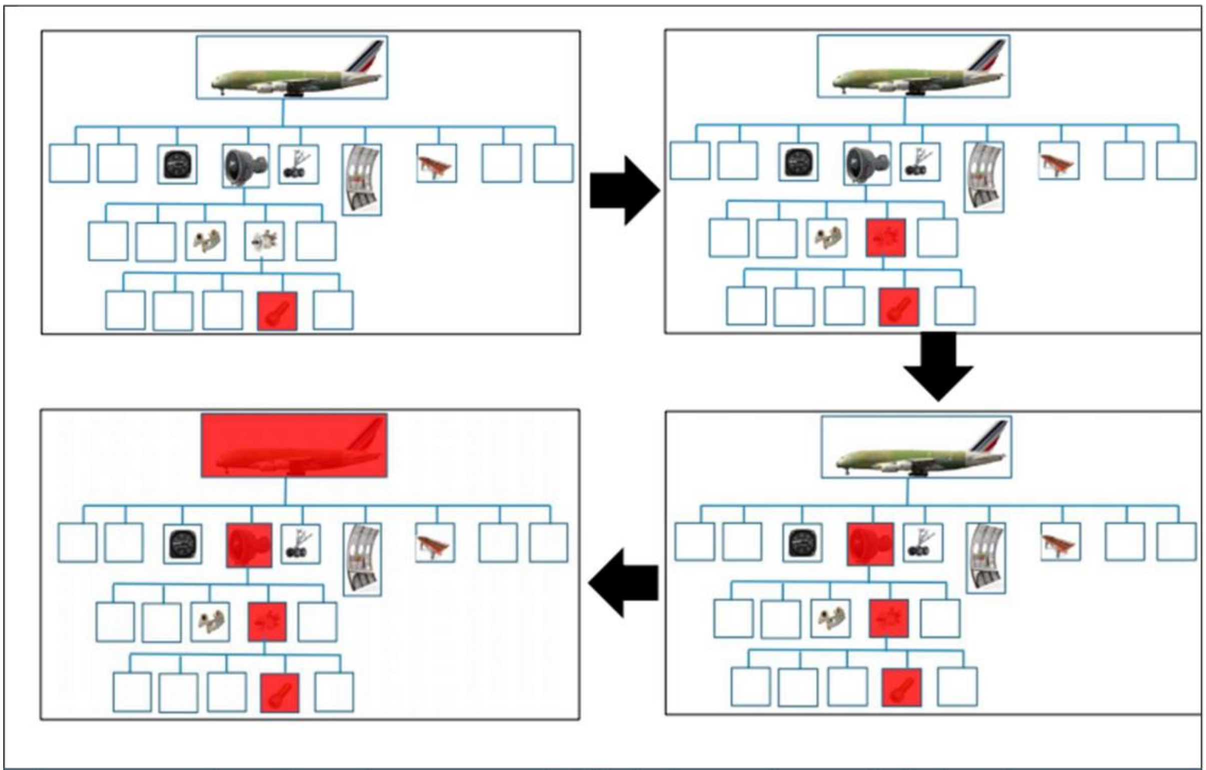


Figure 5–1: Interdependency of component availability in the manufacture of a final product

Figure 6. Schematic from an ADCR authorisation submission (March 2023) illustrating the interdependency of component availability in the manufacture of the final A&D product (in this case, a commercial airliner[4]

2.3.4.1 Frameworks to understand the "readiness" of an alternative for commercial deployment and market acceptance

To ensure a common understanding of the path to commercial deployment of a new technology, ASD share details on the frameworks that are used to describe the stages and milestones involved. Evidence of successful lab scale results does not imply ultimate successful field testing or commercial deployment. Commercial deployment in turn does not imply market acceptance.

Technology readiness levels (TRLs 1-9) give a framework to describe the stages from "proof of concept" to successful industrial deployment. These were developed by NASA for the space program in the 1970's and are now integrated into EU funding programs since the 2014 Horizon 2020 program[15]. **Manufacturing Readiness Levels**[16] (MRLs 1-10) are also widely used with assessments of innovation readiness and are designed to assess the maturity of a given technology, system, subsystem, or component from a manufacturing perspective. They were developed by the US Department of Defence (DoD) to assist decision-makers (at all levels) with a common understanding of the relative maturity (and attendant risks) associated with manufacturing technologies, products, and processes being considered to meet DoD requirements. Manufacturing readiness and technology readiness go hand-in-hand. In conjunction with TRLs, MRLs are key measures that define risk when technology or process is matured and transitioned to commercial production.

[15]Horizon Europe NCP Portal, TRL Guidance notes available at https://horizoneuropencpportal.eu/store/trl-assessment

[16] Manufacturing Readiness Level Definitions available at https://acqnotes.com/acqnote/careerfields/manufacturing-readiness-levelmanufact

Note that this framework applies for each and every application.

Table 9.Technology Readiness Levels (source EU Commission H2020 programme)[17]

G. Technology readiness levels (TRL)

Where a topic description refers to a TRL, the following definitions apply, unless otherwise specified:

- TRL 1 – basic principles observed
- TRL 2 – technology concept formulated
- TRL 3 – experimental proof of concept
- TRL 4 – technology validated in lab
- TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
- TRL 7 – system prototype demonstration in operational environment
- TRL 8 – system complete and qualified
- TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

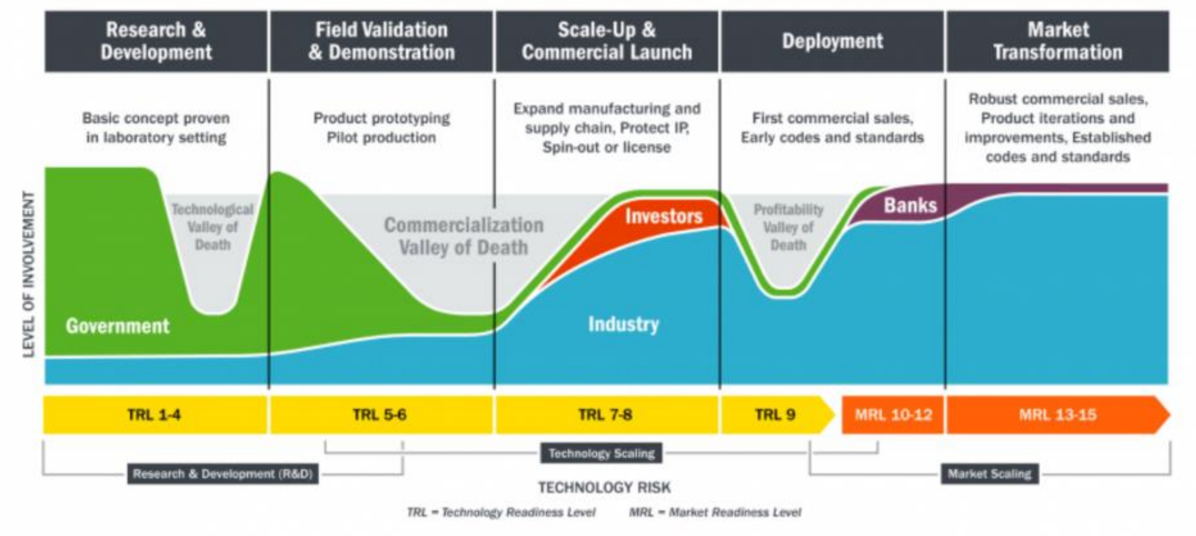
Table 10. MRL frameworks developed for the assessment of the readiness of an innovation for commercial deployment (TRL) and the readiness in terms of actual manufacturing in commercial production (reproduced from [16])

MRL	Definition
1	Manufacturing Feasibility Assessed
2	Manufacturing Concepts Defined
3	Manufacturing Concepts Developed
4	Capability to produce the technology in a laboratory environment.
5	Capability to produce prototype components in a production relevant environment.
6	Capability to produce a prototype system or subsystem in a production relevant environment.
7	Capability to produce systems, subsystems or components in a production representative environment.
8	Pilot line capability demonstrated. Ready to begin low rate production.
9	Low Rate Production demonstrated. Capability in place to begin Full Rate Production.
10	Full Rate Production demonstrated and lean production practices in place.

More recently, "**Market Readiness Levels** (MRLs 10-15)" have also been introduced by the US DoD to take into account that market transformation is also staged. The stages and milestones that need to be achieved to move from R&D to commercial production to market acceptance are illustrated in Figure 7.

[17] Technology Readiness Levels taken from H2020 work programme available at https://ec.europa.eu/research/participants/data/ref/h2020/wp/2014_2015/annexes/h2020-wp1415-annex-g-trl_en.pdf

These frameworks illustrate that commercial deployment and market transformation is staged.



Tech-to Market Process: Technology readiness is commonly measured on a nine-point scale referred to as Technology Readiness Level (TRL). TRLs are used to consistently identify technology development stages across technology types. Market Readiness Levels (MRLs) refer to the readiness of a market to accept and adopt a new technology.

Figure 7. Visualisation of the path from innovation to market that also considers "Market readiness Levels" (from https://www.energy.gov/eere/buildings/technology-market)

Examples of specific PFAS uses in A&D products are given in Annex 2 to highlight the particular challenges faced with substitution. Summaries are given in Table 11. Note the use cases are intended to be illustrative on the PFAS use, the availability of alternatives for that specific use and derogation assessment as per the proposed restriction text. They are not intended to be exhaustive.

The examples may refer to a specific product. The assessment of which derogation may be assigned to the use is specific to the product. For example, hosing in aircraft (case study 2 in Annex 2) may be covered by 6-o but this does not imply that 6-o is generally applicable to all hosing uses in all A&D products.

Table 11. Use cases illustrating where PFAS chemicals are used, the availability of alternatives and possible derogation coverage

#	Specific use case	Application area described in the case study	Type of PFAS	Possible derogation coverage	Key points	Other relevant information
1	Aircraft signal, power wires and cables	Aircraft –all operating systems for power and communication - Electrical wiring insulation given as a specific example	Fluoropolymers	Some coverage under 6-o (12 years)	Aircraft signal, power wires and cables systems are used all over the aircraft. fluoropolymers are used in a variety of different components: cables, connectors, sleeves, conduits, shrinkable elements, connector back-shells, modules, contacts, lugs, pressure seals, tying devices, tapes, optic fibre cables and more complex elements such as electromechanical devices There are no alternatives available to replace fluoropolymers for these uses. Research, development, and implementation of alternatives could take more than a decade and require several different solutions to be developed in parallel, which would put a substantial strain on resources and is not realistic. It is uncertain if alternatives can ultimately be innovated that would not be equally “persistent” as durability and inertness are technical performance requirements. The potential derogation for “transport” (6-o) (fluoropolymers and perfluorethers) would in principle cover these uses - however the time period (12 years) is inadequate as there is no alternative available meaning that new insulation materials will need to be innovated and that substitution will be lengthy. In addition, 12 years is not adequate for MRO of existing aircraft for existing aircraft that have lifetimes of 40+ years. For these reasons, ASD highlight that the derogations are not adequate either in coverage or duration.	See case studies submitted by W.L. Gore & Associates (#6286 and 6301) and Dupont[8] for more detailed information on specific products. The dossier submitter did not consider defence or security related uses and these would not be covered by 6-o.

#	Specific use case	Application area described in the case study	Type of PFAS	Possible derogation coverage	Key points	Other relevant information
2	Hydraulic, oil, air, water (waster), bleed air and fuel hose assemblies in aircraft	Aircraft hose assemblies	Fluoropolymers	Some coverage under 6-o (12 years)	Hoses in the aircraft are used to contain and convey hydraulic fluids, oils, fuel, greases, lubricants, anti-icing and de-icing agents, cleaning agents, oxygen, extinguishing agents and multiple other flight safety critical substances. Those media are either hazardous, toxic, flammable, corrosive and/or reactive. They need to be contained and conveyed in the safest way achievable whilst also meeting the high level of performance necessary to achieve improved rigorous fuel efficiency and sustainability requirements. Different materials can be used to meet the required functions, certification and safety requirements of the products. In each case, hoses are protected with a PTFE liner to protect them from the aggressive media durably during the long lifecycle of the aircraft (40+ years). PTFE fulfils the chemical compatibility, chemical inactivity/resistance requirements meanwhile its longevity makes it viable for as long as the lifespan of the aircraft. There are no alternatives available to replace fluoropolymers for these uses and it is uncertain if alternatives can ultimately be innovated that would not be equally “persistent” as durability and inertness are technical performance requirements. The potential derogation for “transport” (6-o) (fluoropolymers and perfluorethers) would in principle cover these uses - however the time period (12 years) is inadequate as there is no alternative available meaning that new hosing materials will need to be innovated and that substitution will be lengthy. In addition, 12 years is not adequate for MRO of existing aircraft for existing aircraft that have lifetimes of 40+ years. For these reasons, ASD highlight that the derogations are not adequate either in coverage or duration.	The dossier submitter did not consider defence or security related uses and these would not be covered by 6-o.
3	Sealing solutions and seals in aircraft fuel lines	Aircraft - mostly fuel systems	Fluoropolymers	Some coverage under 6-o (12 years)	Aircraft are required to operate in a wide temperature range of -56 to 80°C. For equipment the temperature may exceed 200°C (some areas higher than 220 °C), for example for engine fuel feed and recirculation lines. Seals and sealing solutions must be suitable for use under these extreme temperatures. Fuel seals and fittings must remain pliable at the lowest temperatures, to cope with flexure in the airframe from air movements and aircraft manoeuvres to avoid leaks. They also need to be chemically resistant to oxygen, ozone, fuel and oil. Due to these very specific technical requirements and extreme operating conditions, there are only two fluorinated rubbers which can offer the properties and characteristics needed to be used for aircraft seals and sealings solutions: fluorinated silicones (FMQ) and fluorinated carbon rubbers (FKM). For high-speed seals, the anti-	See case studies submitted by W.L. Gore & Associates (#6286 and 6301 and Dupont[8] for more detailed information on specific products. ASD support the position of the European sealing association – see their case study on the use of

#	Specific use case	Application area described in the case study	Type of PFAS	Possible derogation coverage	Key points	Other relevant information
					extrusion rings contain PTFE. PTFE is needed to prevent O-ring extrusion and permit the use of seals in higher pressure settings (up to 1000 psi) which is essential in the aerospace industry. In a typical aircraft nearly all fuel seals will be affected, as well as majority of the landing gear struts. There are no alternatives available to replace fluoropolymers for these uses and it is possible that alternatives, that are not also considered persistent, will ever be found for such applications where durability/reliability under harsh conditions is a requirement. The potential derogation for "transport" (6-o) (fluoropolymers and perfluorethers) would in principle cover these uses - however the time period (12 years) is inadequate as there is no alternative available meaning that new insulation materials will need to be innovated and that substitution will be lengthy. In addition, 12 years is not adequate for MRO of existing aircraft for existing aircraft that have lifetimes of 40+ years. For these reasons, ASD highlight that the derogations are not adequate either in coverage or duration.	fluoroelastomer sealing elements in gas turbine engines.[18] The dossier submitter did not consider defence or security related uses and these would not be covered by 6-o.

[18]European Sealing Association (ESA) position statement relative to the European proposal for PFAS regulation in relation with the Sealing Industry available at https://www.esaknowledgebase.com/wp-content/uploads/2022/03/ESA-Position-Statement-on-proposed-PFAS-regulation-March-2022-1.pdf

#	Specific use case	Application area described in the case study	Type of PFAS	Possible derogation coverage	Key points	Other relevant information
4	Heat transfer fluids & refrigerants	Aircraft – cooling systems	Perfluorocarbons Perfluoroethers	Some coverage under 5-i (12 years), 5-p and 5-q (5 years); Military vehicles: 5-dd (12 years)	Refrigerants and heat transfer fluids are used in equipment specifically designed for use on aircraft installations to meet high safety and reliability standards. Refrigerant HFC R-134a is used in aircraft cooling systems. Replacing the current refrigerant in the short and mid-term on certified aircraft is extremely difficult as no suitable refrigerants are on the market that have the same behaviour in terms of physical properties, e.g., are neither toxic nor flammable. Heat Transfer Fluid Galden® HT is used as heat transfer fluid in order to remove heat from the galleys and avionics. Alternatives for use on aircraft are available and Galden® HT is not used in new aircraft. Replacing Galden® HT on in-service aircraft is difficult since extensive changes are needed on the equipment. There is no alternative solution without redesigning the equipment, mainly the pumps of the system. For refrigerants and heat transfer fluids used in aircraft cooling systems, it will take at least 12 years for substitution in new aircraft. For MRO of existing aircraft, certified equipment needs to be available up to the end of product range life. Based on the derogation mapping done since the dossier was made available on the ECHA website, it is our understanding that this is not directly covered by either a proposed or potential derogation. Potential derogation 5-dd is specific to military aircraft but not civilian. The proposed derogation 5-i for refilling and maintaining existing HVACR equipment does not cover production and there is some coverage under 5-q depending on the interpretation of "transport refrigeration". ASD highlight that the derogations are not adequate either in coverage or duration. To avoid catastrophic effects on aircraft production and MRO of existing aircraft 18 months after the entry into force, ASD request a derogation for these uses with a review clause and to limit the scope to their use in new products and exclude existing products due to recertification requirements.	
5	Fire suppression – substitutes for halon in aircraft fire suppression systems	Aircraft –fire safety systems	2-BTP (C3H2BrF3) HFC-236fa ($[CF_3]_2CH_2$) Verdagent© (blend of 2-BTP	5-m (12 years)	Fire events have always been considered as one of the most severe threats for aviation, leading industry to develop fire protection systems since the early/mid 1900s. Development of the associated safety level has been supported by the airworthiness authorities that have set up minimum standard to be reached/demonstrated and mandated it through their respective certification standards. extinguishing agents, but because of	ASD supports the position of Halon Alternatives Research Corporation (HARC) (#4457)

#	Specific use case	Application area described in the case study	Type of PFAS	Possible derogation coverage	Key points	Other relevant information
			($C_3H_2BrF_3$) and CO_2)		their high ozone depleting potential, their production was banned in 1994 as part of the Montreal Protocol with limited exceptions for critical applications such as "aviation, military and police use" and subject to phase out deadlines (Annex VI to the Ozone Regulation). However, most Halon 1301 alternatives (HFC-125 (Pentafluoroethane), 2-BTP (bromotrifluoropropene), NOVEC 1230 (Perfluoro(2-methyl-3-pentanone), CF3i (Trifluoroiodomethane)) are PFAS chemicals. All Halon 1211 (Bromochlorodifluoromethane) alternatives (2BTP and HFC-236 (Hexafluoropropane)) are PFAS chemicals. These chemicals are substitutes to Halon (1301/1211) in aircraft safety devices (fire extinguishing systems) currently regulated under the Ozone Regulation. The proposed restriction therefore impacts ongoing substitution to comply with other regulations. There are no other alternatives available to Halon 1310 and 1211 for these specifics applications. The identification of these 3 chemicals as suitable alternatives to Halon took decades. The use is covered by the proposed derogation 5-m "*clean fire suppressing agents where current alternatives damage the assets to be protected or pose a risk to human health*". However, the duration period is not adequate for time needed to identify, qualify, (re)certify alternatives in the systems. There is also no review clause meaning that use must cease upon expiry of the derogation period. This would mean a cease in aircraft production and grounding of existing aircraft due to lack of certified fire systems. MRO for existing aircraft will require availability of certified systems or re-certified systems with alternatives. ASD highlight that the derogation is not adequate in duration. They ask the dossier submitters to consider the ongoing substitution efforts, the absence of suitable alternatives and the low emissions from this use. In line with the position of the Halon Alternatives Research Corporation (HARC) , ASD request the following: • reconsider the time limit and proposed a time-unlimited derogation.	
6	Hydrogen fuel cell (PEMFC)	Aeronautical energy systems	Fluoropolymers	6-e (5 years)	Hydrogen fuelled proton-exchange member fuel cells (PEMFC) provide electrical power generated via electrolysis of air and hydrogen. This technology enables both CO2-free and NOx-free operation of hydrogen fuelled aerospace aircraft/vehicles within the EEA. For	ASD support the position of Hydrogen Council [19]

[19] Position paper from the Hydrogen council on PFAS published 31.7.2023 https://hydrogencouncil.com/wp-content/uploads/2023/07/Hydrogen-Council-White-Paper-PFAS.pdf

#	Specific use case	Application area described in the case study	Type of PFAS	Possible derogation coverage	Key points	Other relevant information
					example, aircraft are expected to use hydrogen fuel cells to create electrical power that complements the modified gas-turbine engines, resulting in a highly efficient hybrid-electric propulsion system. Fluoropolymers are integral to the production, operation and safety of PEMFCs. They are integral to membranes, gas diffusion layer, microporous layers, electrodes; sealants; bonding fasters; Housing for electrical components. There are no alternatives available and time limited derogations are not adequate. Aeronautical uses of PEMFCs have exceptionally high requirements for safety, stability and durability. Currently the only materials that fulfil these requirements are fluoropolymers. For the above reasons ASD highlight that the derogations are not adequate either in coverage or duration. Alternative risk management options are requested (e.g. exception from the restriction until such time as alternatives are available, other legislation to limit emissions and recover materials at the end of life).	
7	Hydraulic fluids (anti-corrosion agent in fire-resistant phosphate-ester based hydraulic fluid)	Aviation hydraulic systems	Potassium decafluoro(pentafluoroethyl) cyclohexanesulphonate	5-o (12 years)	Fire-resistant phosphate-ester based hydraulic fluids (PEBHFs) are used in sealed hydraulic fluid systems within passenger, commercial, and most military aircraft. Due to electrochemical erosion (a unique form of corrosion), Potassium decafluoro(pentafluoroethyl)cyclohexanesulphonate (CAS 67584-42-3) has been included as a corrosion inhibitor in PEBHFs since the 1970s and continues to be used today. To date, despite significant effort and investment, there are no alternatives available for these uses. It is possible that over the course of the derogation period, an inferior chemistry could be identified and brought forward as an alternative which may provide partial protection. However, any associated reduction in safety and reliable operation would be considered unacceptable for these critical aircraft systems. The proposed derogation: "5.o *Additives to hydraulic fluids for antierosion/anti-corrosion in hydraulic systems (incl. control valves) in aircraft and aerospace industry*" gives a derogation period of 12 years. .However based on current research and state of the art for this technology, 12 years will not be adequate since it cannot be predicted if alternatives will be successfully deployed in a given timeframe. In addition, 12 years is not adequate for MRO of existing aircraft for existing aircraft that have lifetimes of 40+ years.	ASD supports Exxon Mobil's submission to the public consultation. See also case study 15 in Annex 2

#	Specific use case	Application area described in the case study	Type of PFAS	Possible derogation coverage	Key points	Other relevant information
					For the above reasons ASD highlight that the derogations are not adequate either in coverage or duration and request the following: - Introduce a review clause in the current derogation for this use - Reconsider the time limit and the conditions of the restriction - Exclude existing products from the scope	
8	Aircraft electro-mechanical equipment	Internal bearings in aircraft control levers – Flaps lever give as an example	Fluoropolymers (PTFE)	6-o (12 years)	The flaps lever for the high-lift system in an aircraft's cockpit is a crucial control that enables the pilot to manage the position of high-lift devices on the wings. These devices, including flaps and slats, are essential for optimizing lift and control during takeoff and landing, and proper control of these devices is fundamental for safe and efficient flight operations. PTFE containing bearings or PTFE containing films are used at the interfaces of moving parts where low friction is required and other methods such as lubricants with associated regular maintenance are not feasible. Alternatives are not available and due to qualification and certification requirements, substitution will be lengthy in new products. For existing products, the re-certification requirements is not likely to be economically feasible. The potential derogation for "transport" (6-o) (fluoropolymers and perfluorethers) would in principle cover these uses - however the time period (12 years) is inadequate as there is no alternative available meaning that new materials will need to be innovated and that substitution will be lengthy. In addition, 12 years is not adequate for MRO of existing aircraft for existing aircraft that have lifetimes of 40+ years. For these reasons, ASD highlight that the derogations are not adequate either in coverage or duration. Alternative risk management options are requested.	See case study 15 for other examples.
9	Guidance section of missile systems	Defence systems	PFAS components of specialist lubricants	Possible coverage under 5-s (12 years); Otherwise no coverage	The Guidance Section is the brain of the missile. It communicates with the aircraft, acquires and tracks the target, performs guidance and autopilot functions. The Guidance Section uses special oils and greases which contain PFAS. Two example use cases given. Neither has available alternatives. This use is possibly covered by proposed derogation 5-s "*lubricants where the use takes place under harsh conditions or the use is needed for the safe functioning and safety of equipment*" depending on the interpretation of "harsh conditions" and "safe functioning	Defence uses were not assessed by the dossier submitters.

#	Specific use case	Application area described in the case study	Type of PFAS	Possible derogation coverage	Key points	Other relevant information
					/safety of equipment”. The derogation period of 12 years in not adequate as it is uncertain if alternatives will be identified and qualified by the expiry of the period. If qualified alternatives are not available, it will impact the operational readiness of defence systems. ASD highlight that the derogations are not adequate either in coverage or duration. Alternative risk management options are requested.	
10	Surface coating - defence systems	Defence systems: Rail launchers for submmunition	Fluoropolymers (PTFE)	Possible coverage under 5-s (12 years); Otherwise no coverage	Rail launchers serve a vital role in various sectors, including defence and aerospace. They are specifically designed for launching projectiles at high speeds, making them crucial for missions that require precision, accuracy, and reliability. These launchers operate in extreme conditions and therefore are subject to significant stresses and challenges. The surface protection system used in rail launchers is essential to their performance and longevity. The current state-of-the-art solution involves hard anodizing-based protection with a PTFE sealing to reduce wear. This combination provides a range of exceptional properties that are critical to meeting the demanding requirements of rail launcher applications. There are no alternatives available and R&D needs to be initiated for new materials. The unique properties and performance of fluoropolymers (PTFE), are indispensable in meeting the stringent requirements of military aircraft systems. Until feasible alternatives are available or in development, derogations are vital to ensure the safety, effectiveness, and readiness of military aircraft as well as to avoid unnecessary burdens on operational capabilities. Note it is uncertain if alternatives can ultimately be innovated that would not be equally “persistent” as durability and inertness are technical performance requirements for operation in harsh/extreme conditions of use to ensure safety and reliability of the system. This use is possibly covered by proposed derogation 5-s “lubricants where the use takes place under harsh conditions, or the use is needed for the safe functioning and safety of equipment”. The derogation period of 12 years in not adequate as it is uncertain if alternatives will be identified and qualified by the expiry of the period. If qualified alternatives are not available, it will impact the operational readiness of defence systems. In addition, 12 years is not adequate for MRO of existing aircraft for existing systems. For these reasons, ASD highlight that the derogations are not adequate either in coverage or duration. Alternative risk management options are requested.	Defence uses were not assessed by the dossier submitters.

#	Specific use case	Application area described in the case study	Type of PFAS	Possible derogation coverage	Key points	Other relevant information
11	Erosion resistant coatings, abrasion resistant coatings – A&D products	Airframe: Areas subject to abrasion and erosion (e.g. leading edges, flap / slat mechanisms)	Fluoropolymers (PTFE, KFM)	6-o (12 years)	The requirements for coatings used in military aircraft systems, specifically in protecting aircraft parts such as radomes and leading edges from abrasion and rain erosion during flight, are highly demanding. Operation of military aircraft face significant challenges in mission environments characterized by supersonic speeds, high altitude, rain, UV-radiation and friction-induced high temperatures. Sprayable coatings are essential for providing effective protection against rain erosion and abrasion, aerodynamic heating, thermal flash exposure, and weathering. There are no alternatives available that have the performance properties in coatings used in military aircraft systems, specifically in protecting aircraft parts such as radomes and leading edges from abrasion and rain erosion during flight. Operating in mission environments characterized by supersonic speeds, high altitudes, rain, UV-radiation and friction-induced high temperatures, military aircraft face significant challenges. Note it is uncertain if alternatives can ultimately be innovated that would not be equally "persistent" as durability and inertness are technical performance requirements for the harsh/extreme conditions of end-use to ensure safety and reliability of the product. This use is possibly covered by proposed derogation 5-s "lubricants where the use takes place under harsh conditions, or the use is needed for the safe functioning and safety of equipment" depending on the interpretation of "lubricant" by the dossier submitter – see ECHA Q&A from the webinar. The derogation period of 12 years in not adequate as it is uncertain if alternatives will be identified and qualified by the expiry of the period. If qualified alternatives are not available, it will impact the operational readiness of defence systems. This means that use would need to stop for production of new rail launchers and maintenance/repair of existing launchers. ASD highlight that the derogations are not adequate either in coverage or duration. Alternative risk management options are requested.	Defence or security uses were not assessed by the dossier submitters and are not covered by 6-o.
12	Aircraft engine uses	Bearings and bushings in a high pressure compressor	Fluoropolymers (PTFE)	6-o (12 years)	Fluoropolymers are very widely used in aero-engines in the form of sockets, gaskets, wedges or wear strips. For example, PTFE is used in engine components such as bearings and bushings. As a specific example, PTFE bearing and bushings are used in the high-pressure (HP) compressor of the engine. A high-pressure compressor in an aircraft engine plays a crucial role in preparing the incoming air for combustion by compressing it to a higher pressure. This compression leads to more efficient and powerful combustion, which	See also case study 8

#	Specific use case	Application area described in the case study	Type of PFAS	Possible derogation coverage	Key points	Other relevant information
					in turn generates the thrust needed to propel the aircraft forward. The function of the bearings and bushings is to improve the rotation and position of the blade for HP compressor in engines. There are no alternatives available to PTFE that fulfil the technical performance requirements (friction properties, mechanical properties, temperature resistance over a wide temperature range, chemical resistance) in the bearings and bushings. This means that R&D programs need to be started to first innovate new materials with no certainty that suitable alternatives will be identified. Once alternatives are identified, it would need to be qualified and then certified for use in the aircraft engine. For existing products, redesign would be needed for new materials and recertification. In this case, as hundreds of components in an engine have to be replaced, it would be necessary to have an alternative for each component before launching the re-certification process for the redesigned whole engine. Note it is uncertain if alternatives can ultimately be innovated that would not be equally "persistent" as durability and inertness are technical performance requirements for the harsh/extreme conditions of end-use to ensure safety and reliability of the product. The potential derogation for "transport" (6-o) (fluoropolymers and perfluorethers) would in principle cover these uses - however the time period (12 years) is inadequate as there is no alternative available meaning that new materials will need to be innovated and that substitution will be lengthy. In addition, 12 years is not adequate for MRO of existing aircraft for existing aircraft that have lifetimes of 40+ years. For these reasons, ASD highlight that the derogations are not adequate either in coverage or duration. Alternative risk management options are requested.	
13	Sealing systems and greases for extreme mobility & extreme environment suspension systems –	Suspension systems for military-specific vehicles	Fluoropolymers (FKM, PTFE, FFKM, PFPE)	Possible coverage under 6-o (12 years). Dubious whether "Transport" cover all necessary	An armored vehicle is a type of military or security vehicle that is specifically designed and built to provide protection to its occupants from various threats such as ballistic projectiles, explosives, and small arms fire. Armored vehicles have reinforced armor plating, typically made of steel or composite materials, that shields the occupants from bullets, shrapnel, and other forms of attack. Despite their added weight from armor, armored vehicles are usually equipped with powerful engines and robust suspension systems to maintain mobility on various terrains. There are no alternatives available to replace PTFE, FKM, FFKM and PFPE parts and greases that are used in the suspension systems. There are currently no promising R&D programs to guarantee possible 1:1 substitution. Key characteristics that	Defence or security uses were not assessed by the dossier submitters.

#	Specific use case	Application area described in the case study	Type of PFAS	Possible derogation coverage	Key points	Other relevant information
	defence products			military vehicles (for example, self-propelled or towed artillery)	prevent the possible use of other materials include the wide temperature range the systems are required to withstand (from -46ºC in order to fulfil NATO Standards for arctic vehicles to operating temperatures in off-road mobility of over 200ºC without degradation), low friction coefficient, compatibility with main NATO standard fluids and chemical inertness. Note it is uncertain if alternatives can ultimately be innovated that would not be equally "persistent" as durability and inertness are technical performance requirements for the harsh/extreme conditions of end-use to ensure safety and reliability of the product. The proposed 12-year derogation is considered insufficient due not only to the lack of current substitute availability which would require R&D programmes lasting more than 12-years in order to develop sealing, guiding, and bearing systems which have passed all related certifications (MIL-STD, Def-Stan), but also due to the long life of the vehicles themselves (over 40 years) which renders MRO impossible for existing vehicles with a 12-year derogation as proposed. Another key point is the consideration of "transport" wherein it is unclear that all military vehicles are included. While certain vehicles such as 4x4s and trucks are certain to be included, other vehicles such as combat systems or artillery system have a very doubtful fit in this category. For these reasons, ASD highlight that the derogations are not adequate either in coverage or duration. Alternative risk management options are requested	
14	Chemical, Biological, Radiological, Nuclear, and high yield Explosives (CBRNE) detection equipment	Security and defence	Fluoropolymers and pefluoroelastomers	Not covered	CBRNE is an acronym for Chemical, Biological, Radiological, Nuclear, and high yield Explosives. These types of weapons have the ability to create both mass casualties as well as mass disruption of society. CBRNE threat detection equipment plays a key role in ensuring the safety of military forces and help protect civilians. Current CBRNE detection technologies are strongly reliant on PFAS due to the bespoke specificities they require. There are no alternatives available. These uses are not covered by any proposed or potential derogation. This means that the use of fluoropolymers in the production of CBRNE detection equipment must stop 18 months after the entry into force of the restriction. Imports of components would also stop meaning that MRO would also stop. This would have the consequence that the industry	Defence or security uses were not assessed by the dossier submitters.

#	Specific use case	Application area described in the case study	Type of PFAS	Possible derogation coverage	Key points	Other relevant information
					would not be able to produce or maintain this equipment meaning that security and defence forces would be unable to detect potential CRBNE threats. This is not a plausible scenario. ASD highlight that the restriction as currently proposed does not have a plausible non-use scenario for these uses. Alternative risk management options are requested.	
15	Aircraft landing gear	Seals & hoses, hydraulic fluids, paints & coatings, insulation (cables and systems)	Fluorpolymers, Specific non-polymeric PFAS as additives for anti corrosion,	6-o (12 years) 5-o (12 years)	Aircraft landing gear and its actuation system are critical components that facilitate the safe takeoff, landing, and taxiing of an aircraft. Manufacturers must ensure that the strict requirements of aviation sector in terms of safety and durability are met. Components like seals and hoses, hydraulic fluids, paints and coatings and isolation material all contain PFAS. There are no alternatives available that fulfil the technical performance requirements for parts/components of landing gear and actuation systems. The potential derogation for “transport” (6-o) (fluoropolymers and perfluorethers) would in principle cover seals, hoses, insulation uses - however the time period (12 years) is inadequate as there is no alternative available meaning that new materials will need to be innovated and that substitution will be lengthy. In addition, 12 years is not adequate for MRO of existing aircraft for existing aircraft that have lifetimes of 40+ years. Hydraulic fluid use would be covered by “5.o *Additives to hydraulic fluids for antierosion/anti-corrosion in hydraulic systems (incl. control valves) in aircraft and aerospace industry*”. However, the derogation period of 12 years will not be adequate-since it cannot be predicted if alternatives will be successfully deployed in a given timeframe. In addition, 12 years is not adequate for MRO of existing aircraft for existing aircraft. Note it is uncertain if alternatives can ultimately be innovated that would not be equally “persistent” as durability and inertness are technical performance requirements for the harsh/extreme conditions of end-use to ensure safety and reliability of the product. ASD highlight that the derogations are not adequate either in coverage or duration. Alternative risk management options are requested.	See also case studies 1-3 and 7
16	SMArt artillery ammunition – defence systems	Defence - PTFE surface coating for shell gliding properties	Fluoropolymers (PTFE)	Not covered	A 155 mm SMArt (Submunition Area Denial Artillery) shell is a type of artillery ammunition used primarily for long-range artillery systems. It is a sophisticated artillery round that is capable of releasing submunitions equipped with sensors and guidance systems. PTFE surface coatings are used in the shells to reduce friction. The coating plays a crucial role in	See also case study 10 and 20.

#	Specific use case	Application area described in the case study	Type of PFAS	Possible derogation coverage	Key points	Other relevant information
		under conditions of fire			the reliable functioning of the end product, even under the most extreme operating conditions (-33 °C to +52 °C). The special sliding properties of the surface coating guarantee error-free mechanical interaction of the components that are briefly subjected to the highest loads during operation. There are no alternatives available. Note it is uncertain if alternatives can be ultimately innovated that would not be equally "persistent" as durability and inertness are technical performance requirements for the harsh/extreme conditions of end-use to ensure safety and reliability of the product. The use of PFAS in artillery ammunition is not covered by any proposed or potential derogations as the dossier submitters did not consider defence uses in their assessment. This means that 18 months after the restriction enters into force, production of the shell would stop. Imports would also stop. Supply would rely on shells in stock with no possibility of restocking once the supply is used up. This would have a security implications as these weapons systems could not be used. This has not been considered by the dossier submitters. This is not a plausible scenario. ASD highlight that the restriction as currently proposed does not have a plausible non-use scenario for these uses. Alternative risk management options are requested.	Defence or security uses were not assessed by the dossier submitters.
17	ePTFE microporous membranes to protect equipment from the effects of pressure and humidity changes	Defence	Fluoropolymers (ePTFE)	not covered	ePTFE (expanded polytetrafluoroethylene) microporous membranes are versatile materials with a unique porous structure. They are used to protect equipment from pressure variations and humidity by serving as effective barriers that control the exchange of gases and moisture between the equipment's interior and the external environment. See details in Annex 2 (confidential)	Defence or security uses were not assessed by the dossier submitters.
18	Fluoropolymers in electronic, optical and microwave equipment	Defence	Fluoropolymers	No coverage	The main products containing fluoropolymers used in electronic, optical and microwave equipment are: - printed circuit boards (PCBs) - connectors and accessories (SMA, SMB, SMP, N, etc.)	Defence or security uses were not assessed by the dossier submitters.

#	Specific use case	Application area described in the case study	Type of PFAS	Possible derogation coverage	Key points	Other relevant information
					- coaxial cables - optical cable sheaths - seals - waterproof membranes, - electronic and microwave functions, in the form of ready-to-use components such as amplifiers, dividers, circulators, etc. See details in Annex 2 (confidential)	
19	Use of PTFE in a radome for a naval multi-function radar	Defence	Fluoropolymers	Not covered	A radome on a naval vessel is a protective enclosure or cover that houses and shields radar antennas and other sensitive electronic equipment from the harsh marine environment while allowing electromagnetic signals, including radar signals, to pass through with minimal loss or distortion. See details in Annex 2 (confidential)	Defence or security uses were not assessed by the dossier submitters.
21	Fluoropolymer bonded explosives	Defence	Fluoropolymer (FPM)	Not covered	Polymer-Bonded Explosives (PBX) are a type of explosive material in which explosive particles or crystals are dispersed within a polymer matrix or binder. Fluoropolymers are used in PBX in military weapons and munitions. The chemical stability of fluoropolymer binders ensures dimensional stability and performance of the explosive composition over time. Degradation of the binder due to ageing (caused by processes such as hydrolysis, oxidation, rearrangement, chemical reaction with surrounding materials, etc.) increases the sensitivity of the explosive composition over time, resulting in unpredictable behavior that poses a safety risk. There are no alternatives available. The time required to identify alternatives and requalify the munitions and weapons is significantly longer than the time proposed for the restriction to become effective (18 month after entry into force). It is uncertain if alternatives can be identified. It would also take a considerable amount of time to industrialize the manufacturing process and increase production to meet demand. Given the unique properties of fluoropolymer-bonded explosives, there may not be a one-to-one equivalent. If R&D efforts are not able to identify alternatives, the entire explosive trains will have to be redesigned and qualified.	See case studies 10 and 16 Defence or security uses were not assessed by the dossier submitters.

#	Specific use case	Application area described in the case study	Type of PFAS	Possible derogation coverage	Key points	Other relevant information
					These uses are not covered by any proposed or potential derogation. This means that the use of fluoropolymers in the production of the concerned weapons and munitions must stop 18 months after the entry into force of the restriction. Imports of the concerned weapons and munitions would also stop. The proposed restriction would cripple the ability to supply armed forces as needed, which would reduce the defence capabilities of Member States as ammunition stocks would likely be depleted long before alternatives are available. This is not a plausible scenario. ASD highlight that the restriction as currently proposed does not have a plausible non-use scenario for these uses. Alternative risk management options are requested.	

2.3.5 Non-use scenario & socio-economic impact of the current restriction proposal (ECHA Q6g)

The impact of the proposed restriction would be exceptionally severe on the A&D sector.

With Restriction Option 1 (RO1) where all PFAS chemicals are banned with no derogations, the economic impacts would be severe and detrimental to the functioning of the EEA both in terms aviation (passenger, cargo, military) and national and European Defence and security.

With RO2 (all PFAS chemicals are banned with time limited derogations for uses by specific sectors/applications), the impact will depend on the eventual coverage of the derogations for uses of PFAS chemicals needed for the production, operation and MRO of A&D products. If the derogation coverage is not complete and/or the expiry periods are not sufficient, the impact could be as severe as RO1. It would affect A&D companies, their supply chains, third-party MRO facilities, customers (including airlines and defence agencies) and those who rely on the products and services provided by the A&D industry. Our use identification and potential/proposed derogation assessment further demonstrates that coverage for A&D uses is not well considered or provided for currently.

In this section, we discuss non-use scenarios for the aviation and defence sectors and consider the impact on the non-availability of qualified parts/components etc. when the restriction comes into force and derogations expire. To provide an appreciation for quantification of the anticipated SEA impacts, we refer to the recent authorisation applications submitted by the A&D sector for the continued use of a limited number of hexavalent chromium compounds CrVI for a limited number of surface treatment of parts/components in the production, operation and MRO of A&D products.[4] We referred to their socio-economic impact assessment to get an illustrative understanding of the wider economic consequences of non-use scenarios. However, it must be recognised that impacts would be even greater, since import of PFAS-containing articles would be prohibited and so any non-use scenario allowing for continued import of articles manufactured outside the EEA, could not be considered in the case of PFAS. For RO2, neither use nor import is allowed. The impacts are summarised in Table 12.

Table 12. Non-use scenario when qualified and certified alternatives are not available for A&D products and the wider economic impact

	Non-use scenario when qualified and certified alternatives are not available (RO1 or RO2 with incomplete/non-aligned derogations)
Aviation	• Production of aircraft/and or aircraft equipment in the EEA stopped • Imports of aircraft to the EEA is stopped (as import of an article containing PFAS is not allowed) • Operation of aircraft and components, including spares containing PFAS components would not be stopped for existing aircraft in use at the time of expiry or other aircraft 'visiting' the EEA • Scheduled maintenance operation activities involving replacing PFAS components in the EU stopped and relocated outside the EEA, only where possible • Aircraft requiring repairs/replacement PFAS parts effectively 'grounded' in the EEA. • Premature retirement of aircraft that can no longer be maintained or repaired. • Operation activities involving PFAS stopped in the EEA (e.g., safety critical window cleaning fluid) • Impacts to production of aviation products in other regions including UK and US, where customers are currently reliant on EU based manufacture or assembly of certain components (global supply chain)

Defence (non-aviation uses)	• Production of defence products stopped in the EEA • All imports of defence products and components, including spares to the EU stopped • Defence equipment requiring repair/replacement parts effectively 'grounded' • Scheduled maintenance of defence assets that require the use of PFAS-containing parts shifted outside the EEA only where possible (in most cases this will not be possible due to security considerations for defence applications) • Premature retirement of defence equipment that can no longer be serviced/repaired • Operation of existing defence products containing PFAS would not be stopped – but production, maintenance and repair would shift outside the EEA only where possible (in most cases this will not be possible due to security considerations for defence applications) • Impact production of defence products in other regions including UK and US, where reliant on EU based manufacture or assembly of certain components (global supply chain)
Wider economic impacts	• Cease in both production and import of A&D products within the EEA • Cease in delivery of spare parts to the EEA (leading to reliance on offshore maintenance services for A&D products used in the EEA) only where possible (in most cases this will not be possible due to security considerations for defence applications) • Inability to service and repair existing A&D products in the EEA or to import repaired and refurbished PFAS-containing components to the EEA – aircraft would be grounded, including defence fleets (with direct impact on national security) • No new A&D products could be imported or produced in the EEA • Loss of functioning A&D equipment in EEA • Premature retiring from service of A&D equipment in EEA • The EEA neither develops innovative new PFAS-reliant products nor benefits from those developed outside the EEA • Remaining existing products reach end of service life and cannot be replaced • EEA aviation sector no longer viable • MoDs cannot procure defence systems • National security is compromised as operational readiness is not possible • Passenger and cargo air transfer relies on depleting and aging stock with all MRO scheduled to be done outside the EEA (leading to increased costs) • Airlines cease business as costs are too high and cannot be passed on to passengers or by increased freight charges • Massive loss of jobs across multiple sectors that rely on the A&D sector • Closure of EEA-based facilities • Loss of strategic innovation and technology development in the EEA

The economic impacts would include:

- Loss of profits – OEMs, suppliers, airlines, repair and maintenance facilities, etc.
- Business closures and lost jobs
- Costs associated with unused stock disposal
- Costs for relocation of work outside of EEA – OEMs, suppliers, repair and maintenance facilities, etc. (only in cases where this is even possible)
- Penalties for failures to meet contracts (e.g. where servicing cannot be completed leading to aircraft being grounded)
- Economic consequences of commercial and freight aircraft groundings and flight cancellations
- Market distortion for aviation services (no EEA based airline companies)
- The EEA ceases to have functioning aviation and defence capabilities due to its inability to procure new products or maintain existing products

- Market distortion of global innovation and technology development to favour locations outside the EEA

The wider consequences are given in the Table above. The consequences would be catastrophic and are not plausible**.** The EEA would cease to have functioning aviation and defence capabilities as production and MRO would all need to be done outside the EEA. Imports would not be possible. All technology development, innovation, investment etc. would move outside the EU and the European defence would rely on other military countries (US, China, others) or must be stopped. This is simply not a plausible scenario.

The 2023 ADCR submission for chromate re-authorisation for the A&D supply chain assessed the economic impact of the non-availability of conversion coatings based on hexavalent chromium compounds on A&D companies[20]. The non-use scenario is similar since without conversion coatings, a significant proportion of production and all MRO activities would cease in the EEA. Whilst the conversion coating non-use scenario allows for relocation and import of articles back to the EU, in the case of PFAS, any relocation of activities would only be able to serve non-EU markets and so the actual realised impacts for the PFAS case would be much more severe. Table 13 gives quantitative estimates for the impact on A&D companies (in the context of the 12 year review period applied for and a 4 % depreciation (UK figures included due to an equivalent authorisation requirement under UK REACH, but there would also be some impact on this market due to UK dependencies on EU-based production of parts)). The non-use scenario in this case would mean that all production and MRO relocates giving a higher impact.

[20] ADCR application for authorisation for continued use of hexavalent chromates; Application ID 0327-01 "*Chemical conversion coating using chromium trioxide, sodium dichromate and/or potassium dichromate in aerospace and defence industry and its supply chains*" available on the ECHA website at https://echa.europa.eu/en/applications-for-authorisation-consultation/-/substance-rev/74108/term

Table 13. Extract from the ADCR submission[4] for the re-authorisation of CrVI based conversion coatings in the A&D supply chain giving the impact on A&D companies

Table 5-8: Summary of economic impacts under the non-use scenario (12 years, @ 4%)		
Economic operator	**Quantitative**	**Qualitative**
Applicants	• Not assessed	Lost profits to applicants in both the EEA and UK are assessed in the Formulation SEA
A&D companies	• Lost operating surplus EEA: €29.6 – 70.5 billion over 12 years (€3.1 – 7.5 billion over one year) • Lost operating surplus UK: €4.7 – 28.0 billion (€0.5 – 2.9 billion over one year)	Relocation costs, disruption to manufacturing base and future contracts, impacts on supply chain coherence, impacts on future growth in the EEA and UK sectors, loss of skilled workforce, impacts on R&D (and potential to deliver new more sustainable technologies)
Competitors	Not anticipated due to sectoral coverage of the application	Not anticipated due to sectoral coverage of the application
Customers and wider economic effects	Not assessed	• Impacts on airlines, air passengers, customers, cargo and emergency services, and thus society as a whole • Impacts on military forces' operation capacity and mission readiness • Lost output/value added multiplier effects due to impacts on civil aviation and loss of defence sector spending • Loss of spin-off effects – innovation and new technologies

The authorisation application reports also considered related aspects; the impact on military forces and companies acting as suppliers to the military forces. It was not considered plausible that the EEA defence forces would rely entirely on non-EEA suppliers, and it was considered that use would continue via defence exemptions. Obsolescence risk was also considered as if solely defence uses are allowed, many suppliers would not have sufficient turnover to remain profitable.

The report highlighted the contribution the defence sector makes to the EEA economy:

> *"Companies in the European defence sector represent a turnover of nearly €100 billion and make a major contribution to the wider economy. The sector directly employs more than 500,000 people of which more than 50% are highly skilled. The industry also generates an estimated further 1.2 million jobs indirectly. In addition, investments in the defence sector have a significant economic multiplier effect in terms of creation of spin-offs and technology transfers to other sectors, as well as the creation of jobs."*

The report highlighted that this multiplier effect would be lost if companies relocate outside the EEA.

Based on the sector wide quantitative assessment done for the same sector for a very limited number of coatings and where imports are not restricted, it can be seen that impact of the non-use scenario is severe. In this case, due to the number of chemicals within scope and the ubiquity of their use in the production, operation and MRO of A&D products, the impact of RO2 would be catastrophic. RO2 would shut down production of new products, stop MRO of existing products, stop the import of products, components, parts etc. The wider economic consequences go beyond lost jobs but would in effect stop all EEA based production of A&D products, stop their imports, stop MRO of existing products, stop import of components, parts etc. Taking civilian aviation as an example, this would mean that aircraft could fly in the EU but could not be produced, serviced or imported in the EEA. Taking national security as an example, existing defence products (aircraft, naval vessels, land vehicles, munitions, weapons) could be operated but not serviced due to lack of spare parts. Existing stocks once depleted could not be replenished. New products/parts could neither be produced nor imported in the EEA. Defence forces would be unable to respond to security threats. These non-use scenarios are not plausible.

ASD ask that the dossier submitters revise their proposal and propose more appropriate and proportionate regulatory risk management measures that explicitly take the specificities of the A&D sector into account and the wider aspects on the functioning of the EEA.

Appendices

Annex 1. Assignment of the specific PFAS reported by ASD members in their questionnaires to PFAS types for the use and derogation assessment

Table 14. Details of the assignment of PFAS reported by ASD members to PFAS types for the use and derogation mapping (see Tables 1, Tables 15-19)

Type of PFAS	Abbreviation	Trade Name(s)	Chemical Name	EC No	CAS No
Fluoropolymer	PFPE		1-Propene, 1,1,2,3,3,3-hexafluoro-, oxidized, polymd.	615-044-1	69991-67-9
	ECTFE		poly(ethene-co-chlorotrifluoroethene); poly(1-chloro-1,2,2-trifluorobutane-1,4-diyl)	polymer	25101-45-5
	ETFE	Tefzel	poly(ethene-co-tetrafluoroethene); ethylene tetrefluoroethylene	polymer	25038-71-5
		Ethene, 1,1,2,2-tetrafluoro-, oxidized, polymd	Ethene, 1,1,2,2-tetrafluoro-, oxidized, polymd; fomblin m15 pfpe	polymer	69991-61-3
	FEP	Teflon FEP; Neoflon FEP; Dyneon FEP	fluorinated ethylene propylene; Tetrafluoroethylene-hexafluoropropene copolymer; Fluorinated ethene propene copolymer	polymer	25067-11-2
	FEPM		Tetrafluoroethylene propylene copolymer	polymer	unknown
	FFKM	Kalrez, Technoflon PFR; Dyneon PFE; DAI-EL GA; Chemraz	perfluoroelastomeric compounds	polymer	multiple
	FKM	Viton, Viton E	family of fluorocarbon-based fluoroelastomer materials	polymer	multiple
		Fluoropolymers	unspecified fluoropolymers	unknown	unknown
		fluorosilicone	fluorosilicone rubber	polymer	unknown
	FPM	Viton	family of fluorocarbon-based fluoroelastomer materials	polymer	multiple

	FVMQ		fluorovinylmethylsiloxane rubber; fluorosilicone rubber	polymer	unknown
		Nafion	Perfluorosulphonic acid-PTFE copolymer	polymer	66796-30-3
		Nedox	(range of surface coating products)	polymer	multiple
		NOVEC 1700 (active)	Fluorinated acrylate polymer	polymer	unknown
	PCTFE		Polychlorotrifluoroethylene	polymer	9003-83-9
			Perfluoroalkane sulfonyl (meth)acrylate polymers	polymer	unknown
			Perfluorocarbon elastomer	polymer	unknown
		Perfuoroelastomer	Perfluoroelastomer	polymer	unknown
	PFA		perfluoroalkoxyl polymer	polymer	unknown
	PFPE	Krytox	perfluoropolyether	polymer	unknown
	PTFE	Teflon; Arlon; Avalon; Turcon; Formulations containing PTFE include: Alexol Stabox; Magnalube G; Microflon M2; PEEK / FC containing PTFE; Polyimide + PTFE	polytetrafluoroethylene	polymer	9002-84-0
	PVDF		Polyvinylidenefluoride; Polyvinylidenedifluoride; poly(1,1-difluoroethylene)	polymer	24937-79-9
	PVDF-HFP		Polyvinylidenefluoride; Polyvinylidenedifluoride; poly(1,1-difluoroethylene) and Hexafluoropropylene	polymer	24937-79-9 and 116-15-4 polymer
			Tetrafluoroethylene-hexafluoropropene copolymer	607-524-4	25067-11-2
		Tufram	(range of surface coating products)	polymer	multiple

Fluorinated Alkene (non polymeric)	HFP	freon R 1216; halocarbon R 1216; fluorocarbon 1216	Hexafluoropropylene; Perfluoropropene; Perfluoropropylene	204-127-4	116-15-4
	TFE		Tetrafluoroethylene	204-126-9	116-14-3
Fluorinated organic fluids (non polymeric)	2-BTP	Halotron BrX	2-bromo-3,3,3-trifluoroprop-1-ene	627-872-0	1514-82-5
		Caldene TME	reaction mass of 1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxybutane; 1,1,1,2,3,3-hexafluoro-3-methoxy-2-(trifluoromethyl)propane	425-340-0	163702-05-4
		DuPont™ Vertrel®	HFC-based products	unknown	unknown
		FK-5-1-12; Novec 1230	Dodecafluoro-2-methylpentan-3-one; 1,1,1,2,2,4,5,5,5-nonafluoro-4-(trifluoromethyl)-3-pentanone	436-710-6	756-13-8
	HFC	HFC	unspecified Hydrofluorocarbons	unknown	unknown
		HFC-43-10mee	(S,S)-1,1,1,2,2,3,4,5,5,5-decafluoropentane;reaction mass of: (R,R)-1,1,1,2,2,3,4,5,5,5-decafluoropentane	420-640-8	138495-42-8
	HFE	HFE	unspecified Hydrofluoroethers	unknown	unknown
	HFE-7300		Pentane, 1,1,1,2,2,3,4,5,5,5-decafluoro-3-methoxy-4-(trifluoromethyl)-	459-520-5	132182-92-4
		Methyl Nonafluorobutyl Ether	Methyl Perfluorobutyl Ether; Butane, 1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxy-; 1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxybutane	829-015-8	163702-07-6
		Novec 71 IPA, NOVEC 1700 (solvent); Promosolv DR1	Methyl perfluoroisobutyl ether; reaction mass of 1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxybutane; 1,1,1,2,3,3-hexafluoro-3-methoxy-2-(trifluoromethyl)propane	422-270-2	163702-08-7 and 163702-07-6

		NOVEC 7500	3-ethoxy-1,1,1,2,3,4,4,5,5,6,6,6-dodecafluoro-2-trifluoromethyl-hexane	435-790-1	297730-93-9
		Perfluoroalkyl ethers / alkanes + aromatics		unknown	unknown
			Heptafluoropropyl pentafluoroethyl ether	611-940-1	60164-51-4
		reaction mass of 2,2,3,3,5,5,6,6-octafluoro-4-(1,1,1,2,3,3,3-heptafluoropropan-2-yl)morpholine and 2,2,3,3,5,5,6,6-octafluoro-4-(heptafluoropropyl)morpholine	reaction mass of 2,2,3,3,5,5,6,6-octafluoro-4-(1,1,1,2,3,3,3-heptafluoropropan-2-yl)morpholine and 2,2,3,3,5,5,6,6-octafluoro-4-(heptafluoropropyl)morpholine	473-390-7	-
Fluorinated gases	HFC-125		Pentafluoroethane	206-557-8	354-33-6
	HFC-227ea		1,1,1,2,3,3,3-Heptafluoropropane; heptafluoropropane; HFC-227; FM-200; apaflurane	207-079-2	431-89-0
	HFC-236fa	HFC-236fa; Freon 236fa; R-236fa; FC-236fa; HCFC 236fa; MH36; R236fa	1,1,1,3,3,3-Hexafluoropropane; 2,2-dihydroperfluoropropane	425-320-1	690-39-1
	HFC-134a	Norflurane; R134a	1,1,1,2-Tetrafluoroethane	212-377-0	811-97-2
Unspecified PFAS		Carbon Fiber with Polyimide resin + PFAS	unknown	unknown	unknown
		Fluoroalkyl		unknown	unknown
		Fluorocarbon	Fluorocarbon	unknown	unknown
		not specified		unknown	unknown
		Perfluoroalkyl amine		unknown	unknown
		PFAS	unspecified PFAS	unknown	unknown

Table 15 gives details on the derogation assessment where an ASD use may be covered by a proposed derogation. Derogations 5k, 5m, and 5s are the most assigned derogations.

Table 15. ASD application areas assessed by the dossier submitters and which may be covered by a proposed derogation

		Unassesse	Assessed		Potential Derogations			Proposed Derogations												
Restriction Use Category	**Use Category Sub-Use**	**No**	**Partial**	**Yes**	**[5dd]**	**[5y]**	**[6o]**	**5b**	**5e**	**5i**	**5k**	**5m**	**5n**	**5o**	**5s**	**5s?**	**5t**	**6e**	**6a**
Applications of fluorinated gas	Cargo fire extinguishing systems		x									x							
Applications of fluorinated gas	Engine and APU fire extinguishing systems		x									x							
Applications of fluorinated gas	Fire extinguishers		x									x							
Applications of fluorinated gas	Handheld fire extinguishers		x									x							
Applications of fluorinated gas	Lavatory fire extinguishing systems		x									x							
Applications of fluorinated gas	Refrigerants			x						x									
Cleaning agents	Cleaning agents			x							x								
Cleaning agents	Cleaning fluids			x							x								
Cleaning agents	Cleaning solvents			x							x								
Cleaning agents	Contact cleaners			x							x								
Cleaning agents	Degreasing solvents			x							x								
Cleaning agents	Precision cleaners			x							x								
Cleaning agents	Specialist cleaning fluids			x							x								
Energy sector	Proton exchange membrane (PEM)			x														x	
Hydraulic fluids	Anti-corrosion liquids (hydraulics)		x											x					
Hydraulic fluids	Hydraulic fluids			x										x					
Laboratory equipment	Calibration of measurement instruments																x		
Laboratory equipment	Calibration standard																x		
Laboratory equipment	Diagnostic tests			x									x						
Lubricants	Anti-friction coatings			x											x				
Lubricants	Chemically resistant greases			x											x				
Lubricants	Dry film lubricants			x											x				
Lubricants	Greases			x											x				
Lubricants	Greases for military applications			x											x				
Lubricants	High temperature greases			x											x				
Lubricants	Lubricants			x											x				
Lubricants	Lubricating oils			x											x				
Lubricants	LVDT lubricants			x											x				
Lubricants	Perforated and non-perforated fluorocarbon release films			x															
Lubricants	PTFE and graphite filled polyamideimides			x											x				
Lubricants	PTFE sheet for cabin emergency trap sealing			x											x				
Lubricants	Self-lubricating coatings			x											x				
Lubricants	Sliding pads			x											x				
Lubricants	Solid lubricants			x											x				
Lubricants	Thread lubricants			x											x				
Miscellaneous	High performance polymeric membrane (filter)			x					x										
TULAC	Fire resistant glass cloth		x						x										

Of the ASD application areas considered to be "partially assessed", "6o-transport" was the more assigned derogation (see Table 16). Note that this is using a very wide interpretation of "transport" – many defence uses are not readily "transport".

Table 16. ASD application areas considered to be "partially assessed" by the dossier submitter AND possibly covered by potential derogation 6o

		Unassessed	Assessed		Potential Derogations			Proposed Derogations											
Restriction Use Category	**Use Category** Sub-Use	**No**	**Partial**	**Yes**	**[5dd]**	**[5y]**	**[6o]**	**5b**	**5e**	**5i**	**5k**	**5m**	**5n**	**5o**	**5s**	**5s?**	**5t**	**6e**	**6a**
Coating and finishings	Abrasion resistant coatings		x				x												
Coating and finishings	Coatings		x				x												
Coating and finishings	Fan blade wear strips		x				x												
Lubricants	Bearings		x				x												
Lubricants	Bushings		x				x												
Sealing applications	Adhesive fabrics		x				x												
Sealing applications	Adhesive sheets		x				x												
Sealing applications	Adhesive tapes		x				x												
Sealing applications	Adhesives		x				x												
Sealing applications	Aircraft window gaskets		x				x												
Sealing applications	Backup rings		x				x												
Sealing applications	Bellows		x				x												
Sealing applications	Collar trim		x				x												
Sealing applications	Drive train seals		x				x												
Sealing applications	Gaskets		x				x												
Sealing applications	Grand plates		x				x												
Sealing applications	Grommets		x				x												
Sealing applications	High temperature sealants		x				x												
Sealing applications	Hydaulic system seals		x				x												
Sealing applications	Insulation tapes		x				x												
Sealing applications	Interlay sealants		x				x												
Sealing applications	O-rings		x				x												
Sealing applications	Overcoating		x				x												
Sealing applications	Pellet and strip locking		x				x												
Sealing applications	Pressure-sensitive tapes		x				x												
Sealing applications	Primary ring adapters		x				x												
Sealing applications	Sealants		x				x												
Sealing applications	Seals		x				x												
Sealing applications	Shutters		x				x												
Sealing applications	Slipping rings		x				x												
Sealing applications	Tapes		x				x												
Sealing applications	Valve seats		x				x												
Sealing applications	Washers		x				x												
Sealing applications	Wedge		x				x												

For two ASD application areas that were assessed by the dossier submitters, release agents and release foils, it is open to interpretation if they are covered by the proposed derogation 5s "*lubricant*". These two applications were mapped separately as "5s?" – see Table 17

Table 17. ASD application areas assessed by the dossier submitter and possibly covered by the proposed derogation by 5s.

		Unassessed	Assessed		Potential Derogations			Proposed Derogations											
Restriction Use Category	**Use Category** Sub-Use	**No**	**Partial**	**Yes**	**[5dd]**	**[5y]**	**[6o]**	**5b**	**5e**	**5i**	**5k**	**5m**	**5n**	**5o**	**5s**	**5s?**	**5t**	**6e**	**6a**
Lubricants	Release agents			x												x			
Lubricants	Release foils			x												x			

A significant number of ASD application areas were considered to be either fully or partially assessed by the dossier submitters but not covered by either a proposed/potential derogation (see Table 18).

Table 18. ASD application areas considered to be "assessed/partially assessed" by the dossier submitter NOT covered by either a proposed or potential derogation

		Unassessed	Assessed		Potential Derogations			Proposed Derogations											
Restriction Use Category	**Use Category** Sub-Use	**No**	**Partial**	**Yes**	**[5dd]**	**[5y]**	**[6o]**	**5b**	**5e**	**5i**	**5k**	**5m**	**5n**	**5o**	**5s**	**5s?**	**5t**	**6e**	**6a**
Applications of fluorinated gases	Cooling agents			x															
Applications of fluorinated gases	Heat transfer fluids		x																
Coating and finishings	Anti-foul paints		x																
Coating and finishings	Anti-slip paint		x																
Coating and finishings	Chemically resistant coatings		x																
Coating and finishings	Electrical coil varnish		x																
Coating and finishings	Lacquers		x																
Coating and finishings	Paints		x																
Coating and finishings	Varnish		x																
Coating and finishings	Varnish for electronics		x																
Electronics and semiconductors	Batteries			x															
Electronics and semiconductors	Cable insulation			x															
Electronics and semiconductors	Cables			x															
Electronics and semiconductors	Coaxial cables			x															
Electronics and semiconductors	Conformal coatings			x															
Electronics and semiconductors	Connectors		x																
Electronics and semiconductors	Dielectrics			x															
Electronics and semiconductors	Electronic displays and touch screens			x															
Electronics and semiconductors	Electronics			x															
Electronics and semiconductors	Harness insulation		x																
Electronics and semiconductors	High frequency connectors		x																
Electronics and semiconductors	Lead-free soldering			x															
Electronics and semiconductors	Optical fibre accessories		x																
Electronics and semiconductors	Printed circuit boards			x															
Electronics and semiconductors	Soldering			x															
Electronics and semiconductors	Soldering fluxing agent			x															
Electronics and semiconductors	Tubing		x																
Electronics and semiconductors	Vapor phase soldering			x															
Lubricants	Moulding			x															
Lubricants	Perforated and non-perforated fluorocarbon release film			x															
Lubricants	Piston bearings		x																
Lubricants	Sliders		x																
Metal plating and manufacture of metal produc	Lamellar zinc plating		x																
Metal plating and manufacture of metal produc	Lamellar zinc surface treatments		x																
Metal plating and manufacture of metal produc	Mist suppresants		x																
Metal plating and manufacture of metal produc	Nickel PTFE coating		x																
Miscellaneous	Composite manufacturing		x																
Miscellaneous	Filters		x																
Miscellaneous	Fuel hose assemblies		x																
Miscellaneous	Fuel tank membranes		x																
Miscellaneous	Hoses		x																
Miscellaneous	Markings		x																
Miscellaneous	Membranes		x																
Miscellaneous	Pipes		x																
TULAC	Coated yarns		x																
TULAC	Cover vehicle seats		x																
TULAC	Yarns		x																

A significant number of ASD application areas were not assessed by the dossier submitters and are mostly not covered by a proposed or potential derogation (see Table 19 (red)). Potential derogations 5dd and 5y are relevant for the A&D sector.

Table 19. ASD application areas not assessed by the dossier submitters and generally not covered by a proposed or potential derogation

		Unassessed	Assessed		Potential Derogations			Proposed Derogations											
Restriction Use Category	**Use Category** Sub-Use	**No**	**Partia**	**Yes**	**[5dd]**	**[5g]**	**[6o]**	**5b**	**5e**	**5i**	**5k**	**5m**	**5n**	**5c**	**5s**	**5s**	**5t**	**6e**	**6a**
Applications of fluorinated gases	Anti-corrosion products	x																	
Body-, hull- and fuselage construction	Cellular materials	x																	
Body-, hull- and fuselage construction	Fire resistant bulkhead	x																	
Body-, hull- and fuselage construction	Housing	x																	
Body-, hull- and fuselage construction	Radomes	x																	
Body-, hull- and fuselage construction	Welding	x																	
Electronics and semiconductors	Boots	x																	
Electronics and semiconductors	Flexible sleeves	x																	
Electronics and semiconductors	Loom guides	x																	
Electronics and semiconductors	Looms	x																	
Electronics and semiconductors	Metal-plated wires	x																	
Electronics and semiconductors	Pin carriers	x																	
Electronics and semiconductors	Protection sleeves	x																	
Electronics and semiconductors	Shrink sleeves	x																	
Electronics and semiconductors	Sleeves	x																	
Electronics and semiconductors	Solder sleeves	x																	
Foils	Covering foils	x																	
Foils	Decorative foils	x																	
Foils	Foil heaters	x																	
Foils	Identification tape	x																	
Foils	Label materials	x																	
Foils	Wrap for engine casings	x																	
Food contact materials and packaging	Critical foam packaging	x																	
Food contact materials and packaging	Potable water systems	x																	x
Laboratory equipment	Chemical detectors for military applications	x											x						
Miscellaneous	Anti-vibration parts	x																	
Miscellaneous	Cable ties	x																	
Miscellaneous	Carriers	x																	
Miscellaneous	Cushion clamps	x																	
Miscellaneous	Duct oil	x																	
Miscellaneous	Dyes	x																	
Miscellaneous	Extruded profiles	x																	
Miscellaneous	Flex	x																	
Miscellaneous	HAD process surface treatments	x																	
Miscellaneous	Half shells for anti-rotation coils	x																	
Miscellaneous	Heat transfer fluids (polymeric)	x																	
Miscellaneous	Heat transfer fluids for brazing furnace	x																	
Miscellaneous	Holders	x																	
Miscellaneous	Hydraulic hoses	x																	
Miscellaneous	Liners	x																	
Miscellaneous	Low friction thermoplastics	x																	
Miscellaneous	~~Mechanical parts~~	x																	
Miscellaneous	Oil hose assemblies	x																	
Miscellaneous	Oil level accessories	x																	
Miscellaneous	Packing	x																	
Miscellaneous	Pin holders	x																	
Miscellaneous	Plastic for interiors	x																	
Miscellaneous	Pneumatic assemblies	x																	
Miscellaneous	Process equipment	x																	
Miscellaneous	Pumping rings	x																	
Miscellaneous	Rubber mats	x																	
Miscellaneous	Rubber strips	x																	
Miscellaneous	Shock absorbers	x																	
Miscellaneous	Site glass	x																	
Miscellaneous	Special rubbers	x																	
Miscellaneous	Tank liners	x																	
Miscellaneous	Thermal insulation	x																	
Pyrotechnics	Igniters	x																	
Pyrotechnics	Plastic bonded energetic material	x																	
Pyrotechnics	Relays	x																	
TULAC	Anti-g suits	x						x											
TULAC	Camouflage nets	x						x											
TULAC	Coated Fabrics for Rafts or Canopy	x						x											
TULAC	Lacing ties	x																	

Annex 2. Case studies

See separate attachment.

RECEIVED
By: OAH on 2/28/2024
Mark Herwig Attachment 4

Impact of the Proposed EU REACH PFAS Restriction on the Aerospace and Defense Sector

AIA Chemical Subcommittee

September, 2023

Aerospace Industries Association of America, Inc.
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Contents

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1 General Comments

1.0 Introduction and Summary

Founded in 1919, AIA is the premier trade association representing over 320 major aerospace and defense manufacturers and suppliers and more than 2.2 million employees. Among its members are the United States of America's leading manufacturers and suppliers of civil, military, and business aircraft, helicopters, unmanned aerial systems, missiles, military airborne, ground-based and naval systems, space systems, aircraft engines, material, and related components, equipment services, and information technology. AIA is pleased to provide the following comments on the proposed PFAS restriction.

Both fluoropolymers (e.g., PTFE, PFA, PVDF, etc.) and non-polymeric PFAS are used in the Aerospace and Defense (A&D) industry in a wide variety of critical applications that are further detailed in this document. The properties of PFAS are commonly unmatched by other materials, and the products containing them are often required for the safe, reliable and effective operation, maintenance and repair of today's commercial and military aircraft and many other A&D products, including critical military equipment. Further, a review of other submissions from the A&D value chain in response to the proposed restriction also reveals a wide dependence on PFAS in developing products for the A&D industry, even for products that do not contain PFAS. Further, we conclude from our and suppliers' information that feasible alternatives are not currently available for most of those uses, and in many cases will not be available for the foreseeable future. In our industry, many uses of PFAS have been formally approved and certified for the functions and capabilities they provide. We also believe that proposal significantly underestimates the socioeconomic costs that the restriction will have on the REACH member states without significant revision. Finally, the A&D industry is very concerned about the continued availability of products and materials needed to manufacture and support industry products, and ensuring those products continue to meet the stringent product performance, safety and reliability requirements demanded by its customers and other stakeholders, including regulatory bodies.

AIA proposes the following changes be made in the restriction proposal as justified by the information presented here:

Derogations for PFAS

In Section 1.8, we propose a derogation for all uses and sub-uses of PFAS chemicals for the aerospace and defense sector;

The derogation should include technology readiness evaluations to determine whether alternatives are available for any uses and sub-uses and what appropriate adjustments should be made to the duration of the derogations.

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Exemption/exclusion for fluoropolymers

As explained in Section 1.5 we fully support removing or exempting fluoropolymers from the scope of the restriction;

The derogation should include low molecular weight PFAS chemicals used for producing fluoropolymers.

Chemical identifiers

In Section 1.3, we strongly suggest that an explicit list of chemical identifiers (CAS numbers) be provided for the PFAS covered by the restriction.

Repair as produced

In Section 1.8, we support the repair as produced principle where products should be allowed to be repaired as originally designed and produced.

1.1 Information on PFAS uses in the aerospace and defense sector

AIA wishes to highlight additional and complementary information about PFAS use in the A&D sector. Much of this information is found in comments submitted directly by other organizations. Where possible these comments are cited in Table 1 and elsewhere in this submission where they are specifically relevant. We also want to highlight comments submitted by Aerospace, Security and Defence Industries Association of Europe (ASD, Submission # 4419 and their follow-on submission), the US Chamber of Commerce (Submission # 6288), American Chamber of Commerce to the European Union (AmCham EU, Submission # 4584) and a white paper developed by International Aerospace Environmental Group (IAEG).

IAEG commissioned a report this year to highlight the uses of PFAS within the A&D industry and illustrate the complexities facing this sector with regard to the identification and understanding of PFAS uses across the supply chain, and the challenges facing the industry in terms of finding substitutes to PFAS across this wide range of applications. Many members of AIA (and ASD) contributed data to the report. In particular, this report aims to:

- Highlight and map the key uses of PFAS within the A&D sector that are covered under the proposed restriction proposal (both in relation to 'transport' and other related sectors), as well as uses that are not explicitly discussed in the restriction proposal.
- Identify the 'critical' uses of PFAS in the A&D sector, where alternatives may not currently meet specific performance or safety standards.
- Illustrate the challenges in identifying if and where PFAS are used in specific products or components and the complexity of the A&D supply chain.

The upcoming report will be found at the IAEG website at https://www.iaeg.com/workgroups/wg5/activities.

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1.2 Risk of obsolescence and disruption of A&D supply chains

The potential for regulatory-driven obsolescence (even for exempted and derogated uses) is a real concern for companies in the A&D industry, with the result of significant socio-economic cost to the EU member states. As mentioned elsewhere, many organizations in the A&D supply chain have identified significant risks from the proposed restriction on their ability to continue to supply to the EU and global markets. Suppliers to the industry may make decisions to remove PFAS substances (including products made from those substances) from the market for various reasons. These can include compliance with anticipated regulations that have not yet entered into force, lack of continued marketability/profitability for PFAS-containing products or limiting their own risks and liabilities associated with continued production and/or processing of PFAS such as with 3M's recent decision to exit the market on all PFAS products.[1] While we recognize that these are decisions that individual companies may make, our concern is that such decisions may be made without full regard to the downstream impacts on customers that rely on these products. Ultimately, aerospace and defense suppliers and companies would be required to mitigate such cases of obsolescence in a manner that could include temporary stockpiling, reformulation, replacement with qualified materials, relocating work outside of the EU/EEA, redesigning, requalifying and recertifying end products.

Further mitigation would not necessarily result in phasing out PFAS. In the simplest of cases companies may switch to a product from another supplier that may already be qualified. If there is not an existing qualified alternative, they may need to qualify an alternative from another source, and this may very well be another product that contains PFAS. In fact, it may be easier to qualify a PFAS-containing alternative, especially when it is the same PFAS chemical, because the products will have similar properties and demonstration of interchangeability will be less time consuming. Thus, given the choice between qualifying a PFAS vs. a non-PFAS candidate alternative, the PFAS option could be chosen to maintain business continuity.

1.3 Difficulty identifying PFAS

While we are just beginning to understand our dependence on substances within the scope of the proposed restriction, tracing chemical substance content information and transparent communication of that information is extremely challenging. For "downstream" manufacturers of complex articles with global, multi-layered supply chains such as those in the A&D industry, this means tracing substance information through many levels of the supply chain, starting with parts manufacturers through to the complex assemblies used in our products. The A&D industry includes thousands of global subcomponent suppliers, including numerous small-to-medium sized companies. In order to determine the chemical composition of these subcomponents, the suppliers must be able to reliably collect and accurately report data on substances used in each specific subcomponent as well as in its manufacturing process at each level of the supply chain. This challenging situation is compounded by the fact that spare parts are routinely produced several years in advance of their use, where the precise understanding of their composition was not available at that time of their manufacture. Further, while process and tools to obtain and use composition data have been under development by the industry for several years, adoption in the global supply chain has not fully developed and significant gaps in such data remain.

[1] https://news.3m.com/2022-12-20-3M-to-Exit-PFAS-Manufacturing-by-the-End-of-2025

Further, the presence of PFAS in chemical products has not been consistently covered by chemical information contained on safety data sheets (SDS) for materials used in the supply chain. In many cases, individual PFAS are still not widely recognized as hazardous, are present below applicable cut-off thresholds and/or are proprietary substances. If a PFAS is not explicitly listed in an SDS (which is common in our experience) with a commonly-recognized identifier (Chemical Abstract Series "CAS" Numbers are the most-commonly used numerical identifier to accurately identify substances worldwide) then the identification throughout the supply chain is extremely challenging, including where substances are processed into articles. If the lack of PFAS identification through the supply chain is not addressed on a global scale, then PFAS content reported through the supply chains for our products will always be incomplete.

Factors that affect a company's ability to connect with and obligate members in global supply chains to collect information for a finished industry product include local regulatory requirements and industry best practices, contractual obligations and agreements between and among members in the supply chain, the number and locations of those members, the types of equipment (e.g., military or commercial), and time (e.g., the number of years in the data call, the amount of time to complete a data call). Supply chain members face challenges to reliably collect and accurately report composition data because of the typical complexity of the articles produced by the industry (e.g. aircraft), the availability of the information, and often limited use of product chemical content data for articles by actors in the supply chain. Stockpiled supplies and replacement parts (i.e., historical supply) add layers of complexity and complication given that supply chain partners regularly change and may no longer have contractual obligations to provide information, and/ or components, complex assemblies and finished articles may have changed chemical content over time.

In practice some A&D companies report that it takes typically around 24-36 months after a substance has been added to the EU REACH Candidate List for data on those substances in industry hardware (articles) to be received from the majority of the global article supply chain. In the case of requests for PFAS to be declared at much lower levels (0.1% for the Candidate List vs. 25 parts per billion threshold in this restriction proposal), we anticipate that it will take much longer to obtain such information from the global supply chain. The large number of substances in scope of this proposal will further extend the time. In addition, if testing is identified as necessary to determine the PFAS content of articles, laboratory testing availability, capability, and capacity (and possibly costs) of suitable tests are also considerations that will lead to longer timeframes for compliance with proposed restriction limits.

Further, basing a restriction on a definition and not explicitly-defined chemical identities (including CAS numbers) will make it extremely difficult for article manufacturers sourcing from many supply chains to understand their dependence on PFAS (including for PFAS in production equipment/ materials that don't appear in supplied products), as many suppliers may not be able to identify a PFAS even when it is reported in an article declaration or an SDS. This difficulty will be exacerbated for goods sourced from non-EU suppliers. The lack of PFAS identifiers will also make consistent enforceability nearly impossible, even though "enforceability" is a requirement of REACH Annex XV (under the section titled "Justification for Restrictions at Community Level") for justifying the need for an EU-wide restriction. **Thus, we strongly suggest that an explicit, comprehensive list of chemical identifiers (CAS numbers) be provided for substances within the scope of the final restriction.**

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1.4 Appropriateness of Regulating All PFAS Identically

We agree with the many comments already submitted that the identical regulation of over 10,000 species of PFAS is inappropriate from both regulatory and risk management standpoints. As a class of substances, PFAS have extremely wide set of chemical properties and functionalities and environmental and human health impact profiles. As such, many PFAS do not meet the criteria that support restriction being the best option to manage risk. Further, we believe that many types of PFAS provide significant benefits to society at minimal risk and therefore should not be covered by the restriction. Certainly, regulatory responses for groups of PFAS exhibiting similar properties have been successfully used to control risks (e.g., the recent addition of perfluorohexane sulfonic acid (PFHxS), its salts and PFHxS-related compounds to the EU POPs regulation), and we encourage that approach be continued in a risk-informed and prioritized fashion. Because of the broad and unprecedented proposed approach to restrict such a large and diverse group of chemicals with many critical uses, many derogations will need to be granted (even with limited existing data) for essential uses, often with only rough estimates of the time needed until replacements might be available. We see that these points have also been made by numerous other commenters and we concur with those comments.

AIA is also very concerned with the implications that the proposed restriction might have on imports to the EU from the US and other EU trading partners. As indicated in this response, AIA (including through many A&D industry suppliers) has identified multitudes of instances where the use of PFAS is essential to the proper operation and support (maintenance and repair) of A&D products, with no alternatives that provide the same levels of effectiveness, safety, and reliability needed to properly conduct air travel, military missions and a wide variety of other socioeconomic functions supported by our industry. However, there are currently no consistent regulatory drivers across many trading partners and EU allies requiring the comprehensive identification of PFAS use; in fact, there are disagreements between countries and other entities as to what even constitutes a PFAS. As a result, efforts to identify PFAS uses have only just recently been initiated in the US and other regions and there is significant risk that critical uses have not have yet been fully identified. As a result, AIA is concerned that the envisioned restriction (if not appropriately and carefully amended) may create barriers to the free trade in commodities and materials where PFAS use is not fully characterized, including those that are essential for the proper functioning and security of EU society.

AIA is also concerned that the proposed restriction of fluorinated gases under Annex XVII is creating confusion and concerns of “double regulation” for “F-gases” - hydrofluorocarbons (HFC), hydrofluoroethers (HFE) and hydrofluoroolefins (HFO), many that are currently essential and are needed for continued use under the HFC phase-down schedules agreed to in the Kigali Amendment to the Montreal Protocol. To prevent this situation and ensure consistent regulation, it is our recommendation that F-gases subject to other regulatory instruments (e.g., the EU F-Gas Regulation) be excluded from the scope of the proposed PFAS restriction.

1.5 Fluoropolymers Are of Low Concern

Polymeric PFAS, generally referred to as fluorinated polymers, include fluoropolymers, perfluoropolyethers (PFPE), and side-chain fluorinated polymers (SCFP). Although fluoropolymers fit the PFAS structural definition, they have been shown to be thermally, biologically, and chemically stable; have very low water solubility and are considered to be nonmobile, nonbioavailable, and

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nonbioaccumulative (Henry et al. 2018)[2]. In this study, four major fluoropolymers were demonstrated to meet the criteria as Polymers of Low Concern (PLC) as set by the Organisation for Economic Co-operation and Development (OECD). Following the analysis presented by Henry et al., 2018, 14 additional commercially manufactured fluoropolymers have recently been shown to also meet the PLC criteria (Korzeniowski et al. 2023)[3]. Taken together, these two studies covered ~ 96% of the global fluoropolymers market and can be considered to be representative of the low environmental and toxicological concern posed by these materials.

Considering this, and as described in the previous section, fluoropolymers generally meet the criteria as persistent but do not pose the toxicity risk warranting restriction. As a result, **we fully support excluding fluoropolymers from the scope of the proposed restriction**.

Since fluoropolymers are produced from the polymerization of low molecular weight PFAS constituents, a **derogation will also be required for the low molecular weight PFAS constituents required to produce fluoropolymers**, with appropriate controls in place to minimize the impact of these low molecular weight PFAS constituents on the environment.

1.6 Uses and Sub-uses:

AIA has compiled a list of PFAS uses and sub-uses from available sources including AIA member queries, IAEG WG5 data, information from other sectors and companies, literature searches, internal engineering records, safety data sheets, etc. As cautioned elsewhere, we are not confident at this stage that the list is comprehensive and as such should be considered indicative. Table 1 PFAS uses and sub-uses of the A&D sector identified by AIA." For each use, AIA has also broadly identified the type of PFAS (e.g.,., whether it is polymeric on non-polymeric).The table also contains information on whether AIA has identified a relevant proposed or potential derogation. Where these have been identified, the identifying paragraph and sub-paragraph of the restriction proposal (RO2) are listed. The text of each potentially applicable derogation is identified following the table. Finally, we list any supporting comments that AIA would like to draw attention to and that could provide more information on the use are included. For some uses additional information is available and included in Section 2 and a cross reference is provided to the specific section for those uses.

[2] Integrated Environmental Assessment and Management 2018: Vol. 14, Number 3, pp. 316-334
[3] Integrated Environmental Assessment and Management 2023: Vol. 19, Number 2, pp. 326-354

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Table 1 PFAS uses and sub-uses of the A&D sector identified by AIA

Use Categories	**Sub-uses**	**PFAS Type** Fluoropolymer: FP Non-polymeric: PFAS	**Derogation**	**Supporting Comments** (Submission #)	**Additional Information**
Semiconductor fabrication	• Cooling fluids • Valving • Sample holders • Tubing • Pump oils	PFAS & FP	PFAS: None FP: None	Dupont. (# 6016) United Monolithic semiconductors. (# 6342) W.L. Gore. (# 6301)	Used for production of aerospace components. PFAS uses not incorporated into components.
Lubricants including greases and dry lubricants	• Grease • Lubricant • Anti-seize • Thread sealant, thread lock • Engine • Bearings/gears/ball screws • Actuators • Fuel pumps • Breathing/oxygen delivery systems • Electronic/electrical systems • O-ring seal • Space/vacuum applications	PFAS & FP	PFAS: 5.s FP: [6.o]	MORESCO Co. (# 4326) IKV Lubricants. (# 4001)	
Seals	• O-rings • Seals for valves, gaskets • Shaft or piston seals • Seals for electronic devices • Seals for bearings • Nut seals	FP	FP: [6.o]	European Sealing Association (ESA), (# 4472) Precision Polymer Engineering Ltd. (# 4501) W.L. Gore. (# 6301) ATP S.p.A. (# 4474) Repack-S. (# 4262) RADO. (# 6268)	Seals are discussed in more detail in Section 2.4

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Use Categories	Sub-uses	**PFAS Type** Fluoropolymer: FP Non-polymeric: PFAS	Derogation	**Supporting Comments** (Submission #)	Additional Information
				DuPont de Nemours, Inc.[4]	
Coatings	• Primer • Topcoat • Abrasion resistant coating • Aluminized coating • Conductive coating • Erosion resistant coating • High temperature resistant • Temporary protective coating • Conformal coating • Fluorocarbon bonding preventative • Adhesion promoter for polysulfide and polythioether sealants • Waterproof coating • Insulation material	PFAS & FP	PFAS: None FP: [6.o]		Coatings are discussed in more detail in Section 2.3

[4] *EPPA, 'Submission document for public consultation of potential restriction of the per- and polyfluoroalkyl substances (PFAS) related to precision polymeric parts and shapes used in high performance industrial operating environments', Report for DuPont, September 2023*) Submission reference number "93f369eb-ff59-4e02-8519-8b0a1cd030d4"

Use Categories	Sub-uses	**PFAS Type** Fluoropolymer: FP Non-polymeric: PFAS	Derogation	**Supporting Comments** (Submission #)	Additional Information
Electronics and electrical components	• Batteries • (PEM in) Fuel Cells (1) also listed in High Performance Membranes • Computer systems • Electrical connectors • Sleeves • Insulators	FP	PFAS: None FP: [6.o]	ASSCON Systemtechnik-Elektronik GmbH (# 4301) Rogers (# 6006)	
Hydraulic fluids	• Hydraulic fluids	PFAS	PFAS: 5.o	ExxonMobil	
Heat transfer fluids	• Heat transfer fluids	PFAS	None		
Fire suppressing agents	• Fire extinguishing agents	PFAS	PFAS: 5.m	HARC (# 4457, and follow on submission) American Pacific Corp, Halotron Division (AMPAC)	Fire suppressing agents are discussed in more detail in Section 2.1
Wires & cables	Electrical components used in computer control systems • Insulated cables • Insulated wires • Optical fibres	FP	FP: [6.o]	Dupont Kapton (# 4530) W.L. Gore (# 6301) Amo Special Cables. (# 4479) Performance Plastics Products (# 6275)	Wires and cables are discussed in more detail in Section 2.5
Fluorinated gases	• Refrigerants	PFAS	PFAS: 5.q & [5.dd]		Refrigerants are discussed in more detail in Section 2.6
Solvents	• Electronics cleaning • Oxygen system cleaning • Vapor degreasing	PFAS	PFAS: 5.k & 5.l		Solvents and cleaners are discussed in more detail in Section 2.7

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Use Categories	Sub-uses	**PFAS Type** Fluoropolymer: FP Non-polymeric: PFAS	Derogation	**Supporting Comments** (Submission #)	Additional Information
Textiles	• Insulation blanket	FP	PFAS: None FP: [6.o]		
High performance membranes	• (PEM in) Fuel Cells (1) also listed in Electronics and electrical components • Gas and water filter membranes	FP	FP: [6.o]		
Metal plating additives	• Hard anodic coating, FP additive • Electroless nickel plating, FP additive • Anti-misting agent	PFAS FP	PFAS: [5.v] FP: [6.o]	SAXONIA Galvanik GmbH. (# 6097)	Used for production of aerospace components.
Metal manufacturing additives	• Used in the production of: • Seals, valves, pump bearings, hoses, tank liners, gaskets	PFAS	None	Watson-Marlow Fluid Technology Solutions. (# 3977) LEUSCH GmbH Industriearmaturen. (# 6338)	Used for production of aerospace components.
Composites and plastic parts	• Mold release • Parting film • Composites • Molded plastic parts	PFAS & FP	PFAS: None FP: [6.o]/None	Kitamura Ltd. (# 4188) Toray Advanced Film Co. (# 4290)	Composites are discussed in more detail in Section 2.8
Others	• Adhesives • Tapes • Damper/cushion for clamps • Low friction wear strips • Military decoy flares • Abrasive cloths	FP	FP: [6.o]		

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Text of derogations relevant to uses of PFAS and FP identified by AIA:

5.k industrial precision cleaning fluids until 13.5 years after EiF

5.l cleaning fluids for use in oxygen-enriched environments until 13.5 years after EiF

5.m clean fire suppressing agents where current alternatives damage the assets to be protected or pose a risk to human health until 13.5 years after EiF

5.o additives to hydraulic fluids for anti-erosion/anti-corrosion in hydraulic systems (incl. control valves) in aircraft and aerospace industry until 13.5 years after EiF

5.q refrigerants in transport refrigeration other than in marine applications until 6.5 years after EiF

5.s lubricants where the use takes place under harsh conditions or the use is needed for safe functioning and safety of equipment until 13.5 years after EIF;

5.v [hard chrome plating until 6.5 years after EiF];

5.dd [use as refrigerants and for mobile air conditioning in vehicles in military applications until 13.5 years after EiF]"

6.o [applications affecting the proper functioning related to the safety of transport vehicles, and affecting the safety of operators, passengers or goods until 13.5 years after EiF]

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1.7 Alternatives and Substitution Timelines

Noting that the identification of aerospace and defense uses is still ongoing, a full assessment of the availability and suitability of alternatives is only at the beginning stages. A detailed analysis must be completed for each use and sub-use.

The continued use of various PFAS chemicals (including FPs) in aerospace and defense products is desirable as these uses are a small fraction of the global utilization of PFAS chemicals yet provide significant societal benefit. Today, there are no known substitutes for PFAS chemical materials with their unique properties partly because the alternatives will also be persistent in nature and will also result in poorer performance overall. Finally, the diminution of functional characteristics is unwarranted and will lead to other unintended consequences especially in aerospace and defense applications where their use is much needed. (A&D products operate in extreme environments, over extended time frames, while having to fulfill significant safely, reliability and technical requirements. Global airworthiness regulations ensure A&D products' safety and reliability. These regulations require a systematic and rigorous framework to be in place to qualify all materials and processes to meet stringent safety requirements that are subject to independent certification and approval through EASA (European Union Aviation Safety Agency), Federal Aviation Administration (FAA) and other national agencies. Air, ground and sea-based defense systems, and also space systems, are subject to similar rigorous qualification requirements. Meeting approvals requires validation and certification of all products used.

Because PFAS-containing products have proven reliable in safety critical A&D applications, the industry has not needed to develop or seek alternative products and materials. The state of available alternatives today is similar to that for hexavalent chrome uses in the late 1980s, when the aerospace and defense sector first started alternative development efforts – alternatives are still not available for all hexavalent chromium uses over 30 years later. While some uses may be fully substitutable in a shorter time, it is not possible to predict with certainty which ones. Given the widespread uses of polymeric and non-polymeric PFAS in the A&D sector, and the extensive validation, certification and industrialisation work OEMs undertake for all affected specifications, components and products, it will take a lengthy (and currently unknown) period of time to identify and implement substitutes.

To help convey the challenges involved in alternatives development and deployment for A&D uses, we call your attention to a paper produced by the Global Chromates Consortium for Aerospace's (GCCA), titled Aerospace & Defence Qualification Process Impacts on Ability to Substitute Cr(VI) Substances which is attached to this submission. Although the GCCA paper was written to support hexavalent chromium Authorisation applications, the qualification and certification processes described are also applicable to substitution of other substances, including PFAS within the A&D industry. The following illustration included in that paper supports the length and uncertainties of the substitution timeline discussed in the previous section.

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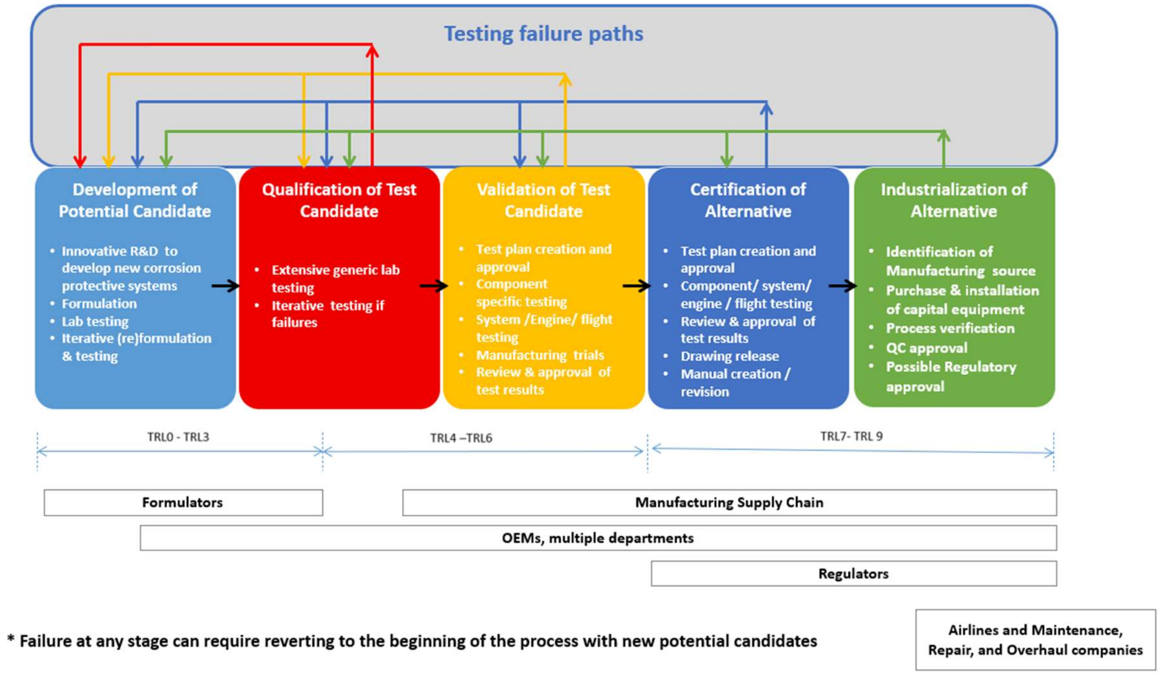

Figure 1. Illustration of the development, qualification, validation, certification and industrialisation process required in the aerospace industry – adapted from the GCCA paper on Aerospace & Defence Qualification Process Impacts on Ability to Substitute Cr(VI) Substances[3].

The GCCA paper provides the following important statement: "The complex relationship between each component and its performance requirements within its own unique design parameters requires certification of each substitution individually (see Figure 2). Qualification in one particular application does not guarantee that use in another application is qualified. Every application must be individually assessed to determine that requirements are met. This process must be independently replicated across all A&D products by each A&D company. A&D products (e.g. a specific aircraft model) may be in service for 30-50 years (even longer in defense uses), requiring maintenance, repair and spare parts over their entire service lives. Any changes to these parts or processes must be fully validated and certified to ensure safety and performance are not compromised."

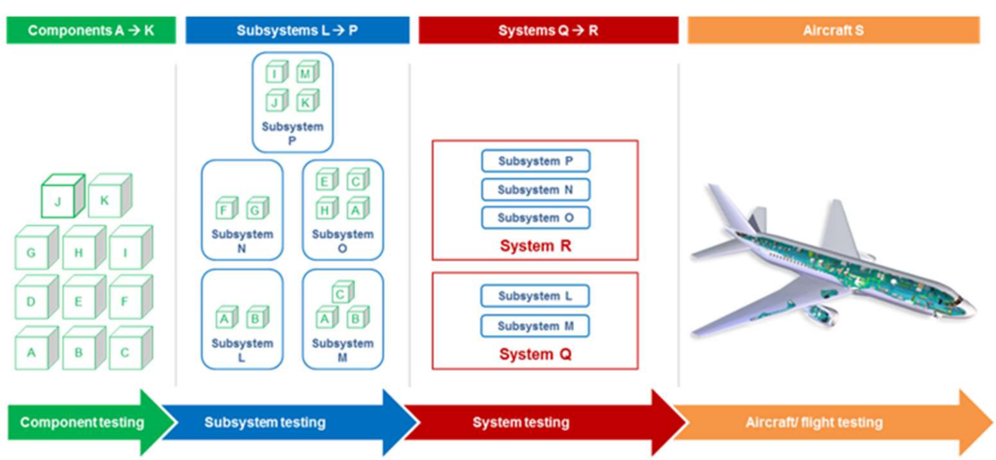

Figure 2. Systems assessment and validation overview, taken from the GCCA paper on Aerospace & Defence Qualification Process Impacts on Ability to Substitute Cr(VI) Substances[3].

The R&D process for finding suitable PFAS-free alternatives to the articles and formulations described in this comment will be robust but complicated. Our industry is still in the early stages of initiating R&D processes to find PFAS-free alternatives. Safety and quality considerations will be paramount given the nature of our industry. The R&D processes will require collaboration between major material suppliers, designers, and parts manufacturers. A key complicating factor is that once suitable PFAS-free alternatives have been identified within the industry, certain PFAS substitution efforts will almost certainly require the approval of the EASA and the U.S. FAA. Such approval processes can take many months if not years.

If viable PFAS alternatives can be identified, best case replacement efforts would require at least 0.5 year of research and require at least €186,000 ($200,000 USD) per material, with a likelihood of successful completion of 75%. Once developed, these formulations would need to go through validation, testing and certifications processes

If no viable PFAS alternatives exist, requiring the development of new materials, a more extensive research effort will be required. This effort would include the following, with the following costs attributable for one member company of our organization:

- *i)* New material discovery, manufacture, and scale up *(€3.7-5.6MM; $4-6MM USD)*
- *ii)* Application development, including material handling, formulation, manufacturing set up, part design, and manufacture *(€75MM; $80MM USD)*
- iii) Extensive testing to ensure the materials, formulations and articles have the critical quality requirements required for the application *(€45-60MM; $48-64 MM USD)*
- iv) Certification and component testing (*€1-3MM; $2-3MM USD)*
- *v)* Change in Design (CID) processing, including engineering and regulatory reviews (*€2MM; $3MM USD)*

For one member company of our organization, the overall research effort is expected to last at least 10 years and cost at least €136-187 MM ($145-200 MM USD).

To reiterate, given the strict qualification and certification requirements in place for A&D products, substitution, of PFAS chemicals would mean that many hundreds of thousands of parts designed, integrated, approved and certified for aviation and other A&D systems would need to go through a requalification process if and when suitable alternatives have been identified. The scale of the substitution effort that would be required based on the current restriction proposal has no precedent as thousands of formulations, parts, components, systems etc. across all A&D products would be in scope. Technical and monetary resources currently engaged in substituting other heavily regulated materials of concern such as hexavalent chromium will get diverted, thus hindering their progress.

The aviation industry has committed to achieving net-zero flying carbon emissions by the year 2050 and increased use of Sustainable Aviation Fuel (SAF) is one of the key enablers being actively pursued. Aerospace OEMS are evaluating and qualifying new SAF pathways for unrestricted use in commercial and military engines. Both blended and 100% SAF are currently being tested for their compatibility with the materials currently in use for aircraft engine oil and fuel systems. These include the seals, O-rings, gaskets, and hoses discussed in section 2.4. If new material is introduced to replace polymeric PFAS, all the testing will need to be repeated in order to ensure compliance with airworthiness regulations. This will be a major setback for the net-zero by 2050 goal.

1.8 Socio economic analysis (SEA) issues

In this section, AIA considers the socioeconomic impacts of a restriction on PFAS as currently proposed where derogations cover some, but not all, aerospace and defense uses. It might be worthwhile to consider the nature of the A&D industry within the REACH member states. The European Commission has summarized the economic impact of aerospace within Europe as follows:

> Air transport makes a key contribution to the European economy, with more than 100 scheduled airlines, a network of over 400 airports, and 60 air navigation service providers. The aviation sector directly employs between 1.4-2 million people and directly or indirectly supports 4.7-5.5 million jobs. Aviation directly contributes more than €110 billion to the European gross domestic product (GDP). Some 900 million passengers departed or arrived at EU airports in 2014. Linking people and regions, air transport plays a vital role in the integration and the competitiveness of Europe, as well as its interaction with the world.[5]

The socioeconomic impacts of the PFAS restriction will clearly depend on its scope as the discussion below explains.

RO1 option – a full PFAS ban: The Annex E report concludes the following with regard to the cost impacts of a total PFAS ban on the Transport sector without appropriate derogations:

> In the event of a full ban, there would be significant disruption to the industry leading to very high producer surplus losses including business closures, which would also lead to substantial employment losses. In the event that it is possible to produce vehicles, there is also a strong likelihood of consumer surplus losses through the sale of vehicles with limited capabilities and reduced reliability.[6]

While this language is direct and alarming, we do not believe it sufficiently captures the scale of costs that the proposed restriction would impose on the REACH member states. The proposed restriction as written would prevent the use or placing on the market of PFAS above certain concentrations in articles. While the restriction's applicability to new articles may be more straightforward, the biggest impact of the restriction would be on aircraft engines flying in and out of the REACH member states. These aircraft—some with 30+ year lifecycles (where PFAS contributes greatly to this longevity due to the strength of the C-F bond) —will continue to require new or refurbished parts that contain PFAS. Removing all PFAS-containing components from these aircraft will require a massive multi-year

[5] See European Commission, Internal market, available at https://transport.ec.europa.eu/transport-modes/air/internal-market_en

[6] Table E.121; page 372.

retrofitting effort. A total PFAS ban within 18 months without appropriate derogations would prevent existing aircraft from getting necessary maintenance and service within the REACH member states. It is not exaggeration to say that this would result in nothing short of a significant disruption, if not a near complete shutdown, of air travel to, from, and among the REACH member states.

Simply put, if no derogations are provided for A&D or other safety critical aspects of the Transport sector, air travel within the REACH member states would not be able to occur compliantly for many years, putting the entire A&D industry within Europe at grave risk. It is not unreasonable to compare such a scenario to the economic impacts of the COVID-19 pandemic impact on the aerospace industry, where global travel slowed to a halt and flights were grounded worldwide. According to a 2023 study by the International Civil Aviation Organization, the pandemic caused total passenger revenues in Europe to decrease €92 billion ($100 billion) in 2020, €81 billion ($88 billion) in 2021, and €37 billion ($40 billion) in 2022, vs. 2019 figures.[7] These figures do not account for the massive job losses and other downstream costs to the EU economy. In short, the restriction as proposed without amendment (including an appropriate derogation accounting for transport safety) would create catastrophic economic impacts on the REACH member states.

RO2 – a PFAS ban but with the proposed derogations, but without the proposed derogation under reconsideration in 6.o: We believe that the discussion above applies nearly equally to the RO2 option without significant revision and without inclusion of a derogation accounting for safety in Transport. The most severe impacts would occur earliest at the time the end of the 18-month transition period when no parts or products containing PFAS or fluoropolymers without a derogation would be allowed to be introduced to the EU market. In the case of A&D products, where every part and component are essential, this means that any one component containing PFAS that cannot be replaced would stop delivery of the entire aircraft or product. In reality, of course, this would be numerous parts and components. However, when considering individual parts and components, such as spares, parts not containing PFAS would be unaffected. But parts containing PFAS and covered by a derogation could still be imported, and those not covered could not be. This situation would shift over time if some PFAS uses are able to be substituted, but at 6.5 years the first tranche of derogations expires and increases the number of parts that cannot be imported. The situation repeats again at 13.5 years with the last tranche of derogations expiring. Of course, the future availability of qualified, validated and certified alternatives for any specific use is not known today, but we can predict with high confidence that there will be some (and probably many) uses where there will not be available alternatives and there will be many PFAS containing parts (especially those with fluoropolymers which we expect to be especially difficult if not impossible to substitute) remaining that could not be imported. Thus, at 13.5 years no PFAS containing spare parts and no products/aircraft could be imported into a REACH member state. Through this entire timeline AIA member companies would be able to continue providing products to customers outside of the EU, but inside the EU newly produced aircraft would be unavailable except for foreign owned aircraft landing at EU airports. It would also place sharp limits on EU military

[7] See ICAO, Effects of Novel Coronavirus (COVID-19) on Civil Aviation: Economic Impact Analysis (April 27, 2023), slide 65, available at https://www.icao.int/sustainability/Documents/Covid-19/ICAO_coronavirus_Econ_Impact.pdf.

interoperability with international treaty partners that rely on fluoropolymers and other PFAS in their defense equipment.

Let's also consider the uses of PFAS. AIA member companies do have some of their own operations based in the EU as well as significant networks of suppliers that produce parts and components (and sometimes full finished products) for products and aircraft that are produced in the US. At the end of the 18-month transition period all uses of PFAS in the EU without applicable derogations would have to cease. However, these same processes could still be performed in the US or other non-EU countries, and AIA member companies would evaluate moving these production processes out of the EU. Shifting large quantities of work would not be done cheaply, so this would be a significant economic impact. Similar to the previous case with importation of PFAS containing parts, there would be two more tranches of activity at 6.5 and 13.5 years when derogations expire for uses without available alternatives.

The situation is similar for maintenance, repair and overhaul (MRO) of aircraft. Non-derogated maintenance activities currently done in the EU would have to shift outside of the EU to continue using PFAS where there are not available alternatives. More maintenance activity would have to shift as derogations expire at 6.5 and 13.5 years. It is unclear under this restriction proposal if a repair that incorporates PFAS into the product (e.g. replacement of a PTFE rub strip) without a derogation would prevent the return of the repaired product/aircraft to service in the EU. In this regard **AIA supports the repair as produced principle where products should be allowed to be repaired as originally designed and produced** (Orgalim)[8].

1.9 Sectors

This comment provides information relevant to the aerospace and defense sector. In the restriction report, A&D is combined with the transport sector. While there are many similarities between A&D and the broader transport sector, products in the A&D sector must meet exacting performance requirements and operate in more extreme environments. Change processes for A&D products are also highly regulated and deliberate to ensure continuity for product performance and safety. For these reasons A&D will likely require different, most likely more and longer, derogations than the rest of the transport sector. Thus, **we suggest that aerospace and defense should be treated as a distinct sector.**

A&D also relies on products from other sectors to be integrated into A&D products. AIA is aware that many of these sectors have already made comments or are planning to make comments to this restriction proposal. We are also aware of individual companies in said sector making supplemental comments. In many cases these comments identify the reliance of A&D (and other sectors) on their products. AIA wishes to emphasize that where a sector does not identify reliance of A&D on their products does not necessarily mean there is not a reliance on their product. It is also important to recall that timelines for A&D to adopt potential alternatives can be very long and potentially exceed estimates of the sectors upon which we rely.

[8] https://orgalim.eu/sites/default/files/attachment/Orgalim%20PFAS%20position%20paper_310823.pdf

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1.10 Emissions and Recycling in the End of Life Phase

The Aircraft Fleet Recycling Association (AFRA) establishes standards and best practices which it uses as a basis for its accreditation program for aircraft disassembly and aircraft materials recycling.[9] Similarly, Tarmac Aerosave is an independent European company actively engaged in decommissioning and recycling.[10] More information about both programs is described in the International Civil Aviation Organization (ICAO) 2019 Environmental Report.[11] Aircrafts are considered valuable assets even at the end-of-life due to the specialized, high performance material contained in them. Comments submitted to this consultation by ASD, provide more information on how commercial aircrafts are stored, recycled and disposed at the end of life. The end-of-life management of military equipment is even more closely managed as is a highly sensitive subject for national security reasons.

1.11 Proposed derogations

With regard to derogations, AIA acknowledges that derogations are proposed for some PFAS uses that are relevant to the aerospace and defense sector. However, not all aerospace uses or sub-uses of PFAS have derogations in the restriction proposal. The list of uses and sub-uses identified by AIA in section 1.5 identifies which uses appear to be "covered" by a derogation and would thus have an additional 5 or 12 years to fully implement alternatives. Many uses, especially of non-polymeric PFAS, do not appear to correspond to any applicable proposed derogation at all. These uses would then have to cease at the end of the transitional period. It appears that most polymeric PFAS uses would fall under a potential 12 year derogation [6.0] under consideration for the broader transportation sector. It is not guaranteed that any of these potential derogations would provide sufficient time to make substitutions in an orderly and carefully controlled manner that is necessary for all our products.

AIA also wishes to reemphasize the importance of highly deliberate change processes that ensure continued operational safety of aerospace and defense products. As described in Section 1.4 substitution timelines can take many years to ensure that all performance requirements are satisfied. Failure to do so can lead to catastrophic results. In the case of substituting PFAS we will need to perform this process many times over for each use that needs to be substituted. We do not yet even know the number of changes (we are still in the process of identifying all uses, and a preliminary listing of uses is provided in Section 1.6 that addresses the specific information request on sectors and (sub-) uses) that would need to be done as a result of this proposed restriction, nor do we have an idea how long each individual substitution would take. But we can say with certainty that 18 months would not be long enough to bring all required aerospace and defense changes through all stages of the process. Where there are longer derogations proposed it is improbable that some substitutions could be completed.

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[9] https://afraassociation.org/
[10] https://www.tarmacaerosave.aero/
[11] https://www.icao.int/environmental-protection/Documents/EnvironmentalReports/2019/ENVReport2019_pg279-284.pdf

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The question then becomes how long would the aerospace and defense sector require to complete substitutions for each use or all uses. This, unfortunately, is unknown at this point. We simply lack all of the information needed to respond here. Among the unknowns:

- Uses and sub-uses of PFAS in the supply chain
- Identity of non-PFAS candidate alternatives to test for each use and sub-use
- Resources required to adequately evaluate all substitutions;
- Whether any particular substitution will be an interchangeable global change or need to be done on a part by part basis

Since the neither the generic 18-month transition period nor the fixed duration derogations are sufficient for aerospace and defense uses and sub-uses, **we propose that a derogation be included for all uses and sub-uses of PFAS chemicals in the aerospace and defense sector**. **The derogation should include technology readiness evaluations to determine whether alternatives are available for any uses and sub-uses and what appropriate adjustments should be made to the duration of the derogation.**

1.12 Potential Derogations Marked for Reconsideration

While we strongly urge the inclusion of a derogation specific to the A&D sector as described above in section 1.9, **we also strongly support the inclusion of the following potential derogation marked for reconsideration: 6.o, "**applications affecting the proper functioning related to the safety of transport vehicles, and affecting the safety of operators, passengers or goods until 13.5 years after EiF." We respectfully provide the following information in support of this potential derogation.

As discussed above, the annual tonnage and emissions of PFAS associated with this sub-use is not possible to quantify at this time. In summary though, we believe that PFAS plays a critical role in ensuring the safety of various components in aircraft and defense.

As explained elsewhere in these comments, the types of PFAS that we have identified serve critical safety functions of heat and fire resistance, fluids chemical resistance, vibration resistance, corrosion resistance, and wear resistance. Many of their uses are described in Table 1 above. Their use qualifies as "applications affecting the proper functioning related to the safety of vehicles, and affecting the safety of operators, passengers or goods."

We estimate that this restriction would directly affect hundreds of different companies in the aerospace industry, including aircraft engine manufacturers and their supply chains, with resulting indirect impacts on airframers, airliners, and their customers. The total number of companies within our industry estimated to be affected by the restriction is estimated to be in the thousands.

We wish to provide comments on the alternatives and cost impact of the proposed restriction on the A&D portion of the Transport sector and particularly on the PFAS sub-use relating to applications

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affecting the proper functioning related to the safety of vehicles.[12] The Annex E report concludes the following with regard to the availability of alternatives to PFAS within the Transport sector:

> The transport sector has an extremely high dependence on PFASs, including use in complex products (e.g. seals, O-rings and gaskets in engines). The properties of PFASs can provide input to the design of such products, with the result that drop-in substitutes will not always be available. Even where they are, testing and certification procedures would need to be followed. It is therefore concluded that a full ban is not feasible for the transport sector and that substitution potential is low.[13]

We agree with this statement but wish to reiterate that for the formulations and articles discussed above, there are currently <u>no</u> available PFAS-free alternatives for such products on the EU market (or elsewhere globally) that we have yet been able to identify. The concern is particularly acute in the context of aerospace servicing and manufacturing given the rigorous safety and qualification process that are required of any changes to engine design and specification. Please see the discussion in Section 1.8 concerning the socioeconomic impacts of a restriction without inclusion of this potential derogation. As described in Section 1.5 alternatives for fluoropolymers (and PFAS) are not available because R&D into potential alternatives has only just begun. This will be a complex and expensive process. As alternatives are not yet available we do not have information to provide regarding cases where substitution is technically and economically feasible or where substitution is not technically or economically feasible.

[12] Annex XV restriction report, pp 101-102; Annex E, pp 346-387.
[13] Table E.121, page 372.

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2 Aerospace PFAS Use Examples

The following section provides more commentary on several of the uses and sub-uses presented in Table 1. Where possible, we have added information on describing the use(s) in A&D applications, key functionalities, the current state of knowledge on alternatives and adequacy of any potential derogations. It is noted that not all uses in Table 1 are covered here and those not included should not be considered as less important to the A&D sector.

2.1 Fire Suppressing Agents

In general, there are many classes of fire suppressing agents including water, inert gases, carbon dioxide, and vaporizing liquids (referred to as Clean Agents in NFPA nomenclature. Clean agents extinguish fires rapidly, leave no residue, are efficient (i.e., they have excellent space/weight characteristics) and are safe to use where humans are present. For this reason, they are required for protection of high-value assets, e.g., computer rooms, nuclear power plants, aviation and military applications.

There are two main approaches to extinguish fire: either fill the entire space with the required amount of fire extinguishing agent, a process known as "total-flooding", or directing the fire extinguishing agent at the source of the fire (if it is known), a process called "local application or streaming".

A class of halogenated hydrocarbons or halons were identified as particularly effective in a joint study by Purdue University and the US Army[14]. Halons were fully commercialized in the 1970's and formed the mainstay of clean agent fire protection of over 20 years until they were implicated in ozone depletion. Under the Montreal Protocol, production of halons ceased in 1993 in developed countries and 2010 in developing countries.

For total flooding applications bromotrifluoromethane (CF3Br, Halon 1301) was preferred, whereas for local application bromochlorodifluoromethane (CF2BrCl, Halon 1211) was preferred.

However, the need for fast, effective, clean agents had not gone away and the fire protection industry has been developing alternatives to halon for the last 30 years. Alternatives including HCFCs, HFCs, inert gases, and a perfluoroketone were developed as clean agents for total-flooding applications and HCFCs, HFCs and 2-bromo-3,3,3-trifluoropropene were developed as streaming agents.

More recently, HCFCs are subject to a phase-out under the Montreal Protocol, and since the issue of global warming, HFCs are being phased down, e.g., under the EU F-gas regulations.

This leaves aerospace and military fire protection in a difficult situation. The proposed PFAS regulations remove all candidate agents, apart from halons, CF3I and HFC-23. The specific implications for aerospace and military fire protection applications are discussed in the following section.

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[14] Purdue Research Foundation and Department of Chemistry. "Final Report On Fire Extinguishing Agents for the Period September 11, 1947 to June 30, 1950." Purdue University, West Lafayette, IN, July 1950.

2.1.1 Fire extinguishers used on-board aircraft

2.1.1.1 Description of Use

In commercial aircraft fire suppression agents utilizing Bromochlorodifluoromethane (Halon 1211) or Bromotrifluoromethane (Halon 1301) have been used in 4 main systems described below.

Application	Historic Use	Replacement
Handheld	Halon 1211	The most common non-halon handheld fire extinguisher agent that is in use on commercial airplanes is 2-BTP (CF3CBr=CH2). Replacements have been ongoing since 2019. 2-BTP is PFAS according to the definition in this restriction proposal. The only non-PFAS alternative would be to revert to using Halon 1211. However, this would be in contradiction of the EC Regulation 1005/2009 as amended by (EU) 744/2010.
Cargo	Halon 1301	A blend of CO2 and 2-BTP is the leading candidate for cargo applications. 2-BTP is a PFAS according to the definition in this restriction proposal. Non-PFAS alternatives in the form of water mist plus inert gases or inert gases alone have been evaluated but these approaches would entail significant space and weight penalties as well as a more complex certification approach.
Lavatory	Halon 1301	HFC-227ea (CF3CHFCF3) and HFC-236fa (CF3CH2CF3) have both been used as replacements for Halon 1301 in lavatory waste compartment fire protection[15]. (PFAS) There are no other clean agents that are not classed as PFAS. CF3I is precluded owing to its toxicity profile. The only non-PFAS alternative would be to revert to using Halon 1301. However, this would be in contradiction of the EC Regulation 1005/2009 as amended by (EU) 744/2010.
Propulsion	Halon 1301	CF3I is the top candidate for propulsion applications. (Not PFAS)

The ozone depletion and global warming potential of the traditional CF3Br (Halon 1301) suppression agent necessitated the development of suppression agents. The alternative agents have not as yet been successful at suppression in all circumstances, but the one thing they all have in common are carbon-fluorine bonds. This is of particular importance for fire suppression because even after the donation of a more loosely-bound halogen like iodine or bromine to the catalytic flame suppression reaction, the base molecule must remain stable in the hot environment. The base molecule must also have little or no bonded species that can be oxidized to CO2 and water as this would promote rather than suppress flame. The combination of carbon-fluorine bonds (with their inherent stability) and carbon bonded to another catalytic halogen (e.g., bromine), provides suppression of flames which are the primary driver of fire spreading to new fuel sources.

For gas phase fire suppression chemicals to work they must either absorb heat or release an atomic species that will catalytically quell the flame front, or both. The binary agents are combinations of these two methods using CO2 to absorb heat and a molecule that will release bromine atoms (the catalytic

[15] https://www.icao.int/Meetings/a41/Documents/WP/wp_096_en.pdf

agent). The molecule that releases bromine at the flame front must be stable enough to survive the trip to the flame front at high temperature. Current methods include the use of chemicals such as 2-BTP (2-bromo-3,3,3-trifluoroprop-1-ene), here the inherent strength of the carbon-fluorine bond is utilized to gain enough molecular stability to release the bromine at the flame front. There are still two hydrogen-carbon bonds that can be oxidized in the fire which is why this chemical cannot be used on its own (i.e., without CO2). Without carbon dioxide the 2-BTP is oxidized in the gas phase by gas phase fuel fires; which is not acceptable for mixed fuel fires such as aircraft cargo fires.

2.1.1.2 Key functionalities

Required functionality generally includes the following.

- Ability to extinguish fires,
- material compatibility (e.g. with materials found on aircraft),
- toxicity,
- low ozone depletion,
- low global warming potential
- weight

2.1.1.3 Availability, technical and economic feasibility, hazards and risks of alternatives

The only current alternative for 2-BTP would involve reverting to Halon 1211 for handheld fire extinguishers. As previously stated, Halon is not an acceptable nor available alternative.

- Subject to Montreal Protocol,
    - Ozone-depleting substance
    - High global warming potential
    - Global production has ceased
    - Subject to phaseout in 2025 under EC Regulation 1005/2009 as amended by (EU) 744/2010.
- Limited available global supply

2.1.1.4 Status of R&D where alternatives not available

Fire suppression is also an example of there not being a universal answer when seeking a chemical solution to an environmental problem. In the last four years several experiments in a full-scale fire suppression test facility have shown that a different set of chemical constraints are important to the function of fire suppression materials.

Two "not-in-kind" technologies have been extensively evaluated.

Inert gas, either used alone or combined with water mist has been shown to be capable of extinguishing the types of fires encountered in cargo compartments. However, the space and weight requirements for a high-pressure inert gas system are prohibitive. An AIA member company has proposed inert gas on numerous responses to Requests for Information (RFIs) or Requests for Proposal (RFPs), and on each occasion the aircraft OEM was not able to integrate the much larger and heavier system into the airplane. Inert gas systems have also not been tested to the latest FAA/EASA Minimum Performance Standard test.

CF3Br vs. CF3I has been extensively investigated. Iodine is next down in the halogen column from bromine. The C-I bond is less robust and thus the CF3I molecule has a much shorter half-life in the atmosphere (on the order of days). However, one step down the periodic table was too large a jump in bond strength. CF3I failed to suppress a smoldering cargo fire and decomposed via several free radical mechanism to CO2, I2 and HF (hydrofluoric acid) which is not the desired outcome. For liquid fuel fires CF3I is quite effective when applied directly on the fire, and it can also suppress fires caused by exploding aerosol cans in the cargo hold of an aircraft. But it cannot control a smoldering fire due to the low bond energy of the C-I bond.

Binary fire suppression agents are now being tested. These combine CO2 and other agents to achieve desirable performance in the case of a fire, but they weigh more and require more complex suppression system designs that are also heavier than those for a single component suppression agent. However, the blend of 2-BTP/CO2, as noted above, is the leading agent to replace Halon 1301 in cargo compartments.

While CF3I is a non-PFAS alternative being explored for propulsion applications it has been ruled out for cargo applications. It was evaluated thoroughly in 2019, and failed the smoldering fire test. It has not been considered as a candidate an alternative for handheld or lavatory applications because of its toxicity profile. Handheld and lavatory fire protection applications are in areas where people are present, and the use of CF_3I would exceed maximum safe concentrations.

2.1.1.5 Information on substitution where alternatives are available

The only area of fire protection where a non-PFAS is being considered is that for propulsion / APU, where CF3I is one of the agents being evaluated. CF3I has passed the minimum Performance Standard

2.1.1.6 Socio-economic impacts

The proposed restriction includes a derogation for “clean fire suppressing agents where current alternatives damage the assets to be protected or pose a risk to human health until 13.5 years after EiF”. This will have the effect of delaying the eventual outcome of a non-use scenario. The continued use of Halon 1301 would create a crisis of its own, as global supplies are projected to run out as soon as the mid-2030s. This would leave airlines with two very untenable choices – continue to use Halon 1301, which would require a change to the Montreal Protocol to allow new production as recycled Halon 1301 can no longer address demand, or switch to the 2-BTP/CO2 blend, which would be restricted and require removal in approximately 2038. The two are not interchangeable without a significant airplane modification. The uncertainty created by the proposed restriction will prevent adoption of the halon alternative, which will increase the chance of a requirement to produce new Halon 1301 or ground the European airline fleet.

2.1.2 Conclusion and adequacy of proposed/potential derogations

Substitution of Halon fire suppressants has been time consuming and difficult to complete. Original development efforts began in 1990 for all 4 main applications. Lavatory applications were successfully substituted starting in 2006. Substitution of handheld fire extinguishers began in 2019. As noted previously, efforts for cargo and propulsion are still ongoing meaning the overall substitution timeline to

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move away from Halon will be greater than 25 years, assuming the current candidates are successful. Considering the challenges and time duration to get to this point, it is not unreasonable to conclude that substitution with non-PFAS, non-Halon, alternatives meeting all requirements would take much longer than 13.5 years, if an alternative can be identified at all. Recalling the bond energies carbon-fluorine compared with other carbon-halogens, new non-fluorinated chemicals with low GWP are not currently foreseen and 13.5 years is inadequate. We cannot predict if or when a new candidate will become available to test, so it would not be prudent to suggest a different duration. We also acknowledge that requesting a permanent derogation for this use may not be palatable for certain parties. Rather, we would suggest an open-ended review period with periodic technology review checkpoints.

2.1.3 Fire extinguishers used in military fighting vehicles

Many of the arguments presented in Section 2.1.1 above are equally applicable to military vehicle fire protection, so will be summarized briefly here. The requirements for military applications are in some ways more demanding and HFCs remain the only viable extinguishing agent type, other than halons, for military vehicle protection.

In the military environment large fast-growing fires can be encountered. In the case of military vehicles, the extinguishing system in crew compartments is required to extinguish an explosion in an occupied space very rapidly (<150 milliseconds). If the extinguishment takes any longer than this there is a risk of burns to the vehicle occupants. The extinguishing agent must be safe to use at its design concentration, must generate acceptable levels of decomposition products, and also provide protection against reignition. In addition, the extinguishing agent is required to provide protection across a wide temperature range. Currently only HFC agents (HFC-227ea and HFC-236fa) can meet these exacting criteria. Both of these are classified as PFAS.

Considering the alternatives to HFCs: Water freezes, so it does not meet the temperature specifications and is therefore not an option. Whilst the addition of antifreezes can prevent freezing, the nature of the fire means that a gaseous agent is required to prevent the fire re-igniting. Water has been extensively tested and it has been shown that fire can reignite, which means that water-based fire extinguishing agents are not appropriate for military vehicle fire threats. Inert gases require too much space and weight and are therefore also not appropriate for military vehicle fire threats.

The only other current alternatives are Halons 1301 and 1211. However, these have high ozone depletion potentials as well as high global warming potentials. Reverting to halons would be considered as a “backward step” as well as being in contradiction to EC Regulation 1005/2009 as amended by (EU) 744/2010.

2.2 Hydraulic fluid

Commercial airplane hydraulic power systems are used for actuation of primary and secondary flight control surfaces, extension and retraction, steering, and brakes for landing gear systems, cargo doors, engine thrust reversers, and other services requiring precise control of large operating loads. Military airplane hydraulic systems share commonality with commercial type services where applicable, but include many others such as: weapon bay doors, drives for guns and the delivery of missiles and other ordnance material, aerial refueling equipment, auxiliary power unit (APU) start systems, catapult and arresting hooks, radar antenna, and emergency generator drives. Missile, rocket booster, and space vehicle hydraulic systems are used primarily for controlling vehicle flight path by vectoring engine thrust and controlling aerodynamic surfaces. Helicopter hydraulic systems are used for controlling the rotor swashplates in both the cyclic and collective pitch modes, for stability augmentation servos, tail rotor blade pitch control, hoist winches and cargo hooks, landing gear retraction, brakes, steering, and APU and engine starting.

2.2.1 Key Functionalities

The control of streaming potential (movement of ions in hydraulic fluids that cause electrochemical corrosion) is done by the use of polyfluorinated surfactants. These surfactants also increase the lubricity (lowering friction) of the hydraulic fluid that limit wear on safety critical components of the hydraulic systems in aircraft, space vehicles and submarines as well as all other hydraulic systems that use non-flammable hydraulic fluids.

One of the important factors in designing any hydraulic system for aerospace applications is its weight contribution to aircraft. Lower weight of the hydraulic system provides higher fuel efficiency and less global warming gasses are released during flight of aircraft and space vehicles. To lower the overall mass of the hydraulic system, smaller, lighter tubes and components are used, but this requires the hydraulic fluid to be pumped at higher pressures. In so doing the overall volume of hydraulic fluid in the system is also reduced. In order to smoothly control the aircraft or space vehicle, the pressure must be reduced at the electrohydraulic servo valve (EHSV). While reducing pressure, streaming potential becomes a larger and larger problem as the pressure of the hydraulic system increases. In order to solve problems associated with the operation of the EHSVs at higher and higher pressures, more polyfluorinated surfactant has been needed. The unique characteristics of the carbon-fluoride bonds in these surfactants, accounts for their ability to both provide the lubricity needed under the extreme conditions in the hydraulic pump, and in their ability to quell streaming potential. The combined low acid production along with these other attributes make this surfactant irreplaceable in high pressure hydraulic fluids today.

Please also refer to the comment submitted by ExxonMobil which provides a thorough description of the erosion mechanism.

Required functionality generally includes the following.

- Must be able to operate at high pressure (e.g. 3,000 -5,000 psi)
- Minimize streaming potential that leads to electrochemical corrosion
- Low corrosion / erosion rate

2.2.2 Alternatives and Conclusion

One supplier of aerospace hydraulic fluids reports that non-fluorinated erosion inhibitors have been tested in past decades with less severe system designs, but that no potential replacement chemistry has been identified with adequate stability to survive in hydraulic fluid in aircraft service. Considering that decades of testing have not yet yielded any promising non-PFAS results, we are not confident that a promising candidate will be identified soon. However, any future promising candidate that is identified must successfully progress through the entire change process described in Section 1.7. Because of the importance of hydraulic fluid systems for flight control, functional testing necessary for validation and certification is expected to be extensive and affect the overall timeline for substitution significantly.

The proposed restriction includes a derogation for "additives to hydraulic fluids for anti-erosion/anti-corrosion in hydraulic systems (incl. control valves) in aircraft and aerospace industry until 13.5 years after EiF". Considering the discussion above, we lack certainty if this derogation is long enough, and a derogation with periodic evaluation of the availability of current technology is requested.

2.3 Coatings – Organic finishes

Organic finishes are an important category of uses for the aerospace and defense sectors. As in other sectors, coatings impart important functionality to the parts to which they are applied. Due to their strong influence on safety and reliability of the product, organic finishes are closely controlled by Government/military standards, Federal regulations, and OEM material and process specifications. Organic finishes are used on materials for environmental protection and for aesthetic appearance. They include primers, topcoats, and certain specialty coatings. The selection of finishes is usually predetermined or limited by contractual or product model finish specifications. Selection of finishes begins with the identification of finish requirements as determined by the following:

- Function of the coating
- Contractual or product requirements
- Required operating environments
- Manufacturing and handling environments

Fluorinated compounds may be used in coatings as wetting, leveling, and dispersing agents, and have been used to improve gloss and antistatic properties. They can also be used as process aids when producing individual ingredients that make up the paint, such as when grinding pigments or to improve pigment miscibility. It only been recently reported that fluorine components could be used in a paint formulation as a proprietary ingredient, so if present they may not be documented in the Safety Data Sheet. Both polymeric as non-polymeric PFAS may be used in organic coatings and finishes.

2.3.1 Non-polymeric PFAS in organic finishes

Non-polymeric PFAS use identified in organic finishes is primarily used as a solvent. The primary constituents are Benzene, 1-chloro-4-(trifluoromethyl)- (CAS 98-56-6) and 1,1,1,2-Tetrafluoroethane (CAS 811-97-2).

The purpose of organic solvents in a coating formulation is to dissolve the polymeric chains of the resin and other ingredients and produce a homogeneous liquid to allow acceptable application of the coating to the base material. The organic solvent will diffuse through and evaporate from the applied coating film after application and will not contribute to the film polymerization. In essence, solvents or thinners are added to the paint formulation to dissolve the solid ingredients of the paint formulation so they can be applied as a uniform aesthetically pleasing film that meets desired performance.

The key functionalities of solvents in any coating or organic finish are to:

- Reduce and control coating viscosity so that the coating can be applied to the base material
- Control evaporation and diffusion rate to allow uniform and continuous film formation, free of film defects when the coating cures
- Contributes to wetting of the applied paint to the base material. Improved wetting means better adhesion.

2.3.2 Polymeric PFAS in organic finishes

Polymeric PFAS additives are incorporated into coating formulations that typically comprise significant amounts of components that do not contain fluorine. The purpose is to add or enhance properties imparted by fluoropolymers that are not necessarily present in these coatings.

Additives may be in the form of an aqueous dispersion or by addition of polymeric PFAS particles to the coating matrix.

Key properties given (or improved) by addition of polymeric PFAS to coatings generally include

- Reduction in wear, mar, and scratching
- Reduction in friction
- Improved release properties
- Water and oil repellency

Specific coatings may be optimized for one or more of these or other properties.

2.3.3 Sub-uses and Key functionalities

Organic finish coating formulation usually contains solvent, resin (binder), pigment, filler, and additives. When applied to the underlying substrate, they provide a continuous coating that prevents cracking and structure breakdown during the service due to exposure to various environmental conditions.

Organic finishes are applied to various substrates including metals, plastics and composites. The first coating is typically the primer which can provide corrosion resistance to substrates, and to effect adhesion of subsequent finish coats where finish coating is required. Primers are usually selected as one of the elements of a finish system that can entail metal surface finishing (e.g. anodizing, conversion coating, plating, etc.), priming and application of a topcoat. The elements of a finish system vary based on the specific requirements and service environment of a part or component within an aerospace end product. Both polymeric and non-polymeric PFAS are present in organic coatings used in the A&D sector.

In cooperation with IAEG, AIA has identified a number of sub-uses for this category. These are listed in Table 2 along with an indication of what type of PFAS they contain.

Table 2 Uses of PFAS in coatings

Organic finish /coating	**Non-polymeric PFAS**	**Polymeric PFAS**
Primer	x	
Topcoat	x	x
Abrasion resistant coating		x
Aluminized coating		x
Conductive/RF coating	x	

Erosion resistant coating	x	x
High temperature resistant coating	x	
Temporary protective coating	x	
Conformal coating	x	
Fluorocarbon bonding preventative		x
Adhesion promoter for polysulfide and polythioether sealants	x	
Hydrophobic coating	x	

Primers. Primers are applied to various substrates including metals, plastics and composites. On metallic substrates they are formulated to provide corrosion resistance to substrates, and to effect adhesion of subsequent finish coats where finish coating is required. Primers are usually selected as one of the elements of a finish system, which generally includes metal surface finishing (e.g. anodizing, conversion coating, plating, etc.), priming and application of a topcoat. The elements of a finish system vary based on the specific requirements and service environment of a part or component within an aerospace end product.

Key functionalities

- Corrosion resistance
- Adhesion
- Hardness
- Resistance to chemicals, fluids, humidity, impact, temperature
- Compatibility with other layers

Topcoats. Topcoats are applied as the final finish process to complete the required environmental protection, and/or to provide the required visual characteristics, and/or provide other required special surface characteristics. Topcoating is not always required on permanently installed hidden or obscured items provided that the base material or primers are capable of furnishing the required environmental protection or special surface characteristics. Topcoats are usually selected in conjunction with the proper primer(s) to comprise a finish system.

Key functionalities

- Adhesion
- Hardness
- Resistance to chemicals, fluids, humidity, temperature, UV light or other end-use environment
- Compatible with other layers
- Camouflage
- Chemical agent resistance
- Abrasion resistance

Abrasion Resistant Coating. This coating produces a very smooth surface with high flexibility, impact resistance and lubricity. In situations where the bearing loads are light, it is effective in minimizing the effects of rubbing. These coatings are applied only in the localized area where rubbing will occur in service, such as surfaces that mate against seals.

Key functionalities

- Adhesion
- Abrasion resistance

Aluminum Pigmented Coatings. Aluminum pigmented coatings are used on metallic fasteners. They are formulated to prevent galvanic corrosion and provide aerospace fasteners with lubrication properties.

Key functionalities

- Corrosion resistance
- Appearance

Conductive/RF Coating. Conductive coating consists of a base resin with conductive pigment and a curing agent. Also known as anti-static coatings, they are applied to nonconductive (for example, fiberglass and other plastics) surfaces. They are intended to facilitate the discharging and positive grounding of static electrical charges to the primary structure.

Key functionalities

- Electrical conductivity/resistivity
- EMI/RF performance
- Flexibility
- Adhesion
- Compatibility with other layers

Erosion Resistant Coating. A specialty coating or coating system used to protect surfaces of parts susceptible to rain and sand erosion or damage. Erosion resistant coatings are applied to leading edges of aircraft components flaps, stabilizers, radomes, and engine inlet nacelles, as well as surfaces like helicopter blades and wind turbine blades. Resin formulations of both polyurethane and fluoropolymers are commonly used to meet rain erosion performance criteria.

Key functionalities

- Resistance to erosion by rain and sand
- Flexibility
- Impact resistance
- Weathering and moisture resistance
- Adhesion

High Temperature Coating. Used in higher temperature environments without damage to the coating or underlying structure.

Key functionalities

- High temperature resistance
- Adhesion

Temporary Protective Coating. Used to temporarily protect parts, components, structures etc. from environmental damage during manufacturing or maintenance. The coating is applied when the following step is not performed immediately and protection is required.

Key functionalities

- Corrosion resistance
- Removability

Conformal coating. Conformal coatings are insulating protective coatings, which conform to the configuration of the object coated. Used as a protective layer and encapsulant on in electronics on printed–wiring assemblies (PWAs). It is generally accomplished with an organic resin applied by dipping, brushing or spraying and is generally 0.003 to 0.01 inches thick.

Key functionalities

- Abrasion resistance,
- Electrical insulation
- Environmental isolation.

Fluorocarbon bonding preventatives.

Used to reduce friction and increase slippage between silicone rubber filler compounds and rotating aircraft engine components.

Key functionalities

- Adhesion
- Compatibility to substrates

Adhesion promoter for polysulfide sealants and polythioether sealants. The use of an adhesion promoter can significantly enhance the adhesion and bonding characteristics of polysulfide and polythioether aircraft sealant to a desired substrate. In addition, the use of adhesion promoter can sometimes compensate for surfaces that are difficult to access and may not have been adequately cleaned and prepared. This is especially applicable to repair purposes or when bonding to surfaces that are aged and have already been exposed to fuel and other fluids.

Key functionalities

- Adhesion of sealants to substrates

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Hydrophobic coating. Hydrophobic coatings are carbon-based coatings that utilize a high surface tension pigment, such as Teflon, to repel water from the surface. Fluorinated coatings also perform as hydrophobic coatings. The purpose of hydrophobic coatings is to cause water droplets that form on the surface to bead up and roll off similar to a freshly waxed car. Hydrophobic coatings are predominantly used as radome coatings, windshield coatings, or other surfaces where it is not desirable for water to easily wet.

Key functionalities

- Hydrophobicity
- Adhesion

2.3.4 Status of R&D where alternatives not available

We are not aware of active research and development activities to reformulate coatings using polymeric and non-polymeric PFAS. While AIA is not aware of active efforts to replace PFAS as solvent in existing already approved coatings, we are aware of efforts to proactively reformulate candidate coatings being developed for other aerospace projects and thus avoid the future use of PFAS solvents in these cases. It is still too early report on the success of these efforts. The specific substances being evaluated are proprietary to the formulators and cannot be disclosed at this stage.

For the replacement of polymeric and non-polymeric PFAS, a coating must be fully evaluated through all maturity stages (e.g. development, qualification, validation, certification, industrialization) described in Section 1.7. OEMs will rely on formulators to propose PFAS-free candidates for testing. We question whether formulators would be able to efficiently develop and propose alternatives for all affected materials to be tested by OEMs, and whether OEMs would have the capacity to test many candidates. Under current circumstances, full evaluation and substitution of reformulated coatings may take a couple years in the best cases or much longer where multiple iterations are required. However, if the PFAS restriction becomes final, the number of reformulations that need to be evaluated concurrently will increase significantly, use up available testing capacity and result in increased backlogs and timelines.

2.3.5 Conclusion

Non-polymeric PFAS used as a solvent would be expected to flash off during curing leaving an applied coating without PFAS. We do not have information on whether the applied coating would meet the proposed 25 part per billion concentration limit. If it did meet this limit, one option could be to apply coatings outside of the EU. In this scenario, production, maintenance and overhaul work would have to be done outside of the EU. The resulting non-use scenario would be similar to non-use scenarios described in aerospace and defense Authorisation review reports for chromate uses recently submitted by the Aerospace and Defence Reauthorisation consortium (ADCR).

The use of non-polymeric PFAS in coatings is not addressed by any proposed or potential derogation in the restriction proposal. As such, the transition period would be 18 months after entry into force as currently proposed. This short transition period would not allow sufficient time to fully substitute these coatings.

The use polymeric PFAS in coatings in A&D applications are potentially covered in the restriction proposal under: 6.o [applications affecting the proper functioning related to the safety of transport vehicles, and affecting the safety of operators, passengers or goods until 13.5 years after EiF]

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2.4 Seals

Several high-performance fluoropolymers and fluoroelastomers such as FKM, FVMQ, FFKM and PTFE are used as material for O-rings, seals for valves and gaskets, face seals, hose liners, bearing seals, seals for electronic devices and nut seals etc. A large majority of these are used in the oil, fuel and air systems of aircraft engines. These materials have a long history of successful and safe use in commercial and military aircrafts. The use of these materials is governed by requirements set by industry specifications as well as airworthiness regulations. Fluoroelastomers, such as those meeting the requirements of SAE Aerospace specifications AMS7287 and AMS7257, are used to provide sealing of aircraft fluid systems such as aircraft engine oil and aircraft jet fuel. Fluoroplastics, such as those meeting the requirements of SAE Aerospace specification AMS3678, are used to support fluoroelastomer seals and to function as bearings in aircraft engine oil and aircraft jet fuel systems. These fluoroelastomers and fluoroplastics provide a combination of long-term compression set resistance at elevated temperatures and resistance to aircraft engine oils and aircraft jet fuels that are not available with other polymers. The temperatures experienced in some sealing locations in aircraft engines are well above 200°C and sealing materials other than fluoroelastomers are inadequate under these conditions.

2.4.1 Key functionalities:

Fluoropolymer based materials are vital in providing the following key functionalities to seals, O-rings and gaskets

- Friction and wear properties
- Mechanical strength
- Resistance to aircraft engine oils, jet fuels at elevated temperatures
- Resistance to other chemically aggressive fluids such as hydraulic fluids, de-icing agents, cleaners
- Electrical insulation
- Heat and flame resistance

2.4.2 Alternatives

We are not aware of active research and development activities on non-fluoropolymer-based materials for A&D seal applications. Replacement materials, once developed by formulators must be fully evaluated through all maturity stages (e.g. development, qualification, validation, certification, industrialization) described in Section 1.7. They will require varying levels of component tests and engine tests to establish functionality & durability. These include, but are not limited to required component/system testing to show equivalent levels of performance for various parameters including:

- Thermal resistance
- Pressure resistance
- Geometry (stretch, squeeze, gland depth, seal profile, etc.)
- Material properties (hardness, set etc.)
- Material compatibility (fluids, metals, electrical resistance, etc.)

Current designs use seal/hose geometries established based on operational experience with fluoropolymers and new/alternative materials may also require updated or new geometric design standards.

Potential alternatives to aerospace seal materials made of perfluoroelastomers have been presented in a report compiled by Dupont (EPPA, *'Submission document for public consultation of potential restriction of the per- and polyfluoroalkyl substances (PFAS) related to precision polymeric parts and shapes used in high performance industrial operating environments'*). Data presented in the report show that non-fluoropolymer-based materials such as Hydrogenated Nitrile Butadiene Rubber (HNBR) and Silicone (VMQ), while comparable in some properties, are not able to offer the complete set of characteristics provided by fluoropolymers. Similarly, for wear strips, molded shapes and seals made of fluoropolymers a number of alternatives including bronze, steel, polypropylene, polyvinyl chloride (PVC), polyether sulfone and others are shown to fall short in their ability to meet all requirements.

Other polymers which have been used in aircraft fuel systems in the distant past, such as nitrile polymers, do not have the long-term, high temperature compression set resistance required by today's high efficiency aircraft engines. Substitution of fluoroelastomers with these inferior polymers would result in inefficient aircraft engines with poor durability and increased maintenance.

2.4.3 Conclusions and Adequacy of proposed derogation

The use of fluoropolymers as material for seals in A&D applications are potentially covered in the restriction proposal under: 6.o [applications affecting the proper functioning related to the safety of transport vehicles, and affecting the safety of operators, passengers or goods until 13.5 years after EiF].

In addition to the unmatched properties of the fluoropolymers, the number and variety of applications that employ fluoropolymers will make the identification and qualification of alternatives an immense task, making an extended duration derogation absolutely essential. As mentioned above, there are no alternatives currently available and the testing required for any new material will be extensive.

2.5 Wires, Cables and Optical Fibers

Wires, cables and optical fibers are extensively used in aircrafts, satellites, radars and other A&D systems. They serve to provide a network of reliable electricity and signal transmission to control communications; safety and mission critical systems including flight controls. A single aircraft, satellite, or vehicle will have numerous cables and cable assemblies, each with unique performance requirements based on its specific use in a complex system. Cables and Cable Assemblies used in A&D applications must operate reliably over a long product life cycle that can reach beyond 30 years.

Different types of polymeric PFAS such as PTFE, FEP and PFA are used in aerospace wire insulation applications. In most cases their use is required by standards due to their superior performance for mechanical strength, electrical insulation, heat and flame resistance and chemical resistance.

Fluoroplastics, such as those meeting the requirements of SAE Aerospace specifications AS23053/11, AS23053/12 and AS23053/13, are used as heat-shrinkable tubing to provide mechanical protection and electrical insulation for electrical wiring in aircraft electrical systems. These fluoroplastics provide a combination of mechanical strength, electrical insulation, heat and flame resistance, and resistance to aggressive aircraft fluids that are not available with other polymers. Fluoroplastic electrical insulation, such as that used to meet the requirements of SAE Aerospace specification AS22759/11, is used to coat electrical wiring to provide electrical insulation in aircraft electrical systems.

2.5.1 Key functionalities

Key performance requirements for wires, cables and optical fibers in A&D include:

- Thermal resistance over a wide range of operating temperatures

Cables experience a wide range of operating temperatures from extreme conditions in varied climates, to low temperature at high elevation during flight and the extremes of space. This may range from temperatures below -100 °C for some space applications to greater than 150 °C.

- Dielectric constant (εr)

Dielectric constant is an important material characteristic which relates to the ability of the material to store electrical energy in an electrical field. Low dielectric constant values are necessary for high frequency or power applications to minimize electric power loss, enabling precise, consistent, and efficient signal transmission.

- Chemical resistance

The material must perform its function in harsh conditions and provide chemical resistance to oils, aircraft fluids, fuels, and other chemical substances.

- Mechanical strength and flexibility

The wires and cable materials must be highly durable and withstand frequent/rapid flexing, torsion, and pulling without compromising electrical performance under demanding environments (e.g., extreme temperatures).

- Low coefficient of friction

The cable insulation and jacket layers must have a low coefficient of friction in order to decrease abrasion under continuous flexure and movement and during installation in aircraft and other systems.

2.5.2 Alternatives

To operate in harsh and extreme conditions, cable applications need critical properties that only a small subset of potential materials can provide. Submissions to this consultation by various entities including W.L. Gore (# 6301), Dupont (# 4530), Amo Special cables (# 4479) present thorough analyses of the state of alternatives.

Some of the alternative polymers and their shortcomings for A&D applications are outlined below:

- *Polyimides* – lack of flexibility, high dielectric constant and stiffening under humidity
- *Polyesters, Polyethylene, Polyurethanes* - limited by maximum use temperatures and drop in performance over 80 °C. Further they would require the addition of flame retardants most of which are of regulatory concern
- *Silicones* – limited due to their high dielectric constant which leads to poor performance in signal transmission cables
- *Polyvinyl chloride (PVC)* – lack of chemical resistance and low abrasion resistance

2.5.3 Conclusions and adequacy of proposed derogations

From numerous comments made in response to the current consultation from electronics and semiconductor suppliers (and their representative trade associations), it is apparent how critical fluoroplastics are in developing and supporting A&D products, including aircraft, ground and test equipment and many other A&D products that depend on electricity for their proper functioning. As such, the US A&D industry is greatly concerned about the continued supply and cost of electronics products impacted by the final restriction.

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2.6 Refrigerants

Refrigerants are used in refrigerators, chillers and freezers in aircraft galleys and in liquid cooling refrigeration units for cabin and cargo air conditioning. In defense applications, refrigerants are used in radars, operator shelters and defense vehicles.

Fluorocarbon based refrigerant gasses have been in use in Aerospace and Defense equipment for over 10 years, principally as a replacement for Freon (HCFC-22 and R-22, typically) as a result of the ban on such substances more than a decade ago. These fluorocarbon-based refrigerants (HFC-134A, HFC-125) have proven to be functional in providing reliable and safe alternatives. In order to optimize the necessary thermal cycle however the integration of the fluorocarbon-based refrigerants involved significant redesign of the hardware. Further the Aerospace Industry has not yet identified a substitute for HFC134a that would satisfy the FAA and DoD certification criteria, and in particular a substitute with the low flammability properties of HFC-134a.

Since 2010, our new products have been specifically designed and sized for HFC-134a and HFC-125 fluorocarbon based refrigerants being utilized. As weight/volume is critical within aircraft/spacecraft, this optimization is required to meet both size and purpose of use.

2.6.1 Key functionalities and Alternatives

Fluorocarbon based refrigerants are critical to Aerospace and defense application:

- They must operate at Flying at 35,000 feet which exposes aircraft to -55C
- They must have low flammability properties
- Due to the closed environment of the applications, in the unlikely event of a leakage, the refrigerants must be non-toxic
- They must be thermally efficient to minimize system size and weight

Most alternatives to Freon refrigerants currently available are materials developed to have lower global warming potential than the incumbents. However, these are still based on fluorinated chemicals (HFCs, HFOs or HFC/PFAS). Many of them have issues such as flammability even if they meet some performance requirements. For example, the thermal performance of R1234yf (hydrofluoroolefin; HFO) is similar to R134a, however, R1234yf's mildly flammable property makes it unsuited for use in aircraft environments. Another HFO based refrigerant, R513a is considered a “drop in” replacement (equivalent performance in terms of refrigeration capacity, pressures and temperatures) to R134a, however it has higher global warming potential.

2.6.2 Conclusions and adequacy of potential derogations

Under the current restriction proposal, the use of refrigerants in A&D has potential derogations under the following: 5.q refrigerants in transport refrigeration other than in marine applications until 6.5 years after EiF; and 5.dd [use as refrigerants and for mobile air conditioning in vehicles in military applications until 13.5 years after EiF]. In view of the discussion presented above, it is unlikely that these time periods will be sufficient to substitute PFAS containing refrigerants in A&D use and further technical readiness review with a scope for extension is requested.

2.7 Solvents, Cleaners

The Aerospace and Defense industry depends on PFAS as solvents for many different uses, including as a general solvent in other chemical products (coatings, lubricants, cleaners, adhesives, water proofing agents), as well as direct use in specialized applications such as oxygen system cleaning and electronics precision cleaning.

PFAS-containing cleaners have low surface tension enabling rapid penetration coupled with high solvency (Kb values >100) to remove oils, greases, silicone residues, polar materials and soils, dust, particulate and flux agents. They evaporate quickly and leave low to no residue. They contain low water content (hydrophobic) which is critical to aircraft and space components. They are non-flammable and can be used safely on heated surfaces. Further, PFAS-containing cleaners are safe to use on metals, ceramics, composites, and various plastics including but not limited to PVC, polycarbonates, nylons, phenolics and fluoropolymers such as PTFE and ETFE.

PFAS solvents are used for cleaning equipment intended for use with either liquid or gaseous oxygen. Contaminants in oxygen-rich systems pose serious risks. Where used in industrial settings, oxygen cleaning eliminates fire or explosion danger due to flammable contaminants. They are often specified for use in space systems where low non-volatile residue requirements are mandated, along with oxygen compatibility and non-flammability. Hydrofluoroether-based oxygen system cleaners replace ozone-depleting substances (ODSs) and compounds with high global warming potential (GWP) previously used for that purpose.

A & D. products with precision cleaning requirements include electronic equipment, including PWBs, switches, relays, etc.; Sensors; Actuators; fiber optic termini and fiber optic insert alignment sleeve holders.

2.7.1 Key functionalities and Alternatives

In those uses, PFAS provides numerous beneficial properties, including

- low flammability/ acute toxicity (vs. some other potential alternatives),
- rapid and complete evaporation,
- non-reactivity/ compatibility with other materials,
- low moisture absorbancy,
- excellent solvation/ surfactant properties such as low surface tension
  thermal stability.

Specific uses include uses in coatings, desmutting, degreasing, glass surface treatments for aircraft cockpits and in 3D printing release agents and in primary lithium batteries. PFAS solvents are also essential for the performance of critical fluoropolymer resins.

Expanding on the dependence of our industry to critical uses in the A&D value chain, it is apparent that many parts and assemblies that the industry relies on for consistently producing effective, safe, reliable and supportable products will be severely (if not completely) impacted by a restriction on PFAS solvents.

Solvents historically used for oxygen tube cleaning have been phased out and are no longer available. Trichloroethylene based vapor degreasing was prominent among these. TCE is now listed on Annex XIV and subject to Authorisation. Efforts to qualify aqueous cleaners met with limited success. Ultimately PFAS based cleaners using constituents such as Pentane, 1,1,1,2,2,3,4,5,5,5-decafluoro- (CAS # 138495-42-8), Butane, 1,1,1,2,2,3,3,4,4-nonafluoro-4-methoxy- (CAS # 163702-07-6), 2-[Difluoro(methoxy)methyl]-1,1,1,2,3,3,3-heptafluoropropane - (CAS # 163702-08-7) have been the most successful replacements.

2.7.2 Conclusions

AIA member companies and companies in their supply chains operating the EU as well as their customers, including commercial operators and ministries of defense (MODs), will all require the use of continued use of PFAS-based solvent cleaners until alternatives are developed and qualified that meet all performance requirements. At this time, we cannot say with certainty what alternatives would be pursued nor how long this endeavor would take from start to finish. Nor can we say with certainty that two of the proposed derogations (5.k: industrial precision cleaning fluids until 13.5 years after EiF; and 5.l: cleaning fluids for use in oxygen-enriched environments until 13.5 years after EiF) in the restriction report would allow enough time to develop, qualify, validate, certify and industrialize replacements for all applications. Both of these derogations are clearly applicable to A&D, but is also unclear that these two derogations would cover all of our required uses.

2.8 Composite Processing Applications

Composites in A&D applications usually refers to layered combinations of carbon fiber or fiberglass in a plastic resin, combining properties of each material. They are broadly used aerospace applications because of their ability to be formed into complex shapes, lighter weight, exceptional strength, durability, fatigue properties and reduced corrosion potential. In aircraft applications composites are used for fuselage, radomes, landing gear doors, strut-forward and aft fairing, outboard flap, trailing edge panels, fin torque box, rudder, elevator, floor beams, flaps, ailerons, inboard and outboard spoilers, engine cowling, central torsion box, tail cone, vertical and horizontal stabilizers, and more.

In aerospace composite applications fluoropolymers are important both in processing and sometimes as a functional layer incorporated into composites. In order for composite materials to maintain repeatable processes, careful evaluation and consideration of material types are used. Fluoropolymer based composite release films (or parting films) allow for removal of composite parts from other media used in the curing process. The films also have heat resistance, good elongation and strength and provide a low friction surface. Fluoropolymer films are also used extensively for production of composite parts prior to cure. The lubricity of the film surface is critical in the ability to manufacture said complex shapes with extremely tight tolerances that enable the high level of performance for A&D advanced composite structures. Fluoropolymers are also used extensively in automated equipment used for composite part production. With high speed processing and heated operations, it is critical to the functionality of these machines that the extremely sticky resins typical of uncured composite materials do not stick to contact surfaces within the equipment. Fluoropolymers are ideal for this type of equipment and is used extensively throughout the industry in this way.

Example uses are:

- Location and positioning of materials during the layup of uncured parts. These are commonly referred to as shop aids.
- Teflon backed tapes for maintaining placement of composite part constituents like honeycomb core
- Protective film on table surfaces (for example) for manual manipulation of uncured material
- Rollers, tension bars, guide rails and other components for automated equipment such as Automated Fiber Placement (AFP) and Contoured Tape Laying Machine (CTLM)
- Protective film for material after kitting, moving between work stations
- Utilization as a slip plane for complex part assembly
- Part quality aid during cure such as breather

2.8.1 Key functionalities:

Composite parts must be carefully manufactured, evaluated, & tested to ascertain that the materials repeatably demonstrate critical performance properties as designed. These designs are a key aspect of how composite material achieve the benefits for lighter weight, higher performing structure. Not only does this result in more cost-efficient structure but also A&D platforms with lower environmental impacts due to reduced fuel burn, greater payload capability per trip. Fluoropolymers like PTFE and FEP are used extensively in these highly controlled and detailed manufacturing processes. These materials are chosen for many reasons including:

- Low adhesion for maximum releasability (lubricity) -resin must not stick to these shop aids as loss of resin can result in degradation of material properties. Modern A&D composite material system are typically net resin systems
- Minimum transfer of residue that can result in unacceptable adhesion, mechanical strength or fatigue performance of subsequent layers (e.g. composite, primer/paint, etc.)
- Ease of handling and ability to resist wrinkles, tears or other discrepancies such as delamination, distortion, inclusions etc. that can degrade part quality.
- Strength and durability of the film or machine components to maintain shop operations.

2.8.2 Alternatives

For the use of fluorinated systems as shop aids, one AIA member company has undergone an extensive survey of usage and potential alternative materials as the result of a contamination investigation. Through that investigation, implementation of alternatives like polyethylene (PE) was investigated for placement of preforms, use as a slip plain material, etc. While some applications could make the switch, it was found that there were other instances where the engineering tolerances were such that only the higher lubricity and strength to thickness offered by PTFE was capable of manufacturing the part in question without inducing quality defects.

Other shop aids such as the tapes and breathers have also been difficult to find replacements as many of the alternatives present on the market pose significant risk to part contamination (silicone coated breathers for example or acrylic backed tapes). All contact materials that are used in the production of composite parts go through an extensive testing program to ensure that they do not pose a risk to the resulting structural laminate. If they are used with multiple composite types (e.g. epoxy, bismaleimide (BMI), cyanate ester), they must be screened against each unique resin chemistry and process type to ensure compatibility. This often results in an iterative effort to find a specific shop aid that functions with the material system and part configuration.

For application of fluorinated components in automated equipment, the industry offers some alternatives such as silicone rubber. However, this material does not offer the same wear resistance as its fluorinated counterparts. This material has a much higher risk of contamination to the composite laminate, especially as the components wear over time and usage. Processes and safeguards must be in place to ensure that this does not occur as it can cause structural failure due to silicone transfer to the composite material. This transfer is not detectible with standard NDI techniques or other quality inspection processes. The fluorinated components not only have significantly less contamination risk but also have better wear life typically. Metallic or ceramic components are also sometimes utilized. However, the most common version of these are actually ones that are embedded with PTFE coatings to help with resin release and cleanliness.

The ability to find a substitute or alternative approach around PFAS impacted composite production is very dependent on the structure in question as well as the production environment. The use of PVF as a barrier film on critical structure such as engines helps to protect critical components from water ingress during flight. Multiple efforts over the last 20 years have been undertaken to find an alternative to this material due to cost and sourcing concerns. However, other polymeric systems that could be co-cured with the underlying epoxy substrate did not prove to have either the environmental resistance (was not a good barrier film) or was not resistant enough to the chemical environment found around propulsion systems for life of the airplane usage.

2.8.3 Conclusions

As described above, fluoropolymers provide essential characteristics and functionality in the production of composites in the A&D sector and cannot be easily substituted. A&D companies are not aware of materials with similar properties to fluoropolymers that could fill the roles described here. If potential candidate materials were identified they would need to be fully tested and qualified before being put into use. In fact, since such a change in production method could potentially affect the quality of parts produced and hence the overall design certification of the aircraft, the effort needed to substitute them would need to follow the same process as is used to substitute as described in section 1.7. The clock on the substitution timeline could start only after such materials are identified.

Companies in the A&D sector are confident that the potential derogation 6.o (which allows for applications of fluoropolymers affecting the proper functioning related to the safety of transport vehicles) would be applicable in this situation, as the required composite parts could not be produced without them. However, this potential derogation would expire after 13.5 years, which, given the current state of unknown potential alternatives, would require some (perhaps all) EU composite processing applications to cease (and likely be moved out of the EU).

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Appendix A: GCCA White Paper

AIA understands that the link to the AIA white paper on the GCCA website is currently not functioning. The text of the white paper titled "Aerospace & Defence Qualification Process Impacts on Ability to Substitute Cr(VI) Substances" is reproduced here for reference.

Aerospace & Defence Qualification Process Impacts on Ability to Substitute Cr(VI) Substances

Aerospace and Defence (A&D) products operate and carry people in extreme environments over extended timeframes, while having to fulfil extremely challenging technical, reliability, and safety requirements. To ensure the safety and reliability of aerospace products, comprehensive airworthiness regulations have been in place globally for decades. **These regulations require a systematic and rigorous framework to be in place to qualify all materials and processes to meet stringent safety requirements that are subject to independent certification and approval through, EASA and other agencies requirements.** Air, ground and sea-based defence systems, and also space systems, are subject to similar rigorous qualification requirements. Changes to A&D hardware offer unique challenges that are not seen in other industries.

The A&D companies that design and integrate the products (e.g. aircraft, engines, radar systems, missiles), are each responsible for their own product qualification, validation and certification, according to airworthiness regulations or defence/space customer requirements. Within a single A&D company, even seemingly 'similar' components or hardware used in different systems/models have unique design parameters and performance requirements, driven by the system-level requirements of the final delivered product. **<u>A&D products cannot be placed on the market without going through this demanding process irrespective of any REACH legislation.</u>** The same rigorous process is in place to approve materials used for the repair and maintenance of these products. Figure 1 illustrates the process required in the A&D industry when substituting a material.

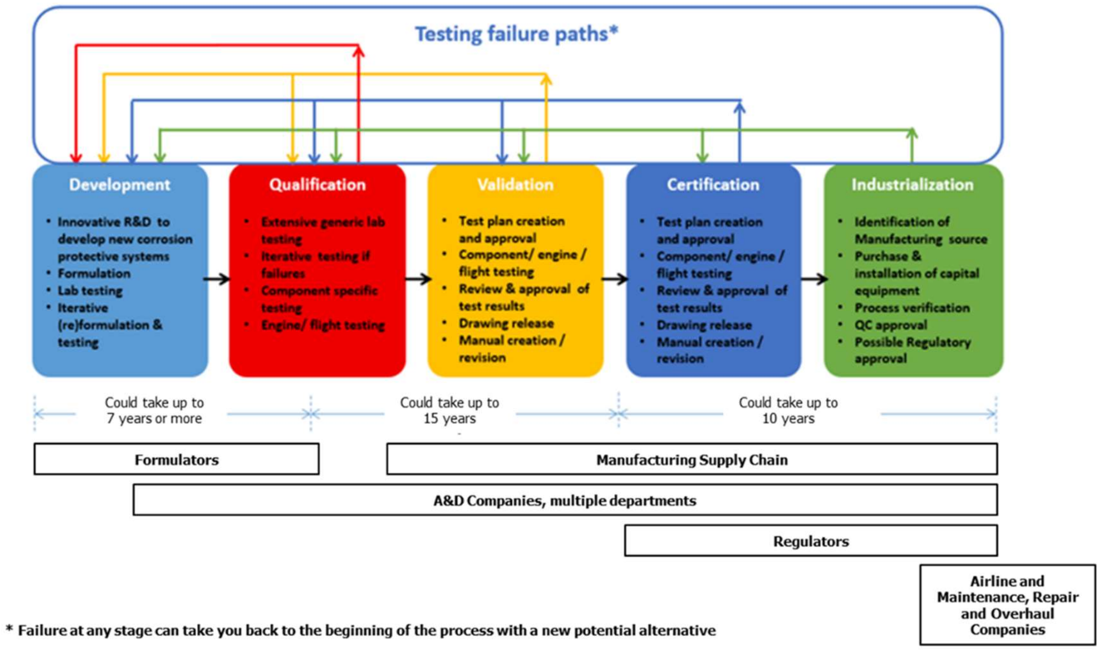

Figure 1: Illustration of the development, qualification, validation, certification and industrialisation process required in the aerospace industry

Whilst a formulator may introduce an alternative into their products, there are many discrete activities required to introduce an alternative candidate into A&D hardware. The testing and qualification criteria is dictated with due regard to the design and performance requirements of each component and system. An example suite of tests for primers may include enhanced corrosion, fatigue, chemical resistance, erosion, repair and manufacturing trials, engine and/or flight tests. Once a candidate technology has reached a sufficient level of maturity, then integration into products is permitted. Industrialisation is an extensive step-by-step methodology followed in order to implement a qualified material or process throughout the manufacturing, supply chain and maintenance operations, leading to the final certification of the A&D product. This includes re-negotiation with suppliers, investment in process implementation and final audit in order to qualify the processor to the qualified process. An individual component may become part of multiple subsystems and systems, each imposing its own design requirements and challenges**. Thus, successful substitution for one component in a given subsystem does not imply that it is suitable for use in a different subsystem. Each individual subsystem and system must be assessed and validated independently.**

Formulators are responsible for developing and performing the preliminary assessment of any candidate alternative's viability. However, **only the original design owner can determine when a candidate alternative is fully qualified and/or validated and therefore meets both airworthiness and comparable performance requirements for each of their A&D applications independently.**

The A&D industry has long recognized the risks associated with Cr(VI) and the necessity of implementing the use of alternatives. Significant efforts have been expended by the A&D industry over several decades to develop and implement alternatives. A&D companies have rigorous processes in place requiring extensive documentation, reviews, and approvals to justify use of Cr(VI) in new designs or changes to existing designs. Once a new validated, certified and approved alternative is incorporated into a design, adherence to the new design becomes a contractual and regulatory requirement.

Despite these efforts, there remain many applications for which no suitable alternative can be implemented. Recognizing that there are many different uses of Cr (VI) and that each must be assessed individually, to date there is no universal replacement for any of these coatings and surface treatments for A&D uses. For many A&D products it may not be feasible to make certain changes due to the complexity of ensuring that no negative impacts are introduced into proven designs. The complex relationship between each component and its performance requirements within its own unique design parameters requires certification of each substitution individually (see Figure 2). Qualification in one particular application does not guarantee that use in another application is qualified. Every application must be individually assessed to determine that requirements are met. This process must be independently replicated across all A&D products by each A&D company. A&D products (e.g. a specific aircraft model) may be in service for 30-50 years (even longer in defense uses), requiring maintenance, repair and spare parts over their entire service lives. Any changes to these parts or processes must be fully validated and certified to ensure safety and performance are not compromised.

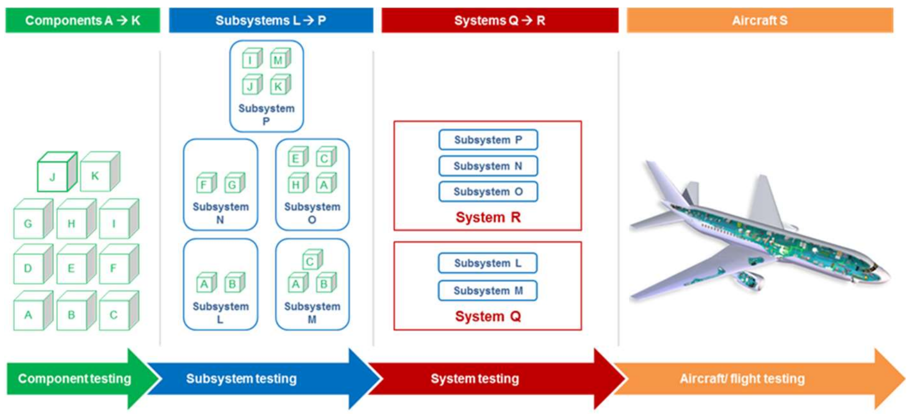

Figure 2: Systems assessment and validation overview

The industry was diligently pursuing alternatives prior the passage of the REACH regulation, and will continue to do so regardless of the details of any particular Authorisation decisions.

Lonnie Hall Attachment RECEIVED
By: OAH on 2/28/2024

KLÜBER LUBRICATION

February 28, 2024
Katrina Kessler
Commissioner, Minnesota Pollution Control Agency
520 Lafayette Road N
St. Paul, MN 55155-4194

Submitted via the Minnesota Office of Administrative Hearings eComments Website

Re: Klüber Comments on MPCA's Planned PFAS in Products Currently Unavoidable Use Rule

Dear Commissioner Kessler:

Klüber Lubrication NA LP (Klüber) respectfully submits these comments on the Minnesota Pollution Control Agency (MPCA) planned rule regarding currently unavoidable use (CUU) determinations for intentionally added PFAS in products (the CUU Rule) to implement Minn. St. § 116.943, subdivision 5(c). Specifically, the statute exempts from its 2032 material restriction uses of PFAS that the MPCA has determined are CUUs because they are "essential for health, safety or the functioning of society and for which alternatives are not reasonably available."

The MPCA's request for comments in part solicited input on whether the agency should make initial CUU determinations through this CUU rulemaking, and for what products and uses. We support the agency making CUU determinations now, since this will help give manufacturers sufficient time to plan for the material restriction that will go into effect in 2032. In addition, we request that the MPCA grant a CUU determination as part of this rulemaking for the use of polymeric PFAS in lubricants and greases (hereinafter "fluoropolymer-containing lubricants and greases").

Klüber offers expert tribological solutions by supplying high-performance specialty lubricants, including fluoropolymer-containing lubricants and greases, to professional and industrial customers in almost all branches of industry and regional markets. Fluoropolymer-containing lubricants and greases in particular represent CUUs of PFAS because they are essential for health, safety, and the functioning of society. These products are crucial in reducing friction and wear, protecting components, and preventing overheating in products and applications that make modern life possible. As such, fluoropolymer-containing lubricants and greases are widely used across many different industries in the most critical and demanding applications such as in transport, nuclear and wind power generation, and medical and other manufacturing.

Likewise, there are no reasonably available alternatives to polymers that fall under the state's PFAS definition for many high-performance applications of lubricants and greases. Switching to non-fluoropolymer lubricants and greases would have many negative consequences including decreased energy efficiency (and therefore higher greenhouse gas (GHG) emissions), decreased product safety, shorter product life (and therefore higher resource consumption), and more intensive maintenance requirements.

Our requested CUU determination is further supported by the fact that the hazards posed by these fluoropolymers are minimal. Most are used in closed systems in small amounts with limited opportunity for exposure to humans or the environment. Furthermore, among PFAS, polymers are expected to present the lowest concern to humans and the environment.

I. Fluoropolymer-containing lubricants and greases are essential for health, safety, and the functioning of society because they are widely used across critical industries.

Fluoropolymer-containing lubricants and greases are used in several critical industries and are found in many industrial, commercial, and consumer products essential for health, safety, and the functioning of society. Negative consequences of switching to an improper alternative might include transportation accidents, nuclear power plant accidents, increased GHG emissions across a variety of products, and increased resource consumption due to shorter product life. Due to their cost, fluoropolymer-containing lubricants and greases are typically used only when non-fluoropolymer lubricants and greases are not practicable choices, for the reasons described in these comments.

Fluoropolymer-containing lubricants and greases are widely used across many different industries in the most critical and demanding applications. Affected industries include, for example:

• Transport (aerospace, automotive, buses, and passenger trains). Fluoropolymer-containing lubricants and greases are used for bearings, small gears, and actuators. For instance, to lubricate plastic gears and actuators in automobiles, a grease or lubricant must last the full lifetime of the automobile. If fluoropolymer-containing lubricants were not used, automobile manufacturers would need to switch to much heavier parts. This could have costly impacts to Minnesota's transportation sector, which supports over 32,000 jobs in freight-focused transportation alone and underpins the many companies that are headquartered in Minnesota due to its robust transportation network.

• Nuclear power generation. In nuclear power plants, fluoropolymer-containing lubricants are used in pumps for radiation-exposed areas. Non-fluoropolymer lubricants would break down under these conditions, leading to pump failure and potential catastrophic consequences. There are two nuclear power generating facilities in Minnesota – the Prairie Island and Monticello Nuclear Generating Plants. The MPCA must ensure the safety and effectiveness of these plants, and granting our requested CUU determination will support this effort.

- Wind power generation. Fluoropolymer-containing lubricants are used in wind turbine applications where friction could lead to critical loss of power generation efficiency. As described by the Minnesota Department of Commerce, "[w]ind is an increasingly significant source of energy in Minnesota . . . As a major producer of wind energy, Minnesota ranks in the top 10 in the nation for generating energy from wind." Without our requested CUU determination, this progress could be undermined.

- Medical and other manufacturing. In industrial manufacturing facilities, including for medical products and other industries with the most exacting specifications, fluoropolymer-containing lubricants and greases are used to lubricate bearings, valves, fittings, and electrical contacts. Minnesota is known as "Medical Alley" because of its robust health tech industry, and the state is home to over 1,100 pharmaceutical and biotech R&D companies that employ nearly 14,265 people. This burgeoning sector in Minnesota's economy could be negatively impacted by Minn. St. § 116.943 if our requested CUU determination is not granted.

Fluoropolymer-containing lubricants and greases serve essential roles within these industries. For example, properly lubricated products and parts are critical for resource efficiency. A study has concluded that 23% of global energy consumption originates from tribological contacts (i.e., friction and wear). If advanced technologies – including fluoropolymer-containing lubricants and greases – are used to reduce friction and prevent wear, that energy loss would be reduced by 18% within the next eight years and 40% within the next 15 years. This would lead to a reduction of 1.460 million tons CO2 emissions within the next eight years and a reduction of 3.140 million tons of CO2 emissions within the next 15 years. Other negative outcomes of a switch to non-fluoropolymer lubricants and greases might include:

- Failure to meet GHG reduction targets. Lubricants are critical for the safe operation of nuclear power generating facilities and the efficient operation of wind turbines. Automobiles would need to switch some plastic components for metal, which would lead to an estimated 100-kilogram increase in weight.

- Availability of consumer products in Minnesota. Certain consumer products, for example automobiles and electronics, contain fluoropolymer-containing lubricants and greases that are necessary to last the lifetime of the product without maintenance. Rather than switch to an inferior alternative, product manufacturers may simply choose to make their products unavailable for sale in Minnesota.

- Transportation accidents. Prematurely worn or improperly lubricated parts could lead to sudden failure of transport systems (e.g., aerospace, automotive, bus, train).

- Tunnel accidents. Fluoropolymer-containing lubricants and greases are used in flue gas ventilation systems necessary to provide life-saving ventilation of tunnels and other enclosed areas in case of fires.

- In-home accidents. Gas fittings in households typically use fluoropolymer-containing lubricants and valves would need to be redesigned to avoid the risk of gas explosions.

- Dangerous maintenance. Some industrial products or systems can be inherently difficult or hazardous to maintain, for example, because of their location. Using non-fluoropolymer lubricants would increase the required frequency of maintenance (e.g., re-applying non-fluoropolymer lubricants or greases or changing worn parts).

- Increased resource consumption. Switching to non-fluoropolymer lubricants and greases for improper uses would lead to premature obsolescence of products. This would cause increased resource consumption as these products were replaced.

II. Fluoropolymer-containing lubricants and greases are also essential because specialized applications often require use of fluoropolymers for their unique performance characteristics.

Some specialized applications of lubricants and greases require the use of fluoropolymers, such as perfluoropolyether (PFPE) and polytetrafluoroethylene (PTFE). Fluoropolymers contain carbon-fluorine bonds, which are the strongest carbon bonds and resist breaking down even in extreme conditions and long lifetimes. The use of these specialized lubricants and greases is required in the following conditions:

- Extreme temperatures. Some equipment must operate efficiently and reliably even at very high or low temperatures. Non-fluoropolymer lubricants and greases are prone to rapidly breaking down or igniting at high temperatures and losing critical functionalities at low temperatures.

- Reactive environments. Some lubricants and greases must be used in corrosive or other reactive environments. Non-fluoropolymer lubricants and greases may break down under these conditions.

- Exposure to radiation. In nuclear power plants, perfluoropolyether (PFPE) is used as a bearing lubricant for pumps operating in radiation-exposed areas. Radiation rapidly decomposes ordinary petroleum lubricants, while PFPE-containing lubricants are able to operate for long periods of time under these conditions without appreciable decomposition.

- Long lifetime specifications. Fluoropolymer-containing polymers have long service lives, in part because they resist oxidation in the presence of oxygen. Certain applications of lubricants and greases must last the full lifetime of products due, for example, to inaccessibility of the components being lubricated or to the inherent danger of maintenance activities for certain products. Use of non-fluoropolymer lubricants and greases for certain applications could shorten the lifetime of the product.

- Low-outgassing specifications. Some specialized equipment – such as optical equipment and light housing – requires the use of lubricants and greases that do not form condensates. For these applications, PFPE or another fluoropolymer-containing lubricant or grease must be used.

- Applications with low failure tolerance. The use of fluoropolymer-containing lubricants and greases is critical for applications with the lowest tolerance for failure, including aerospace and other transport, oxygen supply, medical manufacture, nuclear power generation, and flue gas ventilation.

III. Alternatives to the use of fluoropolymers in lubricants and greases are not reasonably available since none meet the performance capabilities of fluoropolymers.

There are no reasonably available non-fluoropolymer lubricants or greases that meet the performance capabilities of fluoropolymers. Fluoropolymer-containing lubricants and greases have unmatched friction-limiting properties, chemical and radiological inertness, stability, non-flammability, and low vapor pressure. Based on Klüber's technical expertise in this field, if such an alternative existed, we would be aware of it and would make it available to our customers.

Even if there were alternatives, it is foreseeable that these alternatives would not be reasonably available because of the risks they may pose to human health and the environment when compared to fluoropolymers. PFAS are a large and diverse group of chemicals and should not be assumed to all present similar hazards. Fluoropolymers fulfill Organisation for Economic Co-operation and Development (OECD) criteria as polymers of low concern (PLC) and are not considered a hazard for public health or the environment. Fluoropolymers used in lubricants and oils are high molecular weight polymers (more than 10,000 Da) and are not soluble in water, which limits their bioavailability and toxicity.

Additionally, fluoropolymer-containing lubricants and greases are used within closed systems (except in rare cases where this is technically infeasible) and are often used in vary small amounts, both of which limit exposure to humans and the environment. The requested CUU determination would help avoid a situation of regrettable substitution where an alternative with heightened risks to human health and the environment must be used, or in the alternate the lubricants and greases must be pulled from the Minnesota market entirely.

We appreciate the MPCA's consideration of our comments. If you have any questions, please feel free to reach out to us.

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Appendix A: Non-Exclusive List of Current Critical Applications and Impacted Industries for
Fluoropolymer-Containing Lubricants and Greases

Product-Level Applications

- Hydraulic systems
- Pneumatic systems
- Valves
- Seals
- Bearings
- Electric and electronic products
- Tools, machines, installations
- Compressors
- Connection systems
- Low-outgassing applications (e.g., optical instruments)
- High and low temperature applications
- Vacuum applications
- Applications in caustic and radiation-exposed environments
- Water taps
- Applications that require precise compatibility with other media
- Oxygen supplies

Impacted Industries

- Automotive (e.g., cars, buses, motorbikes, public transport)
- Shipping
- Aerospace
- Railroad
- Power (e.g., nuclear power generation, wind turbines and other renewable sources, transmission)
- Plumbing
- Medical and other manufacturing
- Information and communication technology

Dawn Friest Attachment RECEIVED
By: OAH on 2/28/2024

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February 28, 2024

VIA ELECTRONIC SUBMISSION: https://minnesotaoah.granicusideas.com/

Minnesota Pollution Control Agency
Resource Management and Assistance Division

Re: Request for Comments – PFAS in Products Currently Unavoidable Use Rule

The Truck and Engine Manufacturers Association (EMA) hereby submits comments on the planned new rules for the Minnesota Pollution Control Agency's (MPCA) determination of Currently Unavoidable Uses of Per-and polyfluoroalkyl substances (PFAS) in products. The rulemaking is referred to as the PFAS in Products Currently Unavoidable Use Rule (the Rule).

The Minnesota Pollution Control Agency (MPCA) has issued a Request for Comments, giving notice of its intent to begin rulemaking. The purpose of the Rule is to establish criteria and processes through which the MPCA will make decisions on what if any uses of intentionally added PFAS will qualify as currently unavoidable uses (CUU) in products sold, offered for sale, or distributed in Minnesota.

Introduction

EMA represents worldwide manufacturers of internal combustion engines and on-highway medium and heavy-duty vehicles (greater than 10,000 pounds gross vehicle weight rating). EMA member companies design and manufacture internal combustion engines that are used in a wide variety of applications, including: trucks and buses (including school buses); farm, construction, and industrial equipment; marine vessels; locomotives; lawn, garden and utility equipment, and electric generators and other stationary applications. PFAS is widely used in a variety of applications to provide products with strength, durability, stability, and resilience. It is also known to be used for its flame retardant properties. Consequently, EMA's members are significantly and directly impacted by the Rule.

EMA also submitted comments on November 21, 2023, on the MPCA PFAS in Products Reporting Rule. (EMA Comments, 2023). Those previously submitted comments are incorporated herein by reference. Complex products, like heavy-duty engines, vehicles and equipment are composed of hundreds of components and thousands of parts. Additionally, there is a high level of customization with heavy-duty vehicles and equipment, with a variety of options and therefore differing components.

The proposed PFAS definition is extremely broad and could encompass over 12,000 PFAS chemistries. EMA has requested that MPCA establish de minimus reporting thresholds and provide a defined list of CAS identified PFAS chemistries that are subject to the requirements. Without reasonable limits on the scope of the requirements, manufacturers face an unworkable task of investigating thousands of parts in a global supply chain consisting of hundreds of suppliers. Extensive effort will be required to investigate and identify the presence of PFAS in the complex products produced by EMA's members. Hundreds of suppliers in global supply chains, some of whom are 8 to 10 layers deep in the supply chain, hold chemical composition information for parts and components. Chemical composition information is often considered proprietary, and disclosure is not easily obtained. Manufacturers may need to investigate thousands of components and that process could take at least 2 years to complete for complex products. (See EMA Comments, 2023). Although the compliance obligations are directed at the manufacturers of products, PFAS use is fundamentally controlled at the supplier level. Disclosure of PFAS use is also fundamentally controlled at the supplier level.

EMA members and their supply chain are actively engaged in gathering information on the uses of PFAS within their products, as yet not all have been identified. In part this is due to the challenges in their identification as many PFAS used in mixtures have not been classified as hazardous per the Globally Harmonised System for classification and labelling. In addition, many PFAS are not shown on material data sheets even though the substance is present. Moreover, when PFAS are used as articles or articles in complex objects, the complex objects, the parts suppliers are currently under no regulatory obligation to highlight the presence of PFAS.

<u>MPCA Questions for Comment</u>

1. *Should criteria be defined for "essential for health, safety and or functioning of society"? If so, what should those criteria be?*

It is critically important that the MPCA consider the potential impacts, restrictions and bans on the use of PFAS. PFAS plays an important role in the functionality, durability, and safety of many products. Alternatives have not been identified for many critical PFAS uses in engines, vehicles and equipment and as such, the use of PFAS in these applications should be considered "Currently unavoidable use".

If criteria are identified, they should include uses that are necessary to achieve compliance with other regulatory requirements related to safety, durability, emissions requirements, flammability requirements, etc. In the case of engines, vehicles and equipment, EMA member companies are downstream users of PFAS substances, and PFAS may be present in components generally not accessible to users of the products. However, the presence of PFAS is vital to imbue safety, durability and quality attributes to components and finished products.

Criteria should include engines, vehicles and equipment that power construction, industrial and agricultural equipment vital for everyday life; heavy-duty engines that power vehicles used to transport goods and products including food, medicine and almost every consumer product that you can name, and stationary engines that support critical functions in hospitals and other settings. Engines, vehicles and equipment support every aspect of life as we know it, including the functioning of hospitals, data centers, power plants, public transport, emergency and military equipment, just to name a few, and PFAS is present in extremely small quantities (often de minimus levels), to ensure the functionality and safety of these products.

Substitutes for PFAS chemicals will not be easily identified and may not be available in any event. In many instances, their use is necessary to achieve compliance with other regulatory requirements related to flame resistance (i.e., the Federal Motor Vehicle Safety Standard No. 302, Flammability of Interior Materials) and durability requirements to ensure the long-term durability of components, including emissions components. PFAS, as broadly defined in the proposed rule, may also include some refrigerants, like HFC-134a, and HFO-1234yf, which are widely used because of their extremely low global warming potential. In fact, the transition to HFO-1234yf has been spurred by Federal rulemaking activity related to reducing HFCs. MPCA should also consider that PFAS is used in alternative power technologies, including batteries and hydrogen fuel cells to imbue vital functional properties. Many PFAS compounds are very expensive and these compounds are used because they are effective and no suitable alternatives have been identified. (See EMA Comments, 2023).

Where PFAS is used in components subject to other federal requirements (like engines and vehicles), any substitution or change in the components may require significant and time-consuming, testing, verification and certification of any redesign or substitute. Where durability requirements are applicable, testing burdens can be significant. Resources for such testing are finite and are already overburdened with demands related to design and certification of new products. Introducing the additional project of identifying chemical substitutes and proving them out for durability, safety and emissions verification purposes will certainly create timing and resource management challenges that may lead to supply shortages for critical components and products. (See EMA Comments, 2023).

2. *Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?*
4. *What criteria should be used to determine the safety of potential PFAS alternatives?*

Where PFAS is used in components subject to other federal requirements (like engines and vehicles), any substitution or change in the components may require significant and time-consuming, testing, verification and certification of any redesign or substitute. Where durability requirements are applicable, testing burdens can be significant. Resources for such testing are finite and are already overburdened with demands related to design and certification of new products. Introducing the additional project of identifying chemical substitutes and proving them out for durability, safety and emissions verification purposes will certainly create timing and resource management challenges that may lead to supply shortages for critical components and products. (See EMA Comments, 2023). Costs associated with redesign, testing and verification for safety, durability and compliance reasons should be considered in the costs and in determination of what is "reasonable".

MPCA must consider the nature of the products impacted. Heavy duty engines, vehicles and equipment are not the same as a mattresses, frying pans, carpets, and other disposable consumer products, and they should not be treated the same under the proposed rule. Commercial vehicles, engines and equipment are long-lasting, durable by design and regulatory mandate, and utilize end-of-life design provisions to ensure that potentially problematic substances are captured and recycled. Remanufacturing processes are an integral part of the heavy-duty industry and support the development of a circular economy while promoting robust waste management to prevent releases of pollutants to the environment. Aftermarket parts and components must also be considered to ensure that in-service equipment is not impacted by restrictions on legacy parts. Transition to substitutes for PFAS will be extremely challenging for new products moving forward. Expectations that legacy parts and components will also transition to substitutes are simply unrealistic. Failure to recognize this fundamental obstacle will lead to critical shortages of parts and will lead to in-service equipment being rendered obsolete, short of their expected full useful life. Regulatory efforts should focus on high risk PFAS chemicals and high-risk end-use applications. (See EMA Comments, 2023). It is not "reasonable" to impose replacement costs in the absence of consideration of relative risk and the potential for unintended consequences of replacement, like those described in our comments.

In the case of many PFAS uses, there is no suitable alternative and the impacts of the removal of PFAS could be the inability to comply with important regulatory requirements related to safety, durability, emissions compliance and flammability, and could ultimately impact the availability of product. In these instances, cost considerations should take into account the costs associated with increased risks related less effective substitutes, like noncompliance with other important regulatory mandates, the potential impacts of "regrettable substitution", and the consequences of limits on product availability, including consideration of the air quality impacts of slowed fleet turnover to newer, lower emitting engines, vehicles and equipment.

Consideration of alternatives must include time for study of potential long term health and environmental impacts, along with extended durability and reliability studies to understand the effectiveness of options. It would be irresponsible to force a shift to less effective, less suitable, less understood, substances.

5. *How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently avoidable use determination be decided? Should significant changes in available information about alternatives trigger re-evaluation?*

Currently unavoidable use (CUU) determinations should be indefinite for uses where safety, durability and compliance with other regulatory requirements necessitates the use of PFAS and the use of PFAS in the application has not been demonstrated (with unbiased, widely recognized and accepted data) to pose a health risk that cannot be mitigated with safety precautions, like the use of personal protective equipment. The uses of PFAS in engine, vehicle and equipment components in small (often de minimus) quantities, would fall under this description.

As described above, the process for identifying alternatives, conducting appropriate health and safety testing, demonstrating the viability of a substitute in thousands of components, conducting durability testing and complying with re-certification requirements for components with regulatory impacts would be a lengthy process, assuming viable substitutes exist. However, they currently do not and are not anticipated to be readily identifiable.

There is no single time line that can define CUU determinations and the need for CUU determinations could span decades, not years, depending on the scope of the proposed restrictions, the nature of the "substitute", and the specific use. The potential scope of the proposed approach is too wide-reaching to allow for speculation about the length of CUU determinations.

6. *How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?*

CUU determinations should be made by the agency imposing the restrictions. Presumably they should be qualified to evaluate the validity of the request for a CUU determination. Opening the door to requests to prevent or "block" CUU determinations undermines the authority of the regulating agency and will encourage preemptive activity by parties lacking the requisite understanding of the basis for the CUU determination request. Moreover, the CUU determination requests may include proprietary information that cannot be shared. If state regulatory agencies are responsible for the restriction and control of a substance, they should be entrusted with the process of evaluation of the information to make CUU determinations without outside influence. Providing a process to "block" such determinations is ill-conceived at best and will lead to increased demands on MPCA staff to evaluate such "requests".

7. *Please share what uses and products you may submit a request for in the future and briefly why.*

Requests for the entire class of engines, vehicles and equipment may be submitted.

EMA member companies manufacturer internal combustion engines and on-highway medium and heavy-duty vehicles (greater than 10,000 pounds gross vehicle weight rating). EMA member companies design and manufacture internal combustion engines that are used in a wide variety of applications, including: trucks and buses (including school buses); farm, construction, and industrial equipment; marine vessels; locomotives; lawn, garden and utility equipment, and electric generators and other stationary applications. PFAS is widely used in a variety of applications to provide products with strength, durability, stability, and resilience.

Engines, vehicles and equipment support every aspect of life as we know it, including the functioning of hospitals, data centers, power plants, public transport, emergency and military equipment, food production, infrastructure development and transportation and delivery of goods (including food and medicine), just to name the most obvious. These products are "essential for health, safety, or the functioning of society" as described in the definition of "Currently unavoidable use" (Minnesota Statutes 116.943). PFAS is present at the component level, in extremely small quantities, (often de minimus levels), to ensure the functionality and safety of these products.

8. *Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?*

MPCA should exempt engines, vehicles and equipment from the rule. In the alternative, permanent CUU determinations should be established to include engine, vehicles and equipment.

Conclusion

EPA should lead efforts on PFAS reporting and restrictions. If the MPCA engages in PFAS rulemaking, the definition of PFAS must be narrowed and a de minimus threshold must be identified. Engines, vehicles, and equipment should be exempt from the rule or permanent CUU designations should apply to the entire class of engines, vehicles, and equipment.

We appreciate the opportunity to provide these comments. Please do not hesitate to contact Dawn Friest at (519) 999-4480 (or at dfriest@emamail.org) if you have any questions.

Respectfully submitted,

TRUCK & ENGINE
MANUFACTURERS ASSOCIATION

135037

RECEIVED
By: OAH on 2/28/2024
Erica Corser Attachment

Honeywell

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February 28, 2024

Office of Administrative Hearings
Mr. William Moore
600 North Robert Street
P.O. Box 64620
Saint Paul, Minnesota 55164-0620

Re: **In the Matter of the Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS); OAH Docket No. 71-9003-39667; Governor's Revisor's ID Number: R-4837**

Dear Mr. Moore,

The Minnesota Pollution Control Agency requested that the Office of Administrative Hearings review comments on its proposed rules governing PFAS in Products under the statutory authority of Minnesota Statutes Section 116.943, subdivisions 5(c), 9, for the following item:

i. **Definitions, Prohibitions, and Rulemaking Authority**; Minnesota Statutes Section 116.943, subdivisions 1, 5(c), & 9, respectively.

The request for comments was published in the State Register OAH Docket No. 71-9003-39667, on December 8, 2023. Enclosed for your review are the requested comments submitted by Honeywell.

Should you have any questions or concerns with our submission please don't hesitate to get in touch with us.

Sincerely,

Atashi Bell, PhD
Senior Director, Global Government Relations
Atashi.Bell@honeywell.com

Honeywell appreciates the opportunity to comment on the above-referenced Planned Rules ("Planned Rules") on unavoidable use determinations for Per- and Polyfluoroalkyl Substances ("PFAS") ("Unavoidable Use Determination Rule") pursuant to Minn. Stat. § 116.943, subdivision 5(c) issued by the Minnesota Pollution Control Agency ("MPCA" or the "Agency").

Honeywell is an integrated operating company serving a broad range of industries and geographies globally. Our business is aligned with three powerful megatrends - automation, the future of aviation, and energy transition - underpinned by our Honeywell Accelerator operating system and Honeywell Connected Enterprise integrated software platform. As a trusted partner, we help organizations solve the world's toughest, most complex challenges, providing actionable solutions and innovations that help make the world smarter, safer, and more sustainable. The company traces its roots in Minnesota back to 1927 when the Honeywell Heating Specialty Company merged with the Minneapolis Heat Regulator Company to form the Minneapolis-Honeywell Regulator Company.

Today, Honeywell's workforce in Minnesota includes approximately 1,870 employees at five facilities across the State. Three of these sites develop and manufacture various equipment and materials for the aviation, space, and defense sectors ("Aerospace & Defense" or "A&D").[1] Within the A&D sector, fluorinated substances comprise critical components of aircrafts, vessels, satellites, rockets, and missile actuation systems, and enable critical functions including thermal management, life support, avionics, fuel supply, engine operation, auxiliary power, navigation, communication, microelectronics, sensors, radars, insulation, and hydraulics. Of these materials listed, it is worth noting that Honeywell safety systems are included in 90% of all global aircrafts and 80% of all commercial satellites in orbit. Honeywell materials have been instrumental for every NASA human space mission and have demonstrated our ability as an industry leader to provide mission critical, safe, space-based optical and science equipment for nearly 60 years.

In addition to A&D, Honeywell operates two additional sites in Minnesota that produce a variety of switches; safety shut-off valves; flow meters; flame detectors; pressure regulators; residential heat, water, and gas meters; and other materials in the smart energy and thermal solutions sectors which are instrumental in safeguarding against hazards of those working within chemical and other manufacturing plants. These components are designed to meet extensive industry manufacturing standards, responsible manufacturing commitments from industry, and ensure negligible leakage during the use phase for all industrial production in semiconductors, automotive, medical, petrochemical, and crude oil sectors. Fluorinated polymeric materials make these critical components possible.

Honeywell is also a manufacturer of various fluorinated gases, including hydrofluorocarbons ("HFC"), hydrochlorofluoro-olefins ("HCFO"), hydrofluoroolefins ("HFO") refrigerants and their mixtures ("Blends"). Such products are used in refrigeration, heating, ventilation and air conditioning ("RHVAC"), mobile air conditioning ("MAC"), thermal management systems ("TMS") in electric vehicles ("EV"), propellants in medical dose inhalers ("MDI"), and foam blowing agents in insulation applications. Honeywell also manufactures a high-performance fluoropolymer - polychlorotrifluoroethylene ("PCTFE") - used in the primary and secondary packaging of medicinal products, medical devices, and over-the-counter ("OTC") medications globally.

Introduction

On May 24, 2023, Minnesota Governor Tim Walz signed into law Minnesota Session Law – 2023, chapter 60, article 3, section 21, (Minn. Stat. § 116.943). Specifically, subdivision 5(c) prohibits the sale or distribution of "any product that contains intentionally added PFAS, unless the commissioner had determined by rule that

[1] Across the United States, the Aerospace and Defense industry supported 2.1 million jobs in 2022. See https://www.aia-aerospace.org/industry-impact/.

the use of PFAS in the product is a currently unavoidable use," in the state of Minnesota beginning January 1, 2032. The term "currently unavoidable use" is defined in Minn. Stat. § 116.943, subdivision 1(j), as "a use of PFAS that the commissioner has determined by rule under this section to be essential for health, safety, or the functioning of society and for which alternatives are not reasonably available." Subdivision 9 of Minn. Stat. § 116.943 allows the MPCA to adopt "rules necessary to implement this section." Accordingly, the MPCA issued a request for comments regarding the Planned Rules on December 8, 2023. These comments address the specific questions posed by MPCA as well as other possible aspects of the Planned Rules that may assist MPCA in its rulemaking.

Honeywell fully supports MPCA's authority to mitigate unreasonable risks with sensible regulations when such risks are presented by specific chemical substances. However, Honeywell is concerned the Unavoidable Use Determination Rule will impose considerable burdens on the regulated community without achieving commensurate benefit to human health or the environment. It may also be duplicative of new federal and global classification efforts. Several federal agencies have already created robust review programs around PFAS unavoidable use determinations and viable alternatives (i.e. SNAP, TSCA). MPCA has both the authority and the obligation to create the most cost-effective and efficient regulatory program by incorporating use determinations that have already undergone review by a regulatory agency into the initial rulemaking process. Accordingly, Honeywell offers comments on opportunities to improve the effectiveness of unavoidable use determinations, which will be critical to MPCA's mission of assessing and mitigating potential risks to human health and the environment.

Question 1: Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Essential Use Criteria Considerations and Examples

Honeywell recommends the rulemaking establish a clear-cut process under specified timelines for determination and criteria whereby any PFAS-containing product manufacturer may seek a "currently unavoidable use" determination. When making a "currently unavoidable use" determination, MPCA should consider the following factors:

- benefits to public health, the environment, community safety, national security, critical infrastructure, or other critical function of society;
- the known effects of the PFAS or PFAS-containing product on human health and the environment including the specific substance's physical-chemical characteristics, its environmental fate, as well as its toxicity, including how such characteristics compare to other substances which provide the similar performance characteristics;
- the availability of technically and economically feasible chemical alternatives that can be used for the same purpose and which can be demonstrated to be environmentally preferable to the PFAS under consideration;
- whether the use of the PFAS or PFAS-containing product contributes to achieving environmental objectives, including the mitigation of climate change;
- whether the use of the PFAS or PFAS-containing product is of value to society because it contributes to the safety, efficacy, or accuracy of useful activities and products including those used in scientific research, medical equipment or treatments, pharmaceuticals and their packaging, medical devices, and in the manufacture of components in critical goods; and
- whether the use is beneficial in other applications or commercial uses in important sectors of

the economy (such as aerospace, defense, industrial and commercial equipment, and automotive sectors.

- the product or substance has been approved, governed or authorized by a federal or state agency

Possible tools for the agency to adopt in its decision-making process may include a decision tree (Fig. 1) or a risk matrix (Fig. 2) where chemical risks factors like persistence, bioavailability, and toxicity (PBT) characteristics can be ranked in alignment with emissions or production volumes of the chemical in question.

Figure 1: Essentiality Decision tree

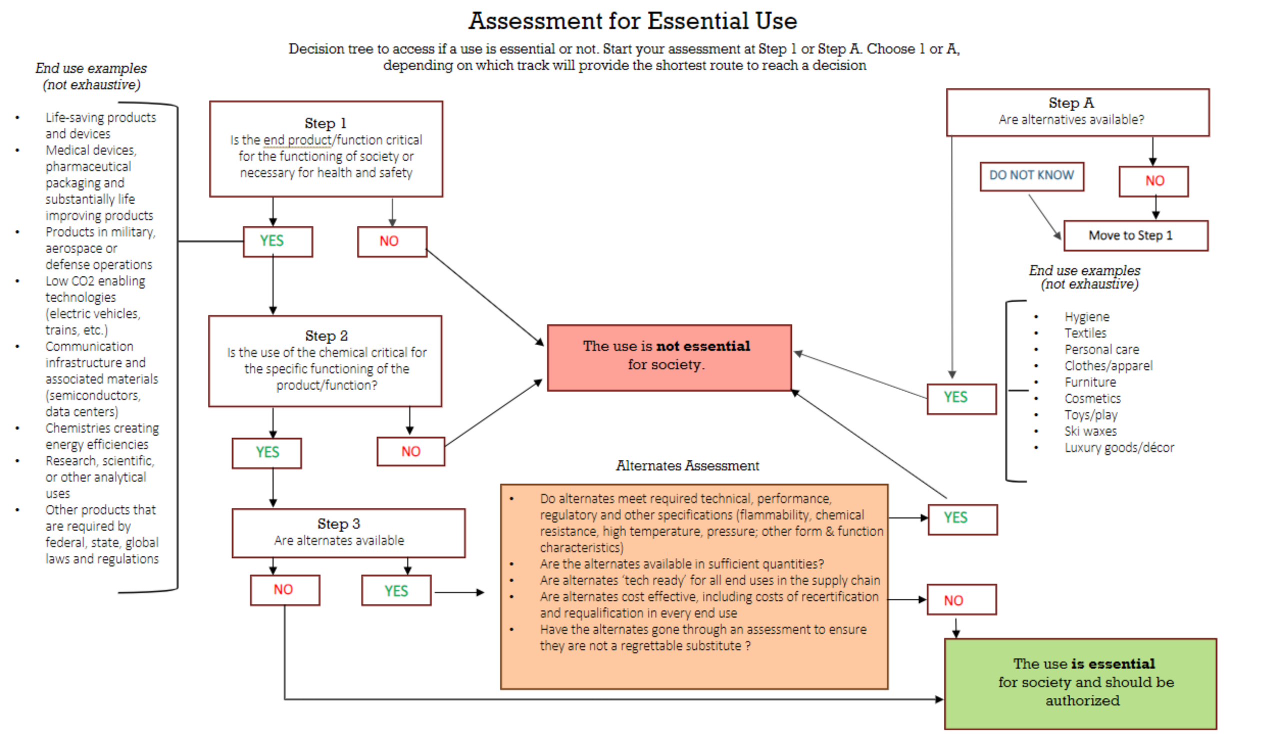


Figure 2: Risk Matrix

	Known Low Production/Emissions	Unknown Production/Emissions	Known High Production/Emissions	
Known High PBT Risk				High priority regulatory targets; decreasing priority to the left
Unknown Risk				High priority for risk studies to identify or eliminate additional substances of concern; decreasing priority to the left
Known Low PBT Risk				Lower priority for both regulations and additional research
	Candidates to monitor for change in production/emissions volume; increasing priority toward the top	Candidates for more research on production/emissions; increasing priority toward the top	Candidates for research on emissions profiles & environmental fate; increasing priority toward the top	

Essential Use Product Example: Honeywell's Solstice® Hydrofluoroolefin ("HFO") Technology

HFO technology is an example of a fluorotechnology that safely meets important societal needs while providing significant environmental benefits. To date, the use of Honeywell HFO technology has helped avoid the potential release of the equivalent of more than 326 million metric tons of carbon dioxide into the atmosphere. This is equal to removing the carbon emissions from nearly 70 million gasoline-powered passenger vehicles annually.[2]

<u>Mobile Air Conditioning (MAC) and Electric Vehicle Thermal Management Systems (EV TMS)</u>

HFO-1234yf (or refrigerant R-1234yf, trademark Solstice® yf) is widely used as a refrigerant in MAC, vehicle HVAC and TMS in EV systems.

HFO-1234yf is a refrigerant that was specifically designed to minimize persistence and overall environmental impact. As of today, **<u>every vehicle manufacturer</u> producing vehicles for sale in Europe, Turkey, the United Kingdom, South Korea, Canada and the US is using HFO-1234yf successfully.** HFO-1234yf is the low-GWP refrigerant of choice for carmakers, consumers and the environment. The shift from R-134a, an older generation automotive refrigerant, to HFO-1234yf, which took 10 years to transition, has had a dramatic positive impact on the environment. The most recent assessment of the Intergovernmental Panel on Climate Change (IPCC AR6 of 2021) shows HFC-134a with a GWP (100) figure of 1530 while the GWP (100) of HFO-1234yf to be 0.501.[3] Assuming 200 million vehicles on the road with R-1234yf and an average charge of 0.6Kg per vehicle, the refrigerant change from R-134a to R-1234yf equals more than 183 metric tons of CO_2e reduction.

HFO-1234yf is a low hazard, non-bioaccumulative, very low persistent (atmospheric lifetime 10 days), mildly flammable gas with very low-GWP, no-ODP and with well-established DNEL/PNEC levels as well as no noticeable health or environmental hazards or PBT/vPvB equivalent concerns.

Oak Ridge National Laboratory on HFOs

Further, as confirmed in recent analyses from Oak Ridge National Laboratory, HFOs represent greater energy efficiencies across important commercial applications, including in appliances, residential air conditioners, supermarket refrigeration systems, and spray foam insulation.[4] In commercial refrigeration applications, HFO solutions will consume 5% to 21% less energy as compared to propane systems over the lifetime of the system (15 years), and 8% to 50% less energy as compared to CO_2 systems over the lifetime of the system (15 years).[5] When evaluating the performance attributes of HFO blowing agents to evaluate energy efficiency, as well as safety attributes to identify HFOs' flammability characteristics, Oak Ridge National Laboratory researchers concluded that "HFOs can effectively replace higher GWP solutions, such as HFCs, to

[2] Calculations are based on actual sales of Solstice products (in lbs.) from Jan 2010 through Jan 2022, and utilize the EPA GHG equivalency calculator for conversion.
[3] Smith C et al. (2021) The Earth's Energy Budget, Climate Feedbacks and Climate Sensitivity Supplementary Material, IPCC AR6 Report, 2021,Table 7.SM.6 at pp. 17-18.
[4] Minnesota's Building Code permits the use of HFO as insulation for residential dwellings. *See* Minn. R. 1322.0402, 1346.0604. Restrictions on the use of HFO under the pending rule would be inconsistent with other agencies that have approved HFO as a safe and appropriate product for residential use.
[5] Oak Ridge National Laboratory Study "Technology Options for Low Environmental Impact Air-Conditioning and Refrigeration Systems"

reduce emissions and mitigate the use of flammable and explosive materials in high-density, urban areas."[6]

Department of Defense on HFOs

The Department of Defense recently identified refrigeration, air conditioning, cooling and electronics thermal control as a ***mission critical application*** in their recent report on the Critical Uses of PFAS report[7] stating that,

> *"Most refrigerants used in civil and military cooling and refrigeration applications can be classified as PFAS. Many next-generation refrigerant alternatives adopted by U.S. industry (and U.S. households) between now and the end of 2025 are also PFAS. Under the AIM Act and EPA technology transition regulations, the U.S. economy is in the process of switching from one set of PFAS-classified refrigerants (e.g., HFCs) to a new generation of refrigerants (e.g., HFOs), which are also, in the broadest definitions, considered to be PFAS. Known non-PFAS alternatives (e.g., hydrocarbon or ammonia alternatives) pose flammability, toxicity, or high-pressure concerns. The same PFAS that are used in quantities of several hundred million pounds per year throughout the U.S. economy for cooling applications are used in much smaller quantities (i.e., a fraction of one percent) for military cooling and military thermal control of all kinds."*

Unavoidable Use Criteria Should Acknowledge Past Precedents and Incorporate Federal Authorizations

The concept of essential use has witnessed both successes and failures in its historical implementation. The following section will aim to summarize examples and concepts from both ends of this spectrum, highlighting the complexities and challenges inherent in balancing policy with the practical needs of society.

A Successful Model: the Montreal Protocol

The "essential-use" concept was first introduced in 1987 in the Montreal Protocol to phase out ozone-depleting chlorofluorocarbons, except for certain "essential" uses. The concept of "essential use" was developed to address situations where the complete elimination of ODSs would cause significant societal or economic harm, or where there were no technically or economically feasible alternatives available at the time. It acknowledges that in some specific applications, alternatives to ODSs may not yet exist, or their adoption might have serious adverse effects on health, safety, or the environment. The Montreal Protocol framework sets rigorous criteria and procedures for determining essential use exemptions, recognizing that the designation of essential use should not be taken lightly. It was agreed that a "controlled substance should qualify as 'essential' only if:

> (1) it is necessary for the health, safety, or is critical for the functioning of society (encompassing cultural and intellectual aspects); and
>
> (2) there are no available technically and economically feasible alternatives or substitutes that are acceptable from the standpoint of environment and health. It is also mentioned that essential uses should be permitted if all economically feasible steps have been taken to minimize the emissions of the controlled substance.[8]

[6] Oak Ridge National Laboratory Study "Assessment of the Performance of Hydrofluoroolefins, Hydrochlorofluoroolefins, and Halogen-Free Foam Blowing Agents in Cellular Plastic Foams"

[7] Department of Defense "Report on Critical Per- and Polyfluoroalkyl Substance (PFAS) Uses" https://www.acq.osd.mil/eie/eer/ecc/pfas/docs/reports/Report-on-Critical-PFAS-Substance-Uses.pdf, p.14

[8] Decision IV/25, 'Essential Uses', 4th Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer,

Under the Montreal Protocol, substances deemed "essential" for specific applications are granted exemptions from phase-out schedules. This means that despite the overall goal of phasing out ozone-depleting substances (ODSs), certain uses are considered necessary and are permitted to continue for a limited time until suitable alternatives become available.

One significant aspect of the essential use concept is the allowance for the use of these substances as feedstocks. Feedstocks are raw materials that are used to manufacture other products. In some cases, ODSs serve as crucial feedstock in various industrial processes, such as the production of pharmaceuticals, electronics, or specialty chemicals. Recognizing the importance of these substances as feedstocks, the Montreal Protocol provides exemptions for their use in specific applications.

Critically, Montreal Protocol focuses on a very limited number of essential substances keeping the scope narrow, well-defined, and reviewed on a regular cadence; publishing its decisions relating to essential uses with the most recent released in 2020.[9]

An Unsuccessful Model: European Union (EU) Chemicals Strategy for Sustainability (CSS)

Recently in 2020, the European Union (EU) released its Chemicals Strategy for Sustainability (CSS), calling for the phase out of the most harmful uses of chemicals, except for those uses that are determined to be essential for society.[10] This strategy was developed with neither prior public consultation nor a proper impact assessment. As such, CSS has been unsuccessful in that it neither defined which harmful chemicals would justify use of this concept, what criteria should be applied, nor did it provide a process to help identify or select chemicals of concern. At present, there does not exist agreement or a formal process to incorporate the essential use concept into existing European frameworks like the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) or the classification, labelling and packaging of substances (CLP). Attempts to bring them into alignment over the last few years have been met with significant debate and concern from various stakeholders. As seen from the notes of the competent authorities for REACH and CLP, many proponents caution that "banning or restricting uses of substances on the basis of their essentiality, without sufficient assessment of the impacts may lead to regrettable substitution or impaired competitiveness and innovation."[11]

Secondly, many of these existing frameworks already have infrastructure built-in for chemicals of concern to request authorizations or "use-specific" exemptions if the requestor can demonstrate that under normal conditions of use, the risks are adequately controlled. Lastly, a broader concern with this concept, cautions that assessments around essential use can vary widely depending on who and how they are determined. Placing diligence around best practices should be exercised where some chemicals deemed "non-essential" today, could be "essential" in the future, thus allowing space for science and technology to evolve, be it for

UNEP, 23–25 Nov. 1992, available at: https://ozone.unep.org/treaties/montreal-protocol/meetings/fourth-meeting-parties/decisions/decision-iv25-essential-uses?q=fr/meetings/fourth-meeting-parties-montreal-protocol/decisions/decision-iv25-utilisations-essentielles

[9] UNEP Ozone Secretariat, Handbook for the Montreal Protocol, Section 3.2 "Essential Use Exemptions" pg 752-767 https://ozone.unep.org/sites/default/files/Handbooks/MP-Handbook-2020-English.pdf

[10] Scholz, S., Brack, W., Escher, B.I. *et al.* The EU chemicals strategy for sustainability: an opportunity to develop new approaches for hazard and risk assessment. *Arch Toxicol* 96, 2381–2386 (2022). https://doi.org/10.1007/s00204-022-03313-2

[11] CARACAL 1, Pg 7 https://files.chemicalwatch.com/38%20%20CA_61_2020_Essential%20uses%20%282%29.pdf

global emergencies, or other unforeseen future needs where flexibility in these areas will be needed to eliminate supply chain vulnerabilities or barriers to innovation, trade, or commerce.

Minnesota-Specific Essential Use Examples

Minnesota has many examples of both successful and unsuccessful regulatory schemes from which to learn in its development of unavoidable use criteria. MPCA should look to the successes and challenges of its past phaseouts when developing unavoidable use criteria. Such learnings may be found in the regulation of Trichloroethylene (TCE), Formaldehyde, Heavy Metals, and PCBs.

For example, in the case of Formaldehyde, Minn. Stat. 325F.174 et seq., the Minnesota legislature recognized the extensive, existing regulatory structures around specific product categories and thus exempted many FDA-regulated products and products in conformance with ASTM International Standard F963. In doing so, the state reduced MPCA's administrative burden, reduced the regulatory burden on industry by minimizing duplicative or inconsistent regulation, and effectuated the goal of reducing this potentially hazardous chemical in Minnesota. A similar approach was taken with Heavy Metals in consumer products, Minn. Stat. 325E.3891 et seq. Further, in the case of TCE, a successful phaseout was tied to an existing permitting program, thereby focusing MPCA's efforts on some of the state's largest users, Minn. Stat. 116.385 et seq. While the Minnesota Legislature did not specifically dictate these exemptions or structures in the case of PFAS regulation, it did give MPCA wide latitude to define and implement unavoidable use criteria.

<u>Recognizing Existing Essential Use Determinations and Criteria</u>

As the MPCA promulgates its own essential use rules, it must ensure that they align with the detailed criteria developed under other domestic and international programs. Harmonization with existing criteria is crucial to maintain consistency in regulations, promote efficiency, and avoid conflicting requirements that could hinder effective environmental protection efforts such as ozone layer protection.

For instance, our strong recommendation would be that the MPCA consider the criteria outlined by the Montreal Protocol and any guidance provided by relevant international bodies, such as the United Nations Environment Programme (UNEP) and its Ozone Secretariat. These criteria typically include considerations such as technical feasibility of alternatives, economic impact assessments, and environmental considerations.

Furthermore, coordination with other domestic programs, such as those established by federal agencies like the Environmental Protection Agency (EPA), is essential to ensure coherence in regulatory frameworks and prevent duplication of efforts. Other PFAS essential use determinations that can be relied on by MPCA include the SNAP program under the Clean Air Act, the EPA's new chemical review program under Section 5 of the Toxic Substances Control Act (TSCA) , the Federal Food, Drug, and Cosmetic Act (FFDCA), and other federal programs whereby either the PFAS, or products containing them, have been deemed acceptable for their intended use through risk assessments by federal agencies. PFAS-containing products that are subject to, or necessary for, meeting federal specifications (e.g., military specifications, United States Federal Aviation Administration (FAA) standards, or NASA requirements) also should be considered currently unavoidable use. Such an approach will help MPCA concentrate its efforts on non-essential uses within consumer products. This approach also provides fairness and market stability for businesses that have successfully completed federal reviews for their PFAS-containing products under these federal programs. The approach will also ensure the continued availability of products that must meet military, technical, or similar government specifications.

Question 2: Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Costs of PFAS Alternatives Should be Taken into Consideration When Determining Their Availability

High costs can create barriers to adoption for industries or applications and may have severe impacts on end users and consumers with limited financial resources. Evaluating costs will allow regulators to assess the economic feasibility, or reasonableness, of transitioning to alternative substances and will ensure that feasible alternatives are identified where needed.

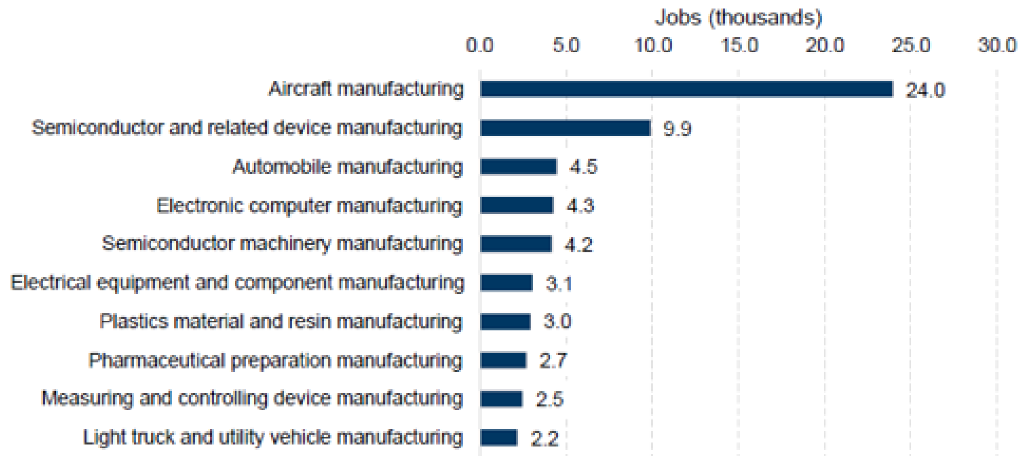
Sector Example: Aircraft Manufacturing in the Aerospace and Defense Industry

In the most recent 'Minnesota by the Numbers' Aerospace and Defense was listed as a top industry in Minnesota[12]. It is important for the agency to perform a sector-by-sector risk assessment within the State that accounts for impacts to Minnesota's top revenue-generating industries. In light of some of these complex supply chains there could also be global repercussions with crippling costs or critical equipment obsolescence that might occur if a key use is missed. When the US Chamber of Commerce recently reviewed trade implications between the US and Europe that could be impacted under PFAS restrictions in Europe[13], the market sector with the largest estimated trade value at risk was Aerospace and Defense at $48 billion. Figures taken from that report also considered US GDP and distribution of total impacts. The figures showed that aircraft manufacturing would suffer the most significant impact to jobs by sector (Fig. 3). Further, the State of Minnesota (fig 4) would have over 8000 jobs that could be impacted by PFAS restrictions if exemptions were not provided for this sector. For Honeywell's A & D facilities alone, an initial assessment has revealed more than 2,000 distinct part numbers stand to be affected should the sector not be classified as essential. This has the potential for significant supply chain disruptions as well as significant financial considerations. As a company with deep ties to the state of Minnesota, and a thriving Aerospace and Defense business, these numbers are deeply concerning to us as an employer within the state in this industry.

12 Minnesota's Aerospace and Defense Industries (mn.gov)
13 https://www.uschamber.com/international/impacts-of-the-pfas-restriction-on-trade-between-the-u-s-and-the-european-union

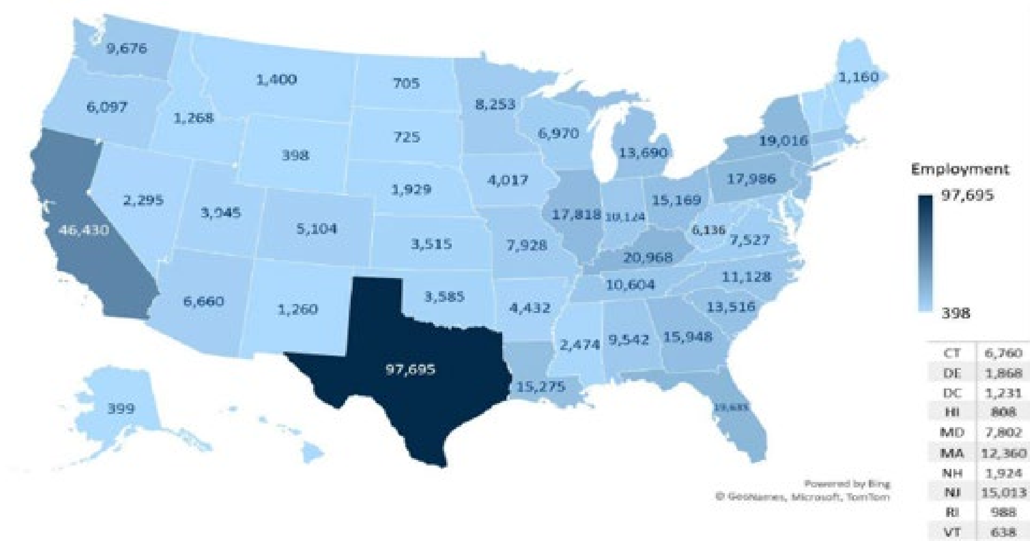
Honeywell

Figure 3: Top 10 Most impacted sector by jobs



Source: https://www.uschamber.com/international/impacts-of-the-pfas-restriction-on-trade-between-the-u-s-and-the-european-union

Figure 4: Job Impacts by State



Source: https://www.uschamber.com/international/impacts-of-the-pfas-restriction-on-trade-between-the-u-s-and-the-european-union

Product Example: PCTFE in Medical Packaging

In the pharmaceutical sector, Honeywell provides the fluoropolymer, PCTFE, for use in medicinal packaging for both humans and animals. If new alternatives must be identified, for every change to an approved packaging, this could require additional stability testing and approval of changes/variations by the US FDA and other international medicine authorities for each existing active substance and dosage of the final medicinal product. This will not only require substantial development time (i.e., tests normally performed for long time periods with regular intermediate controls) but also considerable human resources from the industry and authorizations by authorities. According to available information, the costs of stability testing for each medicinal product could reach $100,000-500,000 USD, for the approval of potential variations. There are currently over 600 products which may be impacted.

In cases where alternative packaging would not provide satisfactory stability characteristics to active substances or final medicinal products, changes to medicinal formulations could be required. Formulation changes will demand considerable costs and time for developing new medicinal products and obtaining marketing authorizations. This will also trigger additional costs for processors/producers of packaging materials to retool and retrofit their machinery for other barrier materials. According to Honeywell's estimates, new packaging changes alone could potentially add over $3 million of additional costs for one drug and close to $2B for the entire PCTFE product portfolio. All of these costs would likely be passed on to final consumers and public budgets.

Understanding the revenue impacts at the state level will help keep regulations from becoming overly burdensome on all sizes of business owners, continue to drive innovation, foster competition, and keep jobs and tax revenue within the State of Minnesota. Regulatory perception amongst investors and entrepreneurs can also impact future business for investment and economic growth, thus making it critical for policymakers to strike a balance between necessary regulations to protect citizens while simultaneously supporting an environment of growth and sustainability of its key industries.

Honeywell further requests that the MPCA make the information used in conducting an assessment or evaluation of alternatives including their socioeconomic impacts on both costs and jobs by sector publicly available for review and comment.

Need to Consider Small Businesses and Municipalities

Finally, Minnesota Statutes Section 14.127, specifically requires MPCA to determine the financial impact of this rule on small businesses and municipalities—if MPCA determines that the rule will cost these entities more than $25,000 in the first year after the rule takes effect, affected entities may apply for an exemption that can only be overridden by subsequent legislative action. A failure on the part of MPCA to consider these entities results in a deviation from proper rulemaking procedures under Minnesota's Administrative Procedures Act. While Honeywell is not a small business under this statute, many of its supply-chain partners in Minnesota fall into this category. Therefore, Honeywell will be working closely with our small business partners to assist MPCA's evaluation of how PFAS regulation will impact these entities pursuant to Minn. Stat. § 14.127. For example, most of the foam blowing contractors reliant on Honeywell's HFOs are characterized as small businesses. These enterprises often operate on a local or regional scale, providing insulation services to residential, commercial, and industrial clients. Due to the specialized nature of their work, these contractors typically have limited resources and may face challenges in transitioning to alternative, blowing agents.

The Reasonable Availability of Alternatives Should Take into Account Multiple Factors Beyond Cost

How the MPCA will determine when alternatives are not reasonably available should also be explained in the regulation and should include the concepts of performance, safety, cost, and supply chain considerations. A long-term perspective is crucial when evaluating unavoidable use, especially considering the potential for future regulations, liabilities, and societal expectations regarding environmental stewardship.

In many essential A&D applications, only fluorinated substances can fulfill all required technical (AMS3255, AMS3678, ASM3659, ASTM D1710, AMS7276, AMS7287, AMS365 AMS3667) and military specifications (MIL-S-46163, MIL-PRF-276717)[14]. A&D production also needs to adhere to strict quality standards like ISO AS9100 and Nadcap. Due to the nature of critical A&D uses, known alternative materials are not available to simultaneously satisfy all required properties, such as low flammability, high service temperature (above~200 °C), low dielectric constant, electric arc tracking resistance, mechanical strength and elasticity, and chemical resistance/inertness to even the most aggressive chemicals.

Moreover, the combination of properties required in most A&D applications will be difficult to achieve in a new material. Even after a material with the suitable combination of properties would be discovered or invented, it will take decades to approve its use by the overall A&D industry (e.g., all major aircraft producers should test and approve) and to certify it under all applicable standards worldwide. It is estimated that, in practice, this process would require approximately 30 years (on average) for many critical aircraft components.

Industry Example: Halons-Based Applications

Although Halons are not part of our chemistry, they are an industry application example of ozone-depleting substances with an essential use exemption under the Montreal Protocol. Despite decades of innovation efforts to replace them, the only result has been a ‘regrettable substitution’. Recently the A&D industry successfully substituted Halon 1211 in portable (handheld) and lavatory receptacle extinguishers used in commercial aircrafts and is working to substitute halons in commercial aircraft fire suppression systems. The new Halon 1211 substitutes constitute a “regrettable substitution,” because they are still technically deemed a PFAS substance under Minnesota’s definition of PFAS, thus making the ‘new’ solutions non-viable.

In addition, the industry has been working for many years to substitute Halon 1301 in cargo & auxiliary power unit (APU) compartment and engines nacelles commercial aircraft fire suppression systems. Despite these efforts, viable halon alternatives have not been found. Many potential alternatives turned out to be technically not feasible, because they do not meet specific performance requirements. Moreover, fire suppression is a critical safety item and specific airworthiness requirements apply to fire suppression, which must be met in the aircraft certification process. Many of the remaining potential Halon 1301 substitutes the industry is currently investigating are PFAS. Therefore, additional restrictions of PFAS potentially used in fire suppression systems would put the industry's achievements at risk and potentially require a restart of the research by focusing on non-PFAS agents, should they even be available.

[14] For example, technical specifications for PTFE/ETFE insulated wire under M22759 (SAE AS22759) standards or requirements for heat transfer fluids, solvent resistance O-rings, etc.

A Transparent and Well-Defined Framework for Reasonableness Determinations

The Agency should consider establishing a transparent and well-defined framework in determining the reasonable availability of alternatives, considering cost and additional factors. Subsection (i) of the American Innovation and Manufacturing Act of 2020 (AIM Act), entitled “Technology Transitions,” may serve as a useful example of criteria that a substitute, or alternative, must meet prior to EPA establishing restrictions on the use of a substance being substituted. Specifically, when determining whether to restrict the use of a substance, EPA, under this provision, is required to consider “the availability of substitutes for use taking into account technological achievability, commercial demands, affordability for residential and small business consumers, safety, consumer costs, building codes, appliance efficiency standards, contractor training costs, and other relevant factors…”[15] Honeywell urges the MPCA to consider adopting a similar approach in assessing substitutes to PFAS, and to identify the criteria that the MPCA intends to use in ascertaining the reasonable availability of alternatives.

Question 4: What criteria should be used to determine the safety of potential PFAS alternatives?

The Definition of “Alternatives” Should Include Concepts of Functional Equivalency and Reduction of Potential Risk

Honeywell requests that MPCA provide a detailed definition of “alternatives” as that term is used within the definition of “currently unavoidable use.” The definition should include concepts of functional equivalency and reducing potential risk to human health or the environment. The basis for those concepts must be consistent, fair, transparent, and well-defined.

For example, in the Montreal Protocol on Substances that Deplete the Ozone Layer, an international treaty designed to protect the ozone layer by phasing out the production and consumption of ozone-depleting substances (ODS), defines “alternatives” as substances or technologies that:

- Do not deplete the ozone layer: Alternatives must not have ozone-depleting potential or, at the very least, have significantly lower potential compared to the substances they are intended to replace.
- Are more environmentally friendly: Alternatives should have a reduced impact on the environment, including lower global warming potential and lower potential for other environmental impacts.
- Are technically and economically feasible: Alternatives should be practical and viable from both a technical and economic standpoint to ensure that industries can transition smoothly away from ozone-depleting substances.

The definition of alternatives is crucial to the success of the Montreal Protocol, as it guides the efforts to find and adopt substitutes for ODS in various industrial processes and applications. The protocol encourages the development and use of alternatives to accelerate the phase-out of substances like chlorofluorocarbons (CFCs), halons, and other ozone-depleting chemicals.

Another example is the definition of “substitute or alternative” under EPA’s SNAP program, which defines the term as “any chemical, product substitute, or alternative manufacturing process, existing or new, that

[15] https://www.govinfo.gov/content/pkg/USCODE-2020-title42/html/USCODE-2020-title42-chap85-subchapVII.htm

could replace a class I or II substance."[16] EPA also takes into account an alternative that "(1) reduces overall risk to human health and the environment, and (2) is currently or potentially available.

In August of 2023, the Department of Defense (DoD) released their "Report on Critical Per- and Polyfluoroalkyl Substance (PFAS) Uses" which speaks to the challenges and costs relating to finding, and qualifying equally performing alternatives to existing materials in key sectors of strategic importance to our national security. When asked if alternatives[17] existed in most of these end uses, there were very few, with most citing complex, multi-leveled supply chains which would require 10–30-year recertification processes, and incompatibilities with other 'like' materials due to the strict performance, regulatory, and safety parameters these materials must meet. Trying to phase out chemistries in these applications could cost program offices millions of dollars, not to mention the countless hours that will need to be spent identifying and qualifying any new materials, thereby creating ripple effects in the economy that would be passed on to consumers, taxpayers, and cause supply issues with mission critical components leaving our country at risk or vulnerable in our defense of national security.

Defining alternatives with respect to Aerospace and Defense (A&D) companies will be challenging. As previously mentioned, these alternatives must be qualified (i.e., evaluated and tested) in the context of the aircraft system or sub-systems. These processes must be repeated where the alternatives are found to be unsuitable. Once qualified, the system must be revalidated to maintain certification of the product (e.g., aircraft, vessel, vehicle, etc.). Certification is strictly controlled by regulatory bodies in both the United States and other jurisdictions, in both the civil aerospace and military domains. Examples include the EASA, the FAA, and their military counterparts.

As A&D products are subjected to some of the most austere environments around the world. They must operate successfully in extremes, including altitude, temperature, pressure, and precipitation, while having to fulfill the highest technical reliability and safety requirements. To ensure aircraft safety, comprehensive airworthiness regulations have been in place around the world for decades. These regulations require qualification of all materials and processes according to a systematic and rigorous process to meet stringent safety requirements subject to independent certification and approval. Such rigorous testing and qualification processes are required to assure that any changes do not compromise the integrity of the affected components or the safety of the product as a whole.

The DoD concluded in their paper that, "it is critical that future laws and regulations consider and balance the range of environmental and health risks associated with different individual PFAS, their essentiality to the U.S. economy and society, and the availability of viable alternatives."

It is critical that Minnesota give credence to federal authorizations for the use of PFAS in the state's development of unavoidable use criteria because failure to do so will jeopardize some of the nation's most critical industries and applications.

Question 5: How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided? Should significant changes in available information about alternatives trigger re-evaluation?

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[16] 40 CFR § 82.172 "Substitute or alternative"

[17] Report on Critical Per- and Polyfluoroalkyl Substance (PFAS) Uses, Appendix A-1 Alternatives Assessment pg 21-27 https://www.acq.osd.mil/eie/eer/ecc/pfas/docs/reports/Report-on-Critical-PFAS-Substance-Uses.pdf

Unavoidable Use Determinations Should Be Good for Unlimited Time

As stated in previous questions, the agency will need to look at each sector's specific use of PFAS and prioritize its actions accordingly. MPCA should identify critical PFAS and align with certain uses that have already undergone federal authorizations within existing regulatory frameworks within the United States for specific uses pursuant to programs such as, but not limited to, the SNAP program under the Clean Air Act, the EPA's new chemical review program under Section 5 of the Toxic Substances Control Act (TSCA) , the Federal Food, Drug, and Cosmetic Act (FFDCA), and other federal programs whereby either the PFAS, or products containing them, have been deemed acceptable for their intended use by federal government agencies. PFAS-containing products that are subject to, or necessary for, meeting federal specifications (e.g., military specifications, United States Federal Aviation Administration (FAA)-issued standards, NASA requirements) also should be considered currently unavoidable use. Such an approach will help MPCA concentrate its efforts on non-essential products. Fairness and market stability should be assured to businesses that have successfully completed federal reviews for their PFAS-containing products under these statutes. Likewise, the longest essential use determinations should be granted to companies that manufacture or provide products that must meet military or similar government specifications, taking into consideration supply chain complexity and length of qualification times for an alternative to be assessed, tested, and demonstrated safe at requisite scale and scrutiny.

Question 6: How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

Role of a Technical Advisory Committee

Honeywell suggests the agency establish a Technical Advisory Committee (TAC) comprised of various stakeholders including but not limited to agency staff, scientists, health professionals, industry experts, small business owners, and those from civil sectors or those most similar representatives from industries within the State of Minnesota. Furthermore, MPCA should open these for public review, much like how the Montreal Protocol does, publishing its decisions relating to essential uses.[18] The agency should seek to find committee members who support the adoption of essential use criteria and help guide the Agency with the principles of understanding changing societal needs and a mindset for future innovations The technical committee must understand that a static view of essentiality could lead to a static society. Many concepts 30 years ago for instance like mobile phones were not considered essential, where now such devices are essential to societal function and progress. Having a process combining public review and proper membership should help guide the agency in its assessment of critical societal needs vetted by necessary expertise, sound science, and data. The technical committee should also help the agency identify representation of vulnerable and at-risk populations impacted by the Rule.

MPCA may model its Technical Advisory Committee after U.S. EPA's Science Advisory Committee on Chemicals ("SACC"). The SACC provides independent advice to EPA to assist the agency in implementing the Toxic Substances Control Act. Members are identified through a public call for nominations and are appointed by the Administrator of the EPA. Members have diverse backgrounds in policy, science, government, and industry, which inform their recommendations to the agency.

[18] UNEP Ozone Secretariat, Handbook for the Montreal Protocol, Section 3.2 "Essential Use Exemptions" pg 752-767 https://ozone.unep.org/sites/default/files/Handbooks/MP-Handbook-2020-English.pdf

Deferring to Environmental Protection Agency's (EPA) Significant New Alternatives Policy (SNAP) program Decisions

Another option that the MPCA should consider modelling their approach to is the EPA's SNAP program which operates as a regulatory framework aimed at identifying and promoting the use of environmentally preferable alternatives to ODS and high- GWP substances in various sectors. Here's how SNAP works to ensure the adoption of the best refrigerants across viable sectors:

1. **Identification of Alternatives:** SNAP assesses potential substitutes for ODS and high-GWP substances used in refrigeration, air conditioning, and other applications. It evaluates the environmental impact, safety, and efficacy of these alternatives to determine their suitability for specific sectors.

2. **Regulatory Determination:** Based on its evaluation, SNAP issues regulatory determinations that categorize alternatives as acceptable, unacceptable, or acceptable subject to use conditions. Acceptable alternatives are those deemed environmentally preferable and safe for use, while unacceptable alternatives are prohibited.

3. **Sector-Specific Guidelines:** SNAP develops sector-specific guidelines and regulations to guide the use of acceptable alternatives in various applications. These guidelines may include usage restrictions, performance standards, and reporting requirements to ensure proper implementation and monitoring.

4. **Stakeholder Engagement:** The SNAP program engages stakeholders, including industry representatives, environmental advocates, and scientific experts, throughout the decision-making process. This collaboration helps to gather input, address concerns, and foster consensus on the adoption of alternative refrigerants.

5. **Technology Assessment and Innovation:** SNAP encourages ongoing research and development of new refrigeration technologies and alternative substances with lower environmental impact. By promoting innovation, the program seeks to continually improve the availability and performance of environmentally friendly refrigerants across different sectors.

6. **Compliance Monitoring and Enforcement:** SNAP monitors compliance with its regulations and guidelines through inspections, data reporting requirements, and enforcement actions against violators. This helps to ensure that the best refrigerants are used in every viable sector while deterring the illegal use of prohibited substances.

Question 7: In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

Uses and Products for Which Honeywell May Submit an Unavoidable Use Request

The following are a categorical list of uses and products for which Honeywell anticipates it will submit an unavoidable use request:

(1) A product used in a manner that has been approved or authorized by a federal or state agency.
(2) Items that are required by Federal or State laws and regulations.

(3) Drugs, medical devices, biologics or diagnostics regulated by the Federal Food and Drug Administration or the US Department of Agriculture or otherwise subject to regulation under the Federal Food, Drug, and Cosmetic Act, as amended, 21 U.S.C. § 301 et seq;
(4) Packaging for drugs, medical devices, biologics, diagnostics or [non-pulp based] food regulated by the Federal Food and Drug Administration or the US Department of Agriculture or otherwise in scope of the Federal Food, Drug, and Cosmetic Act, as amended, 21 U.S.C. § 301 et seq
(5) Products registered for use under the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, 7 U.S.C. § 136 et seq.
(6) Substances designated by rulemaking or otherwise as acceptable substitutes in specific uses under U.S. EPA's Significant New Alternatives Policy (SNAP) program, or substitutes needed to execute the American Innovation and Manufacturing (AIM) Act.
(7) Polymeric substances for which the main chain (backbone) of the polymer is either a per- or polyfluorinated carbon-only backbone or a perfluorinated polyether backbone.
(8) A used product offered for sale or resale.
(9) Finished products certified or regulated by the FAA or the DOD, or both, when used in a manner that was certified or regulated by such agencies, including parts, materials, and processes used to manufacture or maintain such regulated or certified finished products;
(10) Motorized vehicles, including on and off-highway vehicles, such as all-terrain vehicles, motorcycles, side-by-side vehicles, farm equipment, and personal assistive mobility devices;
(11) Inaccessible electronic components of an electronic product, and
(12) Cooling, heating, ventilation, air conditioning and refrigeration equipment, components and servicing needs.
(13) Apparel that would be deemed personal protective equipment or clothing items for exclusive use by the United States military, defense sector, space sector, or another agency or organization fitting these descriptions.

Question 8: Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

<u>MPCA Should Make Initial Currently Unavoidable Use Determinations</u>

Honeywell recommends MPCA make initial unavoidable use determinations by incorporating parallel federal agency determinations into the final rule, much like the suggested list from question 7; MPCA has both the authority and obligation to promulgate initial determinations in this rulemaking for several reasons. First, Minnesota's Administrative Procedure Act (MAPA) specifically directs agencies to avoid unnecessarily costly and ineffective regulatory programs by developing programs that meet the regulatory objectives and provide the "maximum flexibility" for the regulated party. Minn. Stat. § 14.002. MAPA also requires each agency to submit a list of rules that are "duplicative of other state or federal statutes or rules" and act to repeal the duplicative rules. Minn. Stat. § 14.05, subd. 5. These statutes demonstrate the Minnesota legislature's strong preference to create efficient and complementary regulatory programs. Second, MAPA explicitly authorizes an agency to incorporate by reference the text from federal legislation and the Code of Federal Regulations. Minn. Stat. § 14.07, subd. 4. Third, the statutes governing MPCA specifically direct the commissioner to "coordinate the agency's activities where appropriate with the activities of other governmental agencies." Minn. Stat. § 16.03, subd. 2(a)(3). Fourth, Minn. Stat. § 16.943, subd. 3(c) authorizes the commissioner to enter into an agreement with other political subdivisions and accept information to a shared system.

In sum, several federal agencies have already created robust review programs around PFAS unavoidable use determinations and viable alternatives (i.e. SNAP, TSCA). MPCA has both the authority and the obligation to create the most cost-effective and efficient regulatory program by incorporating use determinations that have already undergone review by a regulatory agency into the initial rulemaking process. Failure to align the MPCA's product review process with those federal review processes already in existence would result in a duplicative, inefficient regulatory process that MPCA seeks to avoid. Therefore, Honeywell recommends that MPCA incorporate products that have already completed the federal regulatory review process as final determinations on unavoidable use.

Question 9: Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

<u>Other Issues Related to Defining Currently Unavoidable Use</u>

Speed of Innovation

An additional aspect the agency needs to understand is also the speed of innovation and development and how that process relates to the protection of intellectual property and confidential business information. There are times where inventors, innovators, entrepreneurs cannot discuss or publicize ideas or products prematurely, which could lead to difficulty in:

1. Sharing the idea, concept, or use publicly in a non-essential use/essential use forum.
2. Demonstrating the essential use to a TAC or others due to the 'newness or fluidity of the innovation process'.
3. Create an environment where truly innovative products could be produced outside of the State or the country where the State or United States could never recover to non-US competition.

Confidential Business Information

Much of the data needed to be analyzed to determine unavoidable use will be trade secret and otherwise business confidential. Under existing Minnesota law, this information should not be made publicly available. Minn. Stat. § 13.37, Subd. 2 identifies "trade secret information" as not available to the public pursuant to the Minnesota Data Practices Act. "Trade secret information" is defined under Minnesota law as "government data, including a formula, pattern, compilation, program, device, method, technique or process (1) that was supplied by the affected individual or organization, (2) that is the subject of efforts by the individual or organization that are reasonable under the circumstances to maintain its secrecy, and (3) that derives independent economic value, actual or potential, from not being generally known to, and not being readily ascertainable by proper means by, other persons who can obtain economic value from its disclosure or use." Minn. Stat. § 13.37, Subd. 1(b).

MPCA should apply this standard and pre-identify categories of information provided under the Minnesota Statute as trade secret and not publicly available pursuant to the Minnesota Data Practices Act. Such required information.

Honeywell recognizes the difficulty MPCA faces in its effort to develop and implement unavoidable use criteria. The agency must find a balance between protection of the environment and burden to industry. Honeywell appreciates the opportunity to provide comments to MPCA in the hope that the Unavoidable Use criteria are sufficiently protective while not suppressing innovation or stifling economic opportunity in the state.

Honeywell

Conclusion

Honeywell appreciates your consideration of these suggestions and would be glad to participate in further discussions about these comments. We look forward to reviewing and commenting on the Planned Rule.

Sincerely,

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Kevin Wolfe Attachment
RECEIVED
By: OAH on 2/28/2024

intel.

February 29, 2024

Submitted via the Minnesota Office of Administrative Hearings eComments Website

Katrina Kessler
Commissioner
Minnesota Pollution Control Agency
520 Lafayette Road N
St. Paul, MN 55155-4194

Re: Intel Corporation's Comments on the MPCA's Request for Comments on Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per- and Polyfluoroalkyl Substances (PFAS); OAH Docket No.71-9003-39667; Governor's Revisor's ID Number: R-4837

Intel Corporation (Intel) appreciates the opportunity to provide our comments on the Planned New Rules Governing Currently Unavoidable Use ("CUU") Determinations about Products Containing per- and polyfluoroalkyl substances (PFAS) being developed by the Minnesota Pollution Control Agency (MPCA or the Agency), as authorized in Minn. St. § 116.943 (Section 116.943). These comments discuss the MPCA's planned rules governing currently unavoidable use determinations about products containing PFAS.

Intel is a leading developer of microchip processor technologies, operates semiconductor manufacturing facilities in the United States, and sells semiconductor products into the State of Minnesota. Intel also has participated in providing information to MPCA as a contributor to the more detailed comments provided by the Semiconductor Industry Association (SIA) and SEMI; Intel endorses and adopts the SIA and SEMI comments that will be submitted prior to the comment deadline.

The use of per- and polyfluoroalkyl substances (PFAS) materials in the semiconductor manufacturing process is critical. PFAS' unique chemical properties, including stability and non-reactivity are invaluable to their use as process chemistries in the discrete semiconductor manufacturing steps but also to the use of fluoropolymers in the wider semiconductor manufacturing process ecosystem.

Additionally, a peer-reviewed journal article published by Professor Chris Ober and colleagues at Cornell University summarizes the uses of fluorinated materials in the lithography process and concludes: "The addition of small quantities of fluorinated materials enables patterning capabilities that are otherwise not possible to achieve, and this leads to superior device performance. The compact size of the fluorine atom and its strong electron withdrawing characteristics make it stand out in the periodic table and gives fluorocarbon materials unique properties, unmatched by other chemical compounds."1

As a company committed to environmental sustainability, corporate responsibility, and the safety of our workers and communities, Intel strives to minimize our use of substances that pose risks to the environment or human health. Since 2002, we have migrated from long-chain PFAS (PFOS and PFOA) to short chain PFAS; and it is Intel's policy to no longer use, buy, or conduct research with long-chain PFAS materials. Our focus on eliminating long

[1] Christopher K. Ober, Florian Käfer, Jingyuan Deng, "The essential use of fluorochemicals in lithographic patterning and semiconductor processing," J. Micro/Nanopattern. Mater. Metrol. 21(1), 010901 (2022), doi: 10.1117/1.JMM.21.1.010901, available at http://dx.doi.org/10.1117/1.JMM.21.1.010901

chain PFAS varieties was consistent with the US and EPA regulatory focus and the scientific consensus that longer-chain PFAS are of greater health and environmental concern than shorter-chain varieties. However, today the industry remains dependent on short-chain PFAS, with no non-fluorinated alternatives on the horizon for most existing uses.

The MPCA, in the Request for Comments, is seeking comments on specific questions: The following are Intel's responses to those specific questions on which the MPCA requested input.

1. Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Intel endorses and adopts the SIA and SEMI comments that will be submitted prior to the comment deadline.

2. Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Intel endorses and adopts the SIA and SEMI comments that will be submitted prior to the comment deadline.

3. Should unique considerations be made for small businesses with regards to economic feasibility?

Not applicable, as Intel does not operate as a small business.

4. What criteria should be used to determine the safety of potential PFAS alternatives?

Intel endorses and adopts the SIA and SEMI comments that will be submitted prior to the comment deadline.

5. How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

Intel endorses and adopts the SIA and SEMI comments that will be submitted prior to the comment deadline.

6. How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

Intel endorses and adopts the SIA and SEMI comments that will be submitted prior to the comment deadline.

7. In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

Intel intends to seek a CUU determination for:

- Uses of PFAS in the semiconductor industry as a general category of usage
- Uses of PFAS in cables, connectors, and capacitors

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- Use of hydrofluoroolefin (HFO) refrigerants for Electronics Cooling in Data Centers

Intel requests that a Currently Unavoidable Use (CUU) be provided as a general category for the semiconductor industry that includes all currently unavoidable uses throughout the semiconductor supply chain, including the upstream semiconductor supply chain industries, the semiconductor manufacturing process, and the final packaged semiconductor devices that are produced. Examples of CUU PFAS uses in each of these three subcategories are as partially listed below and including:

- Uses in upstream semiconductor supply chain industries, including but not limited to uses of fluoropolymers and other PFAS used in high purity chemical production and packaging, and fluoropolymers and other PFAS integrated into semiconductor manufacturing equipment, and
- Uses within the semiconductor manufacturing process, including but not limited to PFAS ingredients within specialty chemicals and fluids, fluoropolymers and other PFAS used in production of high purity water and in containment and transport of high purity water and chemicals, and uses of fluoropolymers and other PFAS in facility systems, and
- Uses within the final packaged semiconductor devices, including but not limited to finished semiconductor devices and component parts such as encapsulants, thermal interface materials, adhesives, coatings, and substrates.

Semiconductors form the essential building blocks of modern technology, enabling critical technologies and industries that form the foundation of the U.S. economy and the functioning of society, including the automotive industry, defense, electronics, communications, data storage and analysis, legal and regulatory infrastructure, scientific (including materials) research, medicine and medical devices, the green energy transition, transportation (including aviation), and much more. With up to tens of billions of transistors on a single piece of silicon, producing these complex devices requires highly advanced processes and equipment, as well as the use of chemicals, gases, and other materials with specific performance and functional attributes. Today, the smallest transistor is just 3 nanometers in size – 5 atoms thick and 30,000x thinner than a human hair. The fabrication process can include up to 1,400 process steps, with each process step typically involving the use of a variety of unique, highly sophisticated machines and materials. The supply chain for semiconductor manufacturing is extremely complex, as noted by numerous U.S. government publications.[2]

PFAS are among the inputs essential to chip manufacturing, used in a wide range of industrial processes and consumer products. Although the semiconductor industry accounts for only a small fraction of the world's total PFAS usage[3], many uses of specific PFAS are essential to semiconductor manufacturing. PFAS have essential uses in a wide variety of applications because they possess certain critical performance and functional attributes needed to manufacture semiconductors and the sophisticated equipment and infrastructure needed in the process. The carbon-fluorine bonds and structure of PFAS give them unique physical and chemical properties, such as strong electronegativity, low refractive index, good thermal stability, good barrier properties, hydrophobicity, low dielectric current, uniformity in coating with minimal effect on properties provided by other chemicals, thermal resistance, chemical resistance, low surface adherence, resistance to grease and stain, anisotropic etching capability, selective metal oxide removal, reduced shedding, high-temperature thermal stability, low adhesion strength,

[2] The White House, 100-day Supply Chain Review, *Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth*, June 2021. See: https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf
Government Accountability Office, GAO-22-105923, *Semiconductor Supply Chain Policy: Considerations from Selected Experts for Reducing Risks and Mitigating Shortages*, July 2022. See: https://www.gao.gov/assets/gao-22-105923.pdf
Department of Defense, *Securing Defense-Critical Supply Chains An action plan developed in response to President Biden's Executive Order 14017*, Feb. 2022. See: https://media.defense.gov/2022/Feb/24/2002944158/-1/-1/1/DOD-EO-14017-REPORT-SECURING-DEFENSE-CRITICAL-SUPPLY-CHAINS.PDF
[3] https://www.nature.com/articles/d41586-023-02444-5

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chemical inertness, low volatility, UV resistance, flame resistance, low coefficient of friction, and many others. This range of properties across the many different types of PFAS and applications, are useful in many industrial and consumer applications, including semiconductor manufacturing. Given the complexity of semiconductors and related systems, MPCA must recognize that even just one use of PFAS deemed not to be a CUU could inadvertently prohibit the import of semiconductors into the state and cause all semiconductor manufacturing in Minnesota to cease operations.

The Semiconductor PFAS Consortium[4] has identified over 1000 uses of PFAS in the semiconductor manufacturing process and associated supply chain. Each use is essential to producing the final chip. There are currently no known substitutes for most of these applications. Identifying, developing, and qualifying suitable substitutes will require new inventions, and if found, the process of introducing substitutes into high volume manufacturing is complex; the process can take anywhere from 5 to 25 years, and in many cases may never be possible.

The reason why Intel intends to seek a CUU for use of PFAS in cables, connectors and capacitors is because the PFAS fluoropolymers that are used in these applications provide combinations of essential properties that alternative non-PFAS materials do not.

The reason why Intel intends to seek a CUU for use of HFO refrigerants for electronics cooling in data centers is because of the need to provide adequate cooling for high performance server computing products, such as those that support artificial intelligence (AI), in applications where alternative non-PFAS based cooling technologies are not capable of providing adequate cooling.

8. Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

Intel endorses and adopts the SIA and SEMI comments that will be submitted prior to the comment deadline.

9. Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

Intel endorses and adopts the SIA and SEMI comments that will be submitted prior to the comment deadline.

Conclusion

Intel is grateful for the opportunity to engage on MPCA's planned rulemakings and is available to meet at your convenience to further elaborate on the issues discussed in these comments. If you have any questions or would like to discuss our positions, please do not hesitate to contact Kevin Wolfe (kevin.w.wolfe@intel.com).

[4] In January 2021, SIA facilitated the establishment of the Semiconductor PFAS Consortium, an international group formed to collect the technical data needed to formulate an industry-wide approach and better inform public policy and legislation regarding the semiconductor industry's use of PFAS. The consortium membership is comprised of semiconductor manufacturers and members of the supply chain including chemical, material, and equipment suppliers. To date, the Consortium has published a series of nine technical papers summarizing the uses of PFAS in the semiconductor industry and significant technical challenges to replace these substances in the range of uses in the fabrication process and fab equipment. Additional information is available at www.semiconductors.org/pfas/ Semiconductor PFAS Consortium, Background on Semiconductor Manufacturing and PFAS, May 17, 2023.

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Sincerely,

Kevin Wolfe
Global Environmental PFAS Program Manager, Intel Corporation

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Kazuhito Oosumi Attachment 1 RECEIVED
By: OAH on 2/28/2024

Japan Business Machine and Information System Industries Association
LILA HIJIRIZAKA 3-4-10 Mita Minato-ku Tokyo 108-0073 JAPAN
Phone: +81 3 6809 5010 Fax: +81 3 3451 1770

February 29th,2024

JBMIA's Proposals on Currently Unavoidable Uses (CUUs) under Maine PFAS Law - 38 M.R.S. §1614

JBMIA Chemical Products Technical Committee

Japan Business Machine and Information System Industries Association (JBMIA) represents the global leading companies of business machines industry, and our main products are printers, copying machines, multifunction devices (MFDs), and their consumables, including toner.

JBMIA appreciates the opportunity to give our proposals on Currently Unavoidable Uses (CUUs)under Maine PFAS Law - 38 M.R.S. §1614.

1.Provide a brief description of the type of product including, if applicable, the Global Product Classification (GPC) brick category and code, or if GPC is not applicable than the Harmonized Tariff System (HTS) code.

Global Product Classification (GPC)
10001156 Printer Consumables
10001251 Photocopier Consumables

These are consumables for office machines, multifunctional devices(10005229), photocopiers(10001252) and printers(10001158).

2.Describe the intended use of the product and explain how it is essential for health, safety or the functioning of society.

Multifunction devices, copiers, and printers are devices for printing documents and images in offices and homes. Multifunction printers usually combine multiple functions into one device. Basic functions include printing, copying, and scanning. Some models may also include fax functionality. A printer is a device that is primarily used for printing, and is generally capable of only printing. All of these devices are used to meet a variety of printing needs for work, study, and personal use, and are essential infrastructure for society.

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3.Describe how the specific use of PFAS in the product is essential to the function of the product. If this use of PFAS is required by federal or state law or regulation, provide citations to that requirement.

Copiers and printers can print on paper by using consumables such as toner, ink, and developer (a mixture of toner and carrier). For example, the toner is composed of resin, wax, pigment, and other additives, and as part of these additives, PFAS (fluoropolymers, fluoroalkyl compounds with functional groups, etc.) are used for the reason that they can simultaneously provide various functions such as low dielectric constant, low dielectric tangent, low surface tension, water repellency, heat resistance, chemical resistance, and high negative charge. Under the copiers and printers of two-component development system, carrier is used for attaching the toner onto the photoconductor by electrostatic effect. PFAS (Fluoropolymers, polymers with fluoroalkyl groups in their side chains, etc.) are used as a component of some carriers to provide high negative charging and wear resistance. (See Attachment 1)

In the case of ink, it is necessary to add a dispersant having a surface-active function in order to disperse the pigment uniformly.

Especially for high-speed printing system of plain paper, PFAS is an essential ink component not only because of its surface-active function but also because of the uniformity of ink droplets and rapid fixing and drying. (See Attachment 2)

If the use of PFAS is effectively banned, they will not be able to produce consumables that use PFAS, and copiers and printers operating in the market which use consumables that use PFAS will not be able to use them.

Printers have already become an essential social infrastructure, and if PFAS is banned, a certain percentage of copiers and printers will immediately become unusable, affecting companies/government agencies/individuals.

4.Describe whether there are alternatives for this specific use of PFAS which are reasonably available.

PFAS replacement requires a review of the entire system configuration of copiers and printers, and it is necessary to develop both the main unit and consumables. At present, the outlook for the time frame and cost required for the current development is uncertain. In addition, if consumables for copiers and printers in the market use PFAS, it is not possible to replace only the consumables with alternatives that do not use PFAS. (See Attachment 3)

If PFAS is completely banned, a certain percentage of consumables for products cannot be supplied, and copiers and printers that can normally operate will quickly become waste before reaching the end of their lifespan, resulting in an increase in waste. Please exempt printer consumables and copier consumables from the sales ban as unavoidable uses.

5.Provide contact information for the submission.

Organization: Japan Business Machine Information System Industries Association (JBMIA)
Address: Lila - Hijirizaka, 3 - 4 - 10 Minato - ku, Tokyo 108 - 0073 Japan
TEL: +81 - 3 - 6809 - 5010 **FAX:**+81 - 3 - 3451 - 1770
Name: Kazuhito Oosumi, Director, Environmental Division, JBMIA
Function: Secretariat
E-Mail: oosumi.kazuhito@jbmia.or.jp

About JBMIA

Japan Business Machine and Information System Industries Association (JBMIA) is the industry organization which aims to contribute the development of the Japanese economy and the improvement of the office environment through the comprehensive development of the Japanese business machine and information system industries and rationalization thereof. The advancement of information technology has brought about sophistication of the age of digitalization and networking and resulted in significant changes in the office environment accordingly. In response to the shift of business emphasis from the hardware to total business solutions including products, JBMIA carries out active committee/group activities regarding important issues that the industries are confronting in and outside Japan by conducting investigations and researches regarding the policy proposals, international cooperation, prevention of warming, environment preservation, standardization, product safety, etc., by deepening the association with the sales and software-related companies, as well as the manufacturers.

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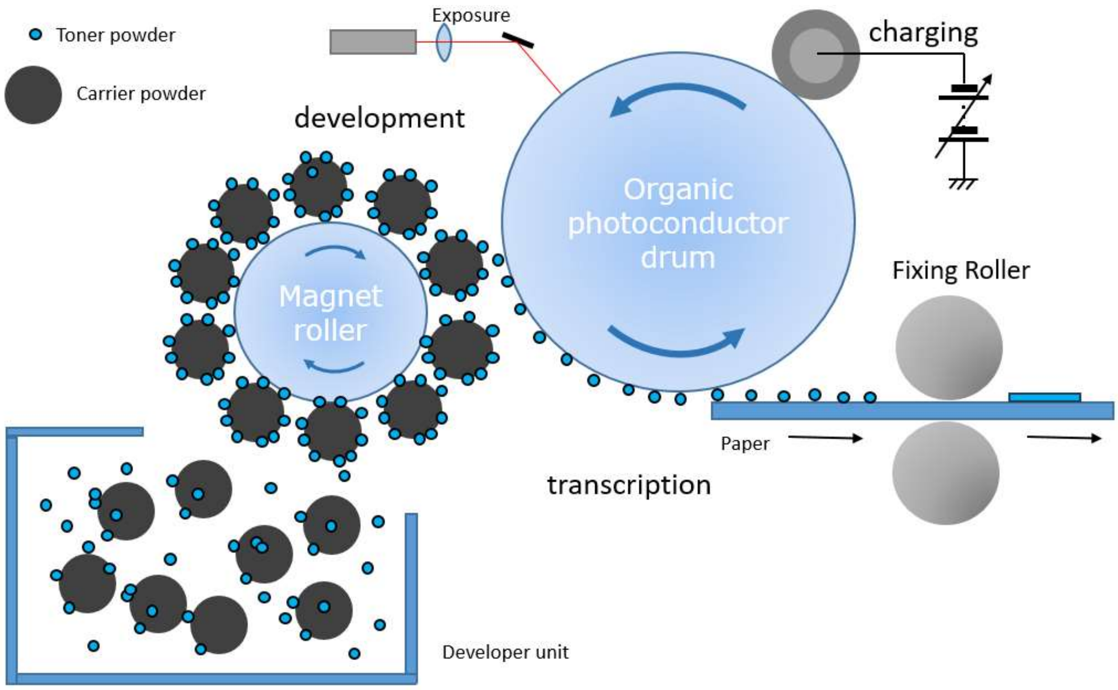
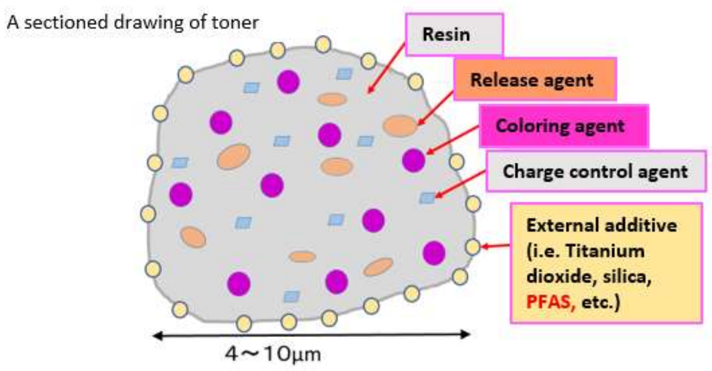
Description about Toner and Carrier

The electro photographic development system is a complex technology that works when there is a perfect balance with the carrier that feeds the toner to the photoconductor.

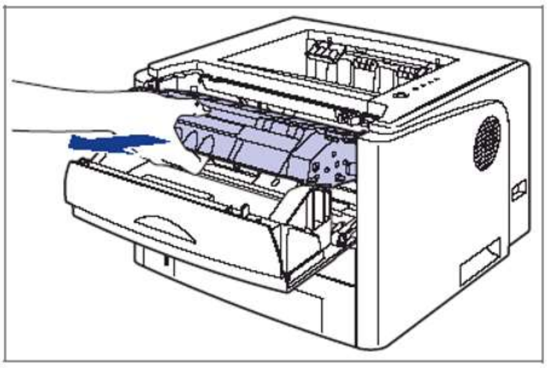
The toner and carrier are mixed and permanently agitated in the developer station to keep the toner particles with the precise electrical charge needed for their development process. This toner and carrier blend is named developer.



The toner is composed by a thermoplastic polymer of 5-10μm particle size, usually a polyester or a styrene-acrylic resin. About 10-20% of its composition are pigments, waxes, silica and other minor additives such as fluoropolymers.



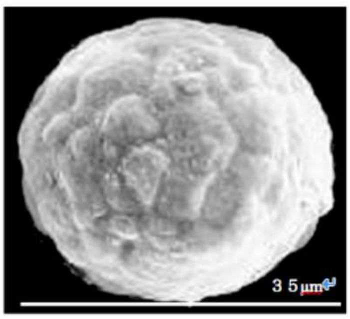
The toner is delivered to the consumer in a sealed condition in a toner cartridge. Plural kinds of toners of various combinations of constituent materials are used according to the equipment, and the capacity is also different according to the specifications of the equipment, and the shape is also different according to the mechanism of the equipment.
The warranty period of the product is usually around 10 years.
Therefore, we must continue supplying the toner cartridges as consumables to customers who have purchased copiers and printers for at least 10 years.



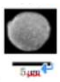
Toner cartridge

Toner bottle

The carrier are bigger particles, usually 40-100μm in average particle diameter, composed by an iron or a ferrite core, and a coating. The coating is usually a fluoropolymer, silicone, or styrene acrylate. Due to the mixing, there is friction between toner and carrier particles which give electrical charge to the toner particles.
we must continue supplying the carrier(developer) as a spare parts to customers who have purchased copiers and printers for at least 10 years.



Toner



Quoted from a certain carrier manufacturer

Description about roles, functions, and necessity of PFAS

By applying PFAS as either of a coating on the carrier particles or a toner surface additive, or by applying PFAS as both of them, friction between the toner and the carrier is reduced, and the toner is protected from degradation and the carrier particles are protected from contamination. As a result, a staggering number of the developer life were established, which could not have been achieved without the use of PFAS.

In addition, its electrical charging properties can contribute to such effects as improving initial charge rising property and ensuring the stable frictional charging to the toner particles during all the developer life.

Relation and Influence with the equipment

Toners including PFAS achieve an increased durability meanwhile printing.

This means that any part or component where there is friction between toner or printed paper and metal such as printer rollers, drums, blades, etc in the printer or in the post-processing equipment will be protected and achieve a longer life thanks to the use of PFAS.

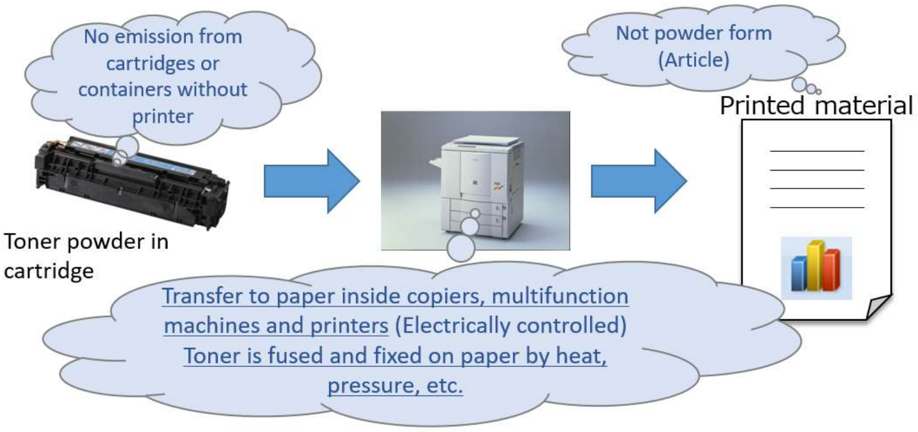
In small and medium size printers for home and office, the damage of unreplaceable components, means a shorter life-time of the printer and an increase of electronic waste generation. In case of large size and production printers, without the aid of PFAS, parts and components of rollers and post-processing units will need to be fixed or replaced earlier with the consequent effect of maintenance cost increase and productivity loss.

Further, the toner containing the PFAS improves initial charge rising property and charging stability. Due to that, effects such as making generation of the toner scattering not easily and making fogging generation not easily, can be obtained, thereby contributing to prevention of contamination in an equipment by scattering toner and stabilization of image quality.

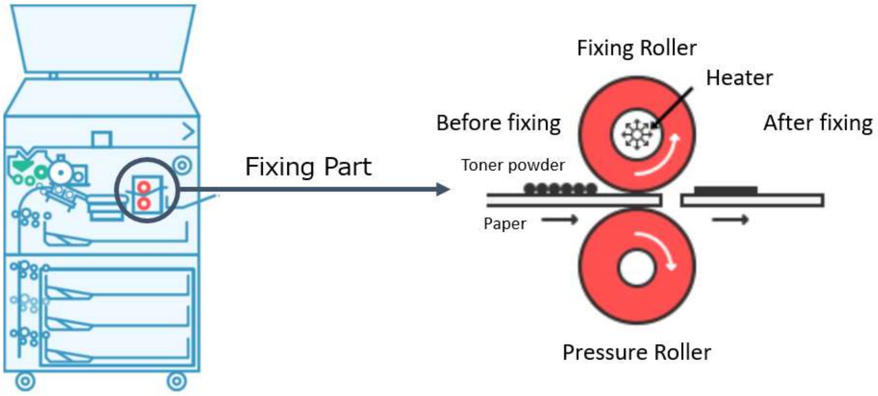
If there is no aid of PFAS, it may have negative effects, such as deterioration of the contamination in an equipment and destabilization of image quality, and it can be considered that the maintenance cost to cope with them will be increased and productivity will be decreased.

Possibility of exposure during use

- Machine design: Extremely low risk of exposure to toner under normal use condition



- Toner powder is melted and fixed into the paper during fixing process.
- The printed material is recognized as an "Article".



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Attachment 2

Ink used in inkjet printing system

The inkjet printing system has inkjet head devices to change ink into fine particles by applying pressure and heat, and ejecting these particles allows printing directly onto print media.

There are various types of ink (pigment ink, dye ink, solvent ink, and water-based ink etc.). The common requirements for these inks are same droplet size, high print density, quick fixing & drying, hard to fade, and hard to clog the inkjet head etc. The ink type is selected according to the application, but water-based pigment ink is preferred to make image less prone to fading and to reduce volatile organic solvents.

Usually, pigment never mix with water, therefore it is needed to add surfactant function. Besides, to achieve above requirements, the ink is mainly composed of pigment, water, dispersant (including surfactant function), resin for fixing, penetrant and organic solvent called wetting agent etc.

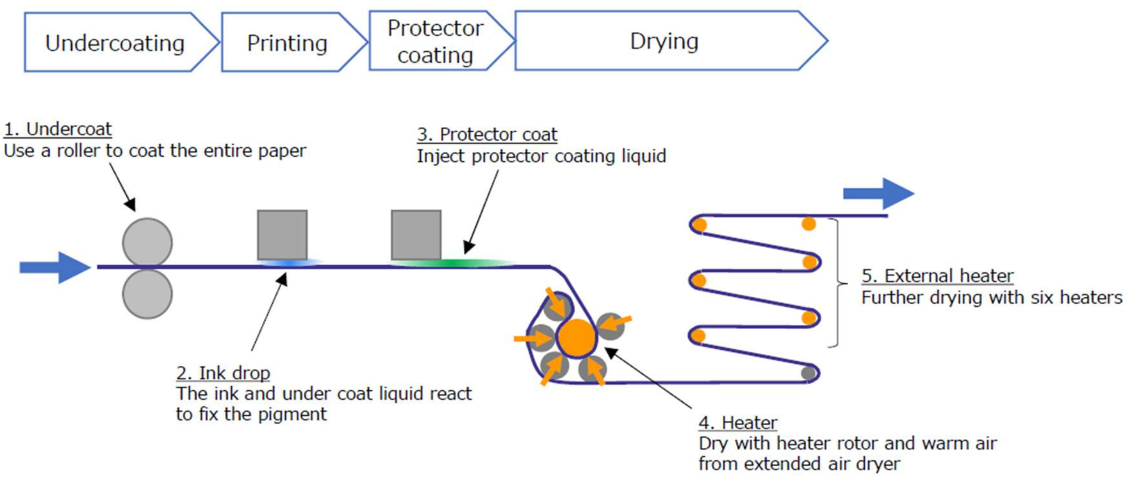

Fig.1 Inkjet system (PFAS contributes to quick fixing and drying.)

PFAS roles, functions, necessity etc.

As mentioned above, it is important to maintain a balance between hydrophobic and hydrophilic substances in the ink. If the balance is lost even a little, ink loses its function. PFAS does not have only surfactant function, excellent chemical resistance, heat resistance, but also maintains its balance for a very long time in usage and transportation environments. Moreover, due to its low surface tension properties compared to other surfactants, PFAS is particularly good at ejecting uniformly sized droplets at high speed, especially on plain paper. Also, PFAS is superior in fixing and drying due to its fast penetration into the print media, so high speed printing (150m/min) could not be realized without PFAS.

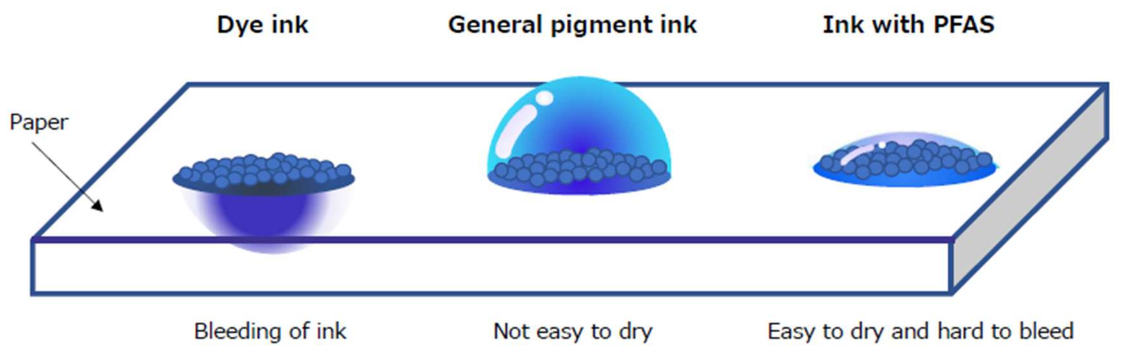

Fig.2 High quality ink droplets

(PFAS achieves both droplets uniformity and high-speed fixing & drying.)

Influence on the printer

PFAS prevents ink from adhering near inkjet head nozzles, so the maintenance period and the inkjet head life can be extended. It means less downtime and increased productivity. Without PFAS, parts need to be replaced soon and it leads increased maintenance cost and decreased productivity.

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Attachment 3

Need a huge time to phase-out PFAS used for printers EVEN IF the substitute material of PFAS is available in the future

The substitute materials instead of PFAS to fulfil for many of necessary functions required in printing process is not available yet.

Challenging issues to be addressed for substitution of PFAS

We expect that it will take a huge time to explore alternative materials to fulfil the superior properties of PFAS, even if we focus only on PFAS containing in toner itself.

Since toner closely interacts with various components and units in the whole printing processes, a change of toner materials will have a large influence on various mechanical components, electrical setting, sequential process and software and so on, which are mutually influence each other. As a result, all of them will need to be changed, so a long period will be necessary for research and development for alternative materials.

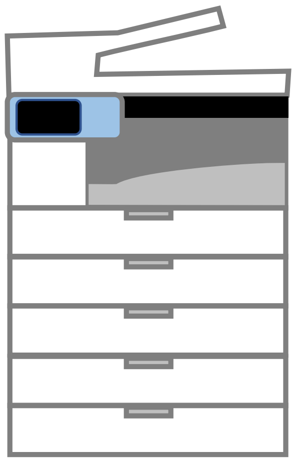
Please note that the above situation is the same as ink other than toner.

Material

Toner and carrier materials affect various behaviors.
In case of changing a material of toner or carrier, a various properties such as charging properties, fluidity and adhesion, etc. will be changed, but only certain property cannot be changed. It is quite possible that extending one property degrades another. In particular, since PFAS is a material that satisfies many excellent properties simultaneously, it is impracticable to substitute materials for the toner and carrier while maintaining the same properties.
In addition, when the material of the toner and the carrier is changed, the mechanical device, the electrical device, the sequence, etc. must be changed.

Mechanical devices

In case of the toner material changes, the behaviors between the toner and the various mechanical components are also changed. (For example, a change in sliding behavior, torque of a motor, etc.)
In addition, the size, angle, thickness, strength, and material of the component may have to be changed to satisfy the physical behavior.
Changing the toner requires adjusting them. Because they interact in complex ways, they cannot be changed independently, and a lot of time is needed to satisfy all conditions.



Software

The printer and copy processes and operations requires precise movement of various parts, components and units in conjunction with each other.
Each timing, elapsed time, voltage magnitude and application time, heater temperature and operation time, motor driving speed and time, etc. must be precisely controlled.
In case of changing a certain material in the toner, it is absolutely necessary to change all of these timings, operation times, intensities, and sequences.
They also affect each other, so it takes a lot of time to find a configuration change that meets all requirements.

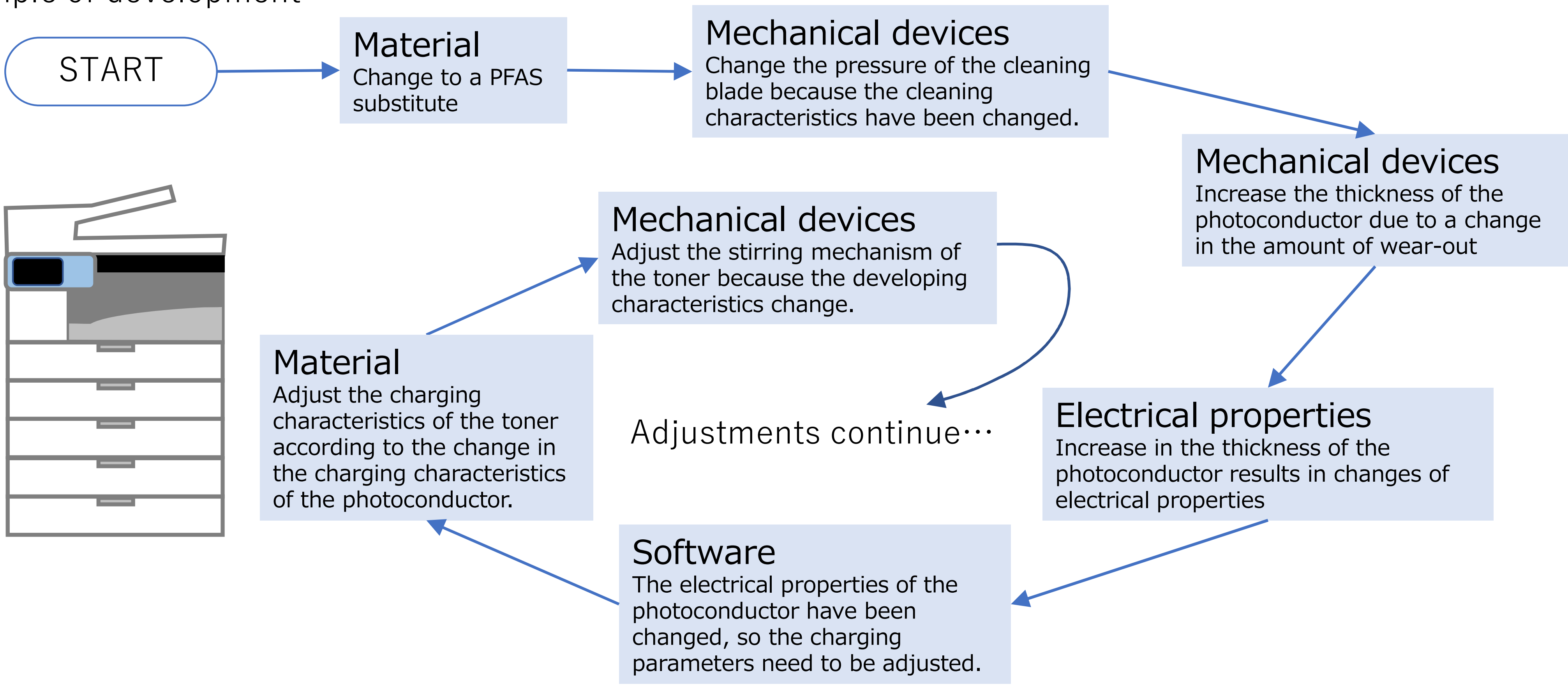
Electrical properties

In the printing and copying operations, the toner must adjust its electrical characteristics with a photoconductive drum or an intermediate transfer belt.
When the toner material is changed, the electrical settings must be changed too, but because various variables affect each other, it takes a lot of time to find an optimized setting change that meets all the performance requirements.

Challenging issues to be addressed for substitution of PFAS

The material change of a certain part will have an influence on many of various components and properties, which are mutually influence each other. As a result, all of them will need to be changed, so a long period will be necessary for research and development for alternative materials.

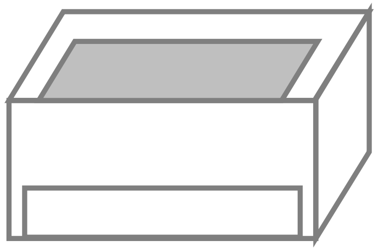
Example of development

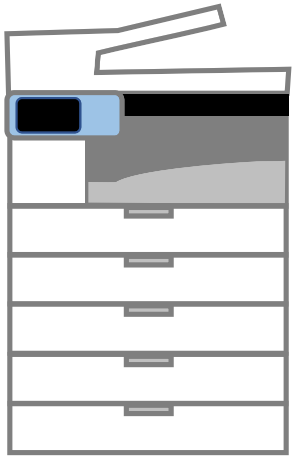


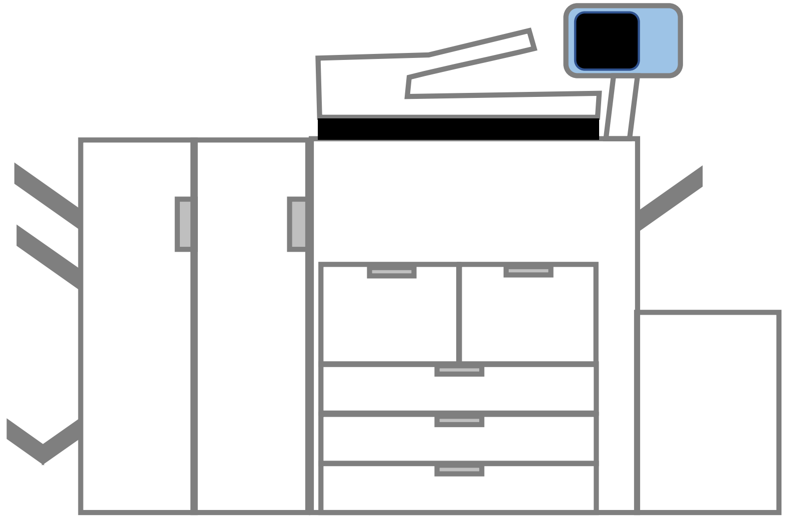
Can the development period of copiers and printers be shortened?

=> We believe that it will be Impracticable

Performance requirements for copiers and printers, quality requirements for printed and copied images, and durability vary by model.
Since there are few common development items in these developments, it is not easy to shorten the development period.
For substituting materials, it will take at least two or three years for equipment development, matching with toner and ink, and production preparation respectively, and multiplied by the number of models.





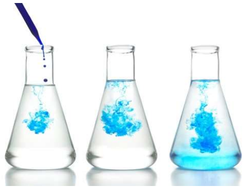


	Consumer model	Office model	High-performance/production model
Examples of performance required	・Maintenance Free ・Space-saving	・High productivity (speed) ・energy-saving property	・Printed image quality ・low running cost
Examples of Output	・Documents used at home	・Office documents	・Catalogs, publications, posters, etc.
Examples of print volume	・10～100 sheets/month	・500～5000 sheets/month	・more than 10000 sheets/month

Need a huge time to phase-out PFAS used for printers EVEN IF the substitute material of PFAS is available in the future,

The substitute materials instead of PFAS to fulfil for many of necessary functions required in printing process is not available yet.

*This page refers to toner as an example of consumables, but also ink.





exploration and development of materials

The substitute material for PFAS is currently not available for toner, so the joint research and development with materials manufacturers will be required.

・confidentiality agreement
・joint development agreement
・Testing of chemical substances and registration
・Screening test for basic characteristics
・Performance tests for material selection
・Adjustment work for improving characteristics
(Material shape, size, mixing ratio, etc.)

toner development

Development of toner & carrier takes time even after material determination

・Matching of new raw materials with other materials
・Adjustment of properties such as friction coefficient, dielectric constant, electrical resistance, fluidity, and thermoplastic properties
・Adjustment of charging characteristics in developing device
・Durability to maintain performance over long periods of time
・Maintaining characteristics under various environments such as high temperature and humidity

development of equipment & Matching

After the development of the toner & carrier, it is necessary to verify whether the functions are appropriately work in the copying and printing processes.

・Is it properly discharged from the container? Is it necessary to adjust the discharge mechanism?
・Is image development is appropriate? Is it necessary to change the agitation?
Is it necessary to adjust the nip width between the developer and the photoconductor?
・Is the toner remaining in the photoconductor properly cleaned? Is cleaner adjustment needed?

production preparation

It is necessary to verify that the quality of the product meets a various requirements as final product prior to production processes.
(For example, it is necessary to measure VOCs emitted from machines and inspect that they fall below the permissible value specified by environmental labels, etc.)

・If production processes and / or facilities need to be changed, it is necessary to develop an investment plan and to carry out modification of facility or construction.
・It is necessary to carry out equipment tests, etc. depending on modification of facility or construction. In some cases, it is necessary to undergo statutory inspections and occupational safety audits.

delivery

Some countries require customs clearance procedures, so it is necessary to do so in advance.

It may take several months to ship products by sea.

For a stable delivery of products, it is necessary to establich a supply system by multiple raw material manufacturers. It is quite important from the view point of the Business Continuous Plan.

3-4 years → 2-3years x models → 2-3years x models → Few months

The warranty period of the product is usually around 10 years. This means that after selling, the company must continue to provide spare parts for another 10 years.
In other words, **the development period of equipment and parts (7 to 10 years or more) plus the provision period of spare parts (10 years) is required** to complete the PFAS-free process.

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Junko Sudo Attachment

Comments on the *PFAS in Products Currently Unavoidable Use Rule*

February 2024

We welcome the opportunity to contribute public comments on the Minnesota Pollution Control Agency's (MPCA) rulemaking for the *PFAS in Products Currently Unavoidable Use Rule*, which will implement Minnesota Statute 116.943. We have prepared and organized our comments below based on the nine questions provided in MPCA's Request for Comments.[1]

1) Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Criteria should be defined. Doing so will promote transparency in currently unavoidable use (CUU) determinations. In addition, it will allow parties seeking such determinations to better understand the bases for such determinations and to provide information that will best inform the MPCA's determinations.

Defining the criteria for CUU determinations presents an opportunity to best protect the health, safety, and economic interests of Minnesota citizens. The statute at issue defines PFAS broadly (Minn. Stat. § 116.943(1)(p)), but not all of the PFAS included in that definition present the same risks to human health and the environment or provide the same irreplaceable value to society. As explained below, to reduce the risk that the statute's broad definition of PFAS will deprive Minnesotans of essential PFAS uses and the associated economic, health, and safety benefits those uses provide, the criteria should promote determinations based on the relative risks and benefits of the particular PFAS compound and use at issue.

The relative risks posed by different PFAS should be accounted for in the criteria. The Minnesota statute's broad definition of PFAS includes a wide variety of PFAS that present different risks to human health and the environment. As a result, the idea of a one-size-fits-all approach for all PFAS and all uses of PFAS is not appropriate. Risks should be quantitatively assessed on a substance-by-substance basis as well as a use-by-use basis.

The risk posed by the particular PFAS, and the particular use of the PFAS, at issue should inform the showing needed to demonstrate that a use is essential. Although PFAS

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[1] *See* https://www.pca.state.mn.us/sites/default/files/c-pfas-rule3-01.pdf (lasted accessed on Feb. 21, 2024).

presenting significant risks may require greater scrutiny in determining whether they are essential, PFAS presenting less risk should receive less scrutiny. Importantly, some of the PFAS included under the Minnesota statute's broad definition are also uniquely suited for uses important to the health, safety, or functioning of society. Such uses include those related to climate goals and green energy, critical infrastructure such as buildings and roads, public transportation, construction, healthcare, critical industry and economic drivers, and cultural traditions. Balancing the risks and benefits of a particular PFAS and its use – such that those posing less risk are more likely to be found essential – would allow Minnesota to best capture the benefits from PFAS uses important to the health, safety, or functioning of society while minimizing risk to Minnesota citizens.

For example, criteria should be adopted that ensure that fluoropolymers, and especially PVDF, are determined to be CUU. Of the thousands of different types of PFAS, there are only about 40 fluoropolymers, and fluoropolymers have fundamentally different physical properties from low molecular weight PFAS such as PFOS and PFOA. Unlike low molecular weight PFAS like PFOS and PFOA, fluoropolymers do not enter the metabolic system of the human body or bioaccumulate and, because they are insoluble in water and non-mobile, they do not leach into soil or water systems when landfilled. Scientific literature indicates that fluoropolymers have minimal impact to human health and the environment, and that 96% of the global fluoropolymer market meet the criteria for Polymers of Low Concern (PLC).[2]

In addition, fluoropolymers have numerous uses critical to health, safety, and the functioning of society. For example, the unique properties of PVDF have led to its essential use in binders and adhesive tapes for lithium-ion batteries, including those for EVs (electric vehicles), various components in the semiconductor industry (pure water piping, chemical piping, etc.), medical applications (pure water piping, chemical pump components, cleaning tank lining, etc.), piezoelectric and pressure sensors (bridges, roads, etc.), piezoelectric speakers, ultrasonic probes, touch panels for smartphones and tablets, coating films (walls, floors, vehicles, etc.), fishing line, and musical instrument strings. These uses of PVDF play an essential, and irreplaceable, role in society. Further, all of these uses take advantage of

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[2] B J Henry et al, 'A Critical Review of the Application of Polymer of Low Concern and Regulatory Criteria to Fluoropolymers.' *Integrated Environmental Assessment and Management* **2018**, 14 3, 316–334; S H Korzeniowski et al, 'Critical Review of the Application of Polymer of Low Concern Regulatory Criteria to Fluoropolymers II: Fluoroplastics and Fluoroelastomers.' *Integrated Environmental Assessment and Management* ***2022***, 326-354.

the unique properties of PVDF, and there is no alternative material that combines all of these properties.

As such, these uses of PVDF fall squarely within the definition of CUU in the Minnesota statute, as "essential for health, safety, or the functioning of society and for which alternatives are not reasonably available" (Minn. Stat. § 116.943(1)(j)). At the very least, clear criteria should be adopted to ensure the uses of PVDF outlined above are determined to be CUU.

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

The costs of potential PFAS alternatives should be considered in any definition of "reasonably available." A cost-prohibitive alternative may have the practical effect of depriving society of a PFAS use that would otherwise be found essential for health, safety, or the functioning of society.

Costs for alternatives would include the economic cost of production – such as the cost of raw materials, and the time and cost to transition manufacturing processes and to market the alternative – as well as the potential resulting social costs. For example, cost-prohibitive alternatives may lead companies to stop manufacturing certain essential products, to raise the prices of those essential products, or to replace products with poorly functioning alternative products.

The cost threshold for determining whether a particular alternative is "reasonably available" will depend on a number of considerations. In addition to accounting for the relative risks and benefits of the particular PFAS and use at issue, the economic incentives created by and socio-economic impacts of a particular alternative should be considered.

3) Should unique considerations be made for small businesses with regards to economic feasibility?

Economic feasibility for Small and Midsized Enterprises (SMEs) should be considered. In comparison to larger businesses, SMEs often have fewer financial and human resources. As such, economic feasibility for SMEs may have a significant impact on the availability of certain essential products. For example, if SMEs can no longer afford to manufacture an essential product, that product may no longer be available or that product's price may rise due to reduced price competition in the market for that product. In addition to considering these SME-specific economic issues, MPCA should examine options to ameliorate SME-specific economic impacts, such as establishing a grace period for compliance by SMEs.

4) What criteria should be used to determine the safety of potential PFAS alternatives?

Criteria should be developed for determining the safety of PFAS alternatives. Such criteria should account for the relative risks and benefits of the particular PFAS compounds being replaced in comparison to the risk posed to human health and the environment over the alternative compound's life cycle.

For example, as explained in the response to Question 1, scientific literature indicates that fluoropolymers (such as PVDF) have minimal impact to human health and the environment and that the vast majority of fluoropolymers meet the criteria for PLC; and fluoropolymers have numerous uses critical to health, safety, and the functioning of society. In addition, fluoropolymers are chemically stable, insoluble in water, and have a long useful life. Indeed, based on recent studies evaluating available data from 2020, it is anticipated that less than 0.01% by weight of fluoropolymers entered relevant waste streams in Europe, which is significantly lower than the 4.8% estimated for other plastics.[3]. Replacing fluoropolymers with other plastics would thus likely result in increased plastic waste.

Accordingly, criteria should be adopted to analyze the safety risks and benefits to human health and the environment of PFAS alternatives, and such criteria should ensure that uses such as those identified for PVDF in response to Question 1 are determined to be CUU.

5) How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

The duration of a CUU determination should not be set uniformly. Each CUU determination should be different, as it should be based upon the relative risks and benefits of the particular PFAS and the particular use at issue, as well as the economic and social costs of any reasonably available alternatives. In addition, the time and cost required to

[3] J Sales et al, 'Fluoropolymers: The Safe Science That Society Needs.' International Chemical Regulatory and Law Review 2022, 5 (1), 13-23.

develop and market alternative products will differ. The duration of a CUU determination should account for such time periods, so as not incentivize companies to rush inadequate alternatives to market before a CUU determination expires.

Although a significant change in the available information about reasonably available alternatives may warrant re-evaluation of a CUU, standards should be set for what qualifies as a significant change. Otherwise, there is a risk that the burdens and costs imposed by the regulatory process itself will make production and sale of products recognized as CUU – namely, products recognized as essential and without reasonably available alternatives – economically infeasible. For example, for the reasons provided above, the uses of PVDF described in response to Question 1 should be determined to be CUU, and the burden of the regulatory process should not deprive Minnesotans of those critical uses.

6) How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

If there are PFAS uses that stakeholders believe should or should not be determined a CUU, they should be given the opportunity to provide reliable evidence supporting their position. Quantitative evidence of the relative risks and benefits of the particular PFAS and use at issue, as well as the economic and social costs of any reasonably available alternatives, should be required. Any evidence should be subject to rigorous scrutiny to determine its reliability.

7) In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

For the reasons provided above, the uses of PVDF described in response to Question 1 should be determined to be CUU. The author currently intends to submit requests that certain uses of PVDF be determined CUU.

8) Should MPCA make some initial currently unavoidable use determinations as part of this

rulemaking using the proposed criteria?

For the reasons provided above, the uses of PVDF described in response to Question 1 should be determined to be CUU.

9) Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

The statute at issue defines PFAS broadly (Minn. Stat. § 116.943(1)(p)), but not all of the PFAS compounds included in that definition present the same risks to human health and the environment or provide the same irreplaceable value to society. In defining the criteria for CUU determinations, the MPCA has an opportunity to reduce the risk that the statute's broad definition of PFAS will deprive Minnesotans of essential PFAS uses and the associated economic, health, and safety benefits those uses provide.

RECEIVED
By: OAH on 2/29/2024

 Masatoshi Tsuruoka Attachment 1

The comment to PFAS in Products: Currently Unavoidable Uses (CUUs)

February 29, 2024

We, NIPPON ELECTRIC CONTROL EQUIPMENT INDUSTRIES ASSOCIATION (NECA), would like to express the gratitude of having the opportunity of stating our opinion to PFAS in Products: Currently Unavoidable Uses (CUUs)

Submission Requirements

1. *Provide a brief description of the type of product including, if applicable, the Global Product Classification (GPC) brick category and code, or if GPC is not applicable than the Harmonized Tariff System (HTS) code.*

0.1.1 About NECA

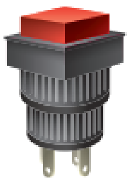
NIPPON ELECTRIC CONTROL EQUIPMENT INDUSTRIES ASSOCIATION (NECA) was established in 1964 and promoting the growth of the electric control equipment fields such as Relays, Switches, Sensors, PLC/FA System Equipment and others, Safety Control Equipment. Our website provides further information on our recent news and activities: https://www.neca.or.jp/en/

0.1.2 Product of NECA

<Relays>

Relays use electrical signals to open or close contacts, and consist of electric coils and contacts.
Variations include solid-state non-contact relays and relays incorporating timers and counters that provide measurement functionalities.

<Switches>



Switches allow users to directly power on and off system and equipment by hand, finger or foot by opening and closing the contacts to toggle electrical signals. These switches act as an interface between human and machine, allowing the user to take control such as starting up an operation.

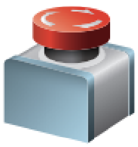
<Sensors>

Sensors that toggle electrical signals or generate an output, by physical contact or non-physical contact based on changes in light or magnetism to detect the presence of an object, its location, color, temperature, or rotational angle.

<PLC/FA System Equipment>

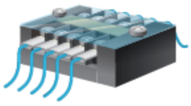
Programmable logic controllers, programmable display equipment, and FA (Factory Automation) system equipment such as ID systems, image processing systems, and temperature control devices that perform control and monitoring functions based on pre-programmed settings.

<Safety Control Equipment>



Emergency stop device, safety light curtains, safety relay, safety PLC, are control devices and I/O devices that conform to safety standards, designed for use in control circuits that ensure compliance with safety regulations for equipment and facilities.

<Other Control Equipment>



Equipment for transmitting electrical signals such as connectors and terminal, display and monitoring equipment such as revolving beacon and panel meters, and other control equipment such as power supply and solenoids for control functions.

<Parts and products in NECA are assembled into other products or system in variety types of business field such as shown below>

Classification	Example
Social infrastructure	Traffic monitoring and control including train and high speed motorway, automated teller machine, automated distribution system, automated ticket gate, analytical instrument, measurement instrument, tele communication, building management system, etc
Industry automation,	Robot for the automation, automated inspection

Process automation, Factory automation	instrument for something such as PCB, (Printed Circuit Board), equipment and protective system intended for use in potentially explosive atmosphere, monitoring and control instrument for the automation etc
Semiconductor manufacturing	To be made input from the business sectors The impact of potential PFAS restriction on the semiconductor section by SIA PFAS consortium is better to understand the examples. (*1)
Automotive vehicle	To be made input from the business sectors
Medical equipment	To be made input from the business sectors

(*1) https://www.semiconductors.org/wp-content/uploads/2023/04/Impact-of-a-Potential-PFAS-Restriction-on-the-Semiconductor-Sector-04_14_2023.pdf

Please see an attached file for HTS codes.

2. *Describe the intended use of the product and explain how it is essential for health, safety or the functioning of society.*

2.1. Features of our products

Our parts and products are assembled into highly specialized instruments used in laboratories, specialized institutions, and industrial sites. Therefore, the user must undergo special training and education in order to use it safely and correctly. In this opinion we will refer to our product as "EEE specialist equipment" to distinguish it from general consumer products.

2.2. Critical for social infrastructure

We would like to emphasize strongly that EEE specialist equipment we manufacture plays a very important role in the social infrastructure. Below are some examples. We believe that you can understand that the nature is different from the product of "nice to have".

<Case-1: Measuring and Control Instruments for Factory and Process Automation >

Measuring and Control Instruments for Factory and Process Automation are a product group for automating the operation of facilities and equipment in factories and infrastructure.

These products are indispensable for the production of all kinds of products that support people's lives and the economy, from raw materials industries such as petroleum and petrochemical products, iron and steel, and paper, to processing and assembling industries such as automobiles, electrical and electronic equipment, to food manufacturing industries such as beverages, and to pharmaceutical and medical equipment manufacturing industries.

It is also widely used as an important facility for the safe and uninterrupted supply of infrastructure such as electricity, gas, water and sewage.

In today's factories and infrastructure, these devices enable efficient and environmentally friendly facility operations and risk management measures, and provide safe and stable living environments for people.

However, parts containing PFAS are used in many Measuring and Control Instruments for Factory and Process Automation.

With the exception of electronic components, these devices have many parts that come into contact with products such as gas, water, and petroleum products and materials necessary for their production (including harmful chemical substances). They are used in a variety of environments, and therefore require high performance, such as, heat resistance, weatherability, chemical resistance, repellency from water and oils, electric insulation, and low friction.

PFAS is the only chemical substance that satisfies all of these requirements, and it is an indispensable material for long-term stable operation of factories and infrastructure.

If the use of PFAS is prohibited, Measuring and Control Instruments for Factory and Process Automation cannot be used within the US and the Maine state, and infrastructure and economically important products will not be supplied.

This will have a major impact on society and the economy.

2.3. Low volume of production, long-life, long supply chain

Our parts and products are assembled into the EEE specialist equipment. It is made in small numbers, is produced for long periods without modification or changes, and is a long-life product. The instruments would have been replaced typically after 7-10 years or more from the release of the products.[1] The supply chains are very long and take time to eliminate restricted substances from the supply chain. The data sources are

[1] Dr Paul Goodman, *Review of Directive 2002/95/EC (RoHS) Categories 8 and 9 – Final Report*, ERA Technology, 2006 Page 27-34
https://ec.europa.eu/environment/pdf/waste/weee/era_study_final_report.pdf

from the European Union; however, EEE used for social infrastructure accounts for small percentage. We believe that the other area around the world , more or less, the status is similar with this.

Characteristic	Test equipment	Mobile phone
Typical numbers sold	350	5.5 million
% of pre- 2003 products on market in 2006	>80%	<1%
Number of current distinct models per manufacturer	1600	300
Number of engineers available for each product	1.9	61.6
Time between launch of one product and its replacement	7 years on average	~ 6 months
Custom made parts	~25%	<5%
Time required for reliability testing (average per model)	4.3	0.7
Authorisations	Up to 2 years	< 6 months

Data from the Test and Measurement Coalition.

Table 1 Table comparison of industrial test equipment with mobile phones[2]

Table 5-4 Amount of EEE (tons) put on the EU market, per year and product category, “Support for the Evaluation of Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment Final Report” shows the percentage of category 8 and 9 products is only 3.5 of all amount of electric and electronic equipment(EEE) (tons) put on the EU market (see the below).[3] EEE used for social infrastructure accounts for small percentage. The statistics is from the European Union. We believe that the other area around the world, more or less, the status is similar with that of the EU.

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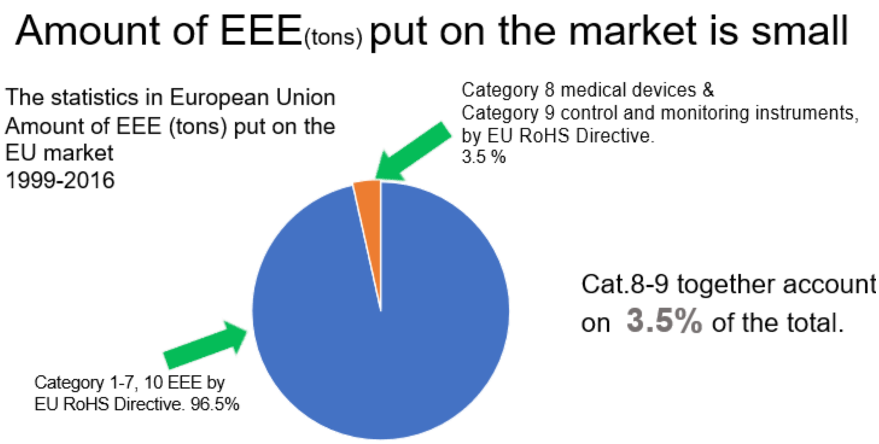
[2] Dr Paul Goodman, Review of Directive 2002/95/EC (RoHS) Categories 8 and 9 – Final Report, ERA Technology, 2006 Page 34 Table 2
https://ec.europa.eu/environment/pdf/waste/weee/era_study_final_report.pdf

[3] Table 5-4 Amount of EEE (tons) put on the EU market, per year and product category, Support for the Evaluation of Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment Final Report, p.147
https://op.europa.eu/en/publication-detail/-/publication/5b807311-9d93-11eb-b85c-01aa75ed71a1/language-en



The picture is produced from Table 5-4 Amount of EEE (tons) put on the EU market, per year and product category, Support for the Evaluation of Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment Final Report, p.147 https://op.europa.eu/en/publication-detail/-/publication/5b807311-9d93-11eb-b85c-01aa75ed71a1/language-en

2.4. Spare (Repair/Replacement) parts are necessary

Spare parts are necessary to guarantee the expected lifetime (more than 20 years) of EEE specialist equipment. Especially since EEE specialist equipment requires high performance and high reliability, we would like to emphasize that the same spare parts are required throughout the life of the product as when it was first evaluated. Without spare parts, waste minimization according to the principles of “Right to repair” and “Repair as produced” cannot be achieved.

2.5. Long development cycle

Our customers are required to be highly reliable because they are manufactured for a long period of time without modification. Along with this, long-term reliability tests are required. If there is a certification request, a longer period is required to obtain it. As a result, development cycles are longer compared to other consumer products.

An example of development process is below:

- Searching of parts and materials: 1-2 years
- Reliability test: performance test of the product: 1-2 years
- Device design: 0.5-1 year
- Develop the production line /buy new production equipment: 1-2 years
- Create Technical Documentation: 0.5 year
- Training at the production site: a few months
- Production management (information to customers): 0.5-1 year
- Third-party certification: 1 year without clinical trial

a few years or more with clinical trial or customer approvals

3. *Describe how the specific use of PFAS in the product is essential to the function of the product. If this use of PFAS is required by federal or state law or regulation, provide citations to that requirement*.

   Please see an attached file.

   Hydrofluorocarbons (HFCs) phase down has been tackled by US EPA. The restriction should be aligned among Marine state and the rules of US EPA.
   Reference materials and substances used in scientific research and development are necessary for the analysis of PFAS. Without these, precise analysis is not possible. Therefore, reference materials for its analysis should be excluded from the scope.

4. *Describe whether there are alternatives for this specific use of PFAS which are reasonably available.*

   Please see an attached file.

5. Provide contact information for the submission.

Contact: Masatoshi Tsuruoka
Organization: NIPPON ELECTRIC CONTROL EQUIPMENT INDUSTRIES ASSOCIATION (NECA)
E-mail: m_tsuruoka@neca.jp
URL: https://www.neca.or.jp/en/

RECEIVED
By: OAH on 2/29/2024

Masatoshi Tsuruoka Attachment 2

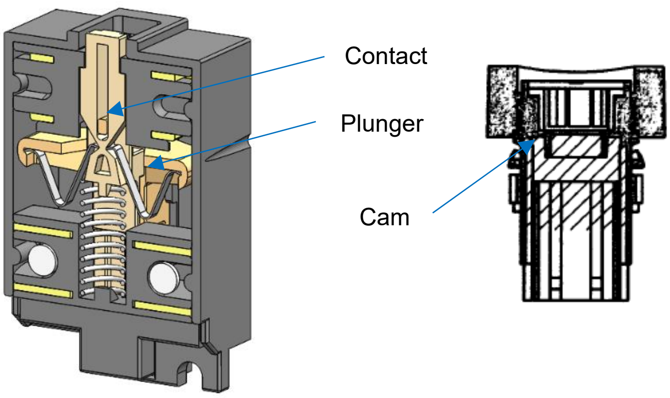
Currently Unavoidable Use

NIPPON ELECTRIC CONTROL EQUIPMENT INDUSTRIES ASSOCIATION (NECA)

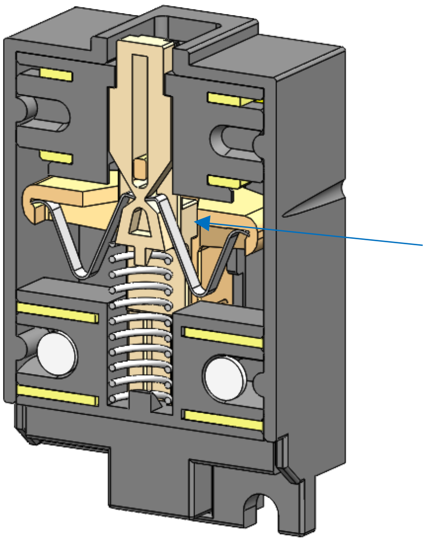
29. February 2024

Currently Unavoidable Use

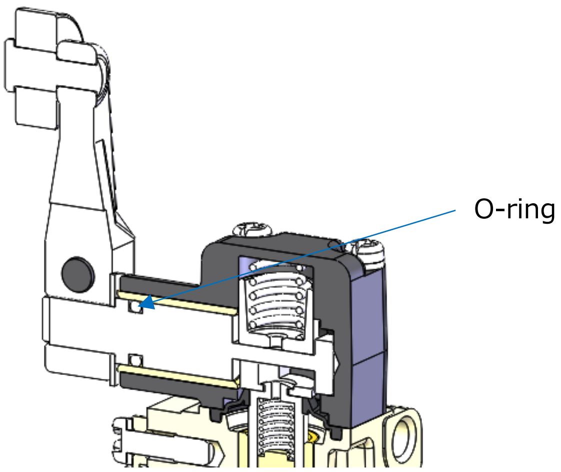
1. Safety switches

Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors
Application/ HTS code	Emergency stop pushbutton switch / 8535.**, 8536.** (excluding .10), 8531.**, 8538.90. Safety switches / 8535.**, 8536.** (excluding .10), 8531.**, 8538.90. Safety limit switches / 8535.**, 8536.** (excluding .10)
CAS RN	9002-84-0, 69991-67-9, 60164-51-4, 1623-05-8, 25038-02-2 and more
Regulated candidate substance name	PTFE [Poly(tetrafluoroethylene)] PFPE [Perfluoropolyether]
Generic name for the final product	Same as above application
Common name for application parts	Plunger, Cam, Contact
Detailed application description	1. Sliding parts of internal switch 2. Contact coating 
Technical Description of Essential Uses	Switches require mechanical durability and high reliability, so the sliding parts are coated with a fluorine-based lubricant to reduce frictional resistance. And it is used in coatings to protect contacts from dirt, reduce frictional resistance, and maintain high reliability. The technically difficult points of substitution are as follows. ・ Abrasion powder is generated when resin/metal parts mechanically slide. Adhesion of abrasion powder to the contacts reduces the reliability of the contacts. ・ Decrease in stability of Switch operation due to increased friction of sliding parts.

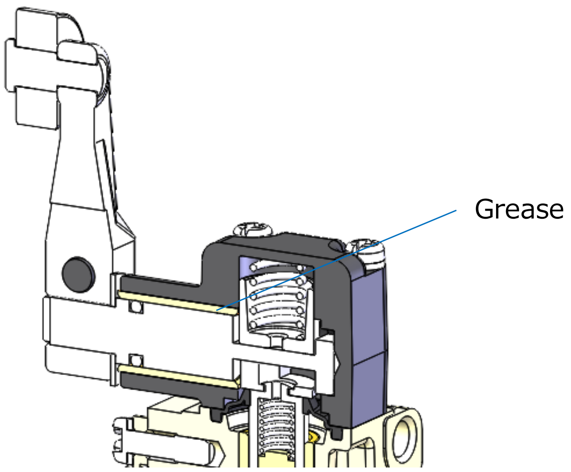
2. Safety switches / Microswitch / Limit switch

Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Push-button switch / 8535.**, 8536.** (excluding .10), 8531.**, 8538.90. Microswitch / 8535.**, 8536.** (excluding .10) Limit switch / 8535.**, 8536.** (excluding .10)
CAS RN	1-Propene, 1,1,2,3,3,3-hexafluoro-, oxidized, polymd. 69991-67-9
Regulated candidate substance name	PFPE (Perfluoropolyether)
Generic name for the final product	Same as above application
Common name for application parts	Plunger
Detailed application description	Sliding parts of internal switch 
Technical Description of Essential Uses	Switches require mechanical durability and high reliability, so the sliding parts are coated with a fluorine-based lubricant to reduce frictional resistance. The technically difficult points of substitution are as follows. ・ Abrasion powder is generated when resin/metal parts mechanically slide. Adhesion of abrasion powder to the contacts reduces the reliability of the contacts. ・ Decrease in stability of Switch operation due to increased friction of sliding parts.

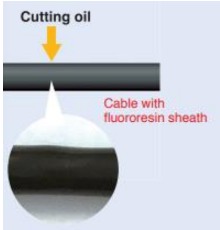
3. Safety switches

Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Emergency stop pushbutton switch / 8535.**, 8536.** (excluding .10) Safety switches / 8535.**, 8536.** (excluding .10) Safety limit switches / 8535.**, 8536.** (excluding .10)
Application	Safety switches
CAS RN	9011-17-0
Regulated candidate substance name	FKM [1,1-Difluorethylene-hexafluorpropene polymer]
Generic name for the final product	Same as above application
Common name for application parts	O-ring
Detailed application description	< Sliding / Seal parts of internal switches > 
Technical Description of Essential Uses	Switches use rubber parts such as O-rings to ensure a protective structure. The technically difficult points of substitution are as follows. ・ High oil resistance and chemical resistance are required. ・ Harmful outgassing must not occur at the contact.

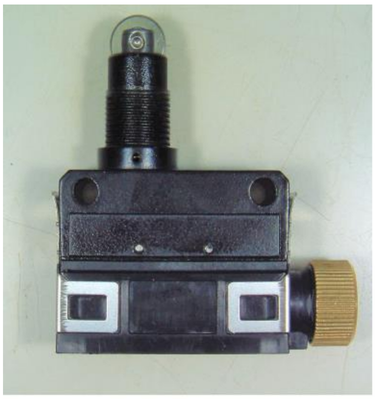
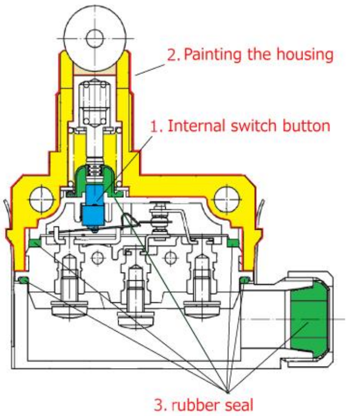
4. Push-button switch / Microswitch / Limit switch

Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Push-button switch / 8535.**, 8536.** (excluding .10) Microswitch / 8535.**, 8536.** (excluding .10) Limit switch / 8535.**, 8536.** (excluding .10)
CAS RN	9002-84-0 Polymer of 1,1,2,2-tetrafluoroethene 9002-83-9 Ethene, 1-chloro-1,2,2-trifluoro-, homopolymer 163702-08-7 Methyl perfluorobuthyl ether 69991-61-3 Ethene, 1,1,2,2-tetrafluoro-, oxidized, polymd.
Regulated candidate substance name	Fluorine grease / PAO grease / Fluororesin
Generic name for the final product	Same as above application
Common name for application parts	Fluorine grease / PAO grease / Fluororesin
Detailed application description	Used for the sliding part inside the switch 
Technical Description of Essential Uses	In order to ensure high durability, the switch applies grease to the sliding parts of the parts. Resin parts with excellent slidability are sometimes used. The technically difficult points of substitution are as follows. ・ If grease is not applied, parts will be seized and high durability cannot be achieved. ・ High heat resistance and chemical resistance are required depending on the usage environment of the customer. ・ Harmful outgas must not be generated at the contact.

5. Push-button switch / Microswitch / Limit switch

Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Push-button switch / 8535.**, 8536.** (excluding .10) Microswitch / 8535.**, 8536.** (excluding .10) Limit switch / 8535.**, 8536.** (excluding .10)
CAS RN	<THV> 116-14-3 Ethene, tetrafluoro- 25067-11-2 Polymer of 1,1,2,3,3,3-hexafluoroprop-1-ene / 1,1,2,2-tetrafluoroethene 25190-89-0 1-Propene, 1,1,2,3,3,3-hexafluoro-, polymer with 1,1-difluoroethene and 1,1,2,2-tetrafluoroethene < O-ring > 9011-17-0 1,1-Difluorethylene-hexafluorpropene polymer
Regulated candidate substance name	[Cable] THV [O-ring] FKM fluorine rubber
Generic name for the final product	Same as above application
Common name for application parts	Cable / O-ring
Detailed application description	1. Used for the cable of Switch 2. Used for the O-ring of Seal parts << Schematic Cross-sectional View >> Cable  1) Cable Fluororesin, which is less likely to be deteriorated by either 7-insoluble or water-soluble cutting oils, is used for the cable sheath. This prevents penetration of cutting oils into the cable. 2) O-ring HNBR+ fluorine rubber kneading, which is less likely to be deteriorated by either water-insoluble or water-soluble cutting oils, is used for the O-ring. This prevents penetration of cutting oils into the connector. In addition, fluorine coating on the O-ring improves assembly and slidability.

6. Limit switch

<table>
<tr><th colspan="2">Essential Application</th></tr>
<tr><td>Main use sector</td><td>Metal plating and manufacture of metal products
Electronics and semiconductors etc.</td></tr>
<tr><td>Application/
HTS code</td><td>Limit switch / 8535.**, 8536.** (excluding .10)</td></tr>
<tr><td>CAS RN</td><td>9002-84-0
75-38-7</td></tr>
<tr><td>Regulated candidate substance name</td><td>Polymeric PFAS /
PTFE, FKM</td></tr>
<tr><td>Generic name for the final product</td><td>Limit switch</td></tr>
<tr><td>Common name for application parts</td><td>Internal switch button (PTFE)
Painting the housing (PTFE)
Rubber seal (FKM)</td></tr>
<tr><td>Detailed application description</td><td>1. Internal switch button
2. Painting the housing
3. Used for each rubber seal of limit switch
 
</td></tr>
<tr><td>Technical Description of Essential Uses</td><td>Although the exterior coating can be changed to other coatings, fluorine is the lowest and most suitable for internal sliding properties.
Sliding : plunger and housing
Sliding: internal switch button and internal switch cover
Addition of fluorine improves slidability.
<table>
<tr><td rowspan="2"></td><td>Fluoropolymer</td><td colspan="2">Resin</td></tr>
<tr><td>PTFE</td><td>PE</td><td>POM</td></tr>
<tr><td>Dynamic friction coefficient (ud)</td><td>0.09</td><td>0.13</td><td>0.18</td></tr>
<tr><td>Heat-resistant(°C)</td><td>260</td><td>70-110</td><td>80-120</td></tr>
</table>
The retention of seals at high temperatures is superior to other rubbers.</td></tr>
</table>

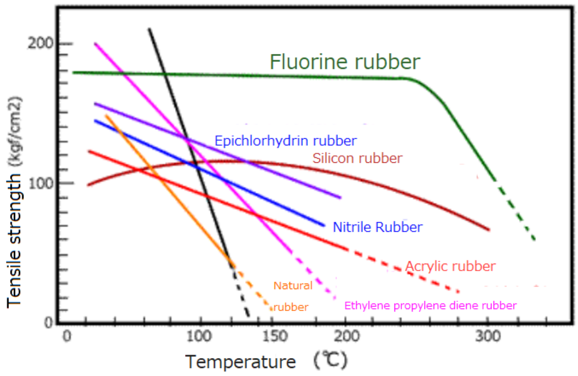
<table>
<tr><td></td><td>


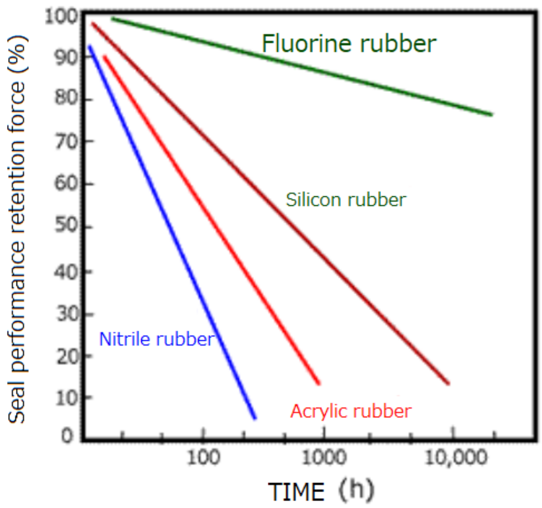
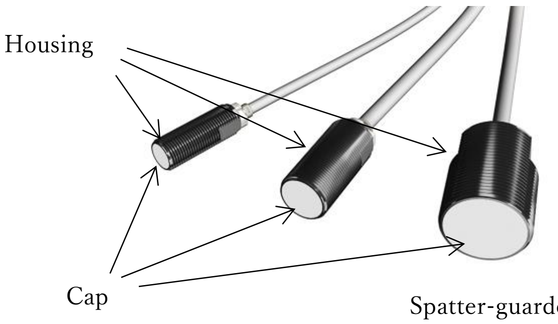
Figure: Heat resistance of various rubbers (after aging for 24 hours at each temperature)


Figure: Seal performance retention of various rubbers (%) at 150°C

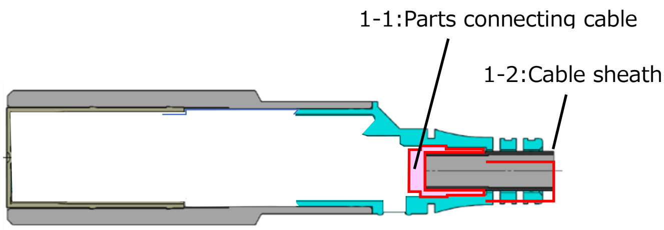
Refer: https://www.packing.co.jp/GOMU/GOMU1/fkm.htm

Switching to silicone rubber is difficult to adopt because of the risk of contact failure.
In addition, it is often used for applications such as cutting fluid that damage silicon rubber, so it cannot be used.
</td></tr>
<tr><td>Sliding performance</td><td>Wear resistance due to sliding, sliding performance.</td></tr>
<tr><td>chemical resistance</td><td>Resistance to water-soluble coolants (basic) used in machine tools and automotive parts processing lines</td></tr>
<tr><td>Heat-resistant</td><td>Heat resistance that can withstand continuous use in a 120°C environment</td></tr>
<tr><td>Seal retention performance at high temperature</td><td>The ability to maintain the seal under the conditions of 120°C</td></tr>
<tr><td>Required derogation period</td><td>13.5 years or more</td></tr>
<tr><td>Socio-economic impact</td><td>Shorter operational lifetime.
Increased frequency and costs of maintenance.
Increased operational downtimes.</td></tr>
</table>

7. Proximity switch

Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Proximity switch / 8536.50.70.00
CAS RN	Unidentified
Regulated candidate substance name	Fluororesin PFA Fluororesin coating
Generic name for the final product	Spatter-guarded proximity switch
Common name for application parts	Cap Housing
Detailed application description	Part of the housing of the spatter-guarded proximity switch used in a welding environment. Cap : Fluororesin PFA sensing surface Housing : Coated with fluororesin.  Spatter-guarded proximity switch
Technical Description of Essential Uses	The following features can be obtained by using Fluororesin. Cap : It can withstand the heat of welding spatter. By making spatter less likely to adhere, reducing malfunctions and improving maintainability Housing : It is difficult for spatter to stick.
Heat-resistant	Heat resistant temperature: about 260°C
No-adhesion	Prevention of adhesion of welding spatter
Required derogation period	13.5 years or more
Socio-economic impact	Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes.

8. Proximity switch

Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Proximity sensor / 8536.50.70.00
CAS RN	9002-84-0, 26655-00-5, 25190-89-0, 116-14-3
Regulated candidate substance name	• Polymer of 1,1,2,2-tetrafluoroethene • Polymer of 1,1,1,2,2,3,3-heptafluoro-3 -[(1,2,2-trifluorovinyl)oxy]propane / 1,1,2,2-tetrafluoroethene • 1-Propene, 1,1,2,3,3,3-hexafluoro-, polymer with 1, difluoroethane and 1,1,2,2-tetrafluoroethene • Ethene, tetrafluoro-
Generic name for the final product	Same as above application
Common name for application parts	As its usage differs by product series of Proximity Sensors, categorized into 1 to 3. (1) Oil resistance 1-1 : Parts connecting cable, 1-2 : Cable sheath (2) Spatter resistance 2-1 : Cap, 2-2 : Case, 2-3 : Clamping nuts (3) Chemical resistance 3-1 : Case, 3-2 : Cable clamp, 3-3 : Clamping nuts
Detailed application description	<u>(1) Oil resistance Proximity Sensor</u>  The product is mainly used in the processes of cutting and polishing parts in automobile industry, and fluorine coating is used to prevent the joint of sensor cables and sensor from being degraded by cutting oil. 1-1 Parts connecting cable and sensor: Fluororesin parts which connects the cable and sensor 1-2 Cable sheath: Cable which sheath is made of fluororesin

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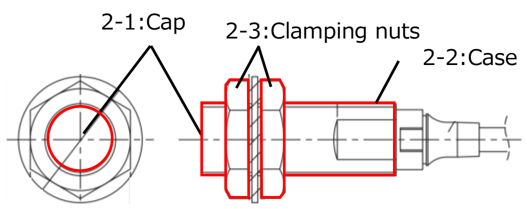
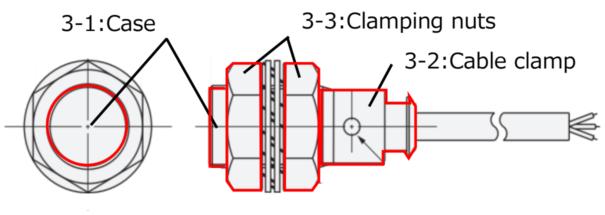
(2) Spatter-resistant Proximity Sensor



The product is mainly used in the welding process in the automobile industry, and fluorine coating is used for the outer parts to prevent spatters (molten iron) from adhering to the sensor.

2-1 Cap: Fluororesin parts
2-2 Case: Metal parts with fluororesin coating
2-3 Clamping nuts: Metal parts with fluororesin coating

(3) Chemical-resistant Proximity Sensor



Fluororesin coating is used for the outer parts to prevent applicable part from corroding by detergent for equipment cleaning in the production processes of food, pharmaceutical, and cosmetics industries.
3-1 Case: Fluororesin parts
3-2 Cable clamp: Fluororesin parts
3-3 Clamping nuts: Clamping nuts made of fluororesin

</td>
</tr>
<tr>
<td>Technical Description of Essential Uses</td>
<td>

(1) Oil-resistance Proximity Sensor

Proximity Sensors are usually installed inside of cutting and polishing machines and subject to spillage of cutting oil on a constant basis. PVC and PUR cables are not resistant enough under such environment. There is no material that can substitute fluorine which has excellent cutting oil resistance and flexibility.

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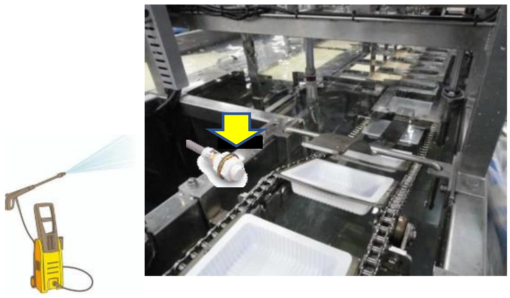
</table>

	(2) Spatter-resistant Proximity Sensor  Proximity Sensors are usually installed near welding machines and used in environment where spatters scatter and adheres to the Sensor. In such environment, there is coating such as silicone coating for outer case and clamping nuts; however, since spatter resistance is lower, the failure cycle of the Sensors becomes faster, and it decreases our customer's productivity. In terms of the cap, in addition to spatter resistance, special chemical surface finishing is performed to join the resin filled inside in the production process of the Sensors. There is no alternative material for fluorine including this processing. (3) Chemical-resistant Proximity Sensor  Equipment which Proximity Sensors are installed is cleaned using detergent for hygienic management. Since detergent is poured on the Proximity Sensors during equipment cleaning, resistant to such detergent is required. Fluorine used for outer parts is required to have corrosion resistance, chemical resistance and heat resistance. Additionally, special chemical surface finishing is performed to join the resin filled inside in the production process of the Sensors. There is no alternative material for fluorine including this processing.
Oil resistance	(1) Oil resistance which oil does not penetrate inside the Sensor in the internal acceleration test (Dipping in water-soluble cutting oil with 55 degrees C for 2000 hours) is required. For cables, penetration must be within about 0.3mm.
Flexibility	(1) As cable is bent to wire to equipment, flexibility which can be bent at 25mm of bend radius is required. Young's modulus of approximately 200 MPa
Spatter resistance	(2) Oil/water repellency that does not allow malfunction of the Sensors when spatters adhere to the Sensors due to degradation of the coating in the test using actual product which applies spatters is required. Continuous use temperature: Approximately 220°C or higher, and contact angle with water is approximately 100° to 110°
Chemical resistance	(3) Chemical resistance that corrosion and degradation do not occur even when exposed to detergent and chemical solutions is required. Typical evaluation conditions are as follows. ・ NaOH concentration 1.5% 70°C 240 hours ・ H_3PO_4 concentration 1.5% 70°C 240 hours ・ H_2O_2 concentration 6.5% 70°C 240 hours

9. Environment-resistant photoelectric switch with built-in amplifier

<table>
<tr><th colspan="2">Essential Application</th></tr>
<tr><td>Main use sector</td><td>Metal plating and manufacture of metal products
Electronics and semiconductors etc.</td></tr>
<tr><td>Application/
HTS code</td><td>Environment-resistant photoelectric switch with built-in amplifier / 8536.50.70.00</td></tr>
<tr><td>CAS RN</td><td>Unidentified</td></tr>
<tr><td>Regulated candidate substance name</td><td>Polymeric PFAS paint /
PTFE, FEP</td></tr>
<tr><td>Generic name for the final product</td><td>Environment-resistant photoelectric switch with built-in amplifier.</td></tr>
<tr><td>Common name for application parts</td><td>Housing made of zinc alloy coated with fluorocarbon resin.</td></tr>
<tr><td>Detailed application description</td><td>

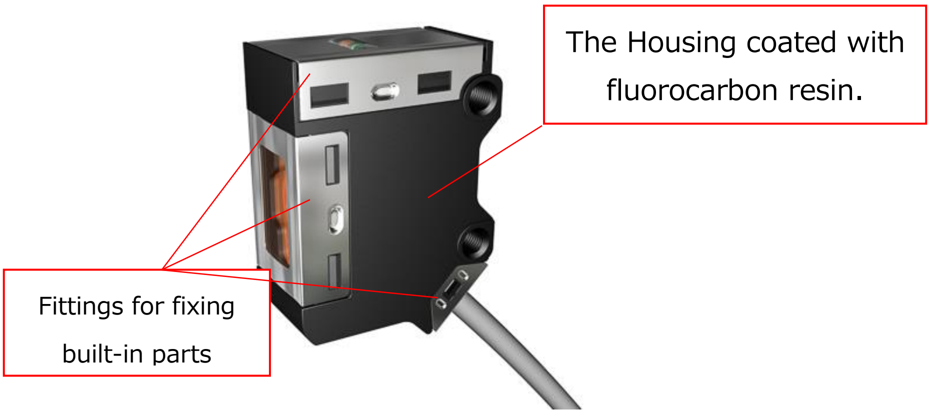


Fig.1 External view

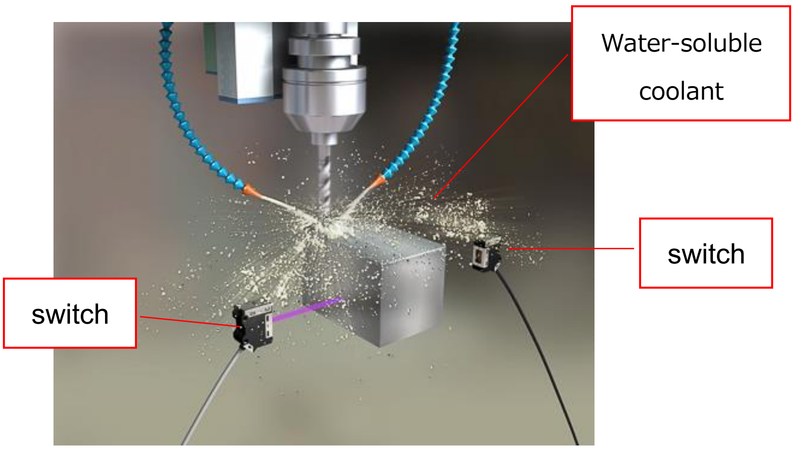


Fig. 2 Detection of workpiece seating in machine tool

The housing of the environment-resistant photoelectric switch is coated with fluorine paint (Fig. 1). There are two purposes of fluoride coating.

1. Improved corrosion resistance of housing

The housing of Environment-resistant photoelectric switch is made of zinc die-cast. Zinc

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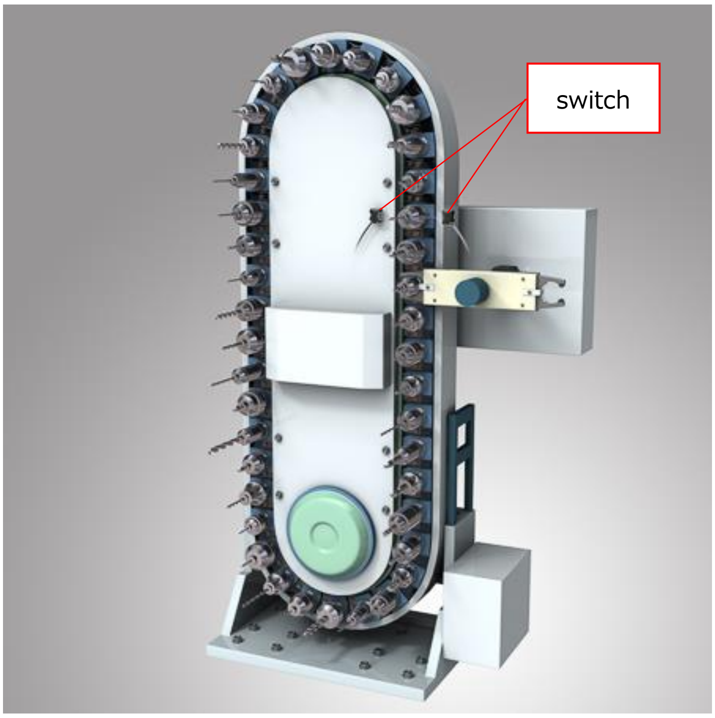
	die-casting has advantages such as high fluidity, easy dimensional accuracy, low molding temperature, and long service life of metal mold, but it has low corrosion resistance. Therefore, it cannot be used in machine tools and automobile parts machining lines, which are users of this switch, unless corrosion resistance is improved by painting and plating. Water-soluble coolant (basic) is often used in machine tools and automobile parts machining lines, and zinc die-cast housing is highly likely to be corroded unless surface treatment such as painting is performed (Fig. 2).  Fig. 3 Confirmation of Existence of Tool in Machine Tool 2. Prevention of crevice corrosion and dissimilar metal contact corrosion The housing is assembled with a metal stopper (SUS plate (zinc plated)) (Fig. 1) and attached to an accessory SUS bracket or the mounting surface of the user side (metal, resin, etc., materials cannot be specified) (Fig. 3). Therefore, it is necessary that the metal surface of the housing is not exposed in order to prevent electrolytic corrosion due to gap corrosion and contact between different metals.
Technical Description of Essential Uses	The former model number of this switch had adopted acrylic coating, but it was changed to fluorine coating due to low resistance to water-soluble coolant. The surface of the housing must be free from exposed metal. Therefore, coating by coating is necessary instead of plating. For the same reason, coating is necessary even if the housing is changed to a highly corrosion resistant metal material such as SUS. There are concerns about the following impacts due to the unavailability of this technology

	・ Affects machining with machine tools that use water-soluble coolant and parts machining and production on automotive parts production lines. ・ There is no alternative technology. When a switch without fluorine coating is used, corrosion of the switch causes contamination of corrosion products (foreign matter) into parts, generation of rust in processed parts, and increase of stoppage period of machine tools and production lines due to increase of sensor replacement frequency. For the above-mentioned reasons, the prohibition of coatings with fluorine-based paints should be exempted indefinitely from this restriction because of the economic burden due to the increased frequency of replacement and the serious degradation to the finished product. In terms of disposal, restrictions should not be applied as coatings by fluorinated paints generally lead to a reduction in waste.
chemical resistance	Resistance to water-soluble coolants (basic) used in machine tools and automotive parts processing lines
Required derogation period	13.5 years or more Note: This application should have the same derogation period as petroleum and mining.
Socio-economic impact	Problem with the safety of the worker. Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes.

10. External protection of liquid leak sensor

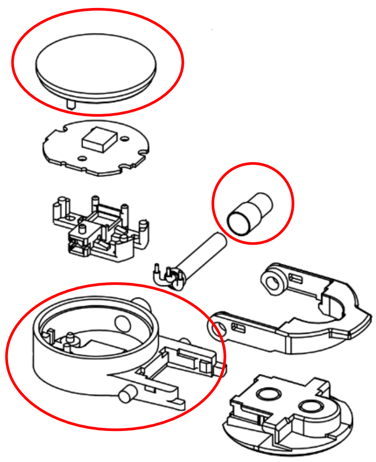
Essential Application	
Main use sector	Electronics and semiconductors etc.
Application/ HTS code	External protection of liquid leak sensor / 8536.50.70 00, 8536.70.00.00
CAS RN	26655-00-5
Regulated candidate substance name	Polymeric PFAS / PFA
Generic name for the final product	Liquid leak sensor
Common name for application parts	housing
Detailed application description	• This leakage sensor is used for the following applications. - Liquid leakage detection in semiconductor wafer cleaning and developing processes - Detection of tank leakage

Liquid tank

Liquid leak sensor

The sensor housing is made of PFA resin.

Schematic diagram of sensor structure
The sensor housing cover, case and tube are made of PFA resin.



Technical Description of Essential Uses	Due to the housing made of PFA resin, this leakage sensor has higher stability against organic solvents than other products. ・ The following characteristics can be obtained by using PFA resin for the leakage sensor. - This leakage sensor functions stably for the detection of organic solvents. - There is no alternative to this function ・ This leakage sensor is used for the following applications. - Liquid leakage detection in semiconductor wafer cleaning and developing processes - Detection of tank leakage ・ There are concerns about the following effects due to the unavailability of this technology : - Cleaning and development of a semiconductor wafer using an organic solvent cannot be carried out safely. ・ For the above reasons, the prohibition of PFA resin in leakage sensors affects safety and should be exempted from this restriction indefinitely.
Chemical resistance	Resistant to chemicals and solvents fluids
Cleanliness performance	Cleanliness performance without elution and volatilization of components from components
Required derogation period	13.5 years or more Note: This application should have the same derogation period as semiconductor manufacturing processes.
Socio-economic impact	Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes. Yield deterioration in the semiconductor manufacturing process

11. External protection of fiber unit for Measurement use

Essential Application	
Main use sector	Electronics and semiconductors etc.
Application/ HTS code	External protection of fiber unit for Measurement use / 8536.70.00.00
CAS RN	25067-11-2 26655-00-5
Regulated candidate substance name	Polymeric PFAS / FEP, PFA
Generic name for the final product	Fiber unit
Common name for application parts	housing and tube
Detailed application description	(see below)

Detailed application description

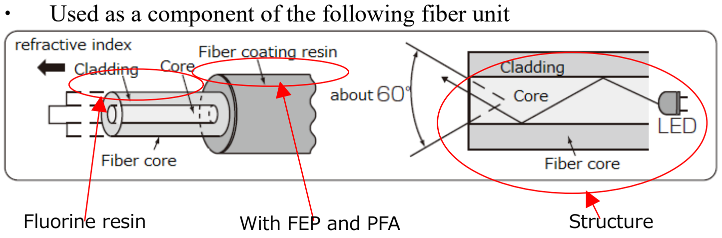
Fiber unit with chemical Liquid detection

- This sensor is used for the following applications.
  - Liquid leakage detection in semiconductor wafer cleaning and developing processes
  - Detection of tank leakage
  - Passage detection in places where there is a possibility of contact with chemical liquid

[Be included in the component] : Parts that are in an inseparable composite state at the time of purchase

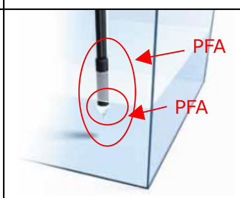
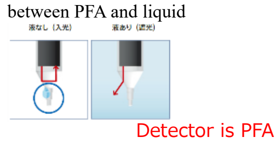
Plastic Optical Fiber

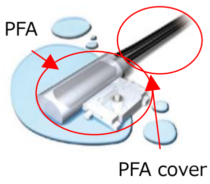
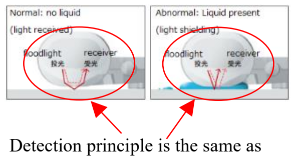
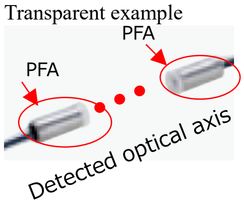
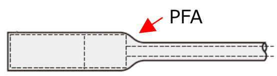
- Used as a component of the following fiber unit



- This is a step index type multimode fiber (using the refractive index difference between core and clad). Fluorine resin is used for the clad. No alternative material has been proposed by the manufacturer at present. In this type of fiber, the basic optical characteristics of the fiber are determined by the refractive index difference between core material and clad material, and the material is selected by the manufacturer in consideration of the manufacturing method. Users use commercially available fiber. FEP is used for the clad and jacket, and PFA is used for the jacket and outer coating.

[Products : fiber units]

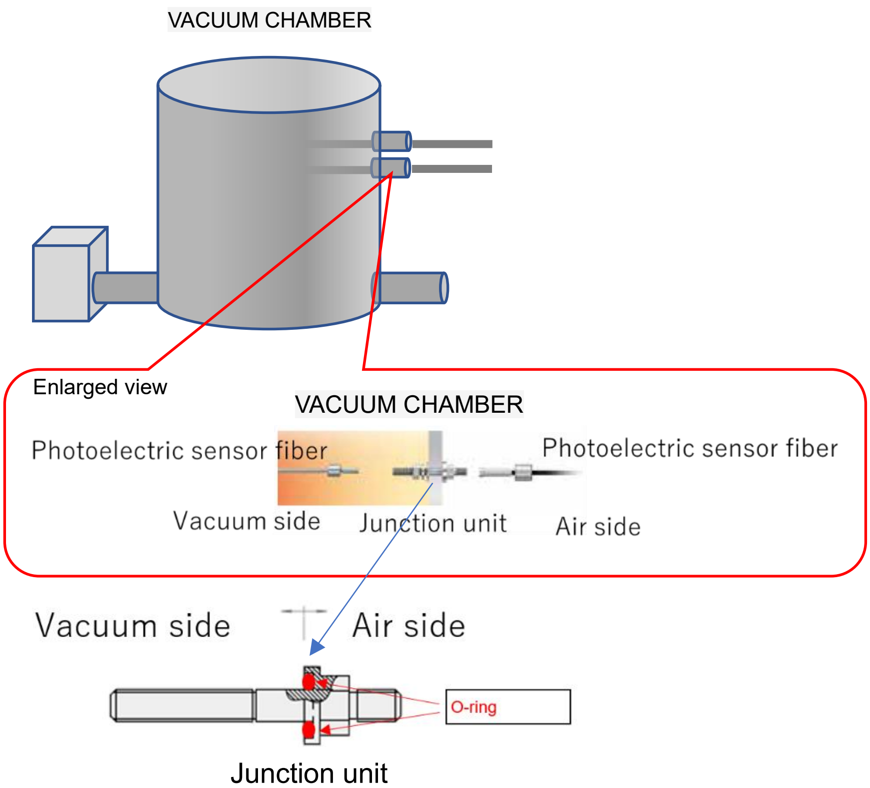
	Detection method and part of use	Purpose and materials used	Principle using PFA characteristics
Liquid level detection		The tip detection part is made of PFA, and the tube material which may come into contact with liquid is also covered with PFA, a material which is easily fused with the tip. In order to make the tip small and non-electric, a commercially available plastic optical fiber cable is	Use refractive index difference between PFA and liquid  No Liquid (Incoming Light) With Liquid (Light Shielding) Detection part It uses the difference in refractive index between liquid and liquid.

		used for guiding the detection light, and fluorine resin (specific material is not disclosed by the manufacturer) is also used as the clad material.	Detection principle ・It utilizes the return light difference due to the refractive index difference (hereinafter referred to as n) between the material of the tip cone and the external contact material. ・Without liquid : In a state of lower refractive index than PFA (n ~ 1.35) (air n ~ 1), most of the light emitted from the projection is reflected by the inner surface of the cone and returns to the light receiving portion to enter. ・Liquid : The liquid has a large refractive index equal to or higher than that of PFA (water n ~ 1.33, ethyl alcohol n ~ 1.36), and the amount of light that is substantially transmitted through the conical surface and returns to the light receiving portion decreases. ・The presence or absence of liquid is determined by this light amount difference.
Leak detection		The detection head and cable, which may come into contact with liquid, are covered with PFA.	Use refractive index difference between PFA and liquid  Detection principle is the same as "liquid level detection"
Chemical resistance	Transparent example 	The detection head and cable, which may come into contact with liquid, are covered with PFA.	Sealing performance is ensured by fusing the tip of the PFA detection head and the tube. 

Technical Description of Essential Uses	Due to the housing made of PFA resin, this fiber unit has higher stability against organic solvents than other products. • The following characteristics can be obtained by using PFA resin for the fiber unit.

	- This fiber unit functions stably for the detection of organic solvents. - There is no alternative to this function ・ This leakage sensor is used for the following applications. - Liquid leakage detection in semiconductor wafer cleaning and developing processes - Detection of tank leakage ・ There are concerns about the following effects due to the unavailability of this technology : - Cleaning and development of a semiconductor wafer using an organic solvent cannot be carried out safely. ・ For the above reasons, the prohibition of PFA resin in leakage sensors affects safety and should be exempted from this restriction indefinitely.
Chemical resistance	Resistant to chemicals and solvents fluids
Cleanliness performance	Cleanliness performance without elution and volatilization of components from components
Required derogation period	13.5 years or more Note: This application should have the same derogation period as semiconductor manufacturing processes.
Socio-economic impact	Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes. Yield deterioration in the semiconductor manufacturing process

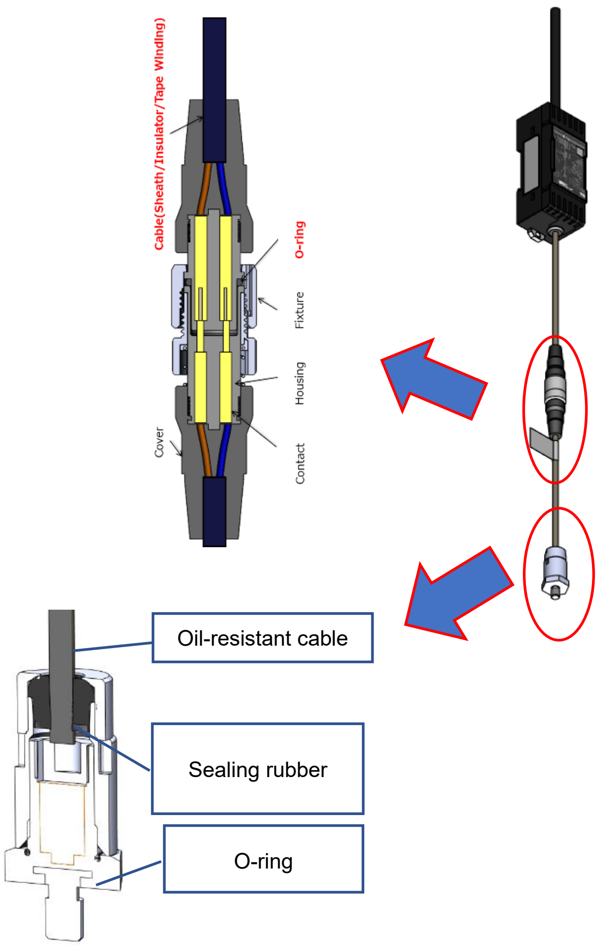
12. Hermetic seal for optical junction unit for vacuum environment

Essential Application	
Main use sector	Electronics and semiconductors etc.
Application/ HTS code	Hermetic seal for optical junction unit for vacuum environment / 8536.70.00.00
CAS RN	Unidentified
Regulated candidate substance name	Polymeric PFAS / Fluorocarbon rubber
Generic name for the final product	Junction unit for vacuum environment
Common name for application parts	O-ring
Detailed application description	Optical junction unit for vacuum environment are used for photoelectric sensors that enable detection in vacuum chambers in the semiconductor and LCD manufacturing processes. Junction unit for vacuum environment is used for a photoelectric sensor that enables detection inside a vacuum chamber by transmitting light from a fiber amplifier through a fiber unit. PFAS is used in O-ring for seal for air and vacuum environment. The optical coupler is provided with sealing ability to pass the detection light through the wall of the vacuum device. The O-ring for sealing is made of fluorine rubber to keep high temperature, high seal and high cleanliness.  Fig. Optical junction unit for vacuum

Technical Description of Essential Uses	To keep high temperature, high seal, and high cleanliness in a vacuum environment, materials other than fluorocarbon rubber are not appropriate.
Heat-resistant	Heat resistance to withstand 200°C
Cleanliness performance	Cleanliness performance without elution and volatilization of components from components
Required derogation period	13.5 years or more Note: This application should have the same derogation period as semiconductor manufacturing processes.
Socio-economic impact	Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes. Yield deterioration in the semiconductor manufacturing process

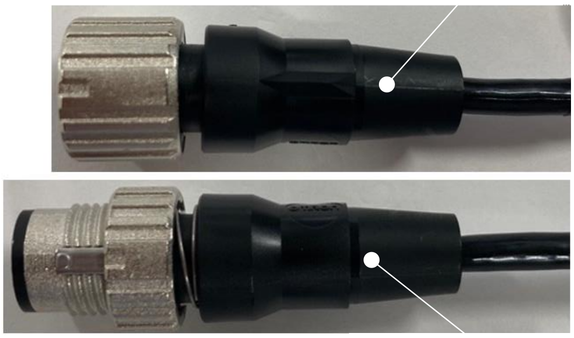
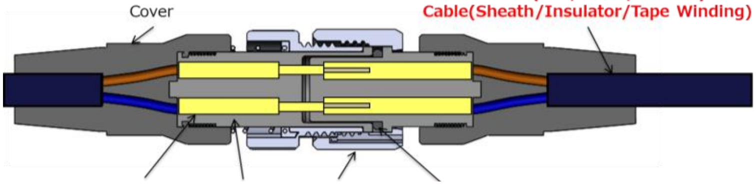
13. Vibration Sensor

Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Vibration Sensor / 9026.10.20.80,
CAS RN	Unidentified
Regulated candidate substance name	Cable : THV, ETFE, PTFE O-ring : FKM, HNBR FH-11-65 Sealing rubber : FH-11-65
Generic name for the final product	Same as above application
Common name for application parts	Oil-resistant cable, O-ring, Sealing rubber
Detailed application description	(1) Used in the cable for Vibration Sensor (2) Used in the sealing between the housing case and wires (3) Used in the sealing between the housing case and base



Technical Description of Essential Uses	(1) Cable Fluororesin which has resistance to both water-insoluble and water-soluble cutting oil is used in the cable sheath. This prevents the cutting oil from penetrating inside of the cable. (2) Sealing rubber Fluororesin which has resistance to both water-insoluble and water-soluble cutting oil is used in the sealing rubber. This prevents the cutting oil from penetrating inside of the cable. (3) O-ring Fluororesin which has resistance to both water-insoluble and water-soluble cutting oil is used in the O-ring. This prevents the cutting oil from penetrating inside of the cable.

14. Connector Cable

Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Connector Cable / 8544.42.90, 8544.49.20.00
CAS RN	Unidentified
Regulated candidate substance name	[Cable] THV, ETFE, PTFE, Soft fluoropolymer [O-ring] FKM, HNBR + fluororubber
Generic name for the final product	Circular Connector Cable
Common name for application parts	1. Cable 2. O-ring
Detailed application description	1.Used for the cable of both Socket Connector Cable and Plug Connector Cable 2.Used for the O-ring of Socket Connector Cable << Exterior photo >>  << Schematic Cross-sectional View >>  3) Cable Fluororesin, which is less likely to be deteriorated by either water-insoluble or water-soluble cutting oils, is used for the cable sheath. This prevents penetration of cutting oils into the cable.

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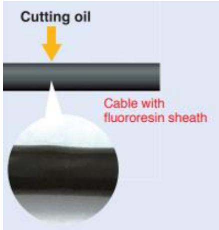
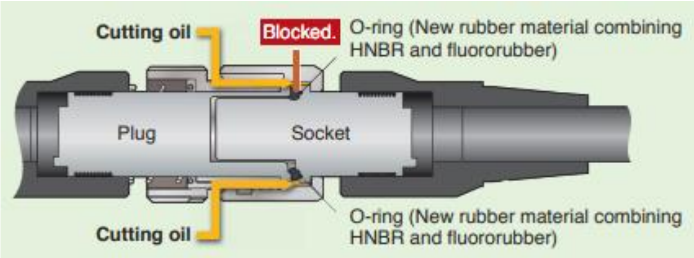
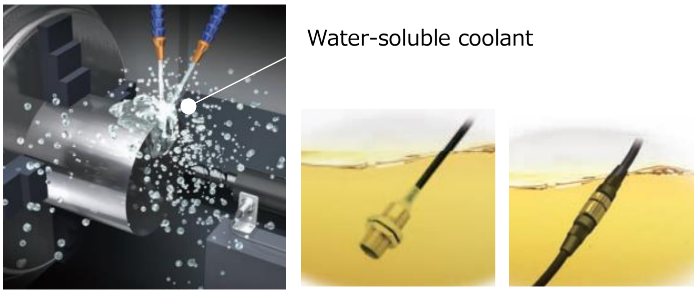
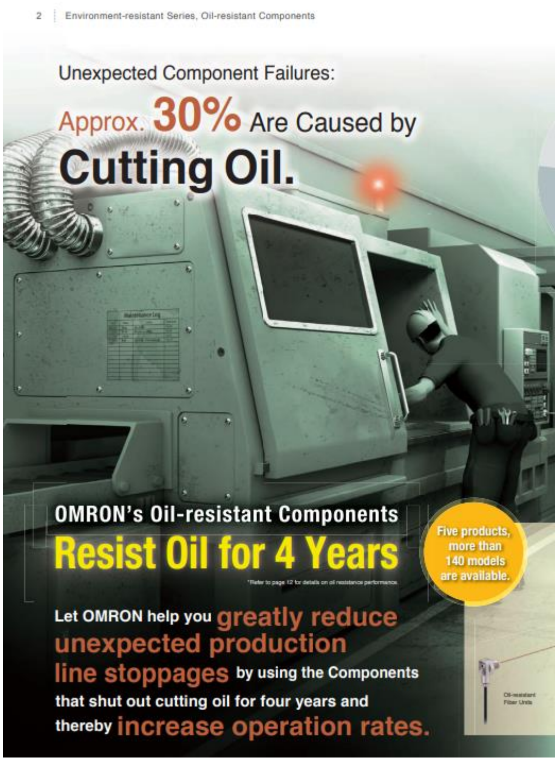


4) O-ring
HNBR+ fluorine rubber kneading, which is less likely to be deteriorated by either water-insoluble or water-soluble cutting oils, is used for the O-ring. This prevents penetration of cutting oils into the connector.


<< Product usage examples >>
Used in combination with proximity sensors for cylinder detection in machine tools, etc.


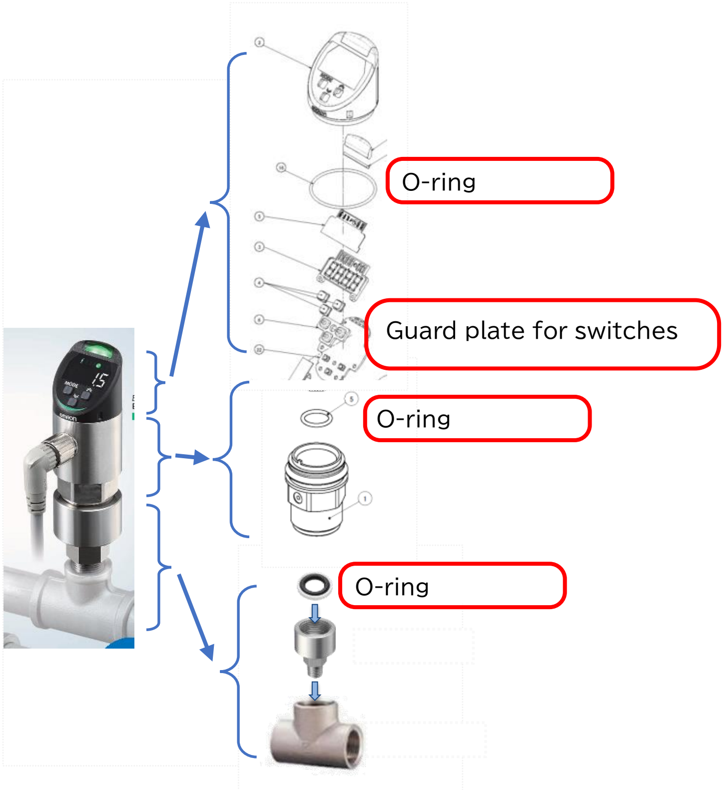
Proximity sensor Connector Cable
</td>
</tr>
<tr>
<td>Technical Description of Essential Uses</td>
<td>1.Cable
Fluorine cable is used to maintain oil resistance.
It is difficult to substitute anything other than fluorine.
2. O-ring
Fluororubber is used to maintain oil and adhesive resistance.
It is difficult to substitute anything other than fluorine.</td>
</tr>
<tr>
<td>Chemical resistance</td>
<td>We have a track record of being used in the customer's on-site environment (acidic and alkaline atmosphere).</td>
</tr>
<tr>
<td>Water repellency / oil resistance</td>
<td>As a robust component product, we do not guarantee it, but the catalog shows that it does not deteriorate for more than 4 years of oil resistance.</td>
</tr>
</table>



2 Environment-resistant Series, Oil-resistant Components
Unexpected Component Failures:
Approx. 30% Are Caused by
Cutting Oil.
OMRON's Oil-resistant Components
Resist Oil for 4 Years
Five products, more than 140 models are available.
Let OMRON help you greatly reduce unexpected production line stoppages by using the Components that shut out cutting oil for four years and thereby increase operation rates.

<< Catalog >>

15. Pressure Sensors

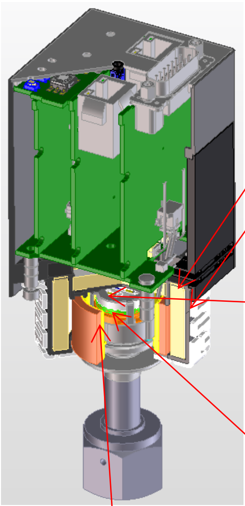
Essential Application	
Main use sector	Medical devices Electronics and semiconductors etc.
Application/ HTS code	Pressure Sensors / 9026.20.40.00
CAS RN	9011-17-0
Regulated candidate substance name	FKM (fluororubber)
Generic name for the final product	Pressure Sensors
Common name for application parts	O-ring Guard plate for switches
Detailed application description	FKM (fluororubber) is used as the material for the O-rings and guard plate for switches to prevent the liquid being measured from entering the inside of the product. 
Technical Description of Essential Uses	As this is a general-purpose senser, substances to be measured are not known. Therefore, FKM (fluororubber) which has excellent characteristics such as oil resistance, chemical resistance, and solvent resistance and is well-balanced between workability and cost is used.

16. Sapphire Capacitance Diaphragm Gauge

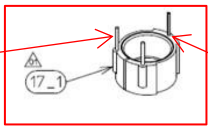
Essential Application	
Main use sector	Electronics and semiconductors etc.
Application/ HTS code	Sapphire Capacitance Diaphragm Gauge / 9026.20.40.00
CAS RN	Unidentified
Regulated candidate substance name	Polymeric PFAS / FKM, PFA, TFE, PTFE
Generic name for the final product	Sapphire Capacitance Diaphragm Gauge
Common name for application parts	Thermal insulation and Cable
Detailed application description	The sapphire capacitance diaphragm gauge is used in deposition equipment and etching equipment in the semiconductor manufacturing process.

■ Integrated Model

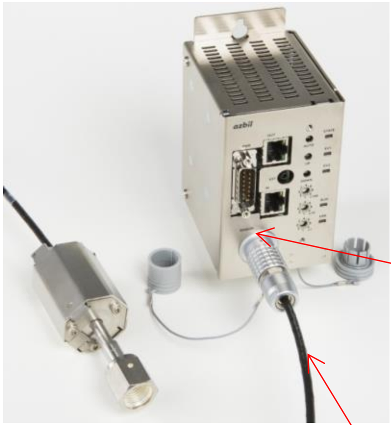
Components corresponding to a heater operating temperature of MAX 250°C



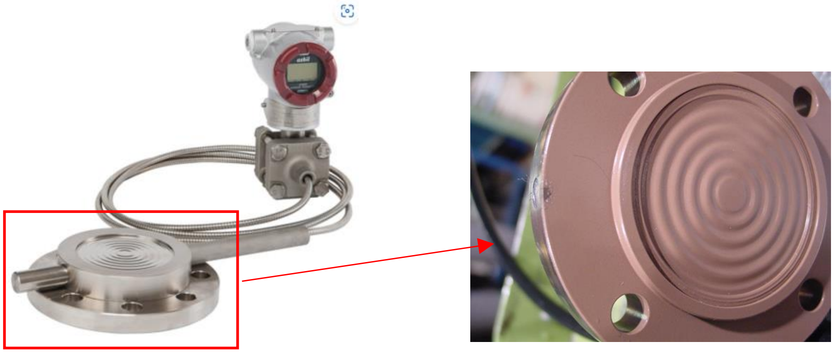
Heater board connection cable



Thermistor

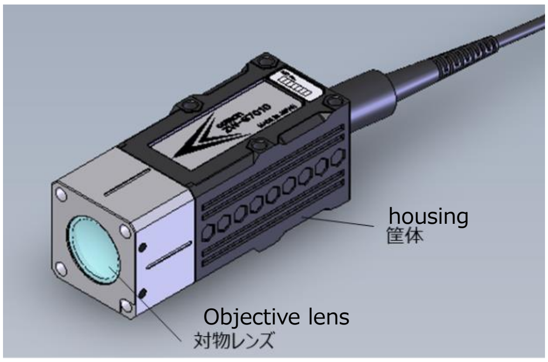
	■Separated Model Components compatible with gauge head operating temperature of MAX 250°C 
Technical Description of Essential Uses	There is no fluorine-free material with equivalent heat resistance.
Heat-resistant	Heat resistance to withstand 250°C
Required derogation period	13.5 years or more Note: This application should have the same derogation period as semiconductor manufacturing processes.
Socio-economic impact	Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes. Yield deterioration in the semiconductor manufacturing process

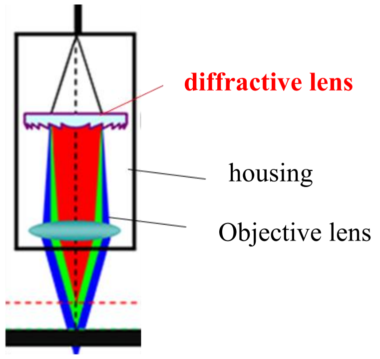
17. Coating and protective covering for diaphragm of industrial pressure transmitter

Essential Application	
Main use sector	Energy sector Petroleum and mining etc.
Application/ HTS code	Coating and protective covering for diaphragm of industrial pressure transmitter / 9026.20.40.00
CAS RN	FEP : 25067-11-2 PFA : 26655-00-5 PCTFE : 25038-89-5 PTFE : 9002-84-0
Regulated candidate substance name	Polymeric PFAS / FEP, PFA, PCTFE, PTFE
Generic name for the final product	Industrial pressure transmitter
Common name for application parts	Diaphragm, Flange
Detailed application description	 Pressure transmitter Diaphragm/wetted parts coating Industrial pressure transmitters are instruments used for measuring pressure in pipes and tanks, particularly in applications that require flow or liquid level measurement. They are commonly utilized in various large-scale equipment, such as industrial chemical plants.
Technical Description of Essential Uses	Industrial pressure transmitters are used to measure corrosive fluids such as chemicals. The measurement of corrosive fluids such as chemicals accounts for 10% of all industrial pressure transmitter applications. Industrial pressure transmitters are required to have the performance to withstand the measurement of these corrosive fluids. To measure corrosive fluids with industrial pressure transmitters, coatings and protective films such as FEP are required on the parts that come into contact with corrosive fluids. ・ As an alternative to coatings such as FEP, there is a possibility that resin coatings such as epoxy can be used. However, substitute materials are poorly resistant to various chemicals in industrial chemical plants and cannot withstand corrosive fluids.

	• With alternative technologies and materials, the pressure transmitter itself connected to the piping must be replaced periodically by shutting down the facility or every time corrosion of the wetted parts occurs, which could be as early as every few months. Pressure transmitters with diaphragm coatings and protective films using FEP etc. can operate stably for at least 10 years without replacement. There are concerns about the following impacts due to the unavailability of this technology • The unavailability of FEP etc. for diaphragm coatings and protective coatings for industrial pressure transmitters will affect the production and supply of chemical products by significantly reducing production efficiency in plants producing corrosive fluids such as chemicals For the above reasons, the prohibition of coating and protective films of diaphragms by FEP etc. on industrial pressure transmitters should be exempted indefinitely from this restriction because of the economic burden caused by the increased frequency of replacement due to equipment shutdown. From the viewpoint of disposal, restrictions should not be applied because the diaphragm coating and protective film of FEP etc. for industrial pressure transmitters allow the pressure transmitter to be used until it reaches its original service life, which generally leads to a reduction in waste.
Chemical resistance	Corrosion resistance with corrosive fluids
Required derogation period	13.5 years or more Note: This application should have the same derogation period as petroleum and mining.
Socio-economic impact	Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes.

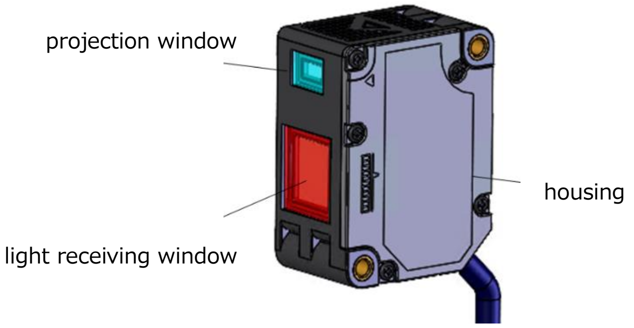
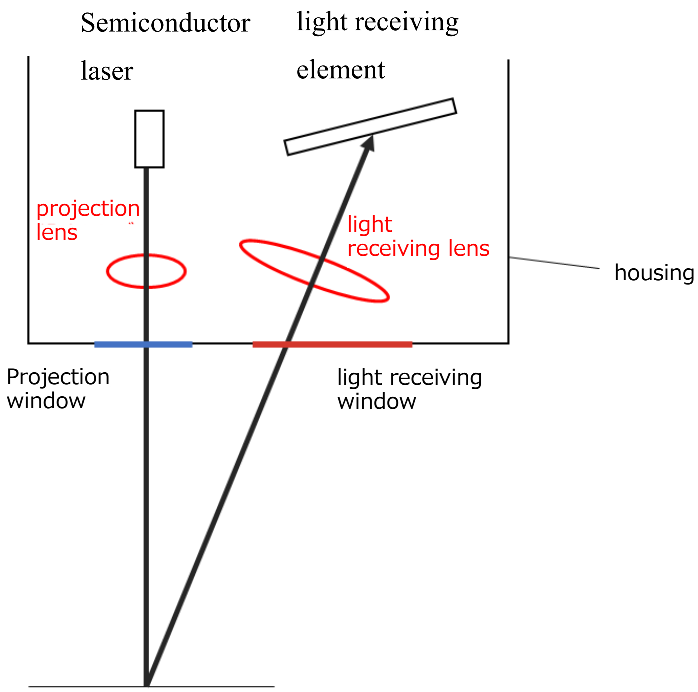
18. Displacement measurement sensor

Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	**Displacement measurement sensor / 9032.89.20 00**
CAS RN	647-42-7
Regulated candidate substance name	3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctanol
Generic name for the final product	Same as above application
Common name for application parts	Diffractive Lens
Detailed application description	Fig. 1 shows the appearance of the displacement measurement sensor. This sensor is a displacement sensor based on the chromatic confocal method, and the material that is targeted for regulation this time is used in the diffractive lens, which is the core optical component of this sensor. Fig. 2 shows an outline of the optical system inside the housing. A diffractive lens can diffract white light, and the light beam angle can be changed for each wavelength. And this precisely conversion (wavelength to angle) directly affects the performance of the sensor. *The chromatic confocal method: One of the principle of the displacement measurement that white light is irradiated to the object to be measured by changing the focus position for each color (wavelength), and only the focused wavelength light is received as reflected light, and the height is determined.  Fig.1 the appearance of the displacement measurement sensor

	 Fig.2 an outline of the optical system inside the housing
Technical Description of Essential Uses	Without using a diffractive lens, the principle of measurement of this sensor cannot be worked. For the displacement measurement sensor based on the chromatic confocal method, it is essential for using the diffraction lens to change the focus position on the object to be measured for each wavelength. So, it is extremely difficult to realize a sensor of this method without using a diffractive lens. The diffractive surface cannot be molded without using this material. Diffractive lens controls the direction of light by means of a diffraction phenomenon caused by extremely fine and complicated structures of nm (nano meter) order on the optical surface. It is extremely difficult to replace the material of the diffractive lens, because it is a dedicated material designed in consideration of the moldability of diffractive surface, releasability, refractive index, Abbe number, phase information, the long-term reliability and so on.
Low friction / Wear resistance	Adhere cellophane tape (Nichiban No.405) to the diffractive surface and instantly remove it in the vertical direction. After repeating the operation three times, the resin layer should not peel off.
Heat-resistant	High temperature and high humidity: No deterioration after left at 65°C, RH85%, 1000H Low temperature storage: No deterioration after 1000 hours storage at -15°C Thermal shock: -15°C to 60°C No deterioration after 100 cycles
Light fastness / Weather fastness	Wavelength 400 to 700nm, 1mW, no deterioration after 7 years or more irradiation
Low refractive index	Refractive index designed value +/- 0.001 accuracy
Other characteristics	Improved releasability during molding
Alternative material	None *As described in the non-substitution explanation above.

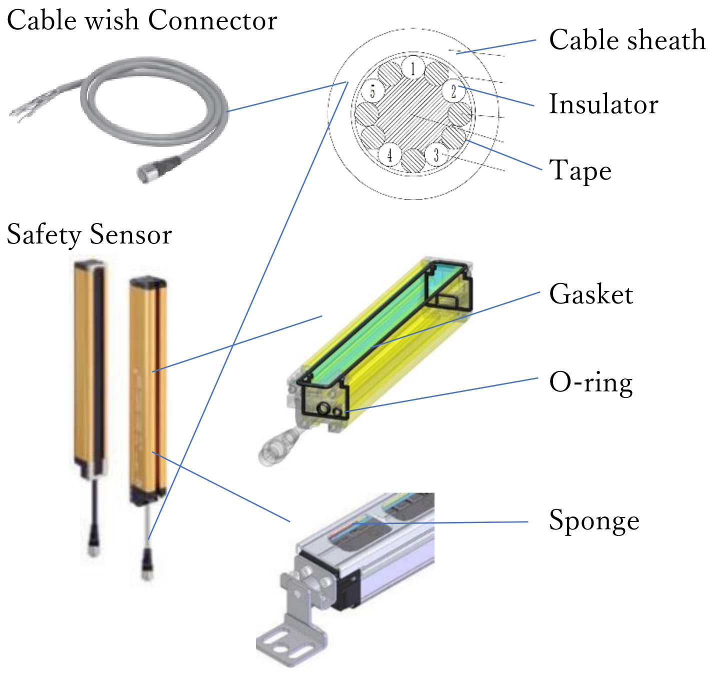
19. Displacement measurement sensor

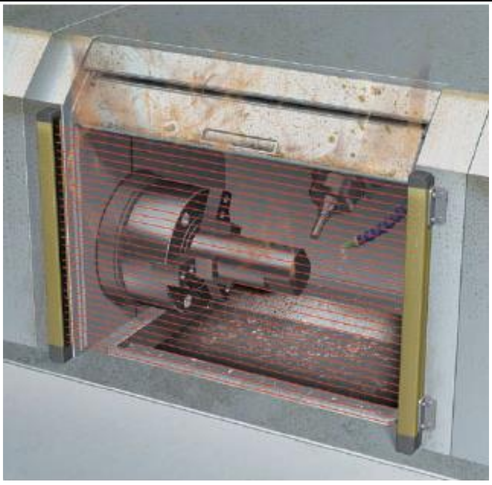
Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Displacement measurement sensor / 9032.89.20.00, 8536.5*
CAS RN	647-42-7
Regulated candidate substance name	3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooctanol
Generic name for the final product	Same as above application
Common name for application parts	Hybrid lens
Detailed application description	Fig. 1 shows the appearance of the displacement sensor. The sensor is a triangulation-based displacement sensor, and the material that is targeted for regulation this time is used in the light-projecting lens and the light-receiving lens, which are the core optical components of this sensor. Fig. 2 shows an outline of the optical system inside the housing. The light emitted from the semiconductor laser is condensed on the surface of the object to be measured by the projection lens, and the reflected light from the object to be measured forms an image on the light receiving element via the light receiving lens. The height is measured by changing the imaging position on the light receiving element according to the distance from the housing surface to the object to be measured. The quality of collected light through the projection lens and receiving lens are extremely important factor that determine the performance in this type of the displacement measurement sensor. A dedicated lens design is required to improve these light collection qualities. Of these, the aberration of the optical system (lens) is important as a design index for improving the light collection quality. Reducing aberrations improves the quality of light collection of the lens. There are two main ways to reduce aberrations. (1) Use an aspherical lens (2) Combine multiple spherical lenses. If (2) is selected, the size of the optical system becomes large, which leads to an increase in housing size and cost. So, the aspherical lens is used in this sensor. As the name suggests, an aspherical lens has a complex aspherical shape rather than a spherical surface. In order to realize this complex shape, the material that is targeted for regulation this time is necessary.

	 Fig.1 the appearance of the displacement sensor  Fig.2 an outline of the optical system inside the housing
Technical Description of Essential Uses	The aspherical shape cannot be molded without using this material. Aspherical lens reduces lens aberration by forming an optical surface into a complex curved shape represented by a polynomial. Realization of this complex shape requires advanced molding technology and material properties customized for this application. Design information of the aspherical surface (material refractive index, Abbe number, curved surface shape, etc.) and moldability (especially, if it is not included the materials, the releasability deteriorates and the desired shape cannot be obtained), and it is extremely difficult to replace it with other materials because it is a dedicated material designed in consideration of long-term reliability in the environment where the displacement sensor is used.
Low friction / Wear resistance	Adhere cellophane tape (Nichiban No.405) to the diffractive surface and instantly remove it in the vertical direction. After repeating the operation three times, the resin layer should not

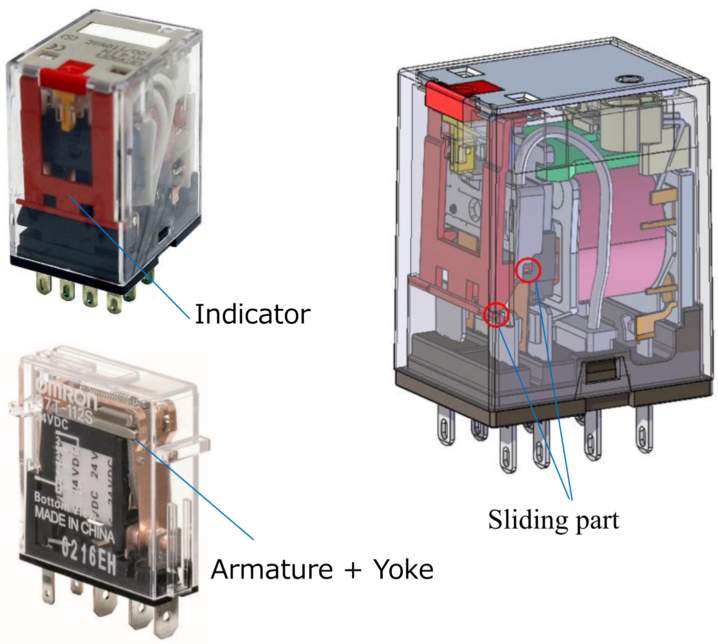
	peel off.
Heat-resistant	High temperature and high humidity: No deterioration after 70°C, RH95%, 1000H Low temperature storage: No deterioration after 1000 hours storage at -15°C Thermal shock: -15°C to 70°C No deterioration after 100 cycles
Light fastness / Weather fastness	Wavelength 660+/-20nm,1mw, no deterioration after 7 years or more irradiation
Low refractive index	Refractive index designed value +/- 0.001 accuracy
Other characteristics	Improved releasability during molding
Alternative material	None *As described in the non-substitution explanation above.

20. Safety Sensor

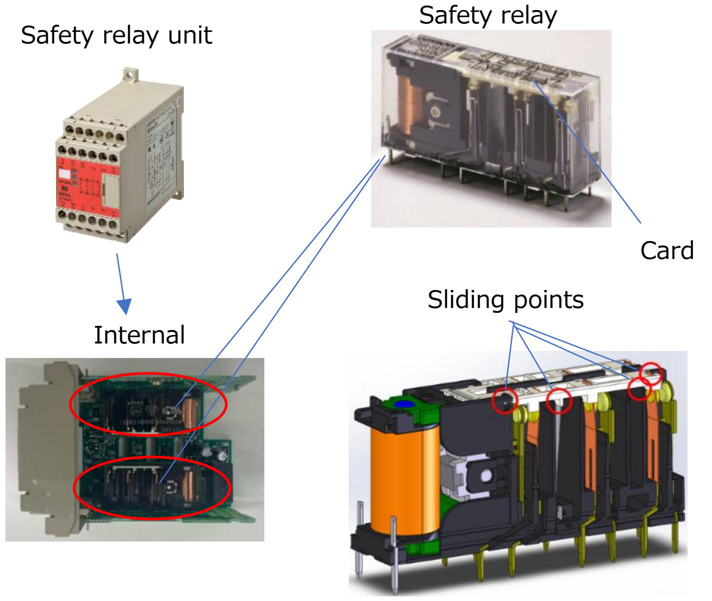
Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Safety Sensor / 8536.50.90.65
CAS RN	113114-19-5, 116-14-3, 1478-61-1, 25038-71-5, 25190-89-0, 27029-05-6, 9002-84-0
Regulated candidate substance name	- Fluorinated polymer of 2,2,3,3-tetrafluorooxetane - Tetrafluoroethylene - Bisphenol AF - Ethene, 1,1,2,2-tetrafluoro-, polymer with ethene - Propene, 1,1,2,3,3,3-hexafluoro-, polymer with 1,1-difluoroethene and 1,1,2,2-tetrafluoroethene - 1-Propene, polymer with 1,1,2,2-tetrafluoroethene - PTFE
Generic name for the final product	Same as above application
Common name for application parts	Cable sheath, Insulator, Tape, Gasket, O-ring, Sponge
Detailed application description	 To ensure environmental resistance, the parts that make up the cables of the safety sensor and the parts that make up the protective structure are used.

Technical Description of Essential Uses	 In some cases, the safety sensor is installed near the extraction port of the processing machine and is exposed to oil mist. In harsh environments, NBR and other materials are not sufficient, and it has become difficult to substitute materials other than fluorine processed materials as materials that are resistant to cutting oil.
Water repellency/ oil repellency	No failure even in a coolant-contaminated environment.
Difficulty in replacing	When substituted with NBR or H-NBR, the physical properties change with cutting oil, causing cutting oil penetration and insufficient sealing pressure in the seal rubber.

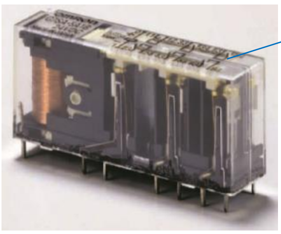
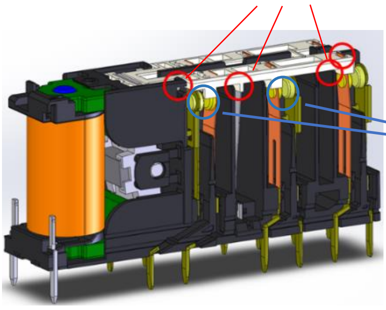
21. Relay

Essential Application	
Main use sector	Electronics and semiconductors etc.
Application/ HTS code	Relay / 8536.4*
CAS RN	Unidentified
Regulated candidate substance name	PFPE [Perfluoropolyether]
Generic name for the final product	Relay
Common name for application parts	Indicator, Armature + Yoke
Detailed application description	1. Sliding parts of internal relay 
Technical Description of Essential Uses	Since relays are required to have high mechanical durability and high reliability, sliding parts are coated with a fluorine-based lubricant for the purpose of reducing frictional resistance. The technically difficult points of substitution are as follows. ・ Because relay has contacts structure, contact reliability is reduced due to abrasion powder generated when plastic or metal parts mechanically operate. ・ Decrease in stability of relay operation due to increased friction of sliding parts. ・ Fluorinated lubricants are commonly used in several relays because they can be easily diluted with similar fluorinated solvents and can be applied evenly and easily dried.

22. Safety relay unit

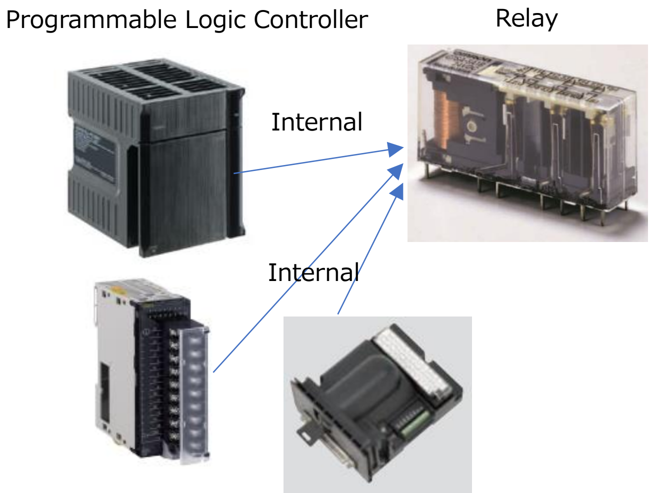
Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Safety relay unit / 8536.4*
CAS RN	69991-67-9, 60164-51-4, 1623-05-8, 25038-02-2 and more
Regulated candidate substance name	PFPE [Perfluoropolyether]
Generic name for the final product	Same as above application
Common name for application parts	Safety relay
Detailed application description	 It is used to reduce frictional resistance on the sliding part (card) of the safety relay built into the safety relay unit to achieve high mechanical durability and reliability.
Technical Description of Essential Uses	The technically difficult points of substitution are as follows. ・ Fluorinated lubricants are commonly used in several relays because they can be easily diluted with similar fluorinated solvents and can be applied evenly and easily dried. ・ Because relay has contacts structure, contact reliability is reduced due to abrasion powder generated when plastic or metal parts mechanically operate. ・ Decrease in stability of relay operation due to increased friction of sliding parts.
Low friction/wear resistant	When parts slide, there is no generation of abrasion powder that causes poor contact of contacts.
Remarks	Since this product relies on the built-in safety relay, please also refer to the application material for the safety relay.

23. Safety Relay

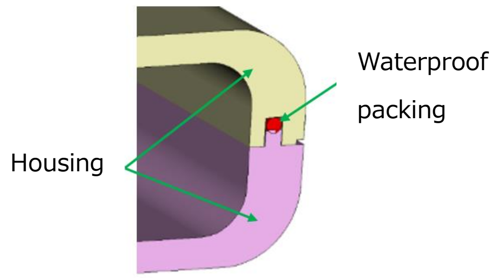
Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Safety Relay / 8536.4*
CAS RN	69991-67-9, 60164-51-4, 1623-05-8, 25038-02-2 and more
Regulated candidate substance name	PFPE [Perfluoropolyether]
Generic name for the final product	Same as above application
Common name for application parts	Card, Contact
Detailed application description	1. Sliding parts of internal relay 2. Contact coating  <Internal structure> 
Technical Description of Essential Uses	Since relays are required to have high mechanical durability and high reliability, sliding parts are coated with a fluorine-based lubricant for the purpose of reducing frictional resistance. And it is used in coatings to protect contacts from dirt, reduce frictional resistance, and maintain high reliability. The technically difficult points of substitution are as follows. ・ Because relay has contacts structure, contact reliability is reduced due to abrasion powder generated when plastic or metal parts mechanically operate. ・ Decrease in stability of relay operation due to increased friction of sliding parts.

	· Fluorinated lubricants are commonly used in several relays because they can be easily diluted with similar fluorinated solvents and can be applied evenly and easily dried.

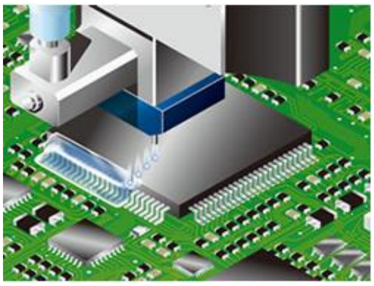
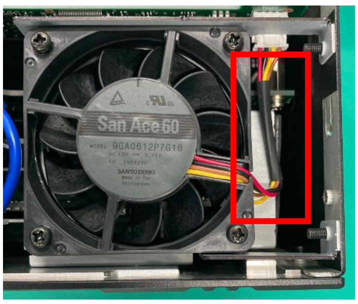
24. Relay / Safety Relay

Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Relay / 8536.4* Safety Relay / 8536.4*
CAS RN	Unidentified
Regulated candidate substance name	PFPE (Perfluoropolyether)
Generic name for the final product	Same as above application
Detailed application description	 It is used to reduce frictional resistance on the sliding part of the relay built into the programmable logic controller to achieve high mechanical durability and reliability.
Technical Description of Essential Uses	Since relays are required to have high mechanical durability and high reliability, sliding parts are coated with a fluorine-based lubricant for the purpose of reducing frictional resistance. The technically difficult points of substitution are as follows. ・ Because relay has contacts structure, contact reliability is reduced due to abrasion powder generated when plastic or metal parts mechanically operate. ・ Decrease in stability of relay operation due to increased friction of sliding parts. ・ Fluorinated lubricants are commonly used in several relays because they can be easily diluted with similar fluorinated solvents and can be applied evenly and easily dried.
Remarks	Since this product relies on the built-in relay, please also refer to the application material for the relay.

25. Terminal with communication function / Programmable display

Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Terminal with communication function / 8471.80.40 Programmable display / 8531.20.**
CAS RN	Unidentified
Regulated candidate substance name	Fluororubber
Generic name for the final product	Same as above application
Common name for application parts	O-ring, Waterproof packing
Detailed application description	A waterproof structure is created by sandwiching it between two housings and crushing it with the upper and lower housings. Some oil-resistant products use fluororubber to improve oil resistance and chemical resistance.  O-ring 
Technical Description of Essential Uses	Fluorine is generally used in products that improve chemical resistance, water repellency, and oil resistance.

26. Image processing system

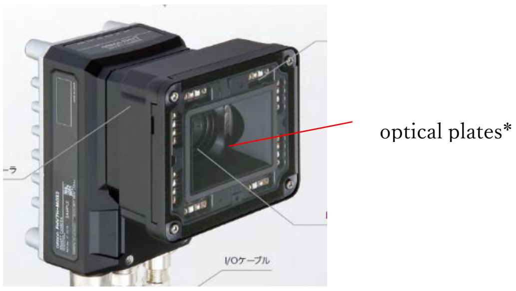
Essential Application	
Main use sector	Electronics and semiconductors etc.
Application/ HTS code	Image processing system / 8525.80
CAS RN	Unidentified
Regulated candidate substance name	PFAS
Generic name for the final product	Image processing system
Common name for application parts	1: Control board protection coating for image processing system 2: Tube for wire protection of image processing system (2,3) 3: Coating for surface plate protection of image processing system (4) 4: Coating to ensure optical system functions of image processing system (5,8,9,10) 5: Packing to ensure the airtightness and water resistance of the image processing system (6,9) 6: Porous PTFE membrane to prevent condensation in image processing system (7) 7: Thermal radiation sheets for image processing system (11)
Detailed application description	1: Coating for maintaining the environmental resistance of the image processing system substrate. Substrate protective coating to protect against special environments (water droplets, foreign matter, gas).  Cited from: https://www.arbrown.com/products/humiseal/ 2: Tube for wire protection of image processing system -Shrink tubing for internal fan cable protection 

-Insulation and protection of various electric wires and parts, waterproof/drip-proof/anti-corrosion, and mechanical protection.

Cited from: https://ja.nc-net.or.jp/company/92714/product/detail/99785/

3: Coating to maintain the optical environmental resistance of image processing system

A coating that has water and oil repellency properties and allows fingerprints, sweat, sebum, and other stains to be easily wiped off. Increases contact angle and retains water and oil repellency.

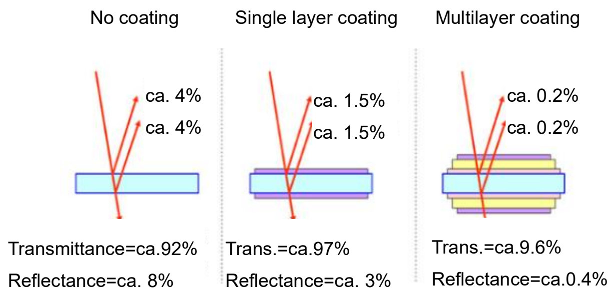


*A resin material that protects the inside of the sensor and transmits light.

Cited from: Water repellency/stain resistance (tokaioptical.com)

4: AR coating for smart image sensors

Coating to reduce light reflection and increase transmittance



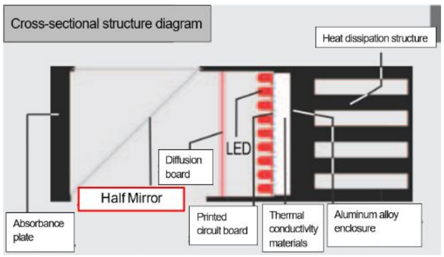
Cited from: https://coating.nidek.co.jp/article/information/type/a37 (nidek.co.jp)

-Half Mirror with water and dirt repellent coating

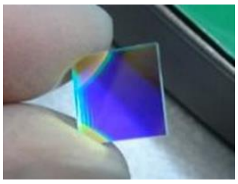
(Transmittance 50%, Reflectance 50%)

This coating has water and oil repellent properties and can easily wipe off fingerprints, sweat, sebum, and other contaminants. It has a high contact angle and possesses water and oil repellency.

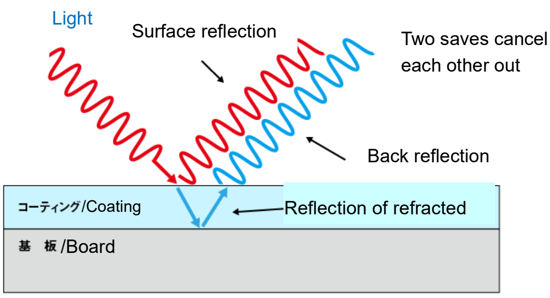
Appearance Cross-sectional drawing



-Coating that suppresses reflection on the surface of bandpass filters and infrared cut filters used in 3D vision sensors, cameras, etc.

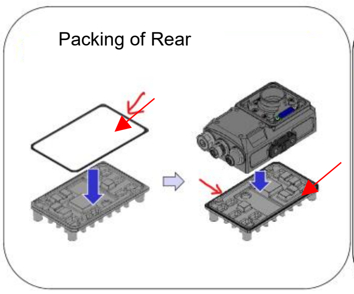


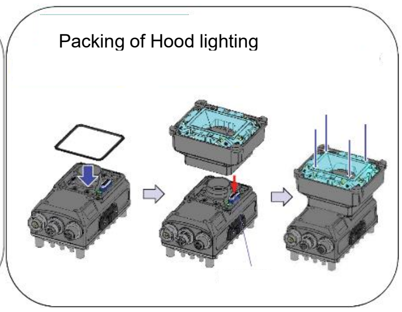
Anti-reflection mechanism



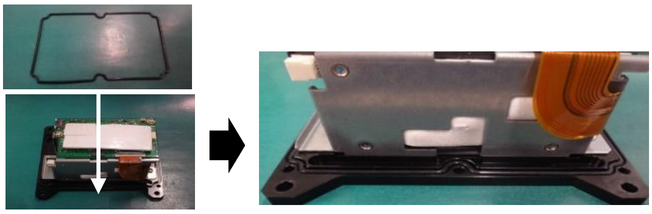
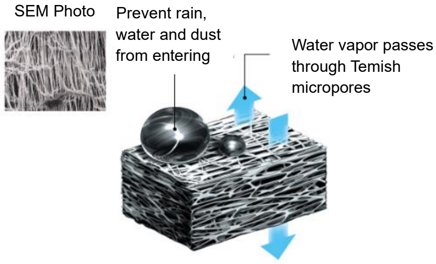
5: Packing to ensure the airtightness and water resistance of the image processing system

-Packing for waterproof IP67 security of smart image sensor



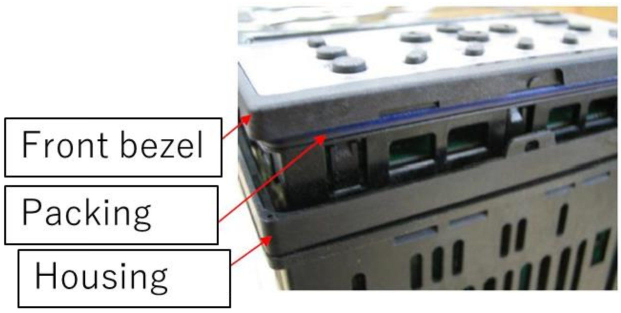


Packing of Hood Cover

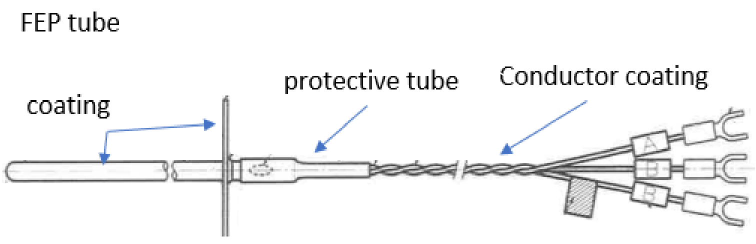
	-Packing to ensure the waterproof specification (IP67) of the 3D vision sensor  6: Porous PTFE membrane to prevent condensation in image processing system It has a porous membrane and achieves both "waterproof/dustproof" and "breathability/moisture permeability". Cited from: https://www.nitto.com/jp/ja/products/temish_search/about/   7: Thermal radiation sheets for image processing system A resin sheet with thermal conductivity. By encapsulating a highly thermally conductive filler in a flexible resin sheet whose main ingredient is acrylic or silicon resin, the resin sheet, which originally does not have thermal conductivity, is given thermal conductivity. By installing it in close contact with the heat-generating parts mounted on electronic equipment, etc., it absorbs heat efficiently and dissipates heat away from the heat-generating parts, thereby preventing malfunctions and failures of the equipment. Appearance 
Technical Description of Essential Uses	1: A coating that protects equipment from water droplets, foreign matter, gas, and dirt in the usage environment and ensures functionality cannot maintain alternative characteristics. 2: Equivalent insulation and protection, waterproof/drip-proof, corrosion-resistant, and mechanical protection equivalent to the current performance are required.

	3: Since lighting equipment such as FL lighting is installed near the workpiece, it is necessary to ensure the lighting characteristics with an anti-fouling coating, and alternative characteristics cannot be maintained. Fluorine-based resin is often the main component in general antifouling coatings. It is possible to change to a product that does not contain PFAS as long as it does not affect the function/performance. 4: Window plates, optical lenses, liquid lenses, and IR cut filter coatings for maintaining environmental resistance cannot maintain alternative characteristics. The main ingredients are inorganic compounds such as MgF2 and SO2, but it is unknown whether they contain PFAS. If it does not affect the optical properties (transmittance, reflectance, wavelength components, etc.), it is possible to change to materials that do not contain PFAS. 5: Since the optical system of the image processing apparatus is installed near the object to be inspected, it is necessary to use highly airtight and water-resistant packing to maintain its function. The main component is rubber. 6: Fluororesin porous membrane. It combines the durability of fluororesin with the breathability of a microporous membrane structure. Fluororesin porous membrane. It combines the durability of fluororesin with the breathability of a microporous membrane structure. The PTFE porous membrane has hundreds of millions of micropores per 1cm2 and exhibits both waterproof and dustproof properties and high breathability at the same time. PTFE resin has excellent properties such as heat resistance, chemical resistance, and non-dusting properties, making it difficult to maintain alternative properties. 7: In order to maintain the processing performance of the image processing system, a high heat dissipation capability is required, and alternative characteristics cannot be maintained.
Heat-resistant	2: 125 degree Celsius (Equal to or better than the current situation.) 4: 200 / 200 degree Celsius
Light fastness/ Weather fastness	4: No functional deterioration in the range from UV light to infrared light (300nm to 2000nm)
Flame resistance	2: Flame resistance VW-1 or higher
Effect on reflectance/transmittance	4: Effect on reflectance/transmittance is within 0.3
Substitution	Substitution unknown

27. Coding for sliding rubber parts of industrial controllers

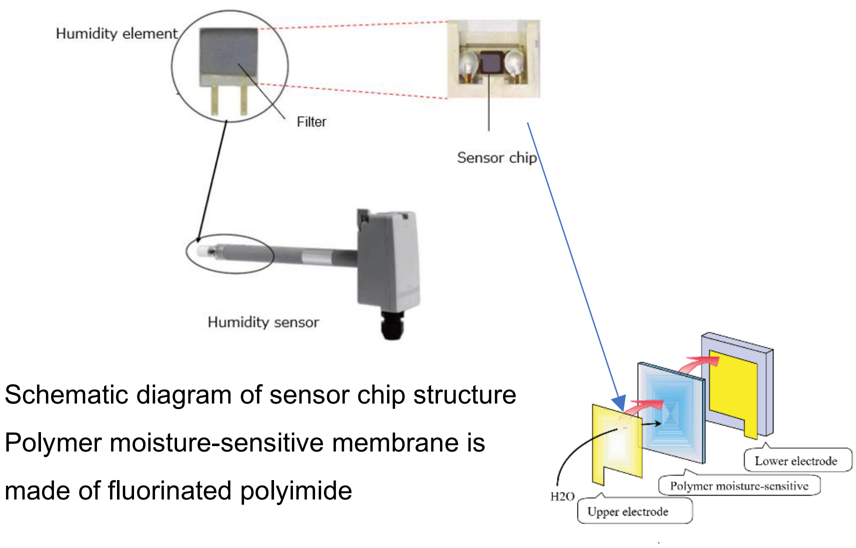
Essential Application	
Main use sector	Electronics and semiconductors etc.
Application/ HTS code	Coding for sliding rubber parts of industrial controllers / 9032.89.60.40
CAS RN	9002-84-0
Regulated candidate substance name	Polymeric PFAS / PTFE
Generic name for the final product	Industrial controller
Common name for application parts	Packing
Detailed application description	A PTFE-coated lubricant is applied to the outer circumference of the packing to make it easier to separate the front bezel from the case. Since the housing is made of resin, there is a risk of solvent cracking, and grease cannot be used.  Fig.1 Overall product  Fig.2 Packing installation explanatory diagram
Technical Description of Essential Uses	・ The film does not peel off when applied to rubber parts. (Good adhesion) ・ Good lubricity and no effect on plastics. (No solvent cracks occur)
Coating durability	Coatings on rubber parts do not degrade over time
Sliding performance	Sliding performance for mounting and dismounting
Chemical stability	No impact on plastic cases due to chemical stability (no volatiles or leachables)

28. Temperature sensor

Essential Application	
Main use sector	Electronics and semiconductors etc.
Application/ HTS code	Temperature sensor / 9032.89.60.40, 8538.90.40.00, 9025.19.80
CAS RN	Unidentified
Regulated candidate substance name	1. Conductor coating / FEP 2. Protective tube / FEP 3. FEP tube /FEP 4. Coating /FEP, PFA
Generic name for the final product	Temperature sensor
Common name for application parts	1. Conductor coating 2. Protective tube 3. FEP tube 4. Coating
Detailed application description	1. Used in the coating for the thermocouple wires 2. Protection of the swage part 3. Protection of the sheath 4. Used in the fluorine coating for protective tube and sheath 
Technical Description of Essential Uses	1. Conductor coating It is used to ensure heat resistance, moisture resistance and chemical resistance; however, there is no substitutable parts. 2. Protective tube It is used to ensure heat resistance, moisture resistance and chemical resistance; however, there is no substitutable parts. 3. FEP tube It is used to ensure heat resistance, moisture resistance and chemical resistance; however, there is no substitutable parts. 4. Coating It is used to ensure heat resistance, moisture resistance and chemical resistance; however, there is no substitutable parts.

29. Humidity sensor

<table>
<tr><th colspan="2">Essential Application</th></tr>
<tr><td>Main use sector</td><td>Electronics and semiconductors
Construction products etc.</td></tr>
<tr><td>Application/
HTS code</td><td>Humidity sensor / 9025.80.10.00</td></tr>
<tr><td>CAS RN</td><td>Unidentified</td></tr>
<tr><td>Regulated candidate substance name</td><td>Polymeric PFAS /
Fluorinated polyimide</td></tr>
<tr><td>Generic name for the final product</td><td>Humidity sensor, Dew point temperature sensor</td></tr>
<tr><td>Common name for application parts</td><td>Humidity element</td></tr>
<tr><td>Detailed application description</td><td>The humidity sensor chip used for a humidity sensor and a dew point temperature sensor measures humidity by capacitance change between electrodes sandwiching the moisture sensitive film. The thickness of the moisture sensitive film is several μm.

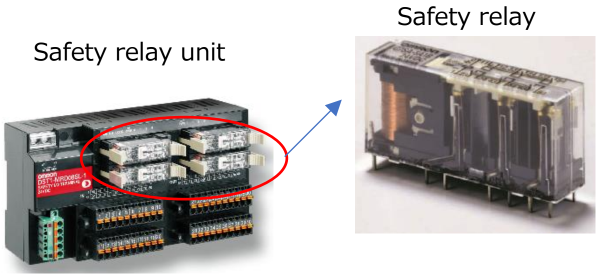
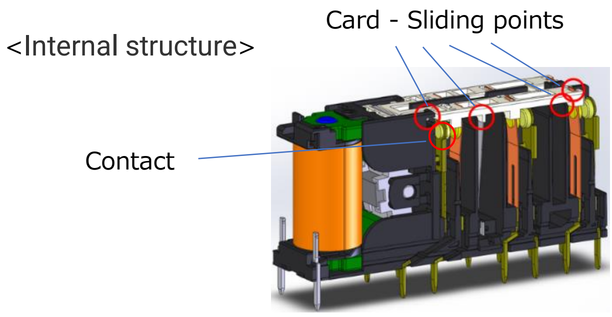


This humidity sensor is used for the following purposes
Humidity sensor installed in an environment in which condensation appears on the sensor itself, such as inside the HVAC duct and the outside air intake section.</td></tr>
<tr><td>Technical Description of Essential Uses</td><td>The following features can be obtained by using fluoride polyimide for humidity sensor
The humidity sensor works stably for a long period in an environment where the sensor is condensed (100% humidity).
Nothing to replace this function.
The humidity sensor has higher stability under high temperature, high humidity and organic solvent atmosphere than other products due to the humidity sensitive membrane using fluorinated polyimide.

The prohibition of this technology is concerned about the following effects.</td></tr>
</table>

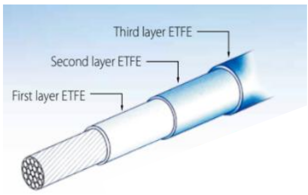
	• It won't be able to properly measure and control humidity on HVAC system in an environment in which condensation appears on the sensor itself. • Other polymer materials such as methyl methacrylate resin (PMMA), polyimide, polysulfone, etc. can be candidates as alternative technologies and materials. • Alternative technology requires replacement of the sensor every time condensation occurs. For example, it is known that condensation appears on a humidity sensor which is inserted into an outside air intake duct several times a year depending on the weather. Humidity sensors without moisture sensitive membrane using fluorinated polyimide for this application will require replacement at least once a year. Moisture sensitive membranes using fluorinated polyimide can withstand at least 8 years of use. • For the reasons mentioned above, the ban on fluorinated polyimide in humidity sensors should be exempted indefinitely because of the economic burden of increased replacement frequency. • From the point of view of disposal, the use of fluorinated polyimide in the humidity sensor should not be restricted as it generally leads to waste reduction.
Heat-resistant	180°C as a humidity sensitive film
Light fastness/ Weather fastness	Weather fastness: 100%RH
Water-repellent	Electrical insulation in condensing environments
Required derogation period	13.5 years or more
Socio-economic impact	Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes.

30. Safety controller

Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Safety controller / 8536.4*
CAS RN	69991-67-9, 60164-51-4, 1623-05-8, 25038-02-2 and more
Regulated candidate substance name	PFPE [Perfluoropolyether]
Generic name for the final product	Same as above application
Common name for application parts	Card Contact
Detailed application description	  It is used to reduce frictional resistance on the sliding part (card) of the safety controller built into the safety relay unit to achieve high mechanical durability and reliability. And it is used in coatings to protect contacts from dirt, reduce frictional resistance, and maintain high reliability.
Technical Description of Essential Uses	The technically difficult points of substitution are as follows. • Fluorinated lubricants are commonly used in several relays because they can be easily diluted with similar fluorinated solvents and can be applied evenly and easily dried. • Because relay has contacts structure, contact reliability is reduced due to abrasion powder generated when plastic or metal parts mechanically operate. • Decrease in stability of relay operation due to increased friction of sliding parts.

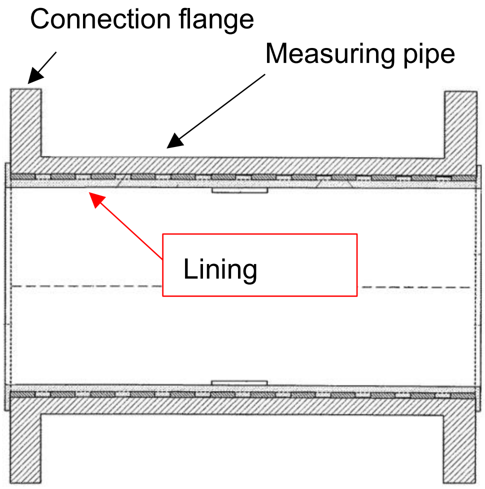
Low friction/wear resistant	When parts slide, there is no generation of abrasion powder that causes poor contact of contacts.

31. Switching power supply / Transformer

Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	Switching power supply / 8504.3* Transformer / 8504.3*
CAS RN	9002-84-0, 26655-00-5, 25038-71-5
Regulated candidate substance name	PTFE [Polymer of 1,1,2,2-tetrafluoroethene] PFA [Tetrafluoroethylene-co-perfluoro (Alkyl vinyl ether)] ETFE [Polyethene-co-tetrafluoroethene]
Generic name for the final product	Same as above application
Common name for application parts	Insulation Wire Non-heat shrinkable Tube
Detailed application description	1. Used for the cable of Switching power supply/ Transformer 2. Used for tube of Seal parts << Schematic Cross-sectional View >> Cable  Tube  1. Insulated wires ETFE or PFA insulated wires are used for transformers installed in power supply equipment, and the main component is ETFE or PFA. ETFE and PFA resin have a low dielectric constant and a high heat resistance of 200°C, so the wire coating can be made thinner. It is essential for miniaturization and weight reduction of equipment. 2. Non heat shrink tubing The transformer installed in the power supply equipment uses non-heat shrinkable polytetrafluoroethylene (PTFE) tube, and the main component is PTFE. Even though the PTFE tube is thin, it has high insulation performance and heat resistance. There is no alternative material that can be used in applications where there is not enough space for insulation and meets the requirements in tight spaces.

32. Measuring pipe lining material for industrial electromagnetic flowmeters

<table>
<tr><th colspan="2">Essential Application</th></tr>
<tr><td>Main use sector</td><td>Energy sector
Petroleum and mining etc.</td></tr>
<tr><td>Application/
HTS code</td><td>Measuring pipe lining material for industrial electromagnetic flowmeters / 9026.10.20.40</td></tr>
<tr><td>CAS RN</td><td>ETFE : 25038-71-5
PFA : 26655-00-5</td></tr>
<tr><td>Regulated candidate substance name</td><td>Polymeric PFAS /
ETFE, PFA</td></tr>
<tr><td>Generic name for the final product</td><td>Industrial electromagnetic flow meter</td></tr>
<tr><td>Common name for application parts</td><td>Measuring pipe</td></tr>
<tr><td>Detailed application description</td><td>

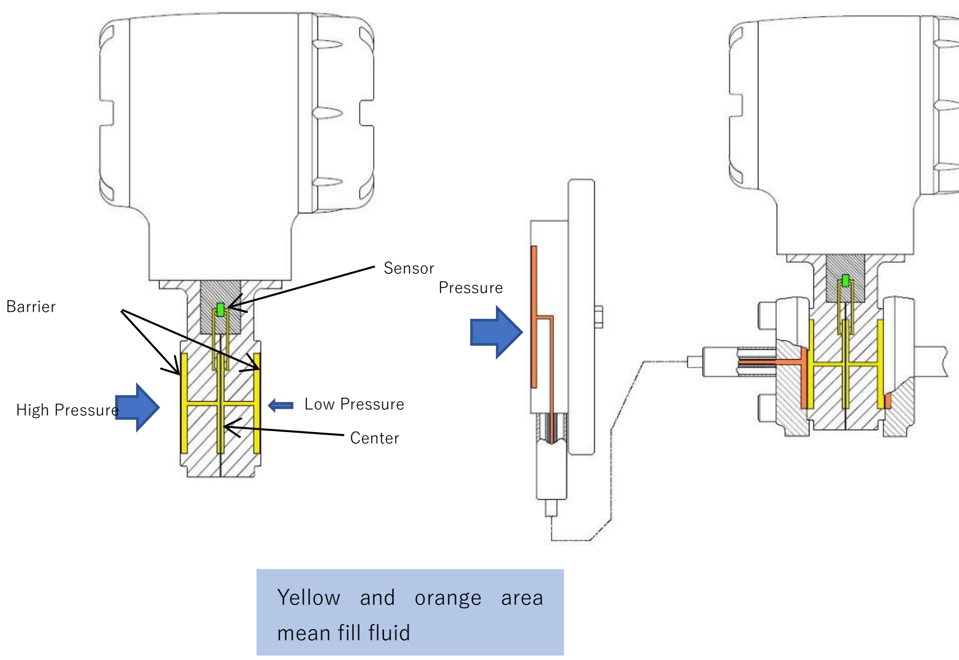


Industrial electromagnetic flowmeters are inserted into pipes that require measurement and are used as part of large-scale equipment such as industrial chemical plants.</td></tr>
<tr><td>Technical Description of Essential Uses</td><td>Industrial electromagnetic flowmeters measure corrosive fluids such as chemicals as an application.
The measurement of corrosive fluids such as chemicals is 30% of the applications of industrial electromagnetic flowmeters.
Industrial electromagnetic flowmeter is required to have performance that can withstand the measurement of corrosive fluid.

In order to measure corrosive fluids with industrial electromagnetic flowmeters, PFA and ETFE measurement pipe linings are required in the flow path where the corrosive fluids come into contact.
• Other polymeric materials, such as rubber and resin, may be used as substitutes for the lining of measuring pipes with PFA and ETFE. However, the alternative materials have poor resistance to various chemicals in industrial chemical plants</td></tr>
</table>

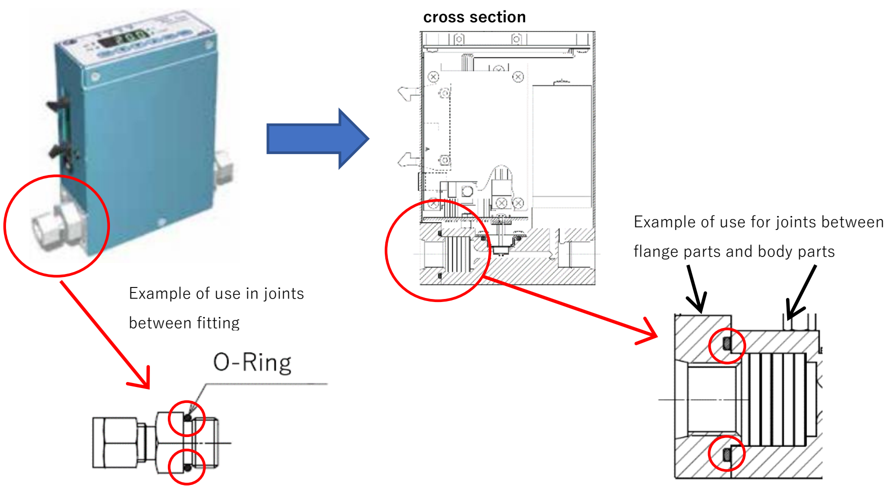
	and cannot withstand corrosive fluids. ・ In alternative technologies and materials, it is necessary to replace the industrial electromagnetic flowmeter itself because the electromagnetic flowmeter itself connected to the pipe is stopped and the corrosion status is periodically checked, and when corrosion occurs, the flow measurement cannot be performed. Electromagnetic flowmeters using ETFE and PFA measuring pipe linings can operate stably for at least 10 years without confirmation. There are concerns about the following impacts due to the unavailability of this technology ・ Production efficiency in production plants for corrosive fluids such as chemicals will drop significantly due to the inability to use lining materials for measuring pipes using PFA and ETFE for industrial electromagnetic flowmeters. This affects the production and supply of chemical products. For the above reasons, the prohibition of lining of measuring pipes by PFA and ETFE in industrial electromagnetic flowmeters should be exempted indefinitely from this restriction due to the economic burden caused by the increase in the frequency of periodic checks and replacements due to equipment shutdowns. From the viewpoint of disposal, restrictions should not be applied because the use of PFA and ETFE lining of measuring pipes in industrial electromagnetic flowmeters allows the electromagnetic flowmeter to be used until it reaches its original service life, which generally leads to a reduction in waste.
Heat-resistant	Must withstand fluids up to 160°C
Chemical resistance	No corrosion from corrosive fluids
Wear resistance	Less wear from abrasive slurry fluids
No-adhesion	Less sticking with sticky slurry fluids
Required derogation period	13.5 years or more Note: This application should have the same derogation period as petroleum and mining.
Socio-economic impact	Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes.

33. Fill Fluid for chlorine or oxygen pressure measurement

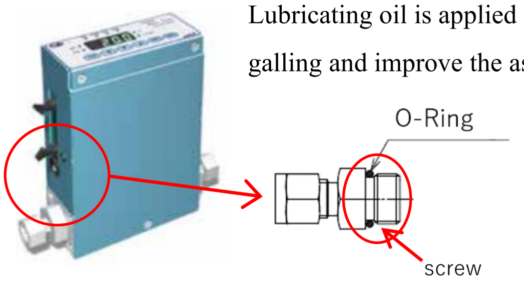
Essential Application	
Main use sector	Energy sector Petroleum and mining etc.
Application/ HTS code	Fill Fluid for chlorine or oxygen pressure measurement / 9026.10.20.40
Application	Fill Fluid for chlorine or oxygen pressure measurement
CAS RN	79-38-9/9002-83-9/113114-19-5
Regulated candidate substance name	PFAS-based lubricant oil / PCTFE / Perfluoropolytrimethyleneoxide
Generic name for the final product	Industrial Pressure Transmitter
Common name for application parts	Fill Fluid for chlorine or oxygen pressure measurement
Detailed application description	Pressure Transmitter 1) Measuring Principal A pressure transmitter consists of a barrier diaphragm that contacts the process pressure, a center diaphragm that protects the sensor, and a sensor that detects the pressure. If there is a difference in pressure on each barrier diaphragm, the fill fluid that carries the pressure creates a pressure difference on either side of the sensor, which distorts the sensor and changes its resistance. Measure the pressure by converting the resistance change of the sensor. Standard type Remote type 
Technical Description of Essential Uses	In addition to the following items, the properties required for the fill fluid include fluidity even at low temperatures, low viscosity, and nonflammability. The only fill fluid that offers all of these is the fluorinated fill fluid, and there is no alternative. In addition to the following items, the properties required for the fill fluid include fluidity even at low temperatures, low viscosity, and nonflammability. The only fill fluid that offers

	all of these is the fluorinated fill fluid, and there is no alternative. The diaphragms that come into contact with process fluids may be damaged due to corrosion or abrasion during use. When broken, the fill fluid comes into direct contact with the process fluid, but otherwise does not leak into the environment. This product is a WEEE target model and is in a controlled state for disposal. Silicon oil is the most likely alternative, but it reacts with chlorine and oxygen at high temperatures and pressures and explodes in the worst case.
Heat-resistant	Sealed liquid is required to have heat resistance.
chemical resistance	Stable against strong corrosive acids and alkalis.
chemical stability	Does not react with chlorine and oxygen even under high temperature and pressure.
electrical insulation	Since the fill fluid is in direct contact with the sensor, high electrical insulation performance is required.
Required derogation period	13.5 years or more Note: This application should have the same derogation period as petroleum and mining.
Socio-economic impact	Problem with the safety of the worker. Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes.

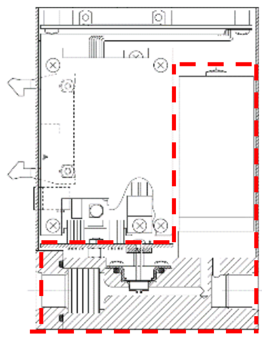
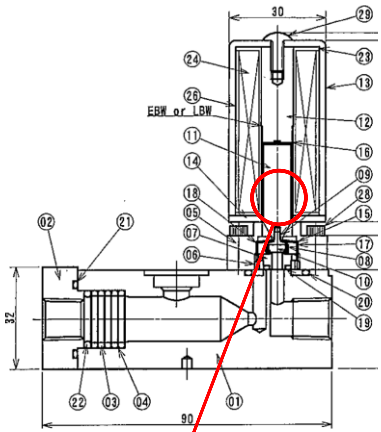
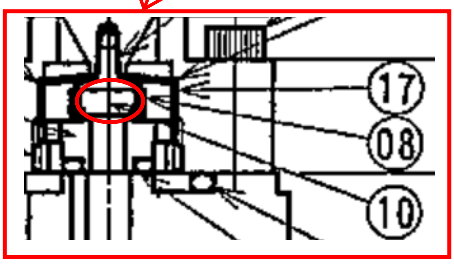
34. Mass Flow Controller seal

Essential Application	
Main use sector	Electronics and semiconductors etc.
Application/ HTS code	Mass Flow Controller seal / 9026.10.20.40
CAS RN	Unidentified
Regulated candidate substance name	Fluorine rubber / FKM
Generic name for the final product	Mass Flow Controller Mass Flow Meter Piping joints used for measurement and control equipment
Common name for application parts	O-ring
Detailed application description	O-rings are used as sealing parts to prevent external leakage at joints between different parts. **<Mass flow controller usage example>** 
Technical Description of Essential Uses	FKM is used for various gases with excellent heat resistance, chemical resistance, ozone resistance, etc., especially when using flammable oxygen gas, it is used due to its high heat resistance and ozone resistance, and the alternative product is a special rubber material, but it becomes a fluorine-based rubber material and the use of fluorine-based substances is unavoidable. If fluorine-based materials are not used, safety is significantly impaired.
Heat-resistant	The flexibility of rubber does not change from -10°C to +60°C
Chemical resistance	Chemical resistance to withstand components contained in combustible gases
Ozone resistance	Resistant to ozone gas
Required derogation period	13.5 years or more
Socio-economic impact	Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes.

35. Mass Flow Controller lubricant oil

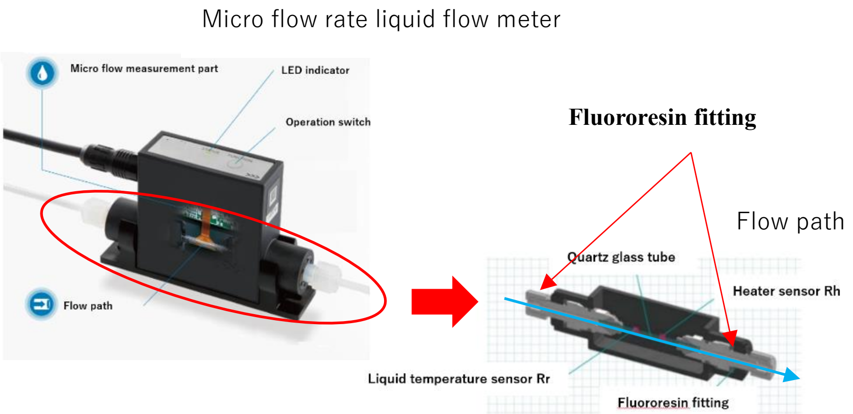
Essential Application	
Main use sector	Electronics and semiconductors etc.
Application/ HTS code	Mass Flow Controller lubricant oil / 9026.10.20.40
CAS RN	Unidentified
Regulated candidate substance name	PFAS-based lubricant oil / PFPE (Perfluoropolyether)
Generic name for the final product	Mass Flow Controller Mass Flow Meter Piping joints used for measurement and control equipment
Common name for application parts	lubricant
Detailed application description	Mass flow controllers and mass flow meters are used for flow control and flow measurement of various industrial gases.  Lubricating oil is applied to joint screws and O-rings to prevent screw galling and improve the assembly of O-rings.
Technical Description of Essential Uses	Ordinary grease and oil cannot be used because they may become a source of ignition when flammable oxygen gas is used, so their safety is significantly impaired.
Chemical stability	Chemical stability that does not react to combustion-supporting gases such as oxygen
Required derogation period	13.5 years or more
Socio-economic impact	Problem with the safety of the worker. Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes.

36. Control valve of mass flow controller

Essential Application	
Main use sector	Electronics and semiconductors etc.
Application/ HTS code	Control valve of mass flow controller / 9026.10.20.40
CAS RN	9002-84-0
Regulated candidate substance name	Polymeric PFAS / PTFE
Generic name for the final product	Mass Flow Controller
Common name for application parts	Control valve
Detailed application description	Mass flow controllers are used for flow control of various industrial gases.  PTFE is used as the material of the valve body of the flow control valve of mass flow controller. See part (10) in the figure below (the right is a partial enlarged view).  Cross-sectional view of the product   Cross-sectional view of the valve  Enlarged view

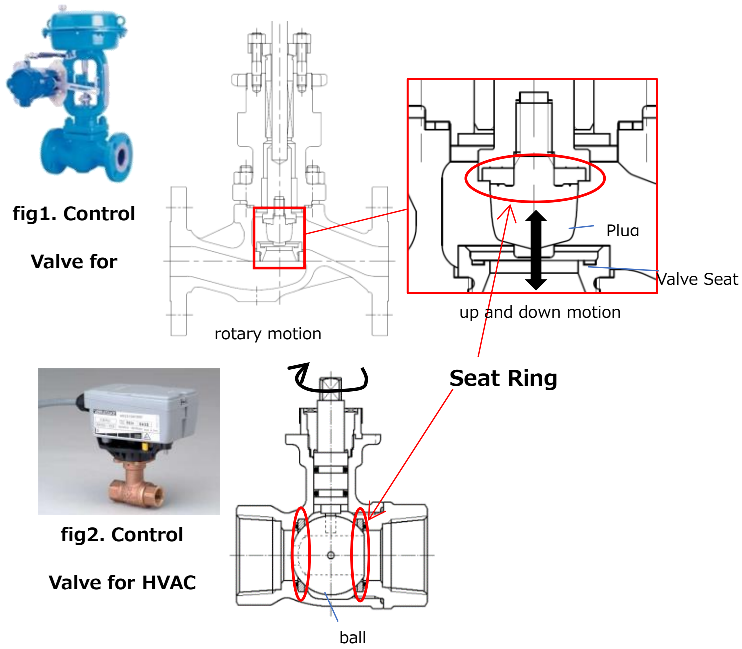
Technical Description of Essential Uses	PTFE has high corrosion resistance and heat resistance. As an alternative, rubber materials will be used, but it will be fluorine-based rubber materials and the use of fluorine-based substances is unavoidable.
Heat-resistant	Heat resistant to withstand operation from -10°C to +60°C
Chemical resistance	Chemical resistance to withstand components contained in combustible gases
Ozone resistance	Resistant to ozone gas
Required derogation period	13.5 years or more
Socio-economic impact	Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes.

37. Fittings for micro-flow rate liquid flow meter for semiconductor manufacturing process

Essential Application	
Main use sector	Electronics and semiconductors etc.
Application/ HTS code	Fittings for micro-flow rate liquid flow meter for semiconductor manufacturing process / 9026.10.20.40
Application	Fittings for micro-flow rate liquid flow meter for semiconductor manufacturing process
CAS RN	26655-00-5 9002-84-0
Regulated candidate substance name	Polymeric PFAS / PFA, PTFE
Generic name for the final product	Micro flow rate liquid flow meter
Common name for application parts	Fitting
Detailed application description	Micro flow liquid flow meters are used to measure micro flow rates of fluids used in semiconductor manufacturing processes. If impurities are mixed in the fluid used in the semiconductor manufacturing process, it will adversely affect the yield of semiconductor production. The liquid flow path inside the micro flow rate liquid flowmeter is composed of a quartz glass tube that does not elute into the fluid. Fluororesin is used for the fitting of the micro flow rate liquid flow meter. 
Technical Description of Essential Uses	Semiconductor manufacturing process is required high level chemical controls, due to chemical contamination makes negative influences on quality of products. PTFE and PFA which are inert to various chemicals and also include low additives, are suitable materials for flow paths in semiconductor manufacturing process. Impact of prohibition using PFA, PTFE It will be impossible to keep miniaturization technology used in current semiconductor manufacturing process.

	To avoid this problem would require a great deal of effort and technical innovation.
Chemical resistance	Resistant to chemicals and solvents fluids
Cleanliness performance	Cleanliness performance without elution and volatilization of components from components
Required derogation period	13.5 years or more Note: This application should have the same derogation period as semiconductor manufacturing processes.
Socio-economic impact	Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes. Yield deterioration in the semiconductor manufacturing process

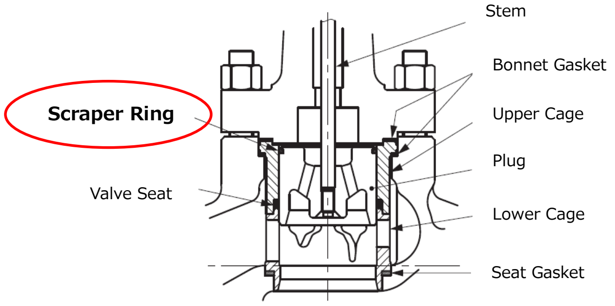
38. Control valve seat ring

Essential Application	
Main use sector	Energy sector Petroleum and mining etc.
Application/ HTS code	Control valve seat ring / 8481.**
CAS RN	9002-84-0
Regulated candidate substance name	Polymeric PFAS / PTFE
Generic name for the final product	Control valve
Common name for application parts	Seat ring
Detailed application description	Control valves are used in a variety of different markets that controls fluid flows in plumbing installed in air conditioning system of building, and Industrial plants, for example petrochemical and power plant. Seat ring is a component of control valves that has a function of stopping the flow by contacting with the plug when it is fully closed.  fig1. Control Valve for fig2. Control Valve for HVAC
Technical Description of Essential Uses	In case of the control valve in fig1, the tight contact load with the PTFE seat ring is generally lower than the contact load with metal seat ring. In case of the control valve fig2, the ball rotates to control flow while sliding with the seat ring. By using the PTFE for the seat ring, it makes possible to reduce operation torque of ball because of low friction. Hence it is enough to operate control valves with PTFE seat ring by downsized actuator. As the results, the downsizing of actuators contributes to reduce usage of metal materials and consumption of energy for the valve operation.

	In general, the friction coefficient of PTFE (0.1 or less) is approximately 1/5 that of metal (approximately 0.5), and the torque required to rotate the plug is approximately 1/5 in proportion to the friction coefficient. Add that, corrosive and high temperature fluid flows through control valves. So, excellent chemical and heat resistance are required to control valves. PTFE fills all of characteristics aforementioned. Furthermore, it has proven track record of long-term use in various fields. It is extremely difficult to use alternate materials simultaneously satisfy the requirements of heat resistance, chemical resistance, sliding performance and seal performance. Hence it is hard to replace PTFE.
Heat-resistant	Heat resistance that can withstand high temperatures of 230°C
chemical resistance	Resistant to water control chemicals and steam containing chemicals
Sliding performance	Wear resistance due to sliding, sliding performance.
Seal performance	High sealing performance with low clamping force
Required derogation period	13.5 years or more Note: This application should have the same derogation period as petroleum and mining.
Socio-economic impact	Upsizing of equipment. Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes.

39. Material for scraper rings in industrial control valves

<table>
<tr><th colspan="2">Essential Application</th></tr>
<tr><td>Main use sector</td><td>Energy sector
Petroleum and mining etc.</td></tr>
<tr><td>Application/
HTS code</td><td>Material for scraper rings in industrial control valves / 8481.**</td></tr>
<tr><td>CAS RN</td><td>9002-84-0</td></tr>
<tr><td>Regulated candidate substance name</td><td>Polymeric PFAS /
PTFE</td></tr>
<tr><td>Generic name for the final product</td><td>Industrial Control valve</td></tr>
<tr><td>Common name for application parts</td><td>VALVE SCRAPER RING</td></tr>
<tr><td>Detailed application description</td><td>

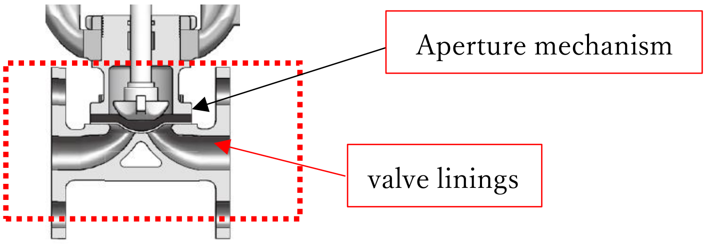


Industrial control valves are installed in pipes of various industrial plants, that are used to control flow of fluids.
Scraper Rings can scrape fluid attached on a cage of the control valve. Scraper Rings have functions to prevent plug-cage sticking.</td></tr>
<tr><td>Technical Description of Essential Uses</td><td>Industrial control valves control corrosive fluids such as chemicals depend on facilities, therefore they must be able to use for the corrosive fluids.
However, it is difficult to identify some corrosive fluid because we can hardly grasp intermediate substances produced by chemical reactions in the chemical production process. Therefore, it is necessary that the control valves have wide range of chemical resistance.

PTFE scraper rings are indispensable parts contacted with corrosive fluid for control flow of the fluid.
Other polymer materials, such as rubber and resin, might be able to substitute for PTFE as the material of scraper rings. However, it is considered that the alternative materials are not suitable, because they do not have enough resistance to various chemicals of chemical plants.
If PTFE substitutes for the alternative material, the control valves and other facilities are regularly stopped to maintain to check corrosive status. Then if corroded parts are found, they should exchange new parts.</td></tr>
</table>

	If use of PTFE scraper ring is prohibited, following influence is concerned. - Productivity of the plants manufacturing the corrosive fluid such as chemicals will decrease markedly, thereby influencing production of chemical products. - Prohibition of PTFE scraper ring will cause increase of maintenance number, thereby increasing economic load and industrial waste from the maintenances. For above reasons, Prohibition of PTFE scraper ring should be exempt from this restriction indefinitely.
Heat-resistant	Heat resistance that can withstand high-temperature fluids of 230°C
chemical resistance	Corrosion resistance with corrosive fluids
Wear resistance	Less wear from abrasive slurry fluids
No-adhesion	Less sticking with sticky slurry fluids
Required derogation period	13.5 years or more Note: This application should have the same derogation period as petroleum and mining.
Socio-economic impact	Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes.

40. Lining and throttling mechanism materials for industrial control valves

Essential Application	
Main use sector	Energy sector Petroleum and mining etc.
Application/ HTS code	Lining and throttling mechanism materials for industrial control valves / 8481.**
CAS RN	25038-71-5 26655-00-5 9002-84-0
Regulated candidate substance name	Polymeric PFAS / ETFE, PFA, PTFE
Generic name for the final product	Industrial Control valve
Common name for application parts	VALVE BODY
Detailed application description	Industrial control valves are installed in pipes of various industrial plants, that are used to control flow of fluids. Industrial control valves are used to control corrosive fluids such as chemicals. 
Technical Description of Essential Uses	Industrial control valves are required to be able to withstand the control of corrosive fluids at high temperatures. In order to control corrosive fluids with industrial control valves, main body linings and throttle mechanisms made of PFA, ETFE and PTFE are required in the flow passages where corrosive fluids come into contact. ・ It is possible that other polymer materials such as rubber and resin can be used as alternative materials for body lining and throttle mechanism using PFA, ETFE, and PTFE. However, alternative materials have poor resistance to a wide variety of chemicals in industrial chemical plants and cannot withstand corrosive fluids. ・ If it is assumed that metal materials such as chromium and nickel alloys will be substituted, it is necessary to periodically stop the equipment and check the corrosion status of the control valves connected to the pipes. When corrosion occurs, fluid control becomes impossible, so it is necessary to replace the industrial control valve itself.

	The use of PFA, ETFE, and PTFE as lining and throttling mechanism materials for industrial control valves may cause the following concerns: ・ The production efficiency in plants handling corrosive fluids, such as chemicals, may significantly decrease, thereby impacting the production and supply of chemical products. For above reasons, Prohibition of PTFE scraper ring should be exempt from this restriction indefinitely. In terms of disposal, the restriction should not be applied to valves containing PFA, ETFE, and PTFE since these components can be used until the product reaches its original service life, leading to a reduction of waste in general.
Heat-resistant	Heat resistance that can withstand high-temperature fluids of 140°C
chemical resistance	Corrosion resistance with corrosive fluids
Wear resistance	Less wear from abrasive slurry fluids
No-adhesion	Less sticking with sticky slurry fluids
Required derogation period	13.5 years or more
Socio-economic impact	Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes.

41. Valve for air volume and room pressure control

<table>
<tr><th colspan="2">Essential Application</th></tr>
<tr><td>Main use sector</td><td>Medical devices
Construction products etc.</td></tr>
<tr><td>Application/
HTS code</td><td>Materials for ensuring slidability, corrosion resistance, chemical resistance, and solvent resistance for airflow valves / 8481.**, 8415.10</td></tr>
<tr><td>CAS RN</td><td>26655-00-5
9002-84-0
24937-79-9
25038-71-5</td></tr>
<tr><td>Regulated candidate substance name</td><td>Polymeric PFAS /
PFA, PTFE, PVDF, ETFE</td></tr>
<tr><td>Generic name for the final product</td><td>Valve for air volume and room pressure control</td></tr>
<tr><td>Common name for application parts</td><td>Body, Pivot arm, S-link, Shaft, Spring, Cone, Brackets, Seal, Tap, e-crip, Bush, Slider, Sleeve, Cap, Bolt</td></tr>
<tr><td>Detailed application description</td><td>
The two main applications of valves are below.

(1) To be installed as a local exhaust ventilation system to prevent workers from being exposed to substances harmful to the human body, such as in chemical manufacturers and biotechnology research laboratories.
For example, when a worker opens or closes the door of the local exhaust device (red dotted frame in Fig.1), the differential pressure across the valve suddenly changes, but by taking advantage of the good sliding property, the valve can be instantly changed to the appropriate valve opening position to maintain exhaust at a constant air volume.
In addition, since valves must control fluids containing various chemicals and solvents, they must be resistant to corrosion, chemicals, and solvents.

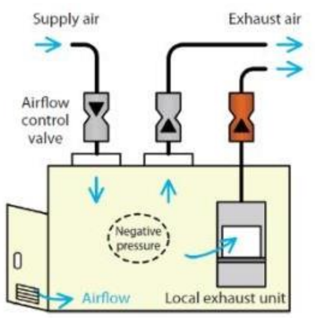


Fig.1 Example of air volume control in a chemical

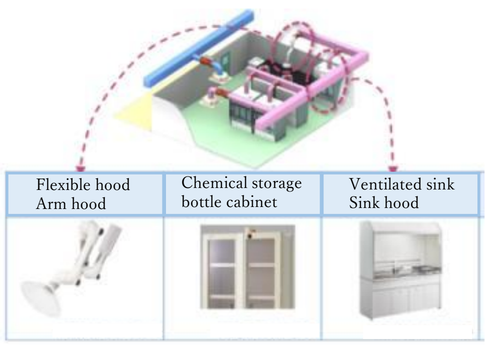


Fig.2 Other exhaust applications

(2) The device is installed in hospital rooms and wards as a negative-positive pressure control device to secure hospital beds for patients with infectious diseases and to protect healthcare workers from infection risk.
Even when the differential pressure across the valve suddenly changes due to the opening and closing of the hospital room entrance door, etc., the air supply and exhaust valves respond instantly by taking advantage of their good sliding characteristics and change to the appropriate opening position, thereby always maintaining the pressure difference between the room and outside.
</td></tr>
</table>

	(see below)

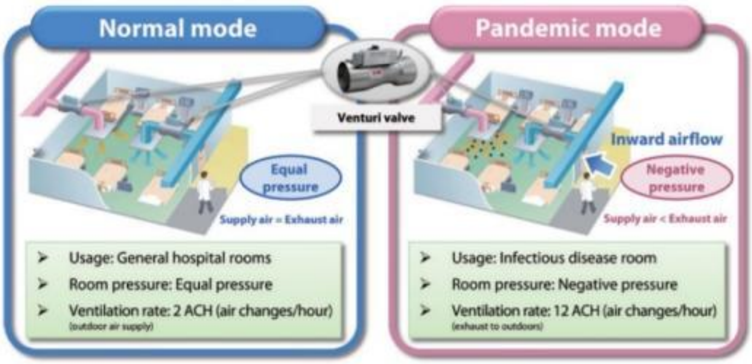


Fig.3 Image of negative and positive pressure control in a hospital room

The parts used in valves that include candidates for regulation are below.

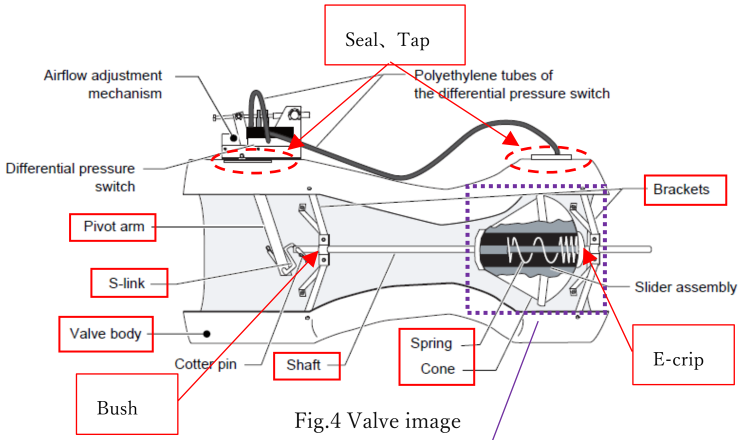


Fig.4 Valve image

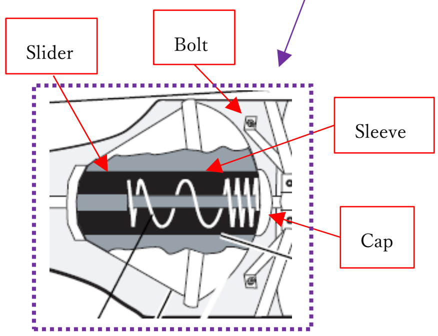


Fig.5 Slider assembly

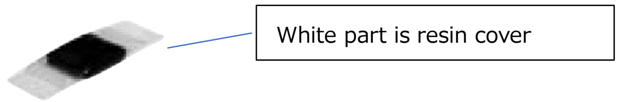
(1) For valves that do not require corrosion resistance, chemical resistance, or solvent resistance, parts (Slider, Sleeve, Cap) containing PTFE should be used to ensure sliding properties.

(2) Valves that require corrosion resistance, chemical resistance, and solvent resistance use the following parts to ensure the above three functions and sliding properties.

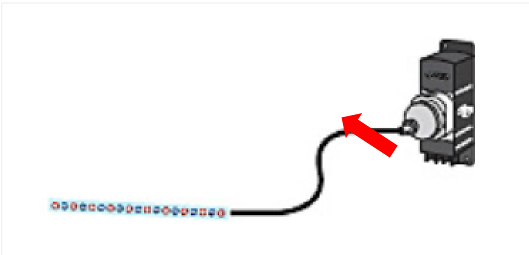
- Parts containing PTFE (Slider, Sleeve, Cap, Bush, Seal, Tap)
- Parts containing PFA (Shaft, Spring)
- Parts containing PVDF or ETFE (Body, Pivot arm, S-link, Cone, E-crip, Bolt)

Technical Description of Essential Uses	As mentioned above in “Detailed application description”, valves must have the sliding property required to respond instantly to sudden disturbances, and the corrosion, chemical, and solvent resistance required to control fluids containing various chemicals and solvents. Therefore, it is necessary to place parts containing PTFE, PFA, PVDF, and ETFE for mechanisms that need to ensure sliding properties and for channel parts that are in contact with the control fluid. (1) Ensure sliding properties Other polymeric materials may be used as an alternative to PTFE for ensuring sliding properties. However, since there is no material with lower sliding resistance than PTFE, the sliding resistance force will increase and the sliding performance required for valves cannot be ensured. (2) Ensure sliding properties, corrosion resistance, chemical resistance, and solvent resistance Other polymeric materials, such as rubber and resin, may be used as alternatives to PFA, PTFE, PVDF, and ETFE for the purpose of ensuring the above four functions. However, the alternative materials cannot ensure the sliding properties, corrosion resistance, chemical resistance, and solvent resistance required for valves due to the deterioration of sliding properties as described in (1) and the lack of resistance to various chemicals and solvents. The following effects are feared as a result of the unavailability of these technologies. The inability to use PFA, PTFE, PVDF, and ETFE for valves will make it impossible to carry out normal operations at chemical manufacturers, biotechnology research facilities, hospitals, and other facilities. This will have a profound impact on the production and supply of medicines, the progress of research in biotechnology, and isolated medical treatment, including coronas. For the above reasons, the prohibition of the use of parts containing PFA, PTFE, PVDF, and ETFE in valves should be exempted from this restriction in terms of ensuring safety for the human body. In terms of disposal, the restriction should not be applied to valves containing PFA, PTFE, PVDF, and ETFE, since these components can be used until the product reaches its original service life, leading to a reduction of waste in general.
Heat-resistant	Heat-resistant max 93°C
chemical resistance	Resistant to chemicals, solvents and corrosive fluids
Sliding performance	Wear resistance due to sliding, sliding performance
No-adhesion	No-adhesion of foreign matter
Required derogation period	13.5 years or more
Socio-economic impact	Problem with the supplying specific pharmaceuticals. Problem with the safety of the biohazard test. Problem with the safety of pandemic countermeasures. Shorter operational lifetime. Increased frequency and costs of maintenance. Increased operational downtimes.

42. RFID tag and antenna

Essential Application	
Main use sector	Metal plating and manufacture of metal products Electronics and semiconductors etc.
Application/ HTS code	RFID tag and antenna / 8523.52.00.**
CAS RN	2655-00-5, 31784-04-0
Regulated candidate substance name	PFA (perfluoroalkoxy alkane)
Generic name for the final product	RFID tag and antenna
Common name for application parts	Cover
Detailed application description	 For chemical and spatter resistance, fluoroplastic-coated covers are attached to the tags and antennas.
Technical Description of Essential Uses	These RFID tags and antennas are specially designed for use in environments where chemicals are used or spatter flies from welding, etc. They are difficult to replace in order to maintain durability.

43. Ionizer

Essential Application	
Main use sector	Electronics and semiconductors etc.
Application/ HTS code	Ionizer / 8421.39.**
CAS RN	Unidentified
Regulated candidate substance name	Teflon
Generic name for the final product	Ionizer
Common name for application parts	Air tube
Detailed application description	A tube to send ionized air to the nozzle 
Technical Description of Essential Uses	Since electrical discharge causes increased concentration of ozone, an ozone-resistant air tube is required.

RECEIVED
By: OAH on 2/29/2024

Emi Yamamoto Attachment 1

February 29, 2024

JP4EE Input for Request for Comments on Currently Unavoidable Uses under Minnesota Session Law - 2023, Chapter 60, H.F. No. 2310

https://www.pca.state.mn.us/get-engaged/pfas-in-products-currently-unavoidable-use

Name of the associations which make this input:

The Japanese electric and electronic (E&E) industrial associations:

JEITA (Japan Electronics and Information Technology Industries Association)
CIAJ (Communications and Information Network Association of Japan)
JBMIA (Japan Business Machine and Information System Industries Association)
JEMA (Japan Electrical Manufacturers' Association)

With the endorsement of the following electric equipment manufacturers' coalition of medical devices, and analysis, measurement, test, control and monitoring instruments:

JAIMA (The Japan Analytical Instruments Manufacturers' Association),
JEMIMA (Japan Electric Measuring Instruments Manufacturers' Association),
JFMDA (The Japan Federation of Medical Devices Associations),
JIMA (Japan Inspection Instruments Manufacturers' Association),
JMIF (Japan Measuring Instruments Federation),
NECA (NIPPON ELECTRIC CONTROL EQUIPMENT INDUSTRIES ASSOCIATION),
SEAJ (Semiconductor Equipment Association of Japan), and
IGMA (Industrial Gas Detectors and Monitors Manufacturers Association).

Contact details of responsible person for this contribution:

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The Japanese electric and electronic (E&E) industrial associations – JEITA, CIAJ, JBMIA and JEMA (JP4EE) – hereby express gratitude to the Minnesota Pollution Control Agency (MPCA)'s for years of efforts to preserve, improve and prevent diminution of the natural environment of the State. We conduct our businesses in the US and all over the world and are firmly committed to protecting human health and the environment and to complying with chemical substance legislations as defined by the countries and regions where we operate. Also, we support active prevention or minimizing chemical pollution by PFAS. In this spirit, we have carefully and conscientiously examined the Request for comments on Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837, and would like to submit our comments and recommendations.

We would highly appreciate the MPCA would carefully consider our input.

General comment:

I. The restriction should be considered based on the risk assessment.

PFAS are a huge group of substances that include many different substances with varying levels of risk. Highly hazardous PFAS such as PFOS and PFOA are already restricted under the Stockholm Convention on Persistent Organic Pollutants (POPs). If other PFAS for which a hazard classification has not yet been identified are to be restricted, as a theory, a proper risk assessment should be conducted and the regulation should focus on applications with high exposure potential and well-established alternative technologies based on the outcome of the risk assessment.

Especially for the risk of fluoropolymers, Chemical industry explains as follows:

> "*Fluoropolymers do not pose a risk to human health or the environment as they are non-toxic, not bioavailable, non-water soluble, non-mobile and do not bio accumulate.*"

In complex articles such as electric and electronic equipment (hereinafter, EEE), most of PFAS essential uses are due to the use of fluoropolymers. If MPCA cannot provide more reasonable justification to restrict such fluoropolymers, it would be appropriate for MPCA to reconsider the proposed measures at least for fluoropolymers. If it is impossible because of the structure of the law, applications of fluoropolymers should be designated as CUU.

II. About essentialities of PFAS which is currently used in EEE

We would like to explain why and how PFAS is essential for certain uses as follows. Details are also specified in the answer to questions below and attachments.

Fluorinated materials are characterized by the combination of several properties, such as; Optical properties (e.g. high transparency, low refractive index), electrical properties (e.g. low dielectric constant, low dielectric loss tangent), durability (e.g. heat resistance, weather/light resistance, chemical resistance), surface functions (e.g. water repellent, oil repellent, low surface tension) and others (e.g. piezoelectric properties, high vapor pressure).

There are printed circuit boards where low dielectric constant, heat resistance and flame resistance are required, and fluorinated materials are suitable and actually used for this application. Non-fluorinated material cannot exist that can satisfy these three properties simultaneously. There are non-fluorinated materials that have each of these properties, but they cannot be mixed together to make an article that satisfies all three at the same time. Even if they could be mixed together, the material mixed would not satisfy heat resistance, as the lowest property of the three substances would appear with regard to thermal properties. The same applies to transparency, low refractive index, low dielectric constant, weather resistance and chemical resistance. When mixed with other materials, they are affected by the poor properties of the other materials and cannot maintain their good properties.

The cases where alternatives to fluorinated materials exist are limited to applications where only one properties, such as heat resistance, water repellency or insulating properties are required, and non-fluorinated materials cannot be used in applications where multiple properties must be achieved.

III. About the difficulties in replacing a substance in the complex articles.

For complex articles such as EEE, even a single substance survey will not work unless the entire global supply-chain responds appropriately to the survey.

When PFAS alternative which is considered really feasible would be found in the future, it is necessary to evaluate not only the safety of the potential PFAS alternative as chemicals but also fulfilment of the required performance with keeping safety and reliability using the alternative in each final product model.

Even if some alternatives are proposed by chemical manufacturers, there is no guarantee that the same performance as before can be obtained. When the substance concerned may be contained in parts having very important functions in products, product design will have to be carefully reviewed and it would take a long period. Even though some "similar" parts without the substance become available, many processes would be needed until the reliability and durability of a whole product can be finally guaranteed. Each level of article manufacturers (of parts, of components or units, and of finished products) must have their own technical processes for reviewing and developing substitution, testing its quality and reliability, and acquiring certification on applicable standards such as on safety as necessary.

Following is necessary step for typical EEE when substituting a substance for which viable alternatives are established. Please note that there are currently no feasible alternatives for essential uses of PFAS in EEE described in our Attachments.

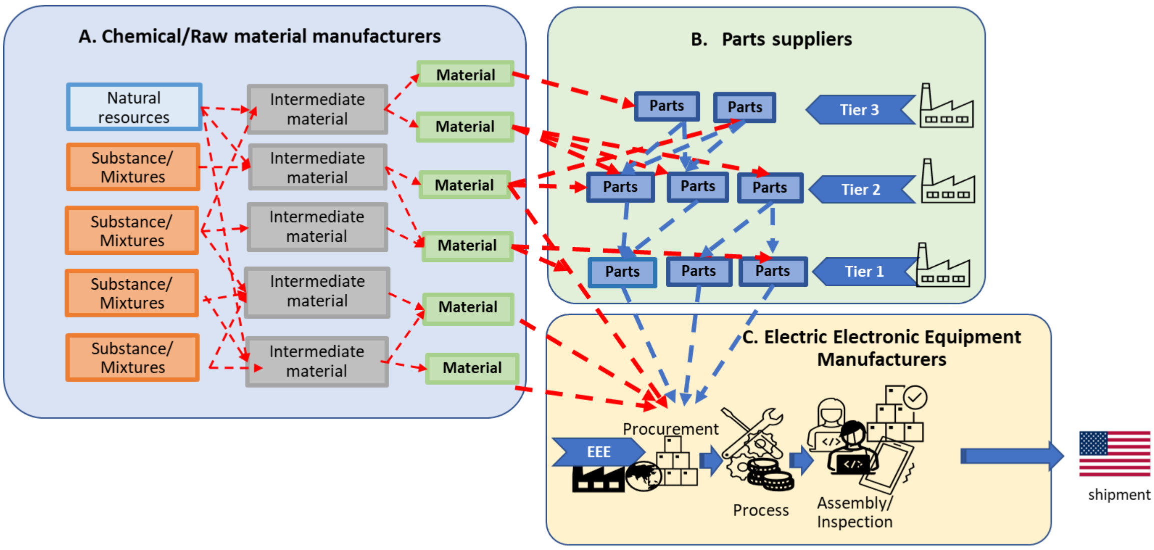
i. Procurement and Assessment of Substitute Parts with Suppliers

This includes following two actions:

- Identification of parts / materials containing PFAS
- Development and evaluation of alternatives at suppliers

EEE is composed of a large number of parts that may exceed tens of thousands of complex items. In addition, there are thousands of primary suppliers who supply parts directly, in complex and multi-layered supply chains with secondary and tertiary suppliers that supply parts for those parts. PFAS is a huge group of substances, and as the identifiers such as CAS RN are not specified for PFAS, the investigation becomes extremely difficult for the EEE manufacturers.

After the substance-containing parts / materials are identified, replacement by alternative products must be investigated.



ii. Internal Quality Assessments

Evaluation items differ depending on the category of the final product (i.e. EEE), but they can be roughly divided into the following items:

a. performance evaluation

b. long-term reliability evaluation

For performance evaluation, following actions are necessary: processing / molding test of purchased parts /materials, assembly test, and mechanical / electrical performance evaluation.

For long-term reliability evaluation, it includes an accelerated test under high temperature and high humidity conditions.

iii. Quality and Safety Certification

As an example, final products (EEE) acquiring IEC 62368-1 “Audio/video, information and communication technology equipment - Part 1: Safety requirements” certification needs to be certified for each individual product, but the acquisition period varies depending on the product specifications. It includes following steps:

a. the preparation of application documents to the issuance of type tests and test reports;
b. conducting factory audits of suppliers, if necessary.

In addition, changing the parts may require re-acquisition of other certifications such as EMC or energy conservation, which may take longer time.

iv. Supplier Coordination and Manufacturing Changes

At production plant of final product and parts / material suppliers, parts inventories are usually stocked for a certain period. In addition, lead time for new orders to suppliers after completion of replacement evaluation is necessary for another certain period. These periods cannot be uniformly shown since they vary depending on product type. Based on the supplying amount and timing of these inventories and alternative parts / materials and sales status of the final product, we determine the production plan. At the same time, manufacturing changes will be made to switch to alternative parts/materials. Necessary actions include changing the manufacturing process, designing prototype/verification, preparing prototype for pre-mass production /verification, and confirming mass production / quality.

IV. The definition of PFAS should be more clarified in harmonization with existing and well-known definitions.

Lastly, there are PFAS which are difficult to judge whether the Minnesota PFAS Law applies to or not due to uncertainty of the definition of PFAS under the Law. We would sincerely recommend implementing rules on reporting or Currently Unavoidable Uses to include supplementary explanation which enables to clarify the definition, or to harmonize with following definition (section 705.3 of TSCA SECTION 8(a)(7) REPORTING AND RECORDKEEPING REQUIREMENTS FOR PERFLUOROALKYL AND POLYFLUOROALKYL SUBSTANCE).

“Per- and polyfluoroalkyl substances or PFAS means any chemical substance or mixture containing a chemical substance that structurally contains at least one of the following three sub-structures:

(i) R-(CF2)-CF(R′)R″, where both the CF2 and CF moieties are saturated carbons;
(ii) R-CF2OCF2-R′, where R and R′ can either be F, O, or saturated carbons; or
(iii) CF3C(CF3)R′R″, where R′ and R″ can either be F or saturated carbons.

We would like to ask the MPCA to examine our input carefully taking into account the risk and benefit of the PFAS uniform ban.

JP4EE answers to the questions from the MPCA

Our input to the questions from the MPCA is as follows. Please note that we attach the attachment 1 to 6 as reference, which are those we have submitted to the State of Maine. There might be description which does not perfectly fit this Request for Comments:

1) Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

We believe the definitions are necessary. The definition should be harmonized among the States in order to ease sharing information among the authorities and to avoid unnecessary confusion in industries.

Concretely, we think the definition in 2. Definition (I) under the posting draft[1] proposed by the Maine Department of Environmental Protection (DEP) is appropriate and reasonable.

> *"Essential for Health, Safety or the Functioning of Society" means products or product components that if unavailable would result in a significant increase in negative healthcare outcomes, an inability to mitigate significant risks to human health or the environment, or significantly interrupt the daily functions on which society relies. Products or product components that are Essential for Health, Safety or the Functioning of Society include those that are required by federal or state laws and regulations.*
>
> *Essential for the Functioning of Society includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, and construction."*

PFAS is the huge group of the industrial chemicals taking indispensable uses on complex articles such as EEE at present, and we consider that all the EEE is indispensable for the "daily functions" based on current information and communication technologies.

The procedures for judging the above are so-called socio-economic impact assessment. As the guidance for such assessment focusing the possible effects on society which may be caused by regulating a substance, we consider *"Guidance on the preparation of socio-economic analysis as part of an application for authorization*" for EU REACH Regulation is detailed and still useful as a reference in this field.

> The European Chemicals Agency (ECHA): *"Guidance on the preparation of socio-economic analysis as part of an application for authorization"* (2011)
>
> https://www.echa.europa.eu/documents/10162/2324906/sea_authorisation_en.pdf/aadf96ec-fbfa-4bc7-9740-a3f6ceb68e6e

As for the Specific criteria for determining what uses of PFAS are considered CUU, we consider that the conditions set out in the Article 5(1)(a) of EU RoHS DIRECTIVE 2011/65/EU, a global pioneer legislation on the restriction of substances in EEE, should be referred for the PFAS in the complex articles. That is, PFAS use in a

[1] It can be downloaded from the following site. (Press the description, "Ch 90 Draft Rule".)
https://www.maine.gov/tools/whatsnew/index.php?topic=dep-rulemaking&id=10415809&v=govdel

specified application in the complex articles such as EEE should be deemed as CUU, where any of the following conditions is fulfilled:

- *their elimination or substitution via design changes or materials and components which do not require any of the PFAS materials or substances is scientifically or technically impracticable,*
- *the reliability of substitutes is not ensured,*
- *the total negative environmental, health and consumer safety impacts caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits thereof.*

Nevertheless, although we can propose the criteria, we would like to highlight that it is not possible to determine YES or NO using uniform criteria. Especially for evaluating substances contained in complex articles, necessary evaluation cannot be determined by such simple YES/NO judgement.

When evaluating the possible alternatives for substances in the finished products (both as chemicals and as articles), we really would like to ask the MPCA to evaluate sufficiently with consideration and understanding of the various critical points of view from all the related stakeholders.

In particular, there are two ways to substitute a substance in an article:

(1) change the material and replace the substance with another substance,

(2) change the product design and replace the parts themselves containing the substance with another parts (or mechanism).

The feasible choice may depend on the substance or the product.

In the method (1), the substance in the article may be required not only for a certain technical function considered as "essential" for the substance, but also for a wide variety of other combined general functions. In many cases, the necessary combination is completely different for each targeted product / article / mixture / process / service. When manufacture of a certain article needs multiple combined “general” functions in addition to the technical functions considered as those comprising the "essentiality" of the substance, then the possible substitute must be a substance that can simultaneously satisfy such complex specifications. If a candidate alternative has only the "essentiality" function, it would not be able to be a substitute for the use in such article.

In contrast, judging the possibility of substitution by method (2) inevitably requires evaluation of the "essentiality" of the parts or components that comprise the finished products. For example, if a part/component is a fundamental and general purpose one used in various products, its "essentiality" is considered to be high. In such cases, it would be almost impossible to replace it by design changes of the whole wide variety of related final products. On the other hand, if it is used in limited components/structures and can be replaced by another design/ technology, the "essentiality" of the part/component itself is not so high. In such cases, if the “most harmful chemical substance” itself is inevitably used in the manufacture of the component and the "essentiality" of the substance itself may be considered as high, it might be substituted by changing the component to another.

That is, it is necessary to evaluate the imperatives of the use of a substance based on their chemical properties, but evaluation of the "essentiality" of the finished products using the substance, especially in complex articles, is also important and necessary to promote the substitution.

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Before considering the cost of PFAS alternatives, no feasible alternative has been found in the first place.

We have continuously been investigating and reviewing the PFAS applications in EEE, and we consider that most of the applications we found out would need derogations from the restriction. Fluorinated materials are generally several to dozens of times more expensive than non-fluorinated materials, and if fluorinated materials could be replaced by non-fluorinated materials, component and equipment manufacturers would have adopted them. However, we have no choice but to use the expensive high-performance materials with PFAS if the products need the indispensable properties that can only be achieved with fluorinated materials.

We believe that socio-economic cost by uniform PFAS ban without appropriate preparation should be dully considered rather than the cost of PFAS alternatives.

For EEE, as we explain in attachments, PFAS are required in many applications.

During the use of articles like EEE, it is presumed that an exposure amount of PFAS is generally negligibly low compared with the exposure of the PFAS as chemicals own. For large extent of PFAS uses which are unavoidable (i.e. Unavoidable Uses) are caused by the use of fluoropolymer and it is particularly considered as low risk.

Under such situation, premature uniform restriction of PFAS would prevent the ICT-based life that Minnesota citizens currently enjoy.

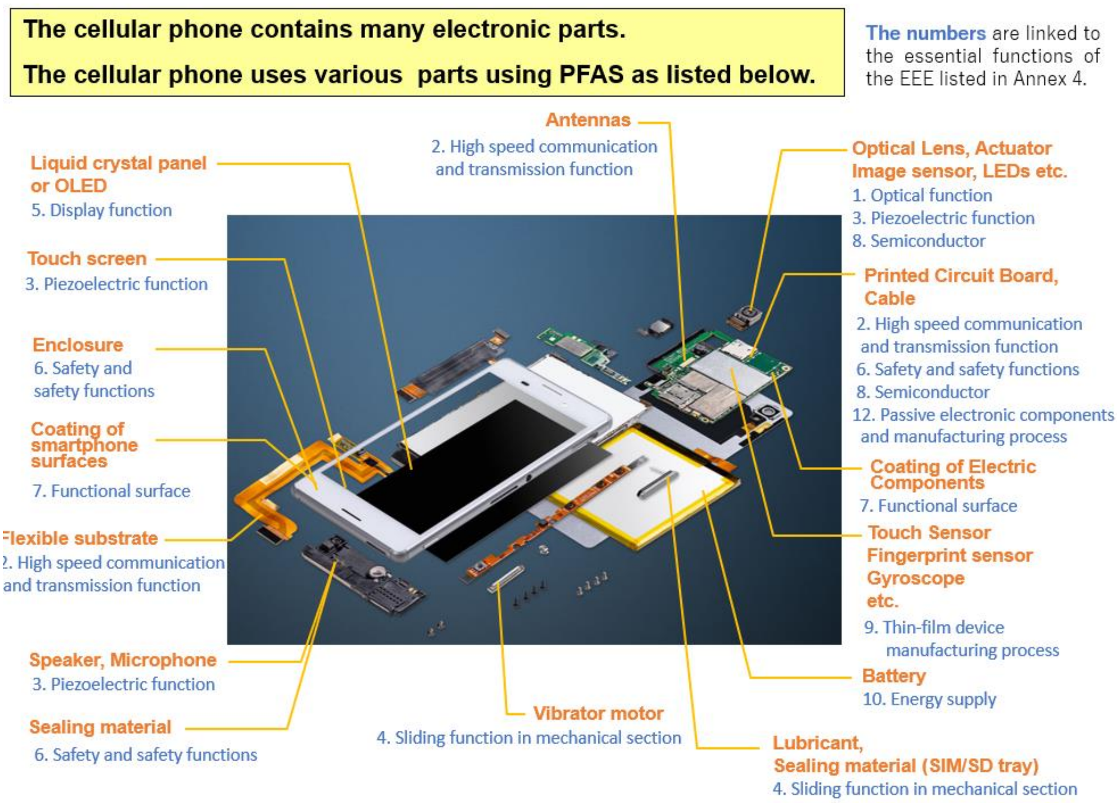
PFAS is widely contained in many critical components such as semiconductors horizontally used in EEE but in very small volume. Therefore, if PFAS is banned in all the applications, almost all the semiconductor and EEE would not be able to be manufactured and used.

Such uniform restriction of PFAS may lead to defective substitution which cannot attain necessary performances but also ensure safety, reliability and durability of the whole products. The end-users will be affected most seriously. This may lead collapse of the whole social infrastructure based on IT and semiconductor technologies.

If only semiconductors listed as "potential derogations marked for reconsideration" in current dossier are finally derogated and the adequate derogations for other applications listed in our Attachment 3 are not set for electronics, the functions necessary for EEE described in Annex 4 and uses exampled in its Column G become non-available, or could be only used in a condition where their performances are remarkably inferior. From about 1970s, PFAS became used in EEE industry widely. Therefore, if PFAS is uniformly restricted, the level of the performances of EEE may return to those at the late 20th century.

For example, about display function, the performance of the thin liquid crystal displays such as TV or monitors, which are widely used today, would return to the level at the latter half of the previous century. More concretely, if the flat panel displays are not able to be manufactured because of PFAS ban, display cannot but return to the cathode ray tube technology which does not use PFAS. We wonder whether consumers in the State of Minnesota would really accept such inferior level of performance or not. Even if accepted, long time has passed since global industry stopped production by such an analog technology, and the supply chain for it has been also abolished, and the production factory does not exist anymore either. If PFAS is banned uniformly, the factories for the old-type products without PFAS must be rebuilt, but it will take several years.

If the large-capacity communication becomes unavailable by PFAS ban along with the inferior display performance, current technologies such as the street view, the surveillance camera or automatic driving by using information via satellites will become also unavailable. If the piezoelectric function is not usable by PFAS ban, the touch panel would not function, either. In addition, the modern minimization and mobilization by making use of the high functional materials using PFAS would become completely impossible, then the smartphone with current performance cannot be produced anymore. Please also see page 2 of our Attachment 2, which illustrates the essential applications of PFAS used in a smartphone.



If the minimization becomes impossible, many products will inevitably return to bigger and heavier ones, and the resulted wastes would remarkably increase. In addition, as operating the bigger products needs more electricity, uniform PFAS ban would cause negative effect also from the point of view of energy efficiency.

Furthermore, the degradation of performance of the motors or the medical equipment, etc. would directly have significant effect on the human safety issues. Unachieved "intended function" leads to "lowering the performance". We sincerely recommend MPCA to examine carefully what degree of deterioration of performances relating to EEE would be acceptable in the modern society.

Considering the potential impact at the uncountable level mentioned above, we believe that the unavoidable PFAS applications should be kept usable under the reasonable management and that the society had better to keep obtaining the benefit from them. We consider that THIS would be a better measure balancing with the socio-economic aspects and in line with the environmental policy along with the economic growth.

3) Should unique considerations be made for small businesses with regards to economic feasibility?

Some consideration may be needed, but we do not have any concrete information on this issue.

4) What criteria should be used to determine the safety of potential PFAS alternatives?

Before considering the cost of PFAS alternatives, no feasible alternative has been found in the first place.

Also, we have serious concerns that the risk assessment of PFAS was not properly conducted before questioning the safety of PFAS alternatives. Please refer to our general comment “I. The restriction should be considered based on the risk assessment”.

The risk assessment caused by the substances in the articles should be also conducted properly. During the use of articles like EEE, it is presumed that an exposure amount of PFAS is generally negligibly low compared with the exposure of the PFAS as chemicals own. The blanket restriction on PFAS will affect many industries. We hope that you will consider our recommendations and information in the following sections and make a scientific and technical decision about the need for and feasibility of regulation.

If the uniform restriction of PFAS in the articles is really planned by MPCA after the proper risk assessment, the assessment of safety of potential PFAS alternatives shall be conducted not only at the substance level but also at **finished product level**. That is, regarding an assessment of alternatives of complex articles like EEE, it also needs an evaluation from the aspect of whether the performance of the final product will not be deteriorated and whether the safety and reliability of the final products will continuously be maintained. This evaluation is inevitably conducted with “socio-economic impact assessment”. Please refer to our answer to question 1 and 2 as above.

5) How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

The timeline must be examined on case-by-case basis.

There are currently no feasible substitutes which can attain the performance needed for EEE for the applications listed in column E of Attachment 5 which we provide as our answer to Question 7. We would like to request the MPCA to set the derogations for them, as the feasibility in EEE becomes assessable only after the viable substitute materials are established. Please see Attachment 6 for the explanation of reasons why the candidate substitutions are not feasible in the actual EEE.

The complex article manufacturers consider that the date set for a derogation should not be an expiry date of the derogation but be a date for reviewing it, if MPCA has to dare setting some timeline. We consider 15 years-interval would be practical and feasible to review the CUU for example, in considering the broad coverage of PFAS group, the time for the chemical industry to develop the new materials and wide-variety of the final applications in EEE.

Only if practicable PFAS alternatives which can attain necessary performance to EEE would be available at the point of the review, it is for the first time possible to examine the timeline for substitution.

A transition period of at least 4 years would be generally needed for the replacement of the chemicals for which alternatives already exist, even in the case of threshold at 1,000 ppm order. However, since PFAS is very huge group of substances, we cannot assume the necessary transition period.

Even if some alternatives are proposed by chemical manufacturers, there is no guarantee that the same performance as before can be obtained. When the substance concerned may be contained in parts having very important functions in products, product design will have to be carefully reviewed and it would take a long period. Even though some "similar" parts without the substance become available, many processes would be needed until the reliability and durability of a whole product can be finally guaranteed. Each level of article manufacturers (of parts, of components or units, and of finished products) must have their own technical processes for reviewing and developing substitution, testing its quality and reliability, and acquiring certification on applicable standards such as on safety as necessary.

On the other hand, if there is no available practicable PFAS alternative at the point of the review, the CUUs should be continued to be valid and be reviewed after another 15 years.

In addition, EEE used for social infrastructures, such as medical practice (such as clinical, diagnostic, inspection, analysis, monitoring and others) and industrial and other types of monitoring, control, analysis, measurement equipment and manufacturing equipment (such as Factory Automation devices, etc.), in laboratories, infrastructures of transportation, lifelines, security, disaster preventions, communications and process control of many types of productions (here in after collectively called as “EEE for social infrastructures”) are widely used in society.

EEE for social infrastructures is produced in small numbers for use over long periods without modification or changes; it must be reliable and needs long-term test for reliability. Certificates and approvals are required for some of EEE for social infrastructures. Their number of parts is large and there are many custom parts, moreover safety confirmation needs to be performed much more strictly than for consumer products. Therefore, it requires longer time to complete the substitution and needs special consideration in reviewing CUU in future.

6) How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

For PFAS in complex articles at least, we have already indicated the conditions to be recognized as CUU in our answer to question 1 . We believe CUU should be granted if it explains that any of items indicated there can be fulfilled. It is necessary to conduct an assessment of substitution potential per each final product.

As for the assessment procedure, the guidance on Socio Economic Impact Assessment under EU REACH Regulation can be used as reference, as we indicated in our answer to question 1 above.

However, If the primary objective of the law is to reduce risk, PFAS uses with low potential exposure, such as internal component of EEE or fluoropolymers, should not be subject to the PFAS restriction in the first place.

7) In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

Since we believe it is important for MPCA to understand how PFAS are used in various applications in EEE, we prepare detailed list and explanation on PFAS CUU in EEE as follows. Please note that these attachments were also submitted to application of CUU in the State of Maine.

(1) JP4EE Attachment 1 :

We would like to submit a list of Electric and Electronic Equipment (hereinafter, EEE) which may use PFAS by using the Global Product Classification (GPC) brick category code. GPC category is based on the purpose of the products and is not based on the technologies on which the products rely. Therefore, GPC for EEE disperse to many categories.

EEE covers so many various product categories, but the technologies and materials and parts used in EEE are basically common. For supplementary explanation on EEE, please see our Attachment 2.

(2) JP4EE Attachment 2 Supplementary Explanation on EEE.

(3) JP4EE Attachment 3 - List of EEE Functions needing PFAS.

This document lists the functions and properties necessary to EEE, which need PFAS materials to attain required performances.

(4) JP4EE Attachment 4 - Explanation on EEE Functions in Attachment 3

This document is Supplementary Explanation on the functions of EEE needing PFAS shown in our Attachment 3 on EEE Functions needing PFAS.

(5) JP4EE Attachment 5 - List of PFAS essential uses in EEE.

The list explains CUU in EEE as per OECD categories of PFAS as chemical materials. The list links the functions listed in Attachment 3 above and includes the reasons why these PFAS cannot be substituted.

8) Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

We believe some initial CUU determinations are necessary in order for predictability and transparency of the law. Also, we would like to ask MPCA to harmonize CUU operations with other States like the State of Maine as much as possible to avoid confusion among the States. It is not realistic that CUU is different among the States.

We also believe that the assessment method (procedure) should be created for better transparency. For example, the guidance on Socio Economic Impact Assessment under EU REACH Regulation can be used as reference, as we indicated in our answer to question 1 above. Nevertheless, even if the assessment method exists, we would like to highlight that the assessment cannot be uniformly determined by simple YES/NO as we stated above.

9) Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

As we stated in General comment I and our answer to Question 4, risk-based approach should be taken rather than hazard-based approach in case of selecting substances to be potentially restricted. We believe that such approach can reduce more risk with less time and resources without inconvenience to people in the State of Minnesota.

Conclusion:

We hope our input would provide substantive information to ensure the smooth and practical implementation of PFAS management to realize a healthy environment and a sustainable economy for the present and future generation in the State of Minnesota.

We wish to work together with the MPCA to make the Rule feasible for implementation. Should you have any questions, please do not hesitate to contact the JEITA secretariat.

Sincerely yours,

Koji Ueno
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Business Strategy Division
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About Japanese electric and electronic (E&E) industrial associations:

About JEITA

The objective of the Japan Electronics and Information Technology Industries Association (JEITA) is to promote the healthy manufacturing, international trade and consumption of electronics products and components in order to contribute to the overall development of the electronics and information technology (IT) industries, and thereby further Japan's economic development and cultural prosperity.

About CIAJ

Mission of Communications and Information network Association of Japan (CIAJ). With the cooperation of member companies, CIAJ is committed to the healthy development of info-communication network industries through the promotion of info-communication technologies (ICT), and contributes to the realization of more enriched lives in Japan as well as the global community by supporting widespread and advanced uses of information in socio-economic and cultural activities.

About JBMIA

Japan Business Machine and Information System Industries Association (JBMIA) is the industry organization which aims to contribute the development of the Japanese economy and the improvement of the office environment through the comprehensive development of the Japanese business machine and information system industries and rationalization thereof.

About JEMA

The Japan Electrical Manufacturers' Association (JEMA) The Japan Electrical Manufacturers' Association (JEMA) consists of major Japanese companies in the electrical industry including: power & industrial systems, home appliances and related industries. The products handled by JEMA cover a wide spectrum; from boilers and turbines for power generation to home electrical appliances. Membership of 291 companies, http://www.jema-net.or.jp/English/

About electric equipment manufacturers' coalition of medical devices, and analysis, measurement, test, control and monitoring instruments that have endorsed this paper:

About JAIMA

The Japan Analytical Instruments Manufacturers' Association (JAIMA) is a sole industry association of Analytical Instruments in Japan, which established under the Japanese law. JAIMA is to contribute to the development of the Japanese economy and the cultural lives of citizens in Japan through efforts to improve and advance technologies related to analytical instruments and the analytical instruments industry for the purpose of the advancement of science & technology.

About JEMIMA

Japan Electric Measuring Instruments Manufacturers' Association (JEMIMA) is the only one association representing this industry in Japan. Electric measuring instruments support all kinds of manufacturing industries as so-called "Mother tools" that support innovative activities for research, development, design and manufacturing.

JEMIMA has active committees that collect technical and market information of electric measuring instruments, and provide member companies with useful information for their businesses. Regarding regulations such as environmental, safety and EMC (Electro-Magnetic Compatibility) issues, JEMIMA has been investigating details and providing proposals to legislative organizations summarizing requirements from the industry in cooperation with international related organizations.

Through these activities, JEMIMA will continue to contribute to the steady growth of electric measuring instruments and related industries in Japan.

About JFMDA

The Japan Federation of Medical Devices Associations (JFMDA) was founded in February 1984 by medical device associations consisting of manufacturers and suppliers of medical and health-care devices, equipment, instruments and materials. Since then, JFMDA has been addressing various national and international issues related to all its member associations. By taking appropriate actions on these issues, and through the support of innovation and sustainable supply of medical devices and technologies to the world, JFMDA has contributed to the growth of the industries it represents and to the improvement of welfare and health care in Japan. JFMDA became a legal entity as of January 6th, 2014.

About JIMA

Japan Inspection Instruments Manufacturers' Association (JIMA) is a corporation aggregate of manufactures and sellers for non-destructive inspection instruments and systems. JIMA is the only industry group in Japan for non-destructive inspection instruments. JIMA would eventually contribute to the safety of social capital and facilities, and quality assurance in various productions through non-destructive inspection technology, and supports the safety and reassurance of people's lives.

About JMIF

Japan Measuring Instruments Federation (JMIF) is an industrial association for measuring instruments manufacturers and related organizations/companies in Japan. JMIF was established in 1952 to develop the whole measuring instruments industry through improvement of measuring instruments, aiming to contribute to the eventual development of the Japanese economy and society.

The main activities by JMIF include supporting new technology development, conducting demand trends survey, developing domestic and overseas markets, and enhancing global cooperation.

About NECA

NIPPON ELECTRIC CONTROL EQUIPMENT INDUSTRIES ASSOCIATION (NECA) was established in 1964 and promoting the growth of the electric control equipment fields such as Relays, Switches, Sensors, PLC/FA System Equipment and others, Safety Control Equipment. NECA has 30 companies as regular members and 35 companies as support members, and shipping amount of relevant products were 812.3billion Yen in FY2022. Our website provides further information on our recent news and activities:
https://www.neca.or.jp/en/

About SEAJ

Semiconductor Equipment Association of Japan (SEAJ), founded in March 1985, promoted by the major semiconductor equipment manufacturers, is a nationwide organization of semiconductor manufacturing equipment, flat panel display (FPD) manufacturing equipment and equipment manufacturers that applied their technology and related equipment manufacturers.

SEAJ had existed as an incorporated association from July in 1995. From April 1st in 2012, SEAJ has been authorized by Cabinet Office as a General Incorporated Association that related to the reform of the public-interest corporations system.

The Japanese semiconductor manufacturing equipment, FPD manufacturing equipment and equipment industries that applied their technology is playing great role in supporting the world's semiconductor industry due to the manufacture of semiconductors, FPDs that lay the foundation of the advanced information oriented industries by supplying manufacturing equipment and the indispensable producer goods to the semiconductor industry to Japan and abroad.

In order to promote the development of the semiconductor manufacturing equipment industry and other related industries and to contribute to the further development such as investigative research on production and distribution, proposing and indicating the direction of semiconductor equipment technologies, investigating and studying the area of Emerging Technology, the activities of popularization and enlightenment by conducting of various seminars and lectures, planning of project and promotion of standardization.

About IGMA

The Industrial Gas Detectors and Monitor Manufacturers Association (IGMA) is the organization that promotes the further spread of safety equipment used in various industries such as oil refining, petrochemicals, chemical plants, and civil construction. It contributes to the prevention of workplace accidents such as explosions involving high-pressure gases, flammable gases, toxic gases, harmful gases, as well as poisonings and oxygen deficiency incidents.

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Supplementary Explanation in Relation to Japan 4EEIA Input for Maine PFAS CUU

Electric and Electronic Equipment (hereinafter, EEE) covers so many various product categories, but the technologies and materials and parts used in EEE are basically common.
Therefore, **we believe that EEE should be treated as one category under Maine PFAS CUU in most cases*.**

*Some product categories such as medical or measurement equipment may need additional applications in addition to those for the other EEE.

In order to have Maine EPA understand EEE using PFAS more concretely, we would like to use the categories under EU RoHS Directive 2011/65/EU, a global pioneer legislation on EEE, to show illustrative examples of PFAS use.

Please note that each category also covers wide variety of products and no one can make an exhaustive list, though we select typical GPC Family codes covering EEE as much as we found. The composition of GPC is different from RoHS, but we consider these can help to show the necessary PFAS applications in EEE better.

Products under other sectors such as automotive, military, space and aviation also need similar applications as EEE if they use electric parts.

<Slide 1>

The cellular phone contains many electronic parts.

The cellular phone uses various parts using PFAS as listed below.

The numbers are linked to the essential functions of the EEE listed in Annex 4.

Antennas
2. High speed communication and transmission function

Liquid crystal panel or OLED
5. Display function

Optical Lens, Actuator Image sensor, LEDs etc.
1. Optical function
3. Piezoelectric function
8. Semiconductor

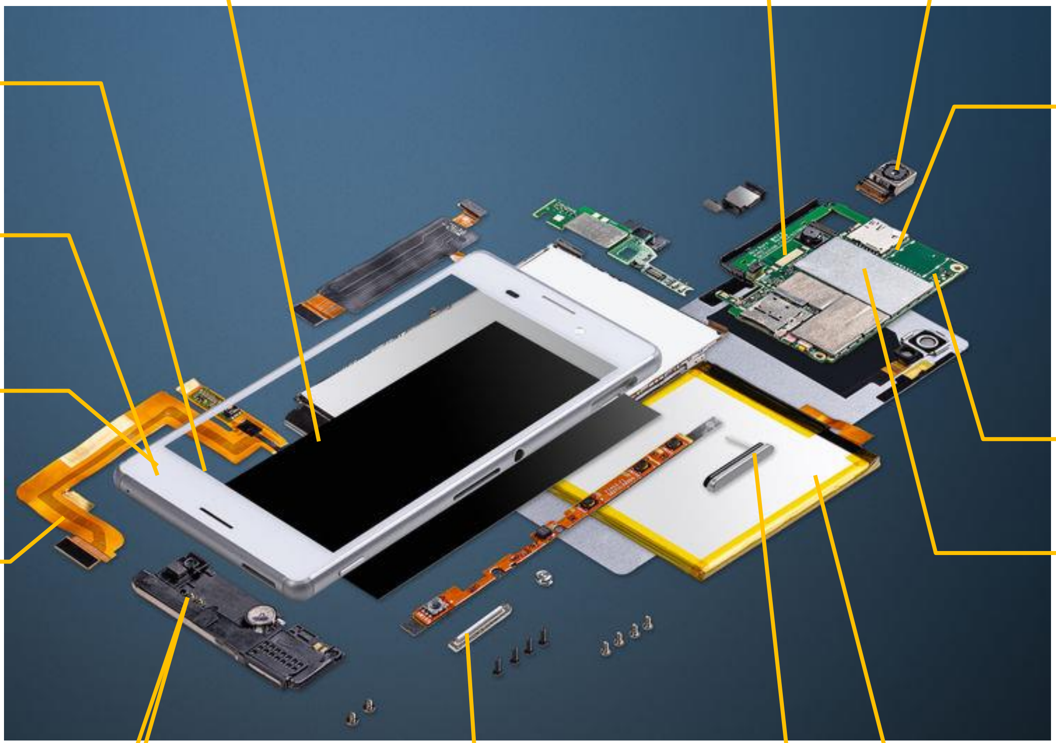
Touch screen
3. Piezoelectric function

Printed Circuit Board, Cable
2. High speed communication and transmission function
6. Safety and safety functions
8. Semiconductor
12. Passive electronic components and manufacturing process

Enclosure
6. Safety and safety functions

Coating of smartphone surfaces
7. Functional surface

Coating of Electric Components
7. Functional surface



Flexible substrate
2. High speed communication and transmission function

Touch Sensor Fingerprint sensor Gyroscope etc.
9. Thin-film device manufacturing process

Speaker, Microphone
3. Piezoelectric function

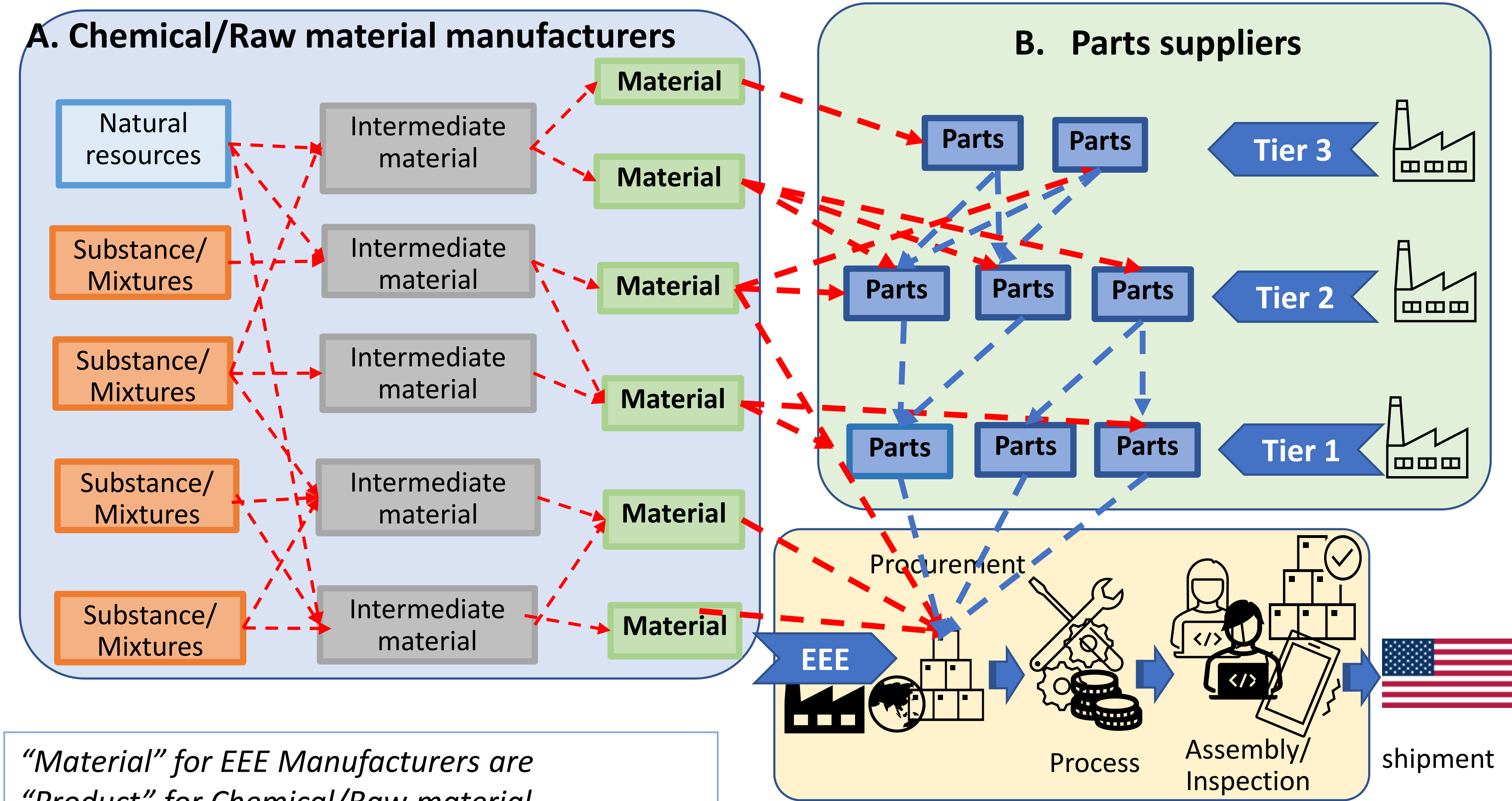
Battery
10. Energy supply

Sealing material
6. Safety and safety functions

Vibrator motor
4. Sliding function in mechanical section

Lubricant, Sealing material (SIM/SD tray)
4. Sliding function in mechanical section

Complexity of supply chain of EEE and related sectors



"Material" for EEE Manufacturers are "Product" for Chemical/Raw material Manufacturers, and thus "lubricant" sector are also related to EEE sector. Likewise, "Semi-conductors" or "batteries" are indispensable to EEE as parts for EEE manufacturers, for example.

C. Electric Electronic Equipment Manufacturers

Categories of EEE covered by EU RoHS (1/8)

Category	Title and examples (with GPC family code)	
1	Large household appliances. For example: Refrigerators(72010000); Freezers(72010000); Other large appliances used for refrigeration(72010000); , conservation and storage of food(72010000); Washing machines(72020000); Clothes dryers(72010000); Electric stoves(79010000); Other large appliances used for cooking and other processing of food; Electric heating appliances(79010000); Electric radiators(79010000); Other large appliances for heating rooms, beds, seating furniture(79010000); Electric fans(79010000); Air conditioner appliances(79010000); Other fanning, exhaust ventilation and conditioning equipment(79010000);	

Categories of EEE covered by EU RoHS (2/8)

Category	Title and examples (with GPC family code)	
2	**Small household appliances.** For example: Vacuum cleaners(72020000); Carpet sweepers(72020000); Other appliances for cleaning(72020000); Appliances used for sewing, knitting, weaving and other processing for textiles(70010000); Irons and other appliances for ironing(47200000); , mangling and other care of clothing; Toasters(72020000); Fryers(72020000); Grinders, coffee machines and equipment for opening or sealing containers or packages(72020000); Electric knives(72020000); Appliances for hair-cutting, hair drying, tooth brushing, shaving, massage and other body care appliances(72020000); Clocks, watches and equipment for the purpose of measuring, indicating or registering time(68010000); Scales	

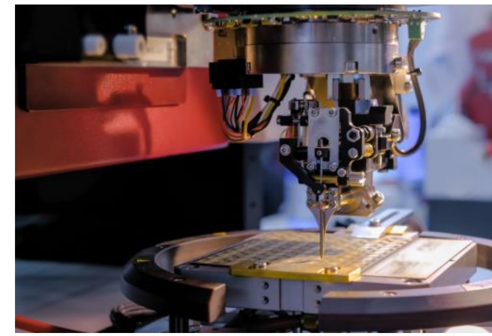
Categories of EEE covered by EU RoHS (3/8)

Category	Title and examples (with GPC family code)	
3	IT and telecommunications equipment. For example: Personal computers(65010000); Laptop computers(65010000); Notebook computers(65010000); Notepad computers(65010000); Printers(65010000); Copying equipment(65010000); Pocket and desk calculators(62060000); and other products and equipment for the collection, storage, processing, presentation or communication of information by electronic means; User terminals and systems; Facsimile(66010000); Telephones(66010000); Smartphone(66010000); Cellphone(66010000); Answering systems(66010000); and other products or equipment of transmitting sound, images or other information by telecommunications(66010000)	

Categories of EEE covered by EU RoHS (4/8)

Category	Title and examples (with GPC family code)	
4	**Consumer equipment.** For example: Radio sets(66010000); Television sets(68010000); Videocameras(68020000); Video recorders(65010000); ; Hi-fi recorders(65010000); Audio amplifiers(68010000); Musical instruments(68010000); And other products or equipment for the purpose of recording or reproducing sound or images, including signals or other technologies for the distribution of sound and image than by telecommunications(68010000)	
5	**Lighting equipment. (78030000)** For example: Luminaires for fluorescent lamps with the exception of luminaires in households(78030000); All kinds of lamps; Other lighting or equipment for the purpose of spreading or controlling light;	

Categories of EEE covered by EU RoHS (5/8)

Category	Title and examples (with GPC family code)	
6	**Electrical and electronic tools.** For example: Drills(82010000); Saws(82010000); Sewing machines(82010000); Equipment for turning, milling, sanding, grinding, sawing, cutting, shearing, drilling, making holes, punching, folding, bending or similar processing of wood, metal and other materials(82010000); Tools for riveting, nailing or screwing or removing rivets, nails, screws or similar uses Tools for welding, soldering or similar use(82010000); Equipment for spraying, spreading, dispersing or other treatment of liquid or gaseous substances by other means(88010000); Tools for mowing or other gardening activities(72020000)	
7	**Toys, leisure and sports equipment.** For example: Electric trains or car racing sets(86010000); Hand-held video game consoles(65010000); Video games(65010000); Computers for biking, diving, running, rowing, etc.(65010000); Sports equipment with electric or electronic components(71010000); Coin slot machines(95160000)	

Categories of EEE covered by EU RoHS (6/8)

Category	Title and examples (with GPC family code)	
8	Medical devices. (51150000) For example: Radiotherapy equipment; Cardiology; Dialysis; Pulmonary ventilators; Nuclear medicine; Laboratory equipment for in-vitro diagnosis; Analysers; Freezers; Fertilization tests; Other appliances for detecting, preventing, monitoring, treating, alleviating illness, injury or disability *Note: The products in this category may need additional special applications in addition to those for the other EEE.	

Categories of EEE covered by EU RoHS (7/8)

Category	Title and examples (with GPC family code)	
9	Monitoring and control instruments including industrial monitoring and control instruments. For example: Smoke detector(91030000); Heating regulators; Thermostats(79010000); Measuring, weighing or adjusting; appliances for household or as laboratory equipment(62060000); Other monitoring and control instruments used in industrial installations (e.g. in control panels)(78020000) *Note: The products in this category may need additional special applications in addition to those for the other EEE.	
10	Automatic dispensers. For example: Automatic dispensers for hot drinks; Automatic dispensers for hot or cold bottles or cans; Automatic dispensers for solid products; Automatic dispensers for money(62060000); All appliances which deliver automatically all kind of products	 

Categories of EEE covered by EU RoHS (8/8)

Category	Title and examples (with GPC family code)	
—	Other EEE not covered by any of the categories above. For example: Industrial manufacturing equipment(11030000); Ignition modules and other electrical and electronic engine control systems for non-mobile equipment (such as non-road professional use equipment) (11030000); motor-operated adjustable furniture such as height-adjustable desks, elevation beds and chairs, excluding medical devices and wheelchairs(75010000); motor-operated building elements such as shutters, blinds, screens, awnings, pergolas, curtains, doors, gates, windows, skylights(91030000); all other products using electric and electronic parts(78020000). *Note: The products in this category may need additional special applications in addition to those for the other EEE.	  

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JP4EE Attachment 4- Explanation on EEE Functions in Attachment 3

Application examples and PFAS essentiality in Electrical and Electronic Equipment.

Contents

1. Optical function and required properties

(1) Optical function

Essential for EEE (Electrical and Electronic Equipment) to control transmission, reflection, diffusion etc. of light.

For example, camera imaging and optical communication of fiber optic cables.

(2) Required properties for parts and components

- Low refractive index, high light transmittance, high durability

  e.g.) Lens (high sensitivity), image sensor (high sensitivity), LED antireflection coating (energy saving), optical fiber (high-speed transmission)

- Transparency/No absorption in visible light (approx. 380 to 770 nm) and water and oil repellency.

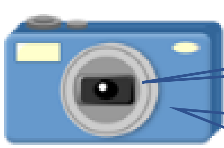
  e.g.) Protective coating for lenses (high durability), encapsulant for LEDs (high reliability, energy saving)

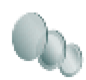
＊( ) indicates achievable performance

<Application examples>

[Digital camera, Surveillance camera, etc.]

Parts in which PFAS is used





Lens
Protective coat

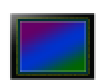
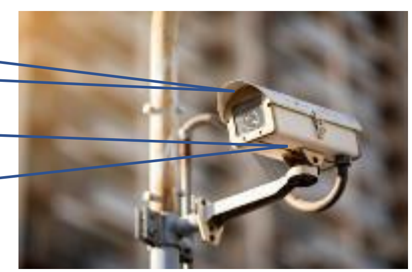


Image Sensor
Optical filter
Anti-reflective film
Thin Film fablication Process



Protective Coating of Lenses

Light reflection occurs between objects with different refractive indices, and the greater the difference in refractive index, the greater the reflection. If light is reflected at the interface between air and lenses with different refractive indices, it will result in loss. Therefore, a layer with a low refractive index, which is intermediate between the refractive indices of air and lens, can prevent reflection and reduce loss. In addition, to protect the lens, stain resistance and durability through water and oil repellency are also essential.

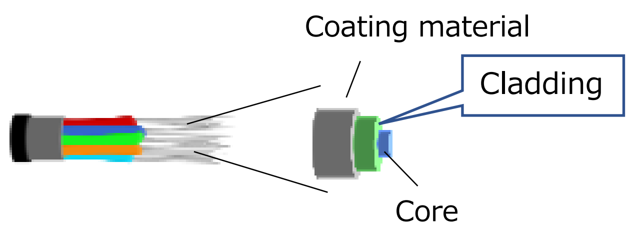
1. Optical function and required properties

<Application examples>

Parts in which PFAS is used

[Optical fiber]

Essential for high-speed communication and transmission functions



<u>Cladding Material of Optical Fiber</u>

Optical fiber has a concentric structure in which a core with a high refractive index is covered with a layer with a low refractive index called cladding, and light is confined and transmitted within the core. Losses occur when light is reflected at the interface between the coating material and core, which have different refractive indices. A layer with a low refractive index prevents diffuse reflection. Durability (heat, moisture, and scratch resistance) is also essential for the application.

1. Optical function and required Properties

(3) Required properties for materials and comparison with non-PFAS materials

Required properties for materials	Materials					Note
	Fluoro-Polymers*	Quartz glass	PMMA	Acrylic	Silicone	
Refractive index (n_d)	1.33～1.42	1.45	1.49	1.48	1.42	・When materials with different refractive indices are mixed, light is refracted and scattered at the interface between the substances, resulting in loss of transparency and cloudiness, so a single composition is necessary. ・For anti-reflection (high transmittance), a materials with a refractive index intermediate between that of air and that of lenses is desirable, especially for glass.
Water and oil repellent	○	×	×	×	△	
Flexibility	○	×	×	△	○	

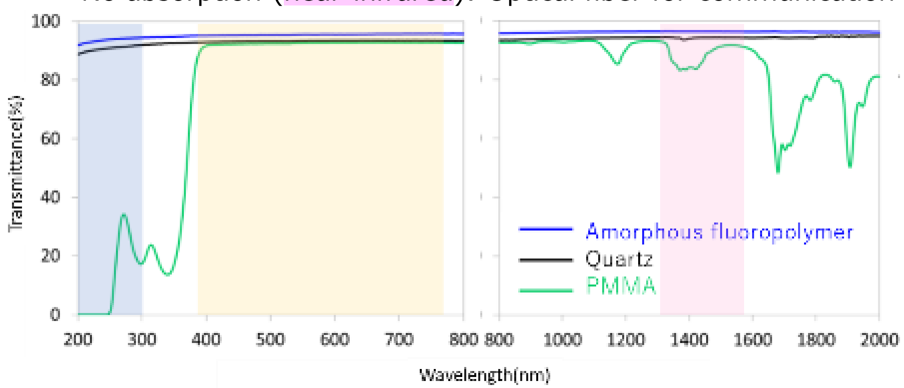
＊ PTFE,PFA,FEP,ETFE,PVDF

○=Excellent; △=Usable; ×=Not well suited for use

<Light transmittance versus wavelength>

High transmittance over a wide wavelength range

- No absorption (UV): UV LED encapsulant
- No absorption (visible light): Coating materials
- No absorption (near-infrared): Optical fiber for communication



＊Source: https://www.agc-chemicals.com/file.jsp?id=file/Cytop_tech14_EN.

- Materials must have a low refractive index (intermediate between the refractive index of air and that of lenses) for optical applications, which are achieved by controlling the transmission, reflection, and diffusion of light. In addition, water and oil repellency and flexibility are also essential to ensure the reliability and durability of devices.
- These must be realized with a single material (A higher refractive index means that light is not focused (scattered) and the intensity of light is reduced, resulting in reduced sensitivity of the device.

There is no material other than fluoropolymers that can achieve a good balance of low refractive index, water and oil repellency, and flexibility (there is no alternative material).

1. Optical function and required properties

(4) Social impact when PFAS cannot be used (example)

1) Fluorine material cannot be used in the camera, resulting in poor imaging performance

- The lack of clarity of the camera lens reduces the security performance of surveillance cameras, and the larger size of the camera lens is required to compensate for the lack of clarity, which is counter to energy conservation.
  In addition, if water and oil repellent coatings cannot be applied to the camera lens, reliability will be reduced and product life will be shortened (more frequent replacements and replacements will be required).

2) When fluorine material could not be used as cladding material for optical fiber

- Optical fiber is a waveguide for propagating light and supports high-speed communication and transmission functions as a transmission path for optical signals in the field of optical communications, an essential function of EEE. In the information society, demand for communication is increasing rapidly. The communication speed is reduced due to the deterioration of transmission loss (the speed is reduced in the Internet, where real-time communication is interfered with), and this will prevent the progress of digital communication in the future.
- If fluorine material cannot be used for the cladding material, the light confinement function in the core is reduced, so it is necessary to thicken the core or increase the number of single wires to increase light intensity. This also deteriorates the handling performance during installation and other operations. Furthermore, because the size of the light source will be changed, the entire optical system will need to be redesigned.
- In additional, the power consumption of the equipment will also increase, which is contrary to energy conservation.

2. High-speed communication/transmission function and required properties

(1) High-speed communication and transmission functions

EEE essential functionality to achieve high-speed, high-capacity communications by using high-frequency radio waves (low transmission loss) with telecommunications and infrastructure equipment.

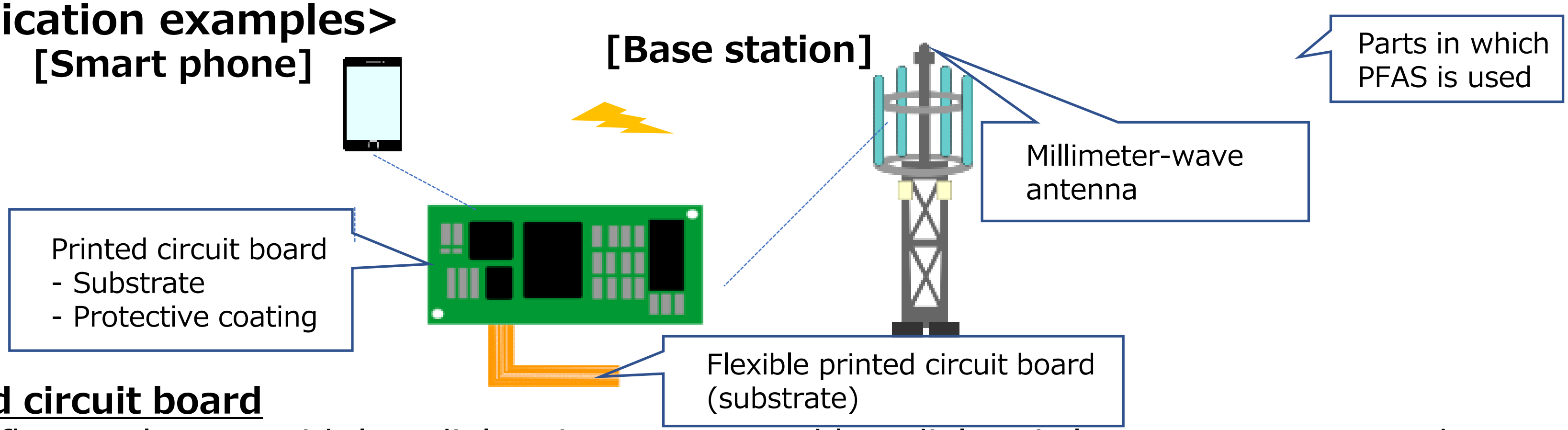
(2) Required properties for parts and components

- Low dielectric constant and dissipation factor at high frequencies and small frequency dependence. Furthermore, high reliability (heat resistance, flame retardance, and long life) is also essential. Therefore, all the performance must be satisfied at the same time.

e.g.) Printed circuit boards for high-speed transmission and millimeter wave radar such as 5G, coaxial cables, satellites and antennas in the millimeter wave band: (high-speed, high-capacity communication, high reliability and energy saving)

＊( ) indicates achievable performance

<Application examples>



<u>Printed circuit board</u>

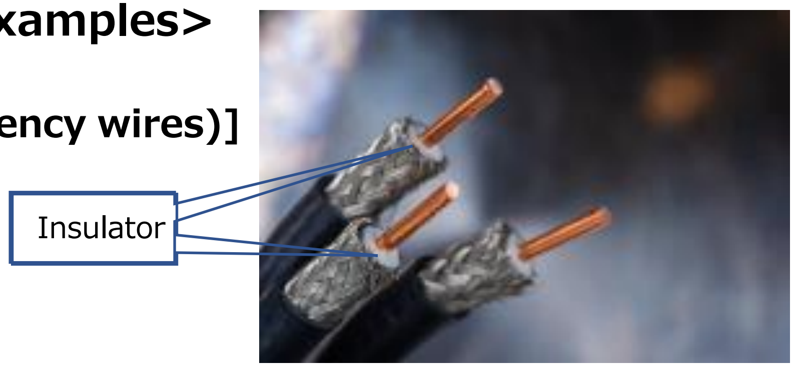
When fluoropolymers with low dielectric constant and low dielectric loss tangent are used as the substrate, the signal energy is not attenuated. This is due to the low rate at which part of the energy is lost internally as heat when current flows. In addition, flame resistance is essential for heat resistance and safety for component mounting. The long life required for base stations can be achieved at the same time, ensuring high reliability.

2. High-speed communication/transmission function and required properties

Parts in which PFAS is used

<Application examples>

[Coaxial cables (high-frequency wires)]



Coaxial cables (high-frequency wires)

The relative dielectric constant of the insulator must be close to that of air (relative dielectric constant: 1) to reduce transmission loss (attenuation of electrical signals due to heat). PTFE has a low relative dielectric constant of 2.1 and is both flame retardant and highly durable to ensure equipment reliability.

2．High-speed communication/transmission function and required properties

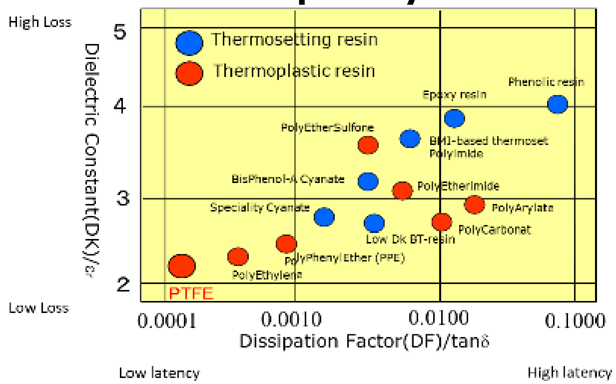
(3) Required properties for materials and comparison with non-PFAS materials

Required properties for materials	Fluoro-polymers*	FR-4 epoxy	Modified polyphenylene oxide（PPO)	Polyimides (PI)	Polyethylene (PE)	Liquid crystal polymer（LCP)	Note
Dielectric constant (ε)	2.1	4～5	3.5	3.2	2.3	2.9	When mixing different materials, inferior properties appear.
Dielectric tangent (tanδ)	0.0006	0.015	0.002	0.002	0.001	00035	
Thermal resistance Non-combustibility	◎	△	〇	〇	×	◎	

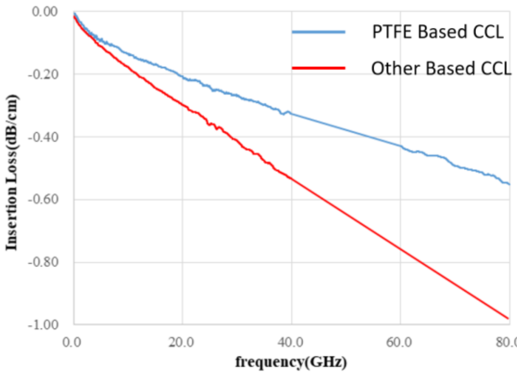
*PTFE,PFA,FEP

◎=Superior; 〇=Excellent; △=Usable; ×=Not well suited for use

<Requirements and frequency characteristics of the equipment>



Characteristics of dielectric constant and dielectric tangent in resin materials



Frequency dependence of transmission loss

＊Source
Nippon Pillar Packing co.,Ltd.
https://www.pillar.co.jp/en/

・The use of high frequencies such as millimeter waves is essential for electrical and electronic equipment for high-speed and high-capacity communications, and transmission losses need to be as low as possible. The material must have a low dielectric constant, low dielectric loss tangent and low frequency dependence to reduce transmission losses at high frequencies (signal energy loss by heat). Furthermore, the high-frequency equipment needs to be highly heat-resistant and reliable, as it is used for millimeter-wave sensors in base stations and ADAS (Advanced Driver-Assistance Systems). These need to be realized in a single substance.
There are no materials other than fluoropolymers that combine low dielectric constant and low loss at high frequencies with high heat resistance and high reliability (no alternative materials).

2. High-speed communication/transmission function and required properties

(4) Social impact when PFAS cannot be used (example)

1) When fluoropolymers cannot be used for high-frequency substrates for smartphones and base stations

- High-speed and large-capacity communication is increasingly required in the information society, but if fluoropolymers cannot be used, transmission losses at high frequencies will increase and large-capacity communication (e.g., video communication) will be delayed. Furthermore, the board generates heat due to high transmission losses, leading to heat generation in the equipment. Therefore, the equipment needs to be designed for cooling (contrary to energy saving).
- Heat generated by the equipment also affects the product life of other components (e.g., capacitors) mounted on the board, thus shortening the life of the equipment (requiring more frequent replacement or exchange).

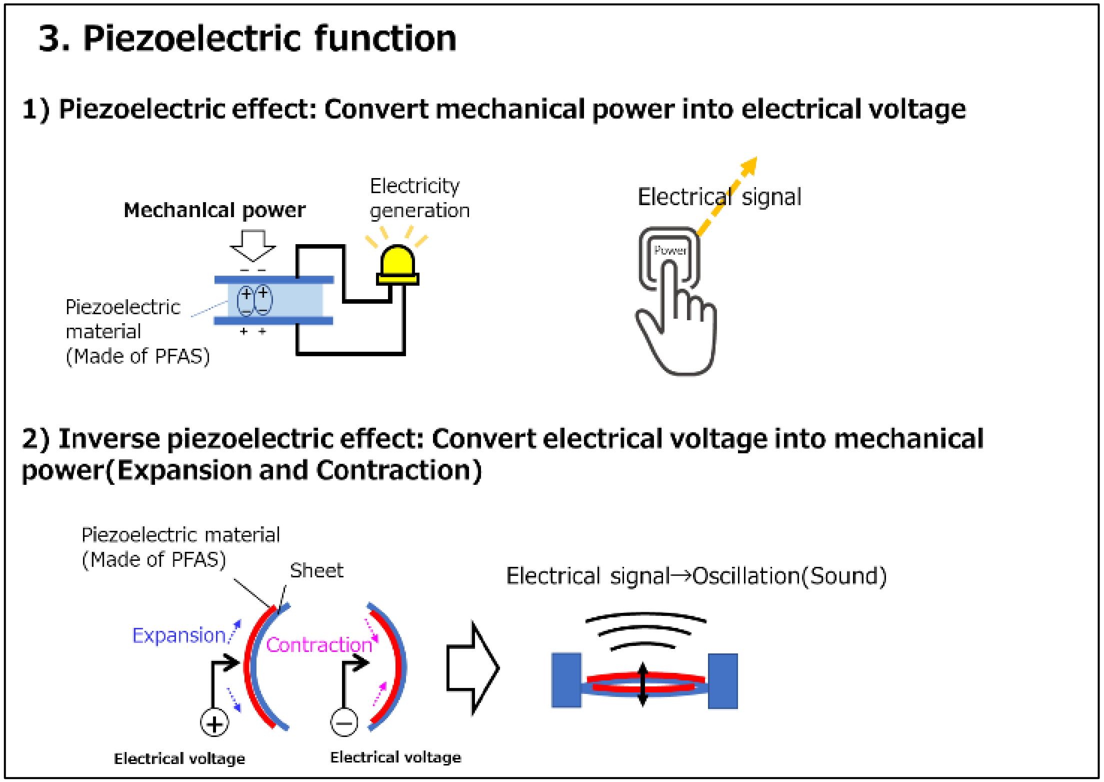
2) When fluoropolymers cannot be used for millimeter-wave radar substrates

- Millimeter waves are used in sensing technology to enhance safety in driving, for example in ADAS (Advanced Driver-Assistance Systems). If fluoropolymers cannot be used in substrates and antennas for high-speed millimeter-wave communications, instantaneous sensing isn’t possible due to the delay in radio waves, which significantly affects human safety. In addition, as vehicles are used in particularly harsh environments, high reliability characteristics (such as heat resistance, moisture resistance and long life) must be met at the same time.
- If millimeter-wave radars have short life, they will require maintenance and replacement within a short period of time, increasing waste and maintenance costs.

3．Piezoelectric function and required properties

(1) Piezoelectric function

Essential for EEE to the performance of crystalline materials in converting mechanical strain into voltage and voltage into mechanical strain.



3． Piezoelectric function and required properties

(2) Required properties for parts and components

- The material must have a high piezoelectric coefficient (the higher the coefficient, the better the response) that converts mechanical strain into voltage and voltage into mechanical strain, and must also satisfy processability and durability (high temperature and high humidity) at the same time.

e.g.) Touch panel, Sensor, Speaker, Headphones, Inkjet printer head：（Freeform、Cost reduction, high reliability)

＊( ) indicates achievable performance

<Application examples>

[Pressure sensor for healthcare]

Parts in which PFAS is used

e.g.：Wrist-mounted pulse wave sensor

Pressure sensor
(Core device of the product)

Pressure sensors for healthcare

Flexibility is essential in addition to piezoelectricity for pressure sensors that require installation on curved surfaces.（e.g.：Wrist-mounted pulse wave sensor)

This flexibility cannot be achieved with inorganic piezoelectric materials, and even with organic piezoelectric materials, only fluoropolymers can achieve high voltage coefficients and high reliability (heat and moisture resistance) in the operating environment as sensors. Since the organic piezoelectric material is in film form, high productivity and large area can be achieved, and low-cost sensors can be provided.

3． Piezoelectric function and required properties

(3) Required properties for materials and comparison with non-PFAS materials

	Organic type		Inorganic type		
Required properties for materials	Copolymers VDF with trifluoroethylene	Polylactic acid	Piezoelectric crystals	PZT（Ceramic piezoelectric materials）	PZT（Piezoelectric films）
Piezoelectric constant d_{33}（pC/N）	～40	7～12	2.0	100～600	100～600
Durability	○	△	◎	◎	○
Fabrication of thin films	◎	◎	×	×	◎
Pliability	◎	◎	×	×	×
Cost reduction	◎	◎	△	○	×

◎=Superior; ○=Excellent; △=Usable; ×=Not well suited for use

・They are inferior to inorganic materials in terms of piezoelectric constants and reliability. However, ceramic materials are generally brittle and difficult to process, making it difficult to form and process them as large-area, thin-film materials. Flexibility and large area, which can only be achieved with organic piezoelectric materials, and lower cost due to significant changes in the production process are important factors that cannot be realized with inorganic piezoelectric materials. Important Technologies Supporting Wearable Electronics.

(4) Social impact when PFAS cannot be used (example)

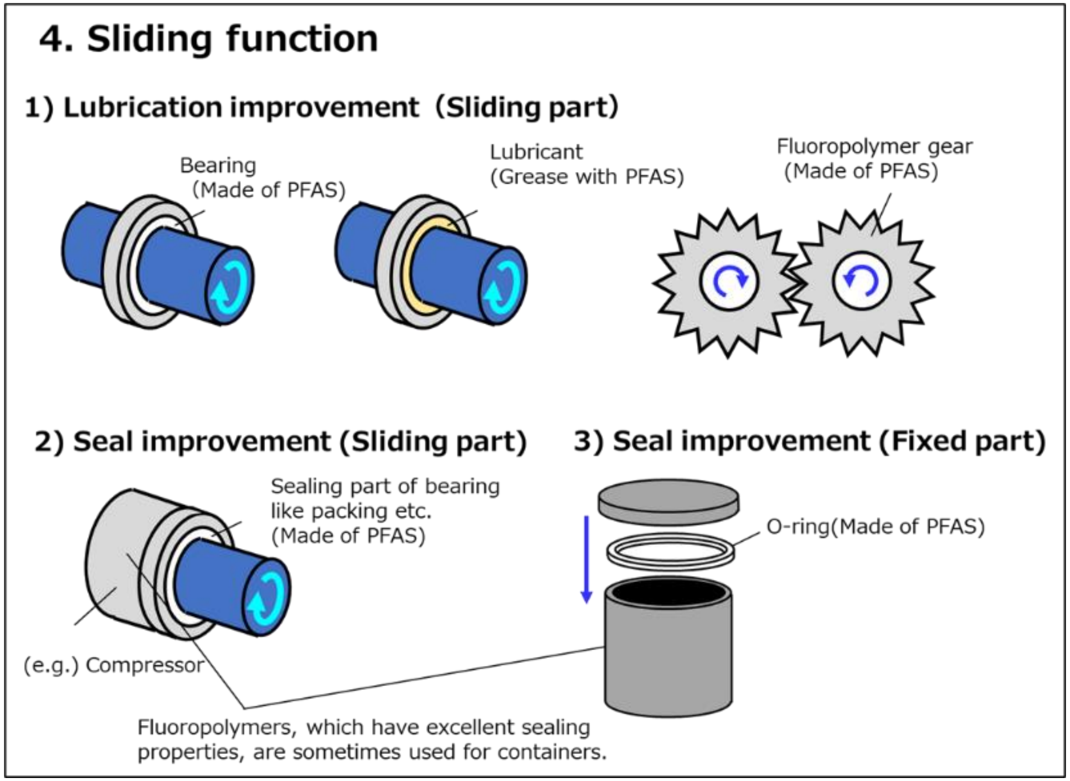
■ When fluoro resin could not be used for piezoelectric element as pressure sensor for biomedical

- In the healthcare field, there is a need for sensor devices that can more easily and accurately monitor daily vital information (heart rate, respiration, etc.) in a "non-constrained" manner without any hassle or feeling of being worn. Since these sensors are attached to the arm or body for measurement, they need to be curved in shape, lightweight, and sensitive so as not to interfere with daily life. The only organic piezoelectric material that satisfies these requirements is fluoro resin-based in terms of sensitivity.
- In order to live a long and healthy life, the need for sensors for health care, which are also used to manage physical condition, is increasing rapidly. For medical support, it will continue to be necessary to develop sensors that are inexpensive and can be used by anyone, and if PFAS cannot be used in this regard, the potential of future technologies will be destroyed.

4. Sliding function in mechanical section and required properties

(1) Sliding function

Essential function for EEE to control and ensure the smooth movement of driving parts or sealed parts, such as camera zoom lenses, motors, compressors, etc.



(2) Required Properties for Parts and components

- Two or more high-reliability properties such as lubricity and flame retardance must be achieved simultaneously in one material.

  e.g.) Motors, bearings, gears, camera lenses, grease, lubricants (high durability, high reliability)
- Two or more high-reliability properties such as flame retardance, chemical resistance, and water repellency, must be achieved simultaneously in one material.

  e.g.) Packing, O-ring (high durability, high reliability)

＊( ) indicates achievable performance

4. Sliding function in mechanical section and required properties

<Application examples>

[Camera]

Sliding functions in camera's mechanism section

Numerous sliding parts are required to work stably at high speed, with high precision, over a long period, and in harsh environments.

Cameras must satisfy functionality and performance requirements even in harsh environments such as extremely cold, deserts, and tropical regions. If substances derived from lubricant adhere to the lens or sensor, the image will be significantly affected. In addition, the recent trend toward reducing environmental impact requires longer product life. Considering these factors, the lubricants that can be used are limited to fluorine-based lubricants.

<Typical functions of a camera and the role of fluorinated lubricants>

① Autofocus lens drive unit

Image formed on the sensor surface by changing the distance between the lens and the image sensor surface

➡ **Instantly drive on the order of microns to achieve high-speed/high-precision focus adjustment**

② Shutter mechanism

Controls exposure time of image sensors down to a few thousandths of a second

➡ **Contribute to higher speeds and lower dust emissions for shutter blades and driving components**

③ Zoom mechanism

Use a rubber ring on the plastic tube to prevent dust from entering the zoom inside.

➡ **Ensure smooth operation and improves water repellency.**

④ Buttons, dials, etc.

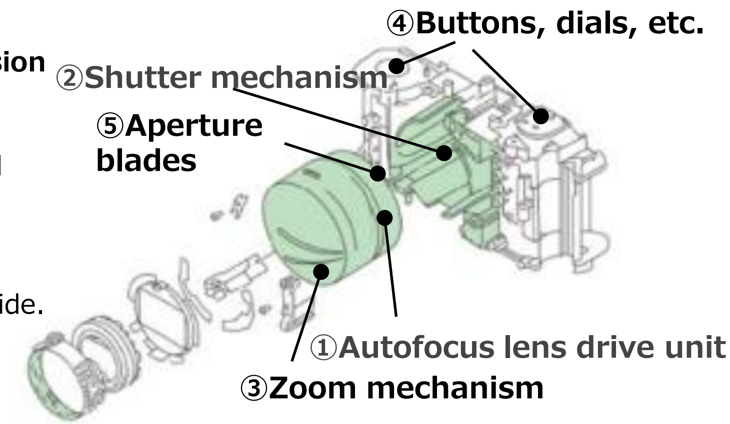
High precision/stable operation, high wear resistance, long product life

➡ **No effects on electrical components and contribute to stable operation and long product life.**

⑤ Aperture blades

The multiple blades that make up the aperture mechanism must be positioned with high precision.

➡ **Provides lubricity and high durability to the blade to ensure reliable operation.**



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Parts using fluorinated lubricants

Cameras require high-speed, high-precision drive/operation and long-life characteristics in harsh environments ⇒ Use of lubricants is essential

4. Sliding function in mechanical section and required properties

<Application examples>

[Laser processing machine ： 1）Lens focus adjustment component]

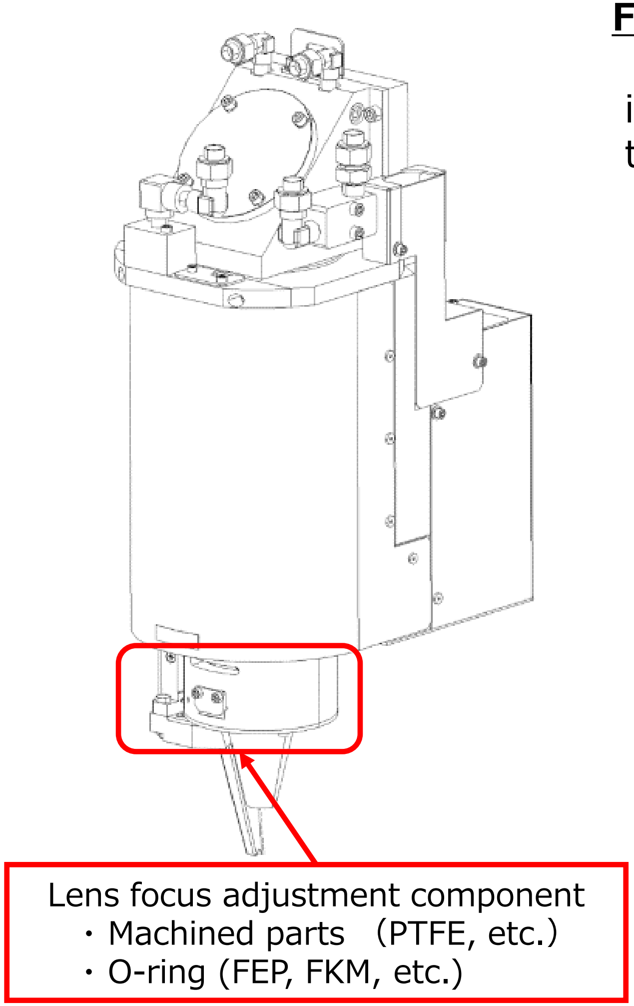


Fig. External view of machining head

<u>Focusing mechanism on processing head</u>

The processing head has a structure that rotates and slides inside the lens focus adjustment component in order to adjust the focus.

- ・ The focus should be changed arbitrarily according to the materials to be processed.
- ・ High sliding capability is required.

<Functions realized by using PFAS>

- ◆ Prevention of damage due to rubbing between parts
- ◆ Prevention of adhesion between parts by reducing friction
- ◆ Extending the life of parts by improving abrasion resistance
- ◆ Prevention of combustion in the case of heat input such as radiated beam
- ◆ Airtightness to prevent dust from attaching on the lens (lens burn prevention)

<Required properties for parts and components>

Lubricity, abrasion resistance, flame retardant, airtightness

For use in more demanding industrial conditions, these PFAS is the only material that satisfies the required properties at the same time.

4. Sliding function in mechanical section and required properties

<Application examples>

[Laser processing machine ：2）Shaft driving part]

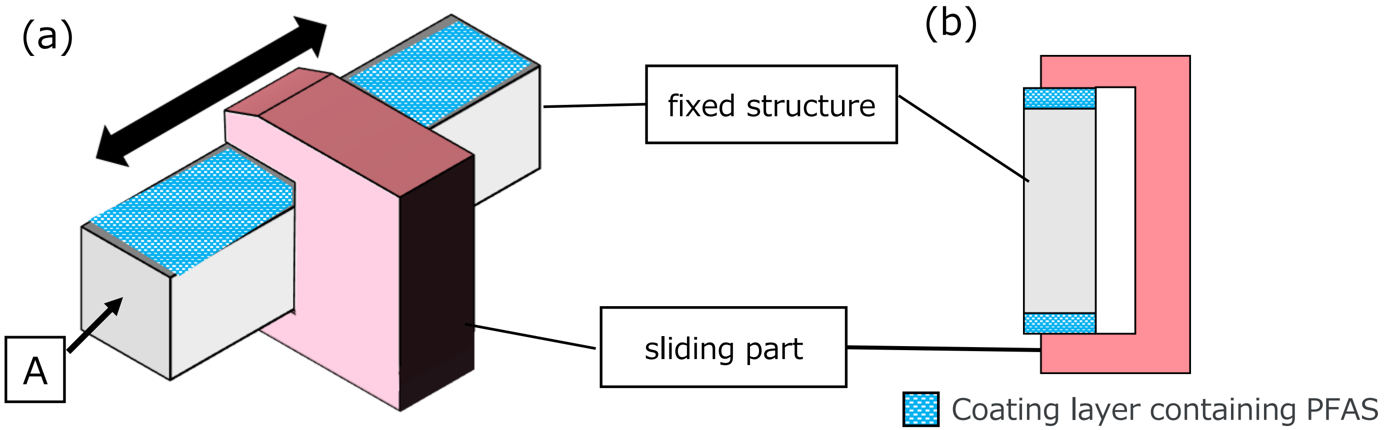


Fig. Simplified diagram of shaft driving part (a)bird-eye view, (b)view from the direction of arrow A (see Fig. (a))

Mechanism of shaft drive part

Laser processing machine must be operated in an environment with a lot of dust including minute fragments of processing materials.

From the viewpoint of dust prevention, the sliding part and the fixed structure are operated in close contact.

<Functions realized by using PFAS>

- Prevention of damage due to rubbing between parts
- Prevention of noise due to rubbing between parts
- Prevention of adhesion between parts by reducing friction
- Extending the life of parts by improving abrasion resistance
- Prevention of combustion in the case of heat input such as radiated beam

<Required properties for parts and components>

Coating for lubricity, abrasion resistance, flame retardancy, and antifouling

For use in more demanding industrial conditions, these PFAS is the only material that satisfies the required properties at the same time.

4. Sliding function (and 6. Safety and safety functions) in mechanical section and required properties

<Application examples>

[Laser processing machine : 3) Laser oscillator]

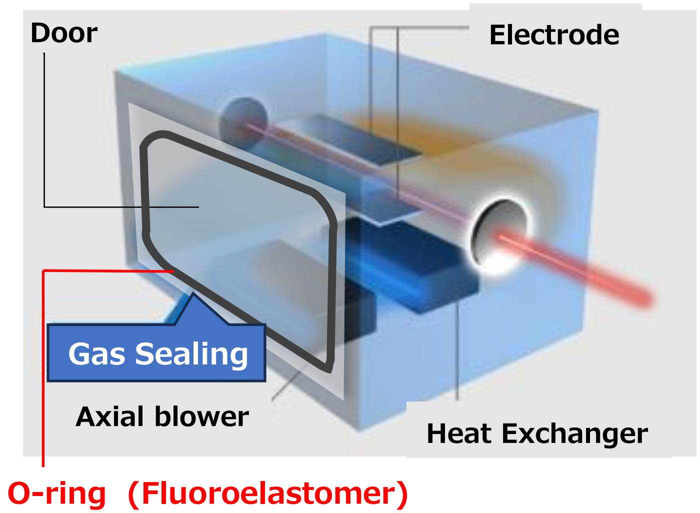


Fig. Simplified diagram of vacuum container

Mechanism of Vacuum container of the laser oscillator

Vacuum container of the laser oscillator must be sealed from outside air and held under the high vacuum or in the laser medium gas environment.

The vacuum container is equipped with an openable door sealed by an O-ring to enable maintenance of internal components.

The O-ring used in the vacuum container must be made of a material that can withstand high temperatures, ultraviolet irradiation, and ozone gas generation caused by discharge during laser oscillation.

Fluoroelastomer is the only material available that satisfies these properties.

＊ In addition to the door, O-rings are used for sealing such as the holding part of optical components.

<Functions realized by using PFAS>

Under the high vacuum, high temperature, ultraviolet radiation, and ozone gas environments,

- ◆ hermetic sealing with low outgas
- ◆ long-term retention of airtightness

<Required properties for parts and components>

Heat resistant, airtightness, corrosion resistant

To ensure occupational safety when using lasers, hermetic seals (PFAS) are essential from the aspect of “6. Safety and safety functions”.
For use in more demanding industrial conditions, these PFAS is the only material that satisfies the required properties at the same time.

4. Sliding function in mechanical section and required properties

(3) Required properties for materials and comparison with non-PFAS materials

1) Articles: Bearings, Gears, Rolls, Sealing materials (Packing, O-rings, etc.)

＊Please see also "6. Safety and safety functions"

■ Resins

Properties	Fluoropolymer	Other Resins						
	PTFE	PE	PVC	POM	PC	PS	PP	ABS
Organic solvent resistance	◎	○	△	○	△	×	○	×
Acid resistance	◎	○	○	×	△	×	△	△
Alkali resistance	◎	◎	◎	○	×	○	○	○
Flammability	not catch fire	Extremely slow	Natural fire extinguishing	slow	Natural fire extinguishing	slow	slow	slow
Dynamic friction coefficient (ud)	0.09	0.13	0.25	0.18	0.45	0.47	0.37	0.48
Surface energy (dyn/cm)	18	31	39	36	42	36	29	42
Water absorption (ratio %)	<0.01	<0.01	0.04～0.75	0.22～0.25	0.15～0.18	0.03～0.1	<0.01	0.2～0.6

◎=Superior; ○=Excellent; △=Usable; ×=Not well suited for use

- **There is no material other than fluoropolymers that can simultaneously satisfy multiple properties such as flame resistance and chemical resistance in addition to lubricity.**

↓

- Fluoropolymers are more expensive than commonly used materials, and therefore they are not used blindly. They are only used selectively in applications where they cannot be substituted under severe conditions, even in required properties for safety and safety functions that are essential for EEE. (There is no alternative material because of selective use.)

4. Sliding function in mechanical section and required properties

■ **Rubbers**

Properties	Fluoroelastomers		Synthetic rubbers			
	FKM	FEPM	Silicone	EPDM	CR	NBR
Heat resistance max use temperature,℃	230	230	230	150	100	120
Chemical resistance	○	○	△	△	○	○
Ozone resistance	◎	◎	○	○	×	×
Cold resistance	△	△	△～○	△～○	△～○	△
Electrical insulation (Dielectric constant ,ε)	△ (3～4)	△～○ (2.5～3.5)	△ (3.2～10)	△～○ (2.5～3.5)	× (7.5)	× (15～20)
Combustibility	◎	◎	△ Chemical resistance is reduced by flame retardant	△ Chemical resistance is reduced by flame retardant	○	△
Gas permeability ($cc \cdot cm/cm^2 \cdot sec \cdot atm$)	1	1	400	15	15	3

◎=Superior; ○=Excellent; △=Usable; ×=Not well suited for use

- **Fluoroelastomers have overwhelmingly excellent chemical resistance, ozone resistance, and insulation properties in addition to heat resistance and flame resistance, compared to other rubber. They also have excellent gas barrier properties (the smaller value, the less gas permeates.), so they are used in sealing materials (packing) that also require heat and chemical resistance and cannot be substituted.**

↓

- Fluoroelastomers are also more expensive than commonly used materials, and therefore they are not used blindly. They are only used selectively in applications where they cannot be substituted under severe conditions, even in required properties for safety and safety functions that are essential for EEE. (There is no alternative material because of selective use.)

4. Sliding function in mechanical section and required properties

2) Preparations: Greases, Lubricants, Protective coating materials

a. Lubricating components

Properties	Fluoropolymer Perfluoropolyethers, etc.*	Molybdenum disulfide	Graphite
Light load lubricity	○	×	×
non-conductive	○	○	×
Polite resistance	○	×	×

*PTFE, PCTFE, PFPE

○=Excellent; ×=Not well suited for use

b. Solvents

Properties**	Fluorosolvent	Petroleum oil	Silicone oil
Chemical Attacks on Plastics	Low	high	low
Generation of volatile gases	low	low	high
Risk of contact failure	not	not	Yes
Temperature viscosity change	low	high	low
flammability	not	Yes	not

** HFE, HFO

Major compositions : a. Lubricating components + b. Solvents
➡ Fluoropolymers + Fluorosolvents is best

- **Only "fluoropolymers and fluorinated solvents" have lubricity, thermal stability, and no negative effects on components (i.e., there are no alternatives).**

4. Sliding function in mechanical section and required properties

(4) Social impact when PFAS cannot be used (example)

1） <u>If fluorine material cannot be used in the cameras, the functional degradation will occur.</u>

- Furthermore, the U.S customers will not be provided with high-performance cameras year after year. Cameras that are significantly less capable than the current ones will likely miss or fail to record key moments in news, sports, events, etc., and will have a significant impact on their coverages with photos and videos in the U.S.
- If the camera lens cannot be coated with a sliding function coating, it will lead to a decrease in reliability and shorten the product life. (more frequent replacements and replacements will be required).
- The performance of mechanical sections such as focusing and zooming is reduced, making it difficult to capture fast-moving subjects.

2） <u>If fluoropolymers cannot be used for safety and high reliability components such as O-rings and packings,</u>

- The safety of electrical and electronic equipment cannot be guaranteed, which in turn places people and the environment in an unsafe situation. Such components are widely used in sections that must simultaneously meet high reliability (safety) requirements such as heat resistance, insulation, flame resistance, and solvent resistance, especially in equipment for professional use. Examples include industrial equipment such as EEE and other production equipment (heating furnaces, molding machines, robots, semiconductor manufacturing equipment, etc.), infrastructure equipment, medical equipment, and analytical instruments.
- If fluoropolymers with excellent water repellency and lubricity cannot be used, the waterproof performance of EEE cannot be guaranteed and product life will be shortened.
- Since fluoropolymers with excellent solvent and chemical resistance cannot be used, it is difficult to meet the required performance, especially in medical devices, analytical instruments, and semiconductor manufacturing equipment, which are likely to come in contact with chemicals and solvents, due to lack of reliability and frequent maintenance replacement, which also affects the life of the equipment.
- Lack of equipment reliability not only leads to increase of waste, but also significantly affects work safety in professional use.

5．Display function (Liquid crystal) and required properties

(1) Display function (Liquid crystal)

Function to display information such as text, graphics, and video by controlling pixel luminance and reflectance by giving each pixel on the screen an On, mid-tone, or Off signal.

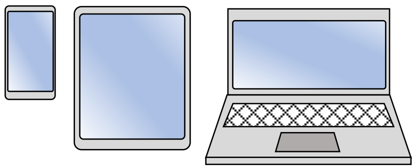
(2) Comparison with other devices as a display

Table 1: Comparative characteristics of LCD, CRT, and OLED

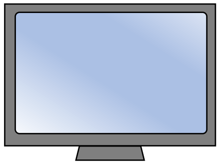
Character	LCD	CRT	OLED
Weight	Light	Heavy	Light
Volume (thickness)	Thin	Large (Thick)	Thin
Large Screen	Available	Unavailable	Available
Power consumption	Low	High (2x of LCD)	1.3x of LCD
High resolution	High	Unfeasible	High
Response speed	Mid	High	High
Contrast ratio	Mid	High	High
Brightness	Mid	High	Lower than LCD
Durability	High	Low Degradation of phosphers	Low Degradation of phosphers
Price	Low	Unavailable	High
Repairability	Easy	Hard	Hard

Table 1 shows that the characteristics of LCDs are better balanced than CRTs and OLEDs

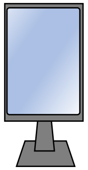
<Application examples>



- ✓ Smartphone
- ✓ Tablet
- ✓ PC



TV



Digital Signage

5．Display function (Liquid crystal) and required properties

(3) Required properties for materials and comparison with non-PFAS materials

- The introduction of fluorine into liquid crystalline compounds has the effects shown in the table below.
- The decrease in Δε has the tendency to increase the drive voltage, but the decrease in viscosity η with the introduction of fluorine results in a rather low threshold voltage due to the decrease in elastic constants. As a result, low voltage drive becomes possible with the introduction of fluorine. This low-voltage drive leads to lower power consumption and contributes to global environmental sustainability.
- There is no other liquid crystal material with these characteristics other than fluorine-based liquid crystals, which cannot be replaced by cyanide-based liquid crystals.
- In particular, the large temperature dependence of the threshold voltage of cyanide-based liquid crystals and their slow response are fatal defects in moving image displays.

General properties and characteristics of materials and properties required for liquid crystal displays.

Properties	Cyano−based LC compounds	Fluorine-based LC compounds	Effect
Viscosity η	High: 20cp	Low: **10cp**	Low viscosity generates high speed response
Refractive index anisotropy	Large	Large	Same Optical properties
Specific resistance	Low: 1.0 E+13Ωcm	High 1.0 E+15Ωcm	Reliability, Preventing image sticking
Dielectric anisotropy ⊿ε	High: 20	Low:10	Low driving voltage
Birefringence index ⊿n	High: 0.2	Low: 0.1	Wider viewing angle
Wavelength dependence of birefringence	High: 0.02	Low: 0.01	Wide operating temperature range
High voltage holding ratio at high temperature	Low: 90%	High: 99%	Reliability, Wide operating temperature range, Preventing image sticking
Temperature dependence of threshold voltage	High: 0.5V	Low: 0.1V	Wide operating temperature range
Temperature range for nematic phase	Narrow Under 100 (deg/C)	Wide Over 100 (deg/C)	Wide operating temperature range

5. Display function (Liquid crystal) and required properties

Fluorine-based LCDs are now capable of displaying moving images, which was not possible with cyanide-based LCDs, thus expanding the range of applications.

Table 2: Comparison of information to display between fluorine-based and cyano-based liquid crystals

Information to display	Cyano-based liquid crystal	Fluorine-based liquid crystal
Text & Graphics	Suitable	Suitable
Still Image	Can be used	Suitable
Video (TV, etc.)	Not suitable	Suitable
Application	Mainly Black and White type (Segment or Passive matrix) • Calculator, Watch (clock) • Simple indicator (Speedometer, etc.) • Old cell phones	Mainly full color type (Active matrix) • TV, Information Display • Current PC monitor (Note PC) • Navigation panel, Smartphone • Tablet, etc.
Usage environment (temperature range)	Mainly indoors	Possible outdoors

Table 2 shows that fluorinated liquid crystals are essential for video display applications.

5. Display function (Liquid crystal) and required properties

(4) Social impact when PFAS-based LCD cannot be used

1) Requirements for electronic displays in an advanced information society.

- An electronic display that converts and displays electronic information into visual information such as characters, graphics, and moving images is essential, and the following items shown in Table 1 are necessary.
  - Portability (small thickness): Measures against the freedom of installation
  - Support for large screens: Measures for increased amount of information and production of presence
  - Low energy consumption: Measures against global warming
  - High resolution: Measures for increased amount of information and production presence
  - Fast response: Measures for video compatible
  - High Contrast Ratio: Measures for Realism
  - High brightness: at least for normal indoor environments
  - Long product life: less waste
  - Availability, including price: penetration in the market
  - Repairability: less waste

2) LCD suitable for video using fluorinated liquid crystal material.

- The development of fluorinated liquid crystal materials (A kind of PFAS) has enabled LCDs to achieve a fast response that cannot be achieved with cyano-based liquid crystal materials, and a small change in driving voltage in response to temperature changes according to brightness of backlight. Those makes LCDs compatible with TV broadcasting (moving images). Cyano-based liquid crystal materials are used for display media that do not require moving images, such as calculators.

3) Current status of electronic displays

- LCDs using fluorinated liquid crystal materials have almost eradicated CRTs from the electronic display market due to their overall superiority over CRTs in terms of requirement 1) above. Although OLED is partially superior to LCD, it is inferior to LCD as a whole, so replacement from LCD is not progressing.

5. Display function (Liquid crystal) and required properties

■ Particular, the unavailability of LCDs would have a negative impact on society in the following respects

4) Low energy consumption

- The power consumption of a display with the same screen size as an LCD is 200% for a CRT and 130% for an OLED, as shown in Table 1. CRTs generate electron beams to illuminate light-emitting materials, and OLEDs require high voltages to drive current through light-emitting organic materials that are insulators. Both of these require high power consumption. When LCDs become unavailable, we have no choice but to change to CRT or OLED. This means an increase in energy consumption, which has implications for energy consumption reduction, climate change countermeasures, and energy security.

5) Product life

- LCDs are non-illuminated displays and consist of an LCD panel, which controls light transmission according to pixel information, and a light source 'backlight' is put behind the LCD panel.
  - A liquid crystal (LC) panel changes the transmittance of a pixel by controlling the alignment of LC molecules with a low voltage not supply any current. Since LC molecules do not degrade because their energy levels (or active states) do not change during operation.
  - Inorganic LEDs that emit light when current is applied are mainly used for the backlight of the light source. LEDs, which are semiconductors, have a longer lifetime than OLEDs and their peripheral circuits also have a longer life.
- Self-emitting displays such as OLEDs or CRTs convert the energy given to the pixels into light. Luminescent substances whose energy levels (or active states) are excited by the given energy are transformed into non-emitting light substances by chemical reactions without emitting due to a certain probability. As a result, the luminous brightness decreases with the passage of time of use. The light-emitting organic substances used in OLEDs decrease their brightness faster and their lifetime is shorter than light-emitting inorganic substances used in CRTs.

5. Display function (Liquid crystal) and required properties

6) Repairability

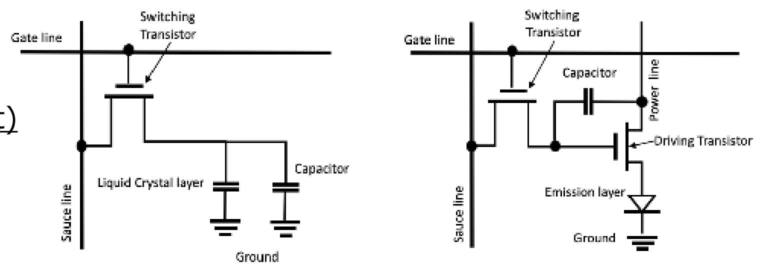
- Display failures can be broadly classified into physical or mechanical damage and component deterioration. Non-illuminated display LCDs consist of an LCD panel and a backlight, so any one of the failed components can be repaired or replaced. Deteriorated backlights can be replaced and components can be easily recycled. On the other hand, faulty repairs are not possible for self-luminous displays OLEDs and CRTs, which can only be replaced. Replaced self-luminous displays are not easily recyclable and become waste.

7) Availability

- CRTs are only produced for special purposes on a limited basis, and are not available for general use. However, the depth close to the display size is necessary, and it cannot correspond to the advanced information society. LCDs and OLEDs have transistors in pixels, but as described below, OLEDs have more complicated pixel transistors and wiring structures than LCDs, which is disadvantageous in terms of cost.

	LCD	OLED
Structure	1 transistor and 2 lines	2 transistors and 3 lines
Transistor	1. Switching A swithing transistor which controls applied voltage to change the orieintation of liquid crystal on the pixel	1. Switching A switching transistor which determines whether or not current flows through the pixel 2. Driving A driving transistor which adjusts the amounts of current to controle the luminance of the emission layer
Line	1. Gate Control switching transistor 2. Sauce Apply voltage to liquid crystal	1. Gate Control switching transistor 2. Sauce Control Driving transistor 4. Power Apply current to emission layer

PIxel structure of LCD (left) and OLED (right)



6．Safety and safety functions and Required properties

(1) Safety and safety functions

Basic and as prerequisite elements and functions for EEE to ensure safe use of equipment and to minimize damage in the event of fire, etc.

(2) Required Properties for Parts and components

- Two or more high-reliability properties, such as heat resistance, flame retardance, chemical resistance and high airtightness (low gas permeability) must be achieved simultaneously in a single material.

e.g.) Cables, Tapes, Protective coatings, Encapsulants and Tubes (safe and reliable)

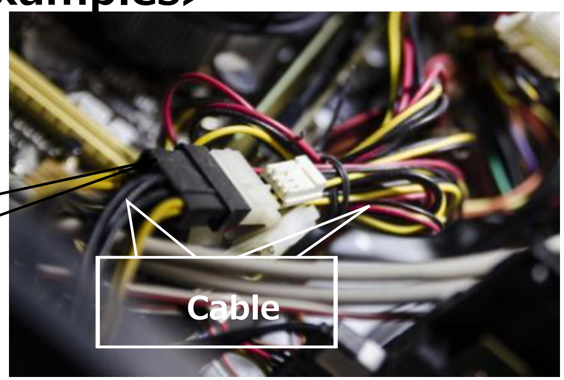
- Prevent dripping of resin components to minimize damage in the event of a fire (enhance flame retardant property)

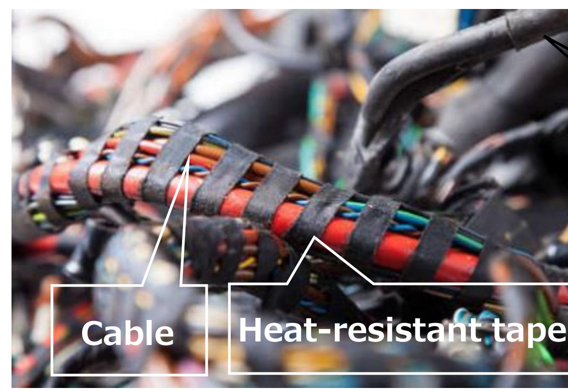
e.g.) Equipment such as PCs and smartphones, Enclosures for power supplies, batteries, etc., Components that make up parts (Safety)

*( ) indicates achievable performance

<Application examples>

[Cable, Tape, Connector,]





Cables, tubes, tapes, etc. (Covering ,Protective Material)

Insulation (low dielectric constant), bendability (flexibility), flame resistance, and resistance to heat and cold are essential for cables, and chemical resistance is required depending on the environment in which the cable is used. In particular, only fluoropolymers simultaneously achieve the high safety requirements of heat resistance, chemical resistance, insulation, and flame retardance.

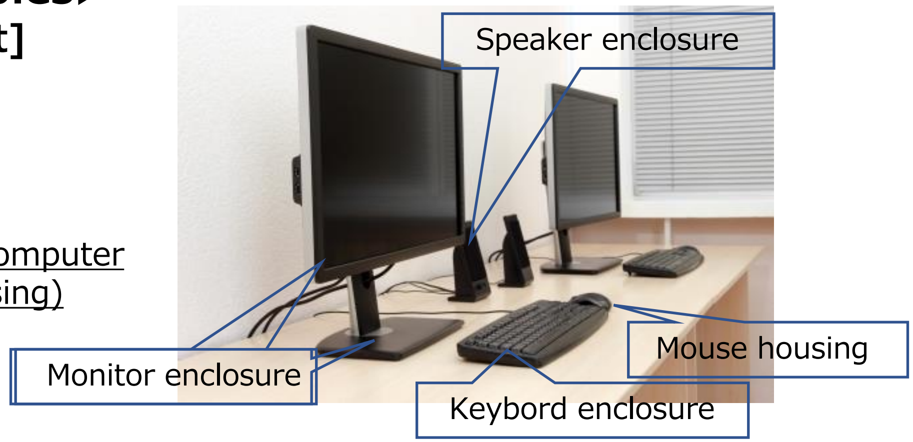
6．Safety and safety functions and Required properties

<Application examples>

[Anti-dripping agent]

Parts in which PFAS is used

e.g. : Personal computer (equipment housing)



Anti-Dripping agent

Resins used for housings for TVs, PCs, etc. must be certified to UL94 (the Standard for Safety of Flammability). Especially for resins that require a high flame retardance above V-0 grade, it is necessary to prevent the generation of burning particles that can lead to ignition, and an anti-drip agent is indispensable. In order to increase the melt tension of low-viscosity resin, the anti-drip agent itself must have extremely high melt viscosity and be high flame-retardant, and only PTFE achieves these requirements.

6. Safety and safety functions and Required properties

(3) Required properties for materials and comparison with non-PFAS materials

■Resins

Properties	Fluoropolymers				Other Resins			
	PTFE	FEP	PFA	ETFE	PVC	PEEK	PI (Film)	Polyolefin resin
Heat resistance Continuous use temperature,℃	260	200	260	150	60～105	180～200	150～200	90～125
Chemical resistance	◎	◎	◎	○	△	△ Oil-proof and Acid resistance NG	○	△ Solvent resistance NG
Flex resistance	○	○	○	◎	△ impact resilience	△ Too rigid	△ Too rigid	△
Cold resistance	○	○	◎	○	△	△～○	○	△～○
Electrical insulation (Dielectric constant, ε)	◎ (2.1)	◎ (2.1)	◎ (2.1)	○ (2.3～2.8)	△ (4～6)	△ (3.2～4.5)	△ (2.8～3.2)	△～○ (2.3～4)
Flame retardancy (Limiting oxygen index)	◎ (>95vol%)	◎ (>95vol%)	◎ (>95vol%)	○ (31vol%)	◎ (45vol%)	○	◎	△ Chemical resistance is reduced by flame retardant

◎=Superior; ○=Excellent; △=Usable; ×=Not well suited for use

・Fluoropolymers have overwhelmingly excellent chemical resistance and insulation properties in addition to heat resistance and flame retardance. Since they also have a very low dielectric constant, they have excellent insulating properties per thickness, leading to thinner base materials, which in turn leads to smaller and lighter electrical and electronic equipment (energy saving).

↓

・Fluoropolymers are more expensive than commonly used materials, and therefore they are not used blindly. They are only used selectively in applications where they cannot be substituted under severe conditions, even in required properties for safety and safety functions that are essential for EEE. (There is no alternative material because of selective use.)

6． Safety and safety functions and Required properties

■Rubbers

Properties	Fluoroelastomers		Synthetic rubbers			
	FKM	FEPM	Silicone	EPDM	CR	NBR
Heat resistance max use temperature,℃	230	230	230	150	100	120
Chemical resistance	○	○	△	△	○	○
Ozone resistance	◎	◎	○	○	×	×
Cold resistance	△	△	△～○	△～○	△～○	△
Electrical insulation (Dielectric constant ,ε)	△ (3～4)	△～○ (2.5～3.5)	△ (3.2～10)	△～○ (2.5～3.5)	× (7.5)	× (15～20)
Combustibility	◎	◎	△ Chemical resistance is reduced by flame retardant	△ Chemical resistance is reduced by flame retardant	○	△
Gas permeability (cc·cm/cm^2·sec·atm)	1	1	400	15	15	3

◎=Superior; ○=Excellent; △=Usable; ×=Not well suited for use

- Fluoroelastomers, like fluoropolymers, have overwhelmingly excellent chemical resistance, ozone resistance, and insulation properties in addition to heat resistance and flame resistance, compared to other rubber. They also have excellent gas barrier properties (the smaller value, the less gas permeates.), so they are used in sealing materials (packing) that also require heat and chemical resistance and cannot be substituted.

↓

- Fluoroelastomers are also more expensive than commonly used materials, and therefore they are not used blindly. They are only used selectively in applications where they cannot be substituted under severe conditions, even in required properties for safety and safety functions that are essential for EEE. (There is no alternative material because of selective use.)

6. Safety and safety functions and Required properties

(4) Social impact when PFAS cannot be used (example)

1） If fluoropolymers and fluoroelastomers cannot be used for safe and highly reliable components such as cables, protective tubes, sealing materials, and pipe,

- The safety of electrical and electronic equipment cannot be guaranteed, which in turn places people and the environment in an unsafe situation.
- Such components are widely used in sections that must simultaneously meet high reliability (safety) requirements such as heat resistance, insulation, flame resistance, and solvent resistance, especially in equipment for professional use (They are also used around engines of automobiles and other vehicles). Examples include industrial equipment such as EEE and other production equipment (heating furnaces, molding machines, robots, semiconductor manufacturing equipment, etc.), infrastructure equipment, medical equipment, and analytical instruments. Lack of equipment reliability also affects equipment life, including frequent maintenance and replacement, leading to increase of waste and, of course, a significant impact on work safety in professional use.

6. Safety and safety functions and Required properties

2） <u>If PFAS cannot be used as an anti-drip agent,</u>

- Resins used for housings of TVs, PCs, and other products, as well as resins used around power supplies and heat-producing component in electrical components, may be required by law to be certified to UL94; the Standard for Safety of Flammability. In order to satisfy these standards, the addition of flame retardants is definitely needed. Especially for resins that require a high flame retardance above V-0 grade, it is necessary to prevent the generation of burning particles that can lead to ignition, and an anti-drip agent is indispensable.
- In some cases that halogenated flame retardants are regulated by law, and inorganic flame retardants and phosphate ester flame retardants must be used, however, inorganic flame retardants require the addition of large amounts of flame retardants to achieve sufficient flame retardant effects, resulting in a loss of resin properties. On the other hand, phosphate ester flame retardants are limited to resins (that easily carbonize with oxygen) due to the flame retardant mechanism (formation of carbonized layer during combustion). Flame-retardant resins made from a polymer alloy of polycarbonate and styrene resin (PC/ABS) with a phosphate ester flame retardant are widely used in Home appliances and OA equipment. However, phosphate ester flame retardants plasticize resins, causing them to drip more easily, so PTFE (a fibrillated fluoropolymer increases the melt tension of low viscosity resins and has an anti-dripping effect) must be added as a flame retardant aid in order to achieve V-0 grade. The addition of an anti-drip agent can also reduce the amount of flame retardant used.

7. Functional surface and required Properties

(1) Functional surface

Essential functions for EEE, such as water-repellent, oil-repellent, non-adhesive, solvent-resistant, moisture-resistant, and weather resistant on surfaces touching with substances for the purpose of stain-proofing and protecting equipment.

(2) Required properties for materials used in parts and materials

- A newly high strength film such as heat resistant, solvent resistant, and water/oil repellent is formed on the surface of the base material.

  ⇒ Baking coating of resin (powder coating) _Adding new functions where there is a requirement for film thickness and high durability. Base materials are limited to metals, ceramics, glass, etc. due to processing temperatures, and cannot be applied to plastics.

  e.g.) Inner surface treatment of cooking appliances (high durability, safety), iron (high durability, high quality), Machines and Equipment (high durability, safety)

- In order to protect the functionality of equipment, a thin film is given to the surface of the base material to provide not only stain resistance but also weather resistance, moisture resistance, insulation properties, etc.

  ⇒ Application coating : A film is formed by foaming and drying at room temperature, so it can be applied to a wide range of base materials.

  e.g.) Touch panel protection (high durability), exterior protection of outdoor equipment (high durability), substrate circuit protection (high durability, safety)

7. Functional surface and required Properties

<Application example>

[Cooking appliances]

Parts and materials using PFAS

<u>Inner pot and surface treatment of cooking appliances: Fluoropolymers baking coating (powder coating)</u>

Inner pots and surface of cooking appliances require functions such as heat resistance to bear cooking temperatures, Antifouling for food baking and cleanliness, and anti-bacterial measures. In order to realize these functions at the same time, fluoropolymers baking coating is applied. Baking coating is a method of forming a film by applying fluoropolymers powder such as PTFE to a heat-resistant base material like metal, ceramic, or glass and heating , melting it to form a coating. In addition, it is the only material and method that can simultaneously ensure water and oil repellency, acid resistance, and non-adhesiveness, which are the characteristics of fluorine material. Particularly in the case of the Automatic Bread Maker, it is essential to use a material that allows the baked bread to be removed from the container without burning. And also particularly in the case of a microwave oven, it is necessary to use a material that does not affect electromagnetic waves for safety reasons. It's because fluoropolymers is baked on, it does not peel off by scratching and dissolve in water, oil, or seasonings, so it can be used safely for the life of the device, contributing to the reduction of waste during long-term use. In addition, fluorine treatment of cooking appliance prevents food from burning, which is said to be carcinogenic, and thus greatly contributes to human health.

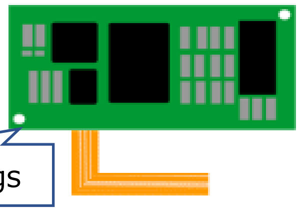
This technology is also used in machinery and equipment for durability and safety purposes because, unlike general coatings, it can form coatings of several tens of micrometers or more.

7. Functional surface and required Properties

<Application example>

Parts and materials using PFAS

[Printed circuit board]



[touch panel]

When used as a coating or protective film on the surface of a touch panel, it must also satisfy the properties required in "Optical Properties (1. Optical Functions)".

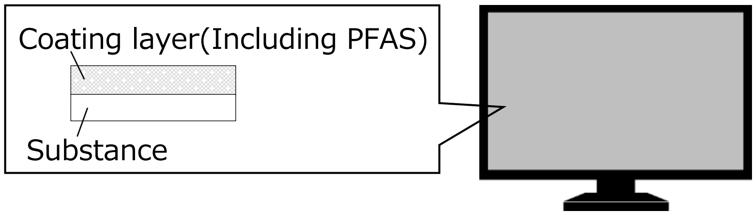
<u>Protective coating of printed circuit board : applied coating</u>

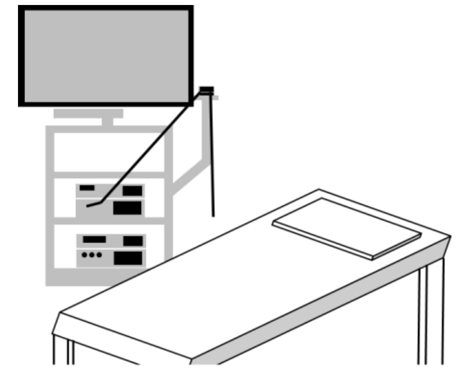
Printed circuit boards are the core of electrical circuits and are used in all kinds of electrical and electronic equipment. And environment these devices are used vary widely. In particular, for mobile devices such as smartphones and cameras, outdoor equipment, and in-vehicle equipment, measures must be taken to prevent migration caused by condensation owing to sudden temperature changes (such as moving from a cold outdoors to indoors), humidity caused by rain, etc. It is necessary to take measures to ensure reliability and safety, such as measures against short circuits due to sticking dust and measures against solvents to prevent leakage from electrolytic capacitors, batteries, etc. In addition to being water and oil repellent, fluorine materials are stain and moisture resistant, and have high solvent resistance and insulation properties that do not cause contact error. Therefore, there is no alternative material with equivalent performance, so fluorine materials are only for protective coatings for printed circuit boards.

7. Functional surface and required Properties

<Application example>

[Optical film for liquid crystal display]





<u>"Molecular orientation" and "Film thickness control" in optical film materials for liquid crystal displays : Coating</u>

Fluorine materials are used as coating agents in coating layers in optical films for liquid crystal displays. Since the fluorine atom has highest electronegativity, the fluorine material is characterized by having a low surface tension. The high optical performance required for optical films for liquid crystal displays can be achieved by low surface tension, which is a major feature of fluorine materials.

<u>Technologies required for optical films for LCD displays</u>

(1) Control of coating layer thickness
The coating layer can be applied evenly due to the low surface tension and wettability with the coating layer substrate.

(2) Control of molecular arrangement in coating layer
Due to its low surface tension and hydrophobicity, the fluorine-containing coating agent is unevenly distributed on the surface, resulting in uniform alignment of molecules in adjacent coating layers.

It is difficult to meet the required performance without fluorine materials, and as a result, we are concerned that it will become difficult to supply displays not only for consumers but also for medical devices within the EU.

7. Functional surface and required Properties

<Application example>

[Optical sensor]

<u>Functional surface coating used for optical sensors in ink cartridges</u>

In order for an optical sensor to perform its functions with high precision, the surface of the sensor's light-emitting and light-receiving element must have good separation from the liquid to be detected (water-based ink), that is, it must be a water-repellent surface.
This sensor detects when the liquid container is not empty and stops the product before it is damaged.
The surface of the element must be kept clean at all times because the amount of remaining liquid is detected by the difference in the light absorption rate of the liquid or air.
The fact that the optical sensor remains clean allows the printer to perform accurate ink detection from the ink cartridge.
In addition to the water-repellent function, this coating must also satisfy optical properties (1. Optical function/2.transparency and low refractive index) because it is a sensor that uses light, and these two required properties must be met. PFAS is the only material that satisfies both requirements and is indispensable for highly accurate remaining amount detection technology as an optical sensor.
It is essential that the liquid on the optical sensor flows smoothly in order to grasp the remaining amount, but the silicone type has insufficient water repellency (higher surface free energy than fluorine type) and abrasion resistance. Because of its poor performance, it was unable to meet the technical characteristics required for the lowest line of optical sensors.

7. Functional surface and required Properties

(3) List of required properties for materials and general physical properties

■ Resin baked coating (powder coating))

Properties	Fluoropolymer	Epoxy resin	Polyester resin	plating	DLC
Heat resistance max use temperature,℃	～350℃	～200℃	～230℃	◎	◎
Abrasion resistance	○	△	△	○	○
Water and Oil-repellent property	○	×	×	×	×
Chemical resistance	○	○	×	○	○
Weather resistance	○	×	○	○	○
Note	Since the film thickness is 30 μm or more, the base material with high strength and excellent durability is limited, and a dedicated factory (dedicated supplier) is required.			When the means are changed, the performance as an inorganic film can be secured, but the surface wetting performance is NG.	

○=Excellent; △=Usable; ×=Not well suited for use

- Powder coating has characteristic of high strength and durability of the coating film, and is often used for home appliances, industrial equipment, medical equipment, automobile parts, etc. fluoropolymers are excellent in all performances, but because of their high heat resistance, the treatment temperature during processing is high, and they are also expensive as materials, so they are appropriately selected and used according to the purpose.
- Fluoropolymers is often used in home appliances, especially in kitchen equipment. As alternative technology there is DLC, plating, but these films do not have water and oil repellency, so they do not meet the required properties.
- In the case of Fluoropolymers, they have not only baked coating but also chemical resistance, so it does not leach into water or oil, and has no environmental impact.
- Ensuring durability through high coating film strength extends product life and contributes to waste reduction.

7. Functional surface and required Properties

■Application coating

Properties	Fluoropolymers		Silicone	Acryl	Urethane
	Resin-type	Modified silane-type			
Heat resistance	○	○	○	×	×
Abrasion resistance	○	○	△	×	○
Water and Oil-repellent property	○	○	○～△	×	×
Moisture resistance	○	○	×	△	△
Electrical insulation	○	○	△ (Risk of contact failure by low-molecular weight siloxane)	○	○
Chemical resistance	○	○	○	△	△
Weather resistance	○	○	○～△	×	△
Light permeability	○	○	△	○	△

○=Excellent; △=Usable; ×=Not well suited for use

・Fluorine materials satisfy most of the performance requirements, but they are very expensive, so they are used only in carefully selected cases when multiple performance requirements must be satisfied at the same time. Therefore, because it is used out of necessity, it is used in applications in which other materials cannot be substituted.

・Adding functions and modifying surfaces by coatings is used to improve durability, ensure safety, and prevent failures of equipment use, extend product life and contribute to reducing waste.

↓

・Fluoropolymer is more expensive than common materials, so fluorine materials should not be used thoughtlessly. It is necessary to achieve multiple required performances at the same time, and it should be used carefully only in applications where it cannot be replaced (fluorine materials are essential so there is no alternative material).

7. Functional surface and required Properties

(4) Social impact when PFAS cannot be used (example)

1） When fluorine resin cannot be used for cooking equipment

- The inner pot and inner walls of cooking equipment are heat resistant to withstand cooking temperatures, stain resistant to prevent food from burning and to ensure cleanliness. Antibacterial measures are necessary.
  In order to realize these at the same time, a fluororesin baking coating is applied.
  Because the fluororesin is baked on, it does not peel off due to scratches, etc., and does not dissolve in water, oil, or seasonings, so it can be used safely for the life of the device, contributing to the reduction of waste during long-term use. Fluorine treatment of cooking utensils also contributes greatly to human health, as it prevents food from burning, which is said to be carcinogenic.
- Powder coating is carried out at a exclusive factory (exclusive supplier), so blindly discontinuing it would cost the supplier their livelihood. Also, if you change the process (plating, DLC), these will also be handled by a exclusive factory (exclusive supplier).
  Since it is necessary, large-scale investment is required due to the problem of supply and demand balance, and it cannot be replaced immediately.

7. Functional surface and required Properties

2） <u>When fluororesin cannot be used for printed circuit boards</u>

- Printed circuit boards are the core of electric circuits and are used in all kinds of electrical and electronic equipment, and the environments in which such equipment is used vary widely. And the material properties of fluorinated coatings (moisture resistance, water repellency, solvent resistance, and insulation) are used to protect the electric circuits, thereby ensuring the reliability and safety of the equipment. Therefore, if fluorinated coating materials are not available, the electrical circuits of printed circuit boards will become unsafe because they will short-circuit and break, or in the worst case, catch fire. In addition, the life of the equipment is shortened, leading to replacements and increased waste, resulting in significant social losses, both economically and environmentally.

8. Semiconductor and required Properties

Please refer to the submissions of the relevant industrial associations.
As PFAS are also used in the manufacturing process of semiconductors and in semiconductors as itself, both should be considered excluded.
Since MEMS* and thin film devices are also manufactured in the same process as semiconductors, both should be treated as semiconductors.
Therefore please consider to exclude semiconductors, MEMS, and thin-film devices as they are essential devices for electrical and electronic equipment.

* MEMS：Micro Electro Mechanical Systems

Many reports have been published on semiconductors, focusing on PFAS. Please obtain them from the following URL and consider them.

PFAS - Semiconhttps://www.semiconductors.org/pfas/ductor Industry Association (semiconductors.org)

- The Impact of a Potential PFAS Restriction on the Semiconductor Sector

Case Study
- PFOS and PFOA Conversion to Short-Chain PFAS Used in the Semiconductor - Manufacturing
- PFAS-Containing Surfactants Used in Semiconductor Manufacturing
- PFAS-Containing Photo-Acid Generators (PAGs) Used in Semiconductor Manufacturing

White Paper
- Background on Semiconductor Manufacturing and PFAS
- PFAS-Containing Fluorochemicals Used in Semiconductor Manufacturing Plasma-Enabled Etch and Deposition
- PFAS-Containing Heat Transfer Fluids (HTF) Used in Semiconductor Manufacturing
- PFAS-Containing Materials Used in Semiconductor Manufacturing Assembly Test - Packaging and Substrate Processes
- PFAS-Containing Wet Chemistries Used in Semiconductor Manufacturing
- PFAS-Containing Lubricants Used in Semiconductor Manufacturing
- PFAS-Containing Articles Used in Semiconductor Manufacturing

9. Thin film device production process and required Properties

The manufacturing process of thin film devices is the same as that of semiconductors and MEMS.
Therefore, the manufacturing process of thin film device must also be excluded as part of the semiconductors.
A number of reports have been made on the requirements of semiconductor processes, and we would like them to be considered.

PFAS - Semiconhttps://www.semiconductors.org/pfas/ductor Industry Association (semiconductors.org)

- The Impact of a Potential PFAS Restriction on the Semiconductor Sector

Case Study
- PFOS and PFOA Conversion to Short-Chain PFAS Used in the Semiconductor - Manufacturing
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- PFAS-Containing Articles Used in Semiconductor Manufacturing

10. Energy supply (Battery, Fuel cells, Solar cells) and required Properties

Please refer to the submissions of related industrial associations and consider to exclude Energy supply (Battery, Fuel cells, Solar cells) since it is essential power for electrical and electronic equipment.

< Battery >

Please refer to the submissions by BAJ

＊BAJ

Battery Association of Japan

< Solar cells >

Comments on the impact of PFAS regulations under REACH regulations in Europe were submitted by solar panel stakeholders, including the Solar Power Technology Research Association (PVTEC).

Please contact the solar panel stakeholders for the details.

10. Energy supply (Battery, Fuel cells, Solar cells) and required Properties

< Fuel cells >

■ Social impact when PFAS can’t be used in fuel cells

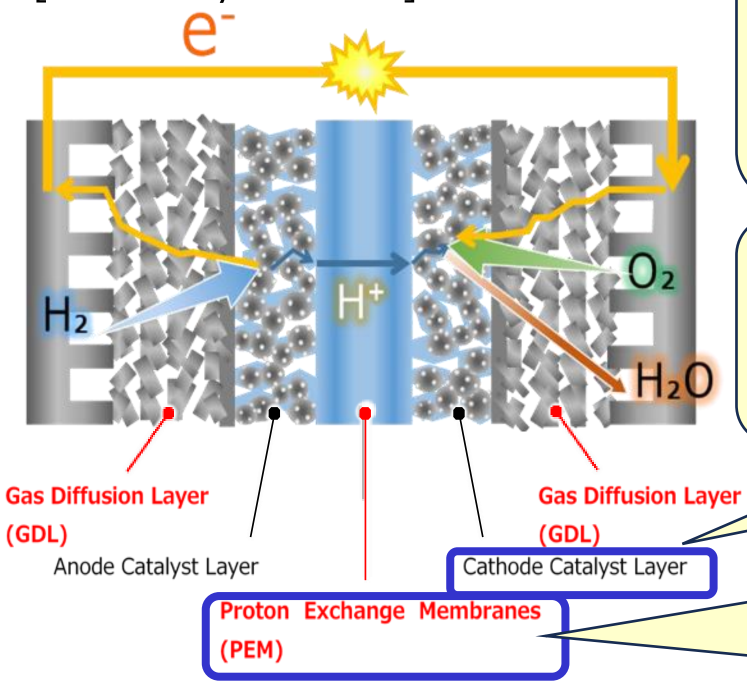
Mass production of fuel cells, indispensable energy supply technology for decarbonization utilizing hydrogen, would become impossible, which adversely affects the realization of a decarbonized society.

■ Required properties for parts and components

For the core materials, Proton exchange membrane, Catalyst layer (ionomer) and Electrode water repellent, Rubber seal, etc.), resistance to strong acidity and high temperature steam is required in order to ensure a product life of 90 K hours in the harsh environment of the cell.

< Application example >

[Stationary Fuel Cell]



● Rubber Seals

[Function] Devide the cathode air and the anode hydrogen air around each cell.
[Required properties] Prevent leakage of H2 and O2 under steam and high oxygen atmosphere under Highly acidic (pH=2-3), and high temperature (100℃)
=>Only FKM (Fluororubber) can be applied.

● Catalyst Layer (Ionomer)

[Function] Bond Proton Exchange Membrane and Diffusion Layer.
[Required properties] Pass both H2 and O2 under highly acidic (pH=2-3), and high temperature (100 ℃) steam.
=>Only Per-fluorosulfonic-acid (PFSA) can be applied.

● Proton Exchange Membrane (PEM)

[Function] Transfer protons from anode to cathode.
[Required properties] Ensure product life of 90 K hours under highly acidic (pH=2-3), and high temperature (100 ℃) steam.
=>Only Per-fluorosulfonic-acid (PFSA) can be applied.

11. Refrigeration, Air-conditioning and heat pump sector RACHP (Refrigerant) and required Properties

Fluorine gases are indispensable for the manufacturing process and operation of electrical and electronic equipment.
Please refer to the submissions of the relevant industrial associations, and consider to exclude fluorine gases for electrical and electronic equipment.

Please refer to the submissions by JRAIA

＊JRAIA

Japan Refrigeration and Air Conditioning Industry Association

12. Passive electronic components, manufacturing process and their required Properties

◆Passive electronic components

Passive electronic components are essential components in the electrical circuits of electrical and electronic equipment that protect semiconductors, filter electrical signals, and attenuate, store, and emit electrical energy.

<Application example>

1) Electrode formation process with safety function for film capacitors

■What is a Film capacitor?

Film capacitors are capacitors that use plastic film as the dielectric and are one of the essential passive components in the circuit configuration of electrical and electronic equipment.

[Example of appearance of Film capacitors]

[Applications]

It is widely used in home appliances, game machines, measuring devices, medical devices, solar power generation, mobile phones, etc.

With the electrification of automobiles, the use of electric cars in automotive applications has expanded.

12. Passive electronic components, manufacturing process and their required Properties

■ Safety function of film capacitor

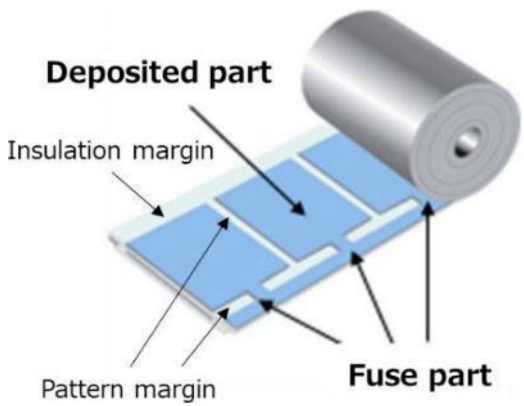


Fig. Internal electrode structure of film capacitor

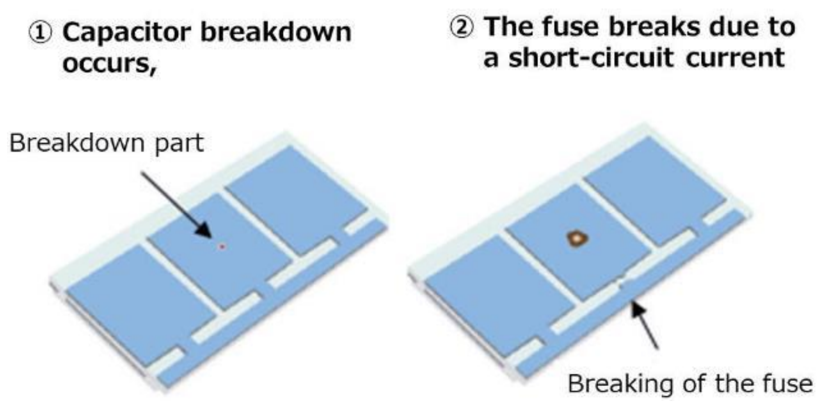


Fig. Safety function of film capacitor by fuse

For film capacitors, it is necessary to separate the deposited electrodes with a "pattern margin" and install an internal electrode pattern (fuse) to protect against overvoltage and overcurrent, and to install an "insulation margin" to ensure insulation between different electrodes.

This fuse is indispensable for the safety function of film capacitors. When a local breakdown occurs, the fuse breaks due to a short-circuit current, and the cell where the breakdown occurs due to the breaking of the fuse is electrically cut off from other cells to maintain the overall function of the capacitor.

In film capacitors, PFPE, a type of PFAS, is used to form pattern margins and insulation margins in the manufacturing process.

In particular, the use of high voltage is increasing in applications for electrification of automobiles. In order to ensure safety of the equipment, film capacitors must have safety fuse.

12. Passive electronic components, manufacturing process and their required Properties

■ Safety function of film capacitor

Manufacturing process of film capacitor using PFPE

To form a fuse, PFPE oil is deposited on a plastic film (oil masking with PFPE), followed by metal deposition. Because no metal is deposited in the oil-masked area, fuses and insulation margins are formed. It is necessary to make the area without metal deposition as thin as possible because it becomes a loss part without generating capacitance. In addition, since the fuse part must be formed as thin as possible in order to enhance the operability, the dimensional accuracy of the order of 0.01 mm is required for oil masking by PFPE (refer to figure below). This technology can only be achieved with highly water-repellent/oil-repellent fluorinated compounds, and no other useful alternative materials exist.

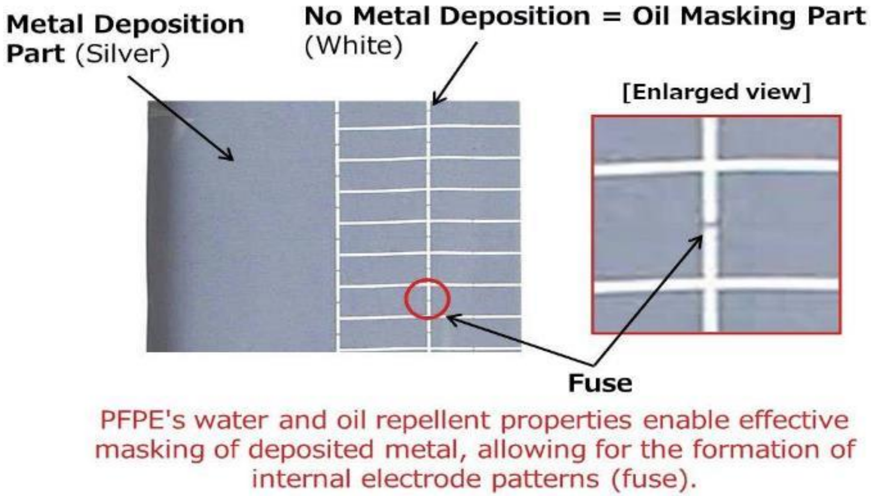


Fig. Appearance of the internal electrode pattern (fuse)

PFPE oil achieves high temperatures during metallization process which takes place under vacuum. Most of the properties of this oil are relevant for process itself and final product performance.

- A non-outgassing oil with a low evaporation loss is required for evaporation under vacuum.
- Chemical stability, non-corrosive, electrical insulation and high dielectric strength are mandatory properties due to this oil is in contact with the main part of film capacitors, which is the metallized film (metallized film = dielectric base film + metal layer).
- Thermal stability, heat resistance at extreme temperatures and non-flammability are also properties required for the oil considering the evaporation process.

Forming a fuse with oil masking using PFPE

12. Passive electronic components, manufacturing process and their required Properties

■ Concerns about substitution

As disclosed in the patent(平3-59981), when paraffin oil or silicone oil is used as an oil other than PFPE (perfluoroalkyl polyether) to form margins, deposited metal may also adhere to the masked margins. This causes problems with the insulation function, which is the original purpose. In addition, bleeding occurs at the boundary between the vapor deposition part and the margin part, and the margin itself becomes discolored, making it impossible to form patterns and fuses with high precision. In addition, bleeding occurs at the boundary between the vapor deposition part and the margin part, and the margin itself becomes discolored, making it impossible to form patterns and fuses with high precision.

At present, there is no prospect of a technology or material that can replace the oil masking performance of PFPE. Therefore, restrictions on PFPE in the film capacitor manufacturing process should be exempted.

(4) 特公 平 3—59981

7

ては、上記した転写ロールの他に、噴霧塗布手段が好適に用いられるほか、装置的な制約の許す範囲で各種印刷手段も用いられる。更に、蒸着はベルジヤーを用いたバツチ方式により行うこともできる。蒸着方式としては、狭義の真空蒸着のほか、各種スパツタリングも可能であり、それに応じて真空度も、例えば10^{-1}～10^{-6}Torrと巾広い範囲が選択可能である。更にフイルムあるいはシート状基材への蒸着は片面に限らず、両面に実施してもよいことは云うまでもない。

以下、代表的な実施例、比較例により、更に具体的に本発明を説明する。

オイル供給装置6として、転写ロールの代りに、スリツト状開口部を有する中空パイプ状噴霧塗布装置を用いる以外は、第1図に示したような、オイルマスク方式の半連続式蒸着機を用い、＊

8

＊オイルの種類を変えて蒸着を行つた。基材フイルム2としては、ポリエチレンテレフタレートのフイルム（厚み2μ、巾500㎜、長さ20000ｍ）を用い、その片面にフイルムの巻取り速度240ｍ／minでAlを蒸着した。蒸着機A内のオイル供給装置設置部の真空度は約10^{-2}Torr、Al蒸着される近辺の真空度は1～3×10^{-4}Torrであつた。オイルは8㎜間隔毎に巾1㎜でフイルム面に蒸気として噴出付着させた。またAl蒸着部の表面抵抗は1.7Ω／□（膜厚として約400Å）になるようにした。

異なるオイルを使用して得られたコンデンサ用金属化フイルムについて、巻取られたロール状態でのマージン部における金属付着量および金属化フイルムの蒸着部とマージン部との境界のボケを目視観察した結果は第1表の如くであつた。

第　1　表

オイルの種類		マージン部における金属の付着状態（色）	ボ　ケ
名　称	平均分子量		
パーフロロアルキルポリエーテル（n=14）	2500	なし（白色、テープマスクと同等）	なし
流動パラフイン(1)	310	有（やや薄ねずみ色）	あり小
流動パラフイン(2)	420	有（やや薄ねずみ色）	あり大
ジメチルシリコーン	800	大（黒褐色）	マージン部着色のため観察不能

更にメタノールを含浸させたガーゼでマージン部を拭きとつて発光分析にかけたところ、流動パラフインおよびジメチルシリコーンを使用したものからはAlが検出されたが、パーフロロアルキルポリエーテルを使用したものからは検出されなかつた。

上記第1表からわかるように、オイルマスク方式によるマスキングの効果はオイルの種類によつて大きな差があり、パーフロロアルキルポリエーテルの特異性が極めて明確である。

次いで、パーフロロアルキルポリエーテルの各種フイルムに対するAl蒸着のマスキング効果を見るために、ベルジヤー型蒸着試験機を使用して実験した。パーフロロアルキルポリエーテル（平均分子量2500）を綿棒に含浸させて各種のフイルムに巾約5㎜の線状に塗布し、フイルムのオイル塗布面にAlを蒸着した。比較のため、ポリエチレンテレフタレートフイルムについてのみ、流動パラフイン（平均分子量310）を塗布したものも実験した。

蒸着後のフイルムについて、オイル塗布部へのAlの付着状態およびオイル塗布部の外周の乱れを観察した結果を第2表に示す。

Only PFPE meets all the requirements for film capacitor foil metallization:
thermal and chemical stability, low evaporation loss, non-corrosion, electrical insulation, high dielectric strength and heat resistance at extreme temperatures.

12. Passive electronic components, manufacturing process and their required Properties

2) Electrode formation process of Electric Double Layer Capacitor (EDLC)

■ Electric Double Layer Capacitors (EDLCs) one of the essential passive components in the circuit configuration of electrical and electronic equipments. EDLCs are used as power storage devices in backup power supplies for electrical and electronic equipment, leveling of output fluctuations in renewable energy, and energy regeneration systems for automobiles.

■ Electrode formation for EDLC (used as binder)

⇒ High dispersibility in activated carbon, chemical and electrical stability, and high reliability (heat resistance and durability) can be secured, and the characteristics of EDLC are stabilized, so the performance and reliability of the backup power supply can be guaranteed.

[Application example : Backup in case of vehicle power failure]

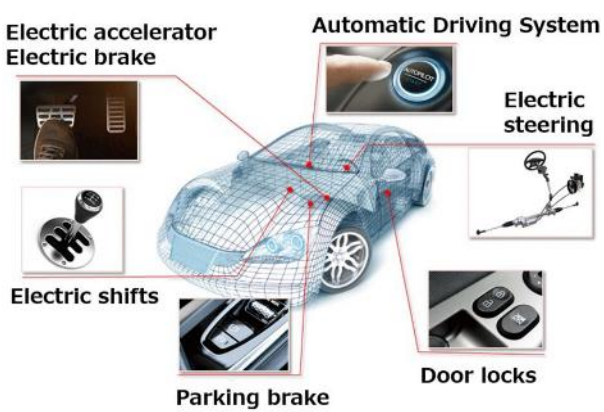


Fig. Examples of use in automotive applications

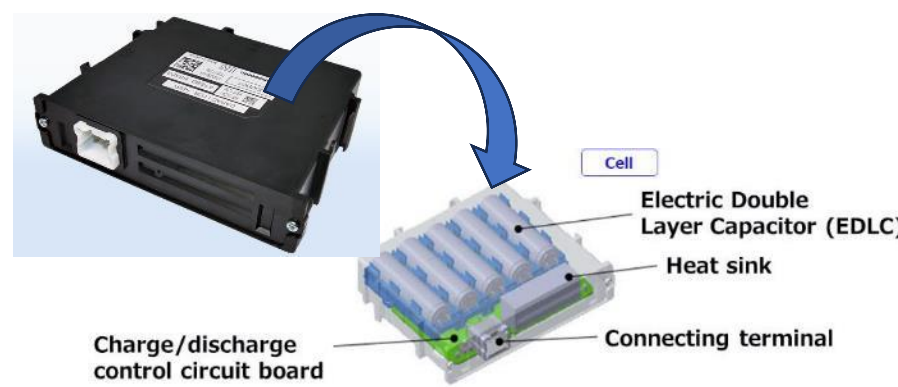
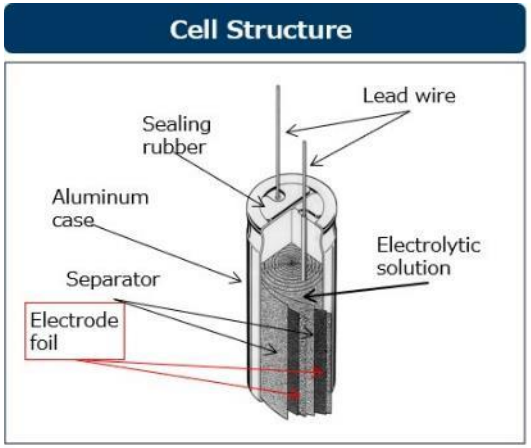


Fig. Backup power supply (power storage device) configuration

12. Passive electronic components, manufacturing process and their required Properties



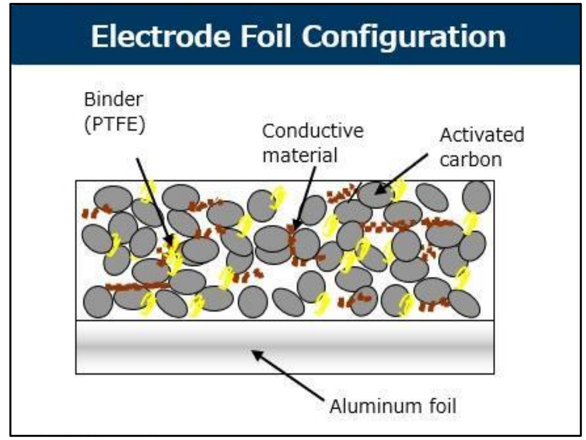


Fig. Cell structure and electrode foil configuration of EDLC

<PTFE Binder>

PTFE bonds activated carbon and aluminum foil. Fibrillated PTFE can hold activated carbon in small amounts

Electrodes are required to store a large amount of electric charge and realize high-speed charge/discharge, while at the same time they are required to have durability and reliability against vibration and impact. As with lithium batteries, the binder must have chemical stability that can withstand electrolytes, durability against electrochemical oxidation/reduction, and heat resistance. In addition, in order to achieve low resistance, it is necessary to form an electrode using a small amount of binder. PTFE is the only binder that simultaneously satisfies these required properties (there are no alternative materials).

Reference:
List of Substance Names Abbreviations and Official Names

Category	Representative Chemical Materials
PFAS	PTFE: Polytetrafluoroethylene
	PFA: Perfluoroalkoxyl polymer
	FEP: Fluorinated ethylene propylene
	ETFE: Ethylene tetrafluoroethylene
	PVDF: Polyvinylidene fluoride
	FKM: Family of fluorocarbon-based fluoroelastomers materials
	FEPM: Tetrafluoroethylene propylene
	PFPE: Perfluoropolyether
	PCTFE: Polychlorotrifluoroethylene
	HFO: Hydrofluoroolefin
	HFE: Hydrofluoroether

Category	Representative Chemical Materials
Non PFAS	PMMA: Poly(methyl methacrylate)
	PE: Polyethylene
	PVC: Poly vinyl chloride
	POM: Polyoxymethylene
	PC: Polycarbonate
	PS: Polystyrene
	PP: Polypropylene
	PPO: Polyphenylene oxide
	LCP: Liquid crystal polymer
	ABS: Acrylonitrile butadiene styrene
	EPDM: Ethylene propylene diene monomer
	CR: Chloroprene
	NBR: Acrylonitrile-butadiene rubber
	PEEK: Poly ether ether ketone
	PI: Polyimide

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By: OAH on 2/29/2024

Office of Administrative Hearings (OAH)
c/o Rulemaking *eComments* website
https://minnesotaoah.granicusideas.com/
Minnesota Pollution Control Agency (MPCA)
Attention: Resource Management and Assistance Division

February 29, 2024

Re: MPCA Request for Comments on Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

General Comments

We request that the Agency exclude HFC, HCFO, HFO and f-gas-based products (hereinafter called f-gas) from the scope of the proposed regulations. F-gas are small molecules that have been demonstrated under Montreal Protocol to identify low hazard for potential impacts on humans. Furthermore, because of their chemical and thermal stability, F-gas are widely used as refrigerant, foam expansion agent, propellent, and solvents that are found in many different products, ranging from heating, ventilation and air conditioning (HVAC＆R) systems to aerospace equipment. Of course, most of HFCs have Global Warming Potential (GWP), so they are subject to use restrictions and are being phased down under the American Innovation and Manufacturing (AIM) act. As this phasedown proceeds, the industry will transition to alternative low GWP substances like HFOs. Compliance with the notification requirement will be exponentially more complex and burdensome if F-gas are not excluded. Such alternatives have been approved for use according to the Significant New Alternatives (SNAP) Program which utilizes a comparative risk framework to assess and list new alternatives as acceptable substitutes.

More specific comments to MPCA's nine questions appear below.

1. Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Yes, MPCA should define criteria for determining "essential for health, safety and functioning of society." However, an "essential" assessment should only be initiated when there is deemed to be a risk to human health or the environment from the use of an intentionally added PFAS in a product. On this point, we reiterate that F-gas have been demonstrated to satisfy internationally accepted under Montreal Protocol. If there is no concern about risk during the use of an intentionally used PFAS in a product, such as a F-gas, MPCA and stakeholder time and resources should not be wasted on an essentiality analysis. Neither should residents of Minnesota be denied access to a myriad of products important to their daily lives simply because those products contain F-gas.

If a potential risk to human health or the environment is identified, MPCA should look to the considerations articulated in the Maine DEP's most recent regulatory proposal:

> ***"Essential for Health, Safety or the Functioning of Society"*** *means products or product components that if unavailable would result in a significant increase in negative healthcare outcomes, an inability to mitigate significant risks to human health or the environment, or significantly interrupt the daily functions on which society relies. Products or product components that are Essential for Health, Safety or the Functioning of Society include those that are required by federal or state laws*

and regulations. Essential for the Functioning of Society includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, and construction.

More generally, the concept of "essential" must be interpreted broadly in order to be workable. Under a narrow interpretation of "essential" it may be argued that products such as cell phones, laptop computers, or automobiles are not "essential to the functioning of society" since society can continue to function without these conveniences. But this narrow, and in our view inappropriate, interpretation fails to properly account for the fact that these types of products are highly beneficial and are an essential feature of our society. Similarly, under a narrow interpretation of "essential" it could be argued that products such as refrigeration units are not "essential to health" since people can live healthy lives without refrigeration. However, this narrow interpretation ignores the critical role that refrigeration plays in supporting good health by preventing food spoilage and preserving pharmaceuticals. These are a few examples of the types of products that, if they became unavailable, would cause massive social and economic dislocation. To avoid this type of disruption we strongly urge the Agency to adopt a broader interpretation of "essential".

Finally, we urge MPCA to take notice of a report recently issued by the Department of Defense (DOD), highlighting the criticality of certain PFAS chemistries across a broad swath of applications of strategic and national importance. Based on an extensive survey of known uses of PFAS chemistries, DOD concluded as follows (emphases added):

PFAS are critical to DoD mission success and readiness and to many national sectors of critical infrastructure, including information technology, critical manufacturing, health care, renewable energy, and transportation. DoD relies on an innovative, diverse U.S. industrial economy. Most of the structurally defined PFAS are critical to the national security of the United States, not because they are used exclusively in military applications (although a few are) but because of the civil-military commonality and the potentially broad civilian impact.

DOD went on to warn that:

Emerging environmental regulations focused on PFAS are broad, unpredictable, lack the specificity of individual PFAS risk relative to their use, and in certain cases will have unintended impacts on market dynamics and the supply chain, resulting in the loss of access to mission critical uses of PFAS. These market responses will impact many sectors of U.S. critical infrastructure, including but not limited to the defense industrial base.

In developing regulations interpreting the concept of "essential" the Agency should heed DOD's warning and ensure that the term is interpreted broadly enough to encompass uses of PFAS that are critical to national infrastructure and supply chains.

MPCA should also consider whether a F-gas is required to meet a specific performance standard or legal requirement. In such cases, they should be deemed "essential" and that designation should extend to the supply chain for that product (or product component).

2. Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

- The cost of alternatives should not be considered a critical factor in determining the definition of "reasonably available".

- F-gas are generally more expensive than other alternatives and are therefore used when potential alternatives cannot meet specific performance requirements. Because F-gas are generally more expensive, the costs of alternatives should not be a factor in evaluating potential alternatives. Where questions of "essential for health, safety, or the functioning of society" are concerned, MPCA should focus on performance, reliability, and availability.

3. Should unique considerations be made for small businesses with regards to economic feasibility?

- We suspect that Minnesota's PFAS law will disproportionately affect small businesses, as no small business considerations were an express part of the legislature's deliberations. For example, small businesses may not have the capacity to comply with the statute's reporting requirements, which are extensive and will require significant effort to plumb the value chain for each product (or product category) that may need to be reported.
- Small businesses may also be disproportionately affected by any costs associated with testing products for the presence of PFAS, testing and qualifying potential alternatives, and the replacement of any equipment.
- The Maine DEP is contemplating some provisions for small businesses, and we encourage MPCA to examine those closely.

4. What criteria should be used to determine the safety of potential PFAS alternatives?

- MCPA should consider reduced potential for risk to human health and the environment should compare the use of the alternative with the F-gas currently in use in the specific product or product component under consideration.
- MCPA should articulate the criteria or information that will be used for comparative evaluations of potential risk.
- MCPA should also consider sustainability impacts such as water use, emissions reduction, energy efficiency, and reliability, including avoiding the use of highly flammable and/or toxic substances.
- Finally, MCPA should consider the approved substitutes under the Significant New Alternatives Policy (SNAP) program, which utilizes a comparative risk framework to assess and list new alternatives as acceptable substitutes.

5. How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

- Unavoidable use determinations should last until safer and more sustainable alternatives are discovered and can be implemented at scale in the economy.

- Therefore, significant changes in available information should trigger a re-evaluation. Re-evaluation should apply not only to the use of a substance with a CUU, as well as any alternative that was identified as the basis for denying at CUU.

- In no case should re-evaluations take place more frequently than 10 years. MCPA should consult with potentially affected industries to determine if a longer re-evaluation period may be necessary to evaluate alternatives or otherwise provide information for the re-evaluation process.

6. How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

- MCPA will need to establish a process by which manufacturers and users can request a CUU determination from MCPA. The process should be flexible enough to accommodate multiple uses of a substance instead of going use by use. The latter would pose a huge time burden on both MCPA and stakeholders.

- The converse process creates even more challenges in terms of allowing adequate time to respond to a request in terms of collecting or generating date to respond to a "not a CUU" request.

- The information requirements for either request should be identical. No party in the process should have a relatively higher or lower bar for substantiating its request.

Any process around the granting or re-evaluation of a CUU must protect trade secrets. As noted in ACC's November 28, 2023, comments on the Planned New Rules Governing Reporting by Manufacturers Upon Submission of Required Information about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4828:

Some types of proprietary information the Agency will request derive independent economic value and are the subject of efforts to maintain its secrecy. Such information may also be recognized as confidential by federal or other state agencies, and trade secrets that are inadvertently disclosed may compromise national security and infrastructure. Therefore, in the proposed rule, the Agency must provide clear instructions regarding the specific steps that must be taken to officially assert and/or substantiate a trade secret claim for information submitted that qualifies as a trade secret under Minnesota law, including the timeline by which such claims must be made relative to the reporting deadlines.

The Agency also should define in regulation a process whereby a manufacturer is to be notified if its trade secret is subject to a public records request or is inadvertently disclosed by the Agency or any organization with which the Agency collaborates or contracts in the administration of the reporting program, including other states and any organization that designs, operates, or otherwise administers the reporting platform. The Agency should not enter into data sharing agreements with any organization, including but not limited to other states, if the Agency cannot assure that those organizations possess equivalently protective policies for trade secrets submitted to Minnesota. As we have previously noted in comments to the State of Maine, we are particularly concerned about how commercially valuable trade secret information will be managed by the Interstate Chemicals Clearinghouse (IC2) of which the Agency is a member.

7. In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

- Refrigerants: Most refrigerants used in civil and military cooling and refrigeration applications are defined as PFAS according to the definition included in DEP's PFAS in Products regulations. Many next-generation refrigerant alternatives adopted by U.S. industry (and U.S. households) between now and the end of 2025 may also be defined as PFAS according to these regulations. Under the AIM Act and EPA technology transition regulations, the U.S. economy is in the process of switching from one set of PFAS-classified refrigerants (e.g., HFCs) to a new generation of refrigerants (e.g., HFOs), which are also, in the broadest definitions, considered to be PFAS. HFOs belong to a class of materials with ultra-low global warming potential, making them ideal tools in meeting decarbonization goals and replacing legacy high-global-warming products. Due to the specific engineered properties of HFOs and HFO blends, transitioning away from these products would necessitate substantial capital investment and major disruption of supply chain. HFOs and blends are often required to meet regulatory, or compliance obligations set by the US EPA or state environmental agencies, including global-warming-potential threshold, flammability criteria, building codes, and other efficiency standards. HFOs and HFO blends have a lack of clear environmentally friendly alternatives that simultaneously meet customer needs for safety, efficiency, and cost.

- Foam Blowing agents: HFOs for foaming agent use are mainly used as a raw material for rigid polyurethane foam. Rigid polyurethane foam is widely used as a heat insulator for consumer and industrial applications. Rigid polyurethane foam consists of minute independent bubbles formed by urethane resin, and gas derived from a blowing agent is sealed inside the bubbles. By using HFOs with low thermal conductivity such as HFO-1233zd(E), HFO-1336mzz(Z) and HFO-1224yd(Z) for that gas, rigid polyurethane foam can achieve higher thermal insulation performance than non-PFAS insulation materials. In addition, urethane resin has high specific strength and good resistance to low temperatures and dimensional stability. Taking advantage of these features, rigid polyurethane foam is mainly used as heat insulating material in the normal to low temperature range. Major thermal insulation applications are in houses, frozen and refrigerated warehouses, refrigerators, vending machines, plants handling low-temperature fluids such as LNG, LNG carriers, and liquid oxygen and liquid hydrogen tanks of large rockets.

  The most common foaming method for rigid polyurethane foam is to vaporize the blowing agent by reaction heat, so the blowing agent used for this method must have a low thermal conductivity of its gas and a boiling point near room temperature. Spray applications used on construction sites requires the foaming agent to be nonflammable. Other characteristics are required, such as adequate solubility in the urethane raw material, chemical stability and non-toxicity, and non-flammability.

  Non-PFAS compounds have high thermal conductivity and flammability and cannot meet all requirements that HFO blowing agents can.

- Fire Suppression: F-gas are used in "clean agent" fire suppression in naval vessels, aircraft, ground combat vehicles and closed space in civil buildings. Most known clean agent, low-corrosion, low-weight, low-toxicity alternatives will likely be classified as PFAS, broadly defined. According to DoD report, since the advent of regulations against halogenated agents, Naval vessels commonly utilize an HFC clean agent in compartments subject to flammable/combustible liquid fuel fires such as engine modules and hazardous material storage spaces. Expanding new technology like AI, DX, etc., Data Center installation are growing.

Non-flammable, non-liquid fire suppression system protect servers in DC resulting data secured.

- Solvents:
  1) F-gas based solvents are being used as electronic and dielectric fluids that are used in civil and military radars and high-power electronics, electrical system/utility system components and semicon mfg process because of their dielectric and heat transfer properties.
  2) F-gas based solvents are being used for degreasing/cleaning products and contact cleaners in vapor degreasing and flux removal. And also, for degreasers are used to effectively remove grease, oil, tar, and other substances from military equipment to increase its operating efficiency. These degreasers leave no residue, have no flash or fire point, and serve as an alternative to legacy solvents (e.g., n-propyl bromide, trichloroethylene, tetrachloroethylene).

8. Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

- Yes, MPCA should propose some initial CUU determinations as part of the rulemaking process. It is our hope that the sooner CUUs are identified, the sooner some markets can have greater certainty about the regulatory environment.

9. Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

- Some "currently unavoidable use" determinations will require MCPA to determine whether reasonably available alternatives exist. The bases for such determinations must be consistent, fair, transparent, and well-defined.

The Department should propose objective criteria for determining when alternatives are or are not "reasonably available," taking into consideration factors such as performance, safety, total cost of ownership, and reduced potential for risk to human health or the environment when compared to products or product components made with alternatives to F-gas.

Thank you for allowing us to provide our information. Please feel free to contact us directly if you have questions or need additional information.

Sincerely,

Japan Fluorocarbon Manufacturers Association (JFMA)
Management Committee Leader
PFAS WG
Junichi Ishikawa
Email: jfmajp@ca.mbn.or.jp
Junichi.ishikawa@chemours.com

RECEIVED
By: OAH on 2/29/2024
Louisa Mitchell Attachment

BioPhorum response to commentary on planned new rules governing determinations of currently unavoidable uses (CUU) of PFAS by the US State of Minnesota Pollution Control Agency.

Contact Information:
If you have any questions or wish to discuss the content of this document please contact louisa.mitchell@biophorum.com

Connect
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Who We Are

This document has been prepared by a collaboration of BioPhorum members who appreciate the opportunity to respond to questions 1-9 below as requested by the Minnesota Pollution Control Agency.

BioPhorum is a global biopharmaceutical manufacturing industry collaboration comprising all major manufacturers and their key suppliers (over 150+ companies, representing > 98% of all biopharmaceuticals manufactured worldwide).

The Biopharmaceutical industry, represented here by BioPhorum, acknowledge the concerns raised regarding the potential adverse effects of various per- and polyfluoroalkyl substances (PFAS) materials on human health and the environment, and fully support efforts to minimise and mitigate the presence of these, and other potential substances of concern in our manufacturing processes and products. Our industry sector shares a responsibility to work with all relevant stakeholders to manage the transition away from materials of concern while maintaining our ability to ensure the safety and wellbeing of patients and the communities in which we operate. Any efforts to restrict usage and production of materials of concern by our industry must be pragmatically considered; the risk of drug shortages and therefore failure to supply medicines to patients must be evaluated against the risk the materials pose to the environment and to that very same population.

Biopharmaceutical drugs (biologics), a subsector of the pharmaceutical industry, include therapies such as monoclonal antibodies, antibody drug conjugates, therapeutic proteins, cell and gene therapies, mRNA and vaccines which treat a wide range of disease indications including immunology, neurology, infectious diseases, diabetes, oncology, cardiovascular conditions, and others. Advancements in biomedical science hold vast potential for growth of the biopharmaceutical market and the ability of these drugs to treat chronic diseases that were previously untreatable is increasing biologics demand enormously with newer therapies under development increasingly being in the biopharmaceutical category.

Today, 50% of the top 100 drugs sold globally are biopharmaceuticals, with predications that this will increase to 55% of all innovative drug sales by 2027 [2], and the industry generates global annual revenues of USD 163 billion.

While this specific response is focussed on the biopharmaceutical sector, BioPhorum and its member companies recognise that the scope of PFAS use and resulting impact of proposed restrictions on other industries is far wider across the Pharmaceutical and Healthcare industries and beyond. It should also be noted that while this submission on unavoidable uses has been prepared in response to the State of Minnesota, any restrictions on the use of PFAS within the biopharmaceutical industry will impact the supply of drugs to the whole of the US (and rest of world).

1. **Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?**

   In the case of regulating PFAS as a broadly defined group of substances, the specific hazards, if any, for an individual substance are unknown; therefore, defining criteria for "essential for health, safety, or functioning of society" requires multiple risk-based analyses, a complex task.

   The reasoning is that the hazard profile of an individual PFAS substance by itself may differ from the hazards associated with use of that PFAS substance by a downstream user in a specific medicinal application.

Any PFAS use required for manufacture, packaging and safe delivery of medicines or medicinal product to patients should be considered **essential for health, safety, or the functioning of society.**

2. **Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?**

   If costs are considered in this context, then consider the full scope of activities that drive monetary costs. For example, consider monetary and economic constraints such as time to substitute (feasibility, product performance, and implementation), raw material availability, logistics, regulatory authority approvals, etc.

   The costs of any substitution, where feasible, are currently unknown but will be significant. Timelines from concept through to final qualification and regulatory approval of alternatives is likely to take a minimum of 20 years.

3. **Should unique considerations be made for small businesses with regards to economic feasibility?**

   Considerations regarding small businesses should include the ability to support niche markets that a supply chain may be dependent upon. Small businesses may not have adequate resources to drive innovation in the Research and Development space and to qualify alternatives.

4. **What criteria should be used to determine the safety of potential PFAS alternatives?**

   The biopharmaceutical industry is required by US Federal Food and Drug Administration to follow Good Manufacturing Practices (GMP) to use materials that are not reactive or additive to our product streams and assure patient safety. The specific PFAS materials utilized by our sector are non-hazardous fluoropolymers (PVDF, PTFE, FKM, FPM, FEP*, etc.) and are proven to present negligible reactive properties. They are particularly beneficial in terms of not adding anything unintentional to medicinal products during drug substance or drug product manufacturing processes (i.e., they best meet the GMP requirements of being non-additive or reactive with the medicine – per 21 CFR 211.65). With any change to materials there is a risk of regrettable substitution (i.e., replacing PFAS components with alternative materials which have properties that have unintended detrimental impact to the quality of the drug).

   *PVDF (Polyvinylidene fluoride), PTFE (Polytetrafluoroethylene), FKM (Fluoroelastomer Polymer), FPM (perfluoro elastomers), FEP (fluorinated ethylene propylene), ETFE (ethylene tetrafluoroethylene)

   Any PFAS materials utilized in biopharma manufacturing processes and by healthcare providers are disposed of at end-of-life by thermal oxidation and do not, therefore persist in the environment.

5. **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?**

Due to end-of-life destruction by thermal oxidation diverting any waste from landfill, permanent CUU determination would be most appropriate for PFAS materials used in biopharmaceutical manufacturing.

Periodically reviewing the status of a Currently Unavoidable Use of a PFAS substance would continue to drive innovation, seeking alternates to be identified and applied in products. In any product category designated as a CUU, the progress toward alternates should be anticipated and therefore a periodic review may be assigned.

This should be also applied to medical and dosing devices and pharmaceutical products in development and clinical trials since these processes will continue to use PFAS materials until suitable alternatives are identified.

6. **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?**

The MPCA should consider uses identified in this response in Appendix 1 as CUU (essential for health safety and functioning of society in general, and for patient safety specifically).

7. **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.**

Dosing delivery devices, biopharmaceutical products and the equipment necessary to research, develop, manufacture, and bring these products to market are included in our response.

100% of the biopharmaceutical products currently being developed or already licensed for sale in the US utilize PFAS somewhere in the development, manufacture, testing, storage of intermediates, drug substance or drug product or in the drug delivery systems. If PFAS used in these processes are not classified as CUU and thus banned, the drugs would be removed from the market until PFAS alternatives (if they exist) could be developed, sourced, validated, and approved for use, thus preventing patient access to life saving therapies.

A PFAS containing component can be present in a product that is placed on the market in multiple different ways due to the complexity of the products they are used in. For example, an FKM based O-Ring could be imported as a stand-alone spare part or accessory, in a complex item used as a replacement part in a pump, in a pump itself, in a hardware system containing a pump or in a larger installation containing a hardware system. This level of complexity in the ways these materials may be placed on the market makes it impossible to provide an exhaustive list of potential GPC or tariff codes impacted.

The biopharmaceutical industry is required by US Federal Food and Drug Administration to follow Good Manufacturing Practices (GMP) to use materials that are not reactive or additive to our product streams. Specific PFAS materials (PVDF, PTFE, FKM, FPM, FEP*, etc.) are required as they are proven to present negligible reactive properties. They are particularly beneficial in terms of not adding anything unintentional to medicinal products during drug substance or drug product manufacturing processes (i.e., they best meet the GMP requirements of being non-additive or reactive with the medicine – per 21 CFR 211.65). It should be noted that the **BioPharma Industry acts as downstream users of PFAS materials and does not own the technical solution outside of end-application qualification.**

Refer to Appendix 1 for a non-exhaustive list of identified CUUs.

8. Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

The MPCA should initially consider the CUU identified in this response in Appendix 1 (essential for health safety and functioning of society in general, and for patient safety specifically).

Would the rulemaking process allow impacted stakeholders to provide additional clarifying information to further the rulemaking process? If so, then it is reasonable for the MPCA to propose initial CUU determinations for select categories and solicit stakeholder engagement.

9. Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination

No further comment.

Appendix 1: PFAS Applications in Biopharmaceutical Manufacture, Supply, and Delivery/Dosage (a non-exhaustive list)

			Industry Application (final product brick reference)						
Product containing PFAS / Application	**PFAS Type**	**Function of product**	**Manufacture of Pharmaceutical drug (10005845)**	**Manufacture of combination product pharmaceutical drug (10005845) plus medical device (10005844)**	**Potential Alternatives**	**Feasibility of replacement**	**Cost to replace**	**Patient safety/drug quality impact risk**	**US Harmonized tariff code for PFAS material/component where known Note: products may also be included as part of more complex items, see product type explanation in document**
Sterile Liquid filtration membranes	PVDF	Ensures patient safety, ensures sterility of final product and safety of patient during drug delivery	x		(PES Nylon Cellulose)	50%	Very high	High	8421990180
	PTFE			x	PES Nylon	<10%	Very high	High	
Liquid filtration- virus clearance	PVDF	Ensures patient safety - removal of viral contaminants from drug product	x		PES	80%	Extremely high	Moderate	8421990180
Films/plastics as primary contact material in manufacture and containment of drug intermediates (drug substance). • Containers/films/bottles • Single use processing bags • Single Use bioreactors • Probes/inserts	PVDF	Protects and maintains stability and quality of drug intermediates e.g. prevents contamination from bioburden/endotoxin/pyrogens.	x		†	TBD	TBD	TBD	3921190000
	PTFE bags/bottles			x					
	FEP bags/bottles			x					
Biopharma drug cryostorage bags and cell culture cryostorage bags and bottles	PTFE	Protects and maintains stability of drug intermediates	x		ULDPE, EVA or EVA blends	<30%*	High	High	3921190000
	FEP								
	custom fluoropolymer								

† Further assessment required; alternatives may be application specific; substitution with a particular non-PFAS material may not be suitable for all applications

Colour coding indicates where the same PFAS materials are used across multiple applications.

Appendix 1: PFAS Applications in Biopharmaceutical Manufacture, Supply, and Delivery/Dosage (a non-exhaustive list)

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Films/plastics (Primary contact material) for final drug product sterile packaging: • cap or stopper coatings/liners • Vial stoppers • Syringe stoppers • Seal linings	ETFE (cap or stopper coatings/liners) PTFE (coating for vial and syringe stoppers and seal linings)	Ensures patient safety, maintains sterility and stability of final drug products		x	No alternatives for drug product requiring barrier coating	0	n/a	High	3921190000
Films/plastics (Primary contact material) for final drug product non-sterile packaging- multi layer blister packs intended for final solid oral dosage.	PCTFE	Ensures patient safety, protects stability and quality of final drug products	x		Suggested alternatives have been proposed but they do not confer sufficient protection	<5%	High	High	3921190000
Intermediate, raw material or ancillary material used in manufacture, purification and testing of protein based drugs	TFA (tri-fluoroacetic acid) or PFAS related compounds	Used in manufacture, purification and testing of protein based drugs	x		No alternatives	0	N/A	High	2915905050 2915901050 29159050 2915901800
Vent and/or Gas Filtration (of bioreactors/carboys)- filter membranes	PVDF	Maintains axenic boundary - prevents microbial contamination of bioreactor	x		No alternatives	<5%	Moderate	Moderate	8421290065
	PTFE				No alternatives	<5%	N/A	Moderate	

† Further assessment required; alternatives may be application specific; substitution with a particular non-PFAS material may not be suitable for all applications

Appendix 1: PFAS Applications in Biopharmaceutical Manufacture, Supply, and Delivery/Dosage (a non-exhaustive list)

			Industry Application (final product brick reference)						US Harmonized tariff code for PFAS material/component where known Note: products may also be included as part of more complex items, see product type explanation in document
Product containing PFAS / Application	**PFAS Type**	**Function of product**	**Manufacture of Pharmaceutical drug (10005845)**	**Manufacture of combination product pharmaceutical drug (10005845) plus medical device (10005844)**	**Potential Alternatives**	**Feasibility of replacement**	**Cost to replace**	**Patient safety/drug quality impact risk**	
Tubing & tube fittings (manufacturing engineering systems and transfer of drug material intermediates and final product, lab testing applications) incl gaskets & O-rings, sensors	PVDF (tubing)	Protection of drug intermediates and personnel during manufacturing process. Inert materials prevent chemical contamination of drug during manufacture and drug delivery to patient..		x	No alternatives	<5%	N/A	High	3917330000 3926904510
	PVDF (Fittings)				Polycarbonate, polypropylene, polysulfone	<5%	Moderate	High	
	PTFE				No PFAS free alternatives	<5%	N/A	High	
	FKM (tubing/O-rings / gaskets)								
	FEP								
	PFA								
	PTFA								
Hardware systems (lined pipes, TFF cassette seals/components/solvent exchange systems/lined valves/gaskets). Pumps & components (diaphragm)	PVDF	Protection of drug intermediates and personnel during manufacturing process. Inert materials prevent chemical contamination of drug during manufacture	x		No alternatives	<5%	n/a	High	8413500050 8421990180 9027905650
	PTFE								
	FKM								
Ultra low temperature refrigerant (low boiling temp gases <-60ºC) for freezing drug intermediates or final product.	multiple PFAS	Provide required temperature for long term storage of intermediates, drug substance and drug products	x		CO_2 : however energy consumption by alternatives is increased by 50%	100% but with energy pay-offs	High	N/A	2705000000
Laboratory Apparatus (funnels, flasks/containers, stirring bars etc)	FEP	Utilized in preparation of small scale solutions to be added to process stream	x		Glass for some applications (compatibility dependant) but increased safety risks due to breakage.	<5%	TBD	TBD	9027905650
	PTFE								
Heat and/or chemical resistant, non reactive coatings/insulation/lubricants used e.g. as components of electronics and stainless steel vessels/skids.	Additive of PFAS origin	Utilized as components of electronics and stainless steel vessels and skids.		x	†	†	†	†	8413500050 9027905650

† Further assessment required; alternatives may be application specific; substitution with a particular non-PFAS material may not be suitable for all applications

(End of document)

RECEIVED
By: OAH on 2/29/2024
Daniel Carey Attachment

POLARIS
Think Outside

February 29, 2024

Mr. William Moore
Minnesota Pollution Control Agency
Office of Administrative Hearings
600 North Robert Street
P.O. Box 64620
St. Paul, Minnesota 55164-0620

RE: New Rules Governing Current Unavoidable Use Determinations about Products Containing PFAS

Dear Mr. Moore,

Polaris Industries Inc. (Polaris) appreciates the opportunity to provide comments to the Minnesota Pollution Control Agency (MPCA), as you consider new rules pertaining to the unavoidable use of products containing Per- and Polyfluoroalkyl Substances (PFAS). As the global leader in powersports, we understand that to execute at the highest levels, you must utilize the expertise of those who best understand a product and its applications. We welcome this chance to submit industry insights and a vested stakeholder perspective on such a critical issue.

Polaris was founded in 1954 in Roseau, Minnesota and now employs almost 4,000 employees at our state-of-the-art facilities across the state and nearly 9,000 employees at twelve total facilities nationwide. Polaris is the #1 market share leader in powersports for off-road, on-road and marine, and named to be one of the most ethical and trustworthy companies in the U.S. in 2023.[1] In addition, the outdoor recreation industry brought in more than $563 billion nationally, with $11.7 billion of that coming from the state of Minnesota in 2022, with ATVs and Motorcycles bringing in $421 million alone, ranking Minnesota 10th in the nation for impact to the state economy.[2] This significant footprint and overall impact to the industry, both in Minnesota and across the country, translates to hundreds of thousands of ORVs, ATVs, snowmobiles and motorcycles in circulation, with an even greater number of components, parts, apparel and equipment potentially impacted by rules such as these.

In keeping with the request from MPCA for continued stakeholder engagement, we have provided commentary below in response to several key MPCA questions listed in the *Request for Comments* document shared earlier this month.

1. Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

If costs of PFAS alternatives are considered in the definition of "reasonably available," determining what "*reasonable*" means, regarding the availability of and overall costs for components, parts, materials, and goods for powersports equipment, is a subjective exercise. Therefore, understanding and identifying a baseline for the term "reasonable" is critical for any future consideration of a viable PFAS alternative.

The U.S. Federal Government defines a reasonable cost in business practices as the following:

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[1] Ethisphere and Newsweek.
[2] Bureau of Economic Analysis Outdoor Recreation Satellite Account, U.S., and States, 2022.

"*A cost is reasonable if, in its nature and amount, it does not exceed that which would be incurred by a prudent person in the conduct of competitive business."* [3]

The key to the above definition when determining a "reasonable" baseline for availability and cost is that these items would not "…*exceed that which would be incurred by a prudent person in the conduct of competitive business."*

Current business practices at Polaris ensure that we utilize a system of proven processes to identify and procure components, parts, materials, and goods. These same proven processes are then employed for testing, validating, and incorporating these items into our machines. We are continually striving to eliminate duplicative efforts and to streamline the daily work of the company, so that we can maximize efficiencies and ultimately, minimize overall costs whenever possible. These processes are critical because cost is not simply a comparison of prices between two competing products.

The costs associated with identifying, testing, validating, and implementing a new material into a product redesign is an expensive, and often years long activity. These activities are done to make sure new parts and components meet critical performance, durability, safety, and quality requirements, and may dwarf the extra costs associated with a PFAS alternative item, if one is even commercially available at the time.

Consequently, the costs associated with utilizing potential PFAS alternatives extend far beyond the product manufacture. New and unproven materials may require more frequent, and more expensive, maintenance costs. They may not provide the same level of durability as current PFAS products do now, leading to a premature failure of the machine/machine parts and an increase in overall waste and costs to both Polaris and our customer base unnecessarily.

The real-world costs of identifying and integrating PFAS alternatives into our machines are based on a series of complex procurement and manufacturing activities. These unknown costs could be significant and detrimental to both the upfront and long-term costs of our products, creating a snowball effect of delayed procurement, production, testing and delivery timelines.

Considerations for the total incurred cost (not simply costs of individual parts, components, materials, and goods) must be based upon the existing processes and procedures found in the marketplace today. As stated in the definition above, a "reasonable" cost should not "…*exceed that which would be incurred by a prudent person in the conduct of competitive business."*

2. What criteria should be used to determine the safety of potential PFAS alternatives?

Since our inception in 1954, Polaris has prided itself on creating industry leading technologies in the powersports space. Due to the nature of how our machines are used in the field, rider safety has been

[3] Acquisition.gov, 31.201-3 Determining reasonableness.

and will always be the number one priority when manufacturing any of our off-road, on-road or marine products.

With that in mind, Polaris equipment and powersports machines in general, must meet highly demanding industry wide technical specifications due to the challenging environments in which these types of machines operate. We design our products to operate for decades under extremely harsh, demanding, and arduous environments. In these environments, materials, parts, and components need to meet rigorous design and testing standards to ensure the safety of the person operating the machine, as well as any other passengers involved.

The technical functions of the components/systems in our equipment help inform the safety and operational design requirements of the machines in our lineup. These technical characteristics often include, but are not limited to, the following variables below:

- **Pressure** - Various systems, such as the hydraulic and engine systems, experience extreme pressure environments.
- **Temperature** - Powersports equipment often contends with cyclical temperature cycling due to machine exposure to outdoor conditions; temperatures ranging from as -57°C to 230°C.
- **Mechanical** – Machines expose parts and components to a high degree of mechanical wear and tear. Sealing parts must survive the shear forces due to the mechanical movement of the equipment.
- **Chemical Resistance** - Seals interact with various fluids and gases, requiring a high degree of chemical and corrosion resistance to ensure the reliability of exposed parts. Exposure to substances such as fuel, hydraulic fluid, coolant with additives like 2-ethyl hexanoic acid, and carboxylic acids, exhaust gas fumes (highly acidic) and engine oil (highly alkaline).
- **Electrical and Flammability Resistance** – Weight, power, and fuel of the machine creates electrical and flammability risks. Components, parts, and systems must include design elements to mitigate these risks.
- **Vibration** – Shaking up to 45.0 mm/s which can cause high frequency fatigue to components due to the repeated strain imposed. The mechanical alternating stress between joint components will make joints undergo cyclic tension and pressure, which may cause the generation, expansion, and extension of cracks.
- **UV Exposure** - Long-term durability against factors such as ultra-violet (UV) light due to exposure to outdoor environments.
- **Material Weight** – The use of lightweight materials to reduce energy consumption and CO_2 emissions.
- **Durability** – Equipment must remain highly reliable over periods of up to, and beyond, 20 years.
- **Environmental** - Withstand use and exposure in harsh environments that can vary from extremely dusty, humid, wet, muddy, and damp. The operation of such equipment is over extended periods of time.

Many parts or components used in our products have varying levels of PFAS included in them, which ultimately provide the material properties required to satisfy the various functions and protections highlighted above. Without a commercially available equivalent that can satisfy these highly technical specifications, the equipment, or individual safety and performance systems, these parts/components/equipment/ would most likely fail, causing immediate and dangerous safety hazards for the operator and other riders/passengers.

It is critical to the safety of the end user, that any replacement material meet the current performance requirements and standards, while still offering the same safety, durability, and quality of product containing intentionally added PFAS.

3. ***How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?***

Commercially available PFAS alternatives for most parts, components and equipment used on Polaris machines do not exist in today's marketplace. Furthermore, a lack of viable and proven alternatives means that integrating PFAS alternatives once available into our product line, without extensive testing, could compromise the integrity of our machines and ultimately the safety of our riders.

Changes to materials and formulations which affect fit, form, function, performance, or safety must undergo extensive testing to ensure any new designs meet internal quality benchmarks, design specifications, and outside regulatory requirements. Due to the challenges inherent to the powersports industry, it is extremely difficult to estimate specific timelines needed to identify, test, and qualify alternative chemical substances for each end use. Any estimation of time for consideration of unavoidable use would be based on the following assumptions:

- A suitable and viable alternative exists (although as described above, there are no known current technical alternatives for most PFAS parts, components, and equipment).

- Polaris procurement and compliance teams do not encounter dead ends during their material assessments, and suitable characteristics are identified the first-time test are completed.

- National and Worldwide supply chain issues do not hamper shipping and transportation timelines.

- Manageable timelines for incorporation of PFAS alternatives. Implementing changes across all product lines simultaneously is unrealistic from both a cost and practical application of workflow perspective as test cells, qualified staff, and other resources are all limited. The higher the number of PFAS substances used in the components and systems of the end-product, the longer the timeline will be.

One recent example of reasonably proposed timelines (which in this instance only takes into consideration one chemical compound) is the EPA ruling on Decabromodiphenyl ether and Phenol, Isopropylated Phosphate (3:1) or better known as PIP 3:1. The precedent set forth from this EPA ruling granted a 15-year transition period for new equipment and 30-year transition period for replacement parts.

Again, these transition periods were simply for one chemical substance, so a 15 to 30-year window of allowable transition time, dependent upon commercially viable and available parts, is a reasonable working time-frame.

Any transition away from PFAS requires significant time and resources to simply identify and qualify any PFAS-free material for use in or on our machines. Validating PFAS alternatives will be a lengthy regulatory, environmental, and proofing process, which if rushed could have detrimental consequences.

4. ***In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.***

Polaris' powersports lineup includes more than 30 brands across the off-road, on-road and marine categories, which translates to thousands of existing parts and components potentially containing PFAS, both for warranty replacement purposes and integration into new machines.

Many of the affected products, parts and components would fall into the below categories:

- **Seals:** All of our machines and boats use fluids to ensure the equipment continues to perform their intended functions. Fluid applications include hydraulic fluid, oil, fuel, refrigerants, coolant, among others. Sealing technology, such as O-rings and gaskets, prevents fluid leaks and ensures water, dirt, dust, and debris stays out of the equipment.
- **Hoses:** Similar to seals, hoses are required and critical to the transmission of fluids from one location to another. Many hoses in the powersports industry use fluoropolymers to safeguard the durability of the machine by protecting its components from various internal pressure, temperature, and chemical stressors.
- **Paints:** These coatings protect our machines and boats from natural, chemical, weather, or water erosion and damage. Paint coatings can help extend the useful life, and maintenance requirements, for all of our product across the company lineup. Many paint providers use PFAS in their paints to improve the flow, spread, and glossiness of the coating, as well as to decrease bubbling and peeling. They are also used in specialty paints to give stain-resistant, and water-repellent properties.
- **Refrigerants/Coolants:** Temperature management is a crucial product design requirement in the powersports industry. Regulating and controlling engine temperatures ensures proper operation for peak performance within the temperature limits of the materials used.
- **Hydraulic Fluid:** Hydraulic fluid enables the transfer of power from the engine to end-use hydraulic systems in our machines and marine crafts. Hydraulic fluid is also heavily used within our manufacturing facilities and is a critical element for functionality in building off-road and on-road machines.
- **Exterior Finishes and Materials:** UV protection was an issue we mentioned in a previous section but remains a continued issue for parts and components such as dashboards, handlebar grips, fenders, seat covers, etc. PFAS acts in a way with these pieces, so that it protects from extended outdoor use and UV exposure by not severely degrading the exterior piece(s) by drying and/or cracking the piece(s) beyond normal wear and tear or safe functionality.
- **Electrical:** Protective coatings on electrical wires and within electrical systems insulate and protect key electronic functionalities for all of our machines and marine products. PFAS is regularly found within these protective coatings.

5. Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

Yes, please. Based on all of the available information on PFAS included materials and the lack of available alternatives, there should be an abundance of consideration given to initial determinations for unavoidable use.

Polaris Industries is appreciative of this opportunity to provide initial comments on the unavoidable use determinations and rule making process for products containing PFAS. We look forward to working together in obtaining the best possible outcome moving forward.

Should you have any questions or need further information, please don't hesitate to contact Daniel Carey at Daniel.Carey@Polaris.com.

Sincerely,

Mike Orlikowski
Materials Compliance Manager
Polaris Industries, Inc.

Daniel Carey
Director, Government Relations
Polaris Industries, Inc.

RECEIVED
By: OAH on 2/29/2024
Francisco Hernandez Attachment

Request for Comments on Planned New Rules Governing CUU Determinations about products containing PFAS

UNIGASKET GROUP (hereinafter **UNIGASKET**) welcomes the opportunity to contribute to the process of request for comments on planned new rules governing Currently Unavoidable Use (CUU) determinations about products containing per-and polyfluoroalkyl substances (PFAS), issued by the Minnesota Pollution Control Agency (Revisor's ID Number R-4837).

In addition, **UNIGASKET** appreciates the work performed by the Minnesota authorities on protecting human health and the environment in front of the effects of the PFAS substances that are of concern.

1. Company description

We represent an international player in producing fluoropolymer hoses, thermoplastic tubing, and gaskets with high-added value for automotive and high-end professional appliances. Over the years, the Group, originally based in Italy, has expanded its presence in international markets thanks to the opening of its branches in the USA, Romania, Spain, the Netherlands, Poland, India, and Hong Kong, and the acquisitions of different companies. Thanks to this growth path, the Group has become vertically integrated, expanding its range, and developing high-tech products for hydraulic and pneumatic braking systems, for industrial, pharmaceutical, and high-tech industry applications. **UNIGASKET** is therefore an integrated and international group capable of offering innovative solutions to create products of tomorrow.

The Group currently comprises the following Companies:

- UNIGASKET S.R.L (Italy)
- ALLEGRI CESARE SpA (Italy)
- POLIPLASTIC S.R.L. (Italy)
- UNIGOMMA S.R.L (Italy)
- MTO Hose Solutions Inc (USA)
- MTO Hose of Texas Inc (USA)
- UNITAPE S.R.L. (Romania)
- UNIGASKET S.L. (Spain)
- POLYFLUOR BV (Netherlands)
- UNIGASKET POLSKA SP z.o.o (Poland)
- UNIGASKET INDIA Private Ltd (India)
- UNIGASKET HONG KONG Ltd (Hong Kong)

Our portfolio of products is composed of, but not limited to the following:

- Hoses and tubes (for brakes, engines, food, etc.)
- Tapes
- O Rings
- Gaskets and seals
- Other semi-finished products




The main products of our company, in economic terms, are hoses and tubes. These products are used by a large number of different industrial sectors, such as Automotive, Industrial, Medical, Pharmaceutical, Semiconductors, etc.

These are the sectors of use in which we are marketing our products:

- Appliances
- Automotive
- Chemical
- Electronics
- Food (e.g. coffee machines)
- Heating
- Heavy industry
- Industrial
- Medical/Pharmaceutical
- Pneumatics
- Push pull cable
- Sanitary
- Semiconductors

The main industrial sectors to which **UNIGASKET** is marketing its products, in terms of revenue and profit, are Automotive and Industrial.

In the Automotive sector, which includes motorbikes, scooters, racing vehicles, and extreme vehicles, our company is producing the hoses that drive the brake calliper, and the hoses used in several applications in the engine design. In both cases, the quality of our products is directly related to the safety of the vehicles and, therefore, to the safety of operators and passengers.

In the Industrial sector, our hoses are used to handle aggressive media in industrial applications, mainly in the chemical and pharmaceutical sectors. However, they can also be used in processes in which high or very low temperatures are reached, such as the Steel, Oil & Gas, and Cryogenic industries. They are the unique solution in the new Hydrogen industry due to their unique performances in terms of chemical resistance, flexibility, low permeation, and wide temperature range.

It is worth noting that our PFA tubes, able to offer high chemical resistance to aggressive and corrosive media, play an essential role in the Semiconductors sector, in which they are used to transport high-purity media in microchip manufacturing.

2. PFAS use

The base of our products are fluoropolymers. This is a specific family inside the vast PFAS group that covers fluoroplastics, such as PTFE, PVDF, ECTFE, FEP, PFA, etc., as wells as fluoroelastomers, such as FKM, FFKM, etc.

UNIGASKET is consuming the following fluoropolymers for the manufacturing of extrusion fluoropolymer-based products:

Acronym	Name	CAS #
PTFE	Polytetrafluoroethylene	9002-84-0
FEP	Fluorinated ethylene propylene	25067-11-2
PFA	Perfluoroalkoxy polymer	26655-00-5 / 31784-04-0
ETFE	Ethylene tetrafluoroethylene	25038-71-5 / 68258-85-5
ECTFE	Copolymer of ethylene and chlorotrifluoroethylene	25101-45-5
PVDF	Polyvinilidene fluoride	24937-79-9
FKM	Fluoroelastomer	9011-17-0
PCTFE	Polychlorotrifluoroethylene	9002-83-9

The most purchased fluoropolymer by UNIGASKET is PTFE in a proportion of about 76%, and the other 24% represents other fluoropolymers, such as PFA, FEP, ECTFE, etc.

Fluoropolymers have unique properties that distinguish them from other PFAS and they do not have the environmental and toxicological profiles associated with some substances in the PFAS group that are of concern (such as PFOA and PFOS).

Fluoropolymers are durable, stable, and mechanically strong in harsh conditions in a variety of sectors including but not limited to automotive, aerospace, environmental controls, energy production and storage, and electronics, as well as in technical apparel. They are also stable in air, water, sunlight, chemicals, and microbes, and chemically inert, meeting the requirements for low levels of contaminants and particulates in manufacturing environments critical for the food and beverage, pharmaceutical, medical, and semiconductor industries. Finally, fluoropolymers are biocompatible, non-wetting, non-stick, and highly resistant to temperature, fire, and weather. These unique characteristics make them a critical material for a broad range of industries and sectors, playing a diverse and crucial role for society, with few, if any, viable alternatives, and making them essential in numerous technologies, industrial processes, and everyday products.

Furthermore, fluoropolymers are known for being considered as Polymers of Low Concern (PLC) according to criteria established by the OECD, therefore they are themselves not hazardous materials. Taking this into consideration, it can be concluded that the use of fluoropolymers by **UNIGASKET** in the manufacturing of our products does not pose any kind of risk for human health or the environment during their complete life cycle.

We strongly believe that, since fluoropolymers are different from the other families of PFAS, there is no scientific, economic, or social basis to justify regulating them in the same way as all of the other PFAS.

3. Questions and responses

1) Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

First of all, UNIGASKET would like to express its concern related to the use of the "essential use concept" as a basis to take regulatory decisions on chemicals. In our experience, this approach is generating significant controversy in Europe which has led to a continuous delay of its implementation at regulatory level. Indeed, it appears to be extremely complex to define correctly what is essential and what is not essential, particularly because uses that may not be regarded as essential today could be found to be essential in the future, when the application may no longer be available. A good example it the use of fluoropolymers in interior air purifying systems, which may have been identified as "nice to have only" before the COVID-19 pandemic but were found to the best systems to ensure efficient interior protection to reduce virus transmission; a ban on this use due to 'non-essentiality' may have prevented such systems from being available when they were desperately needed.

If still the essentiality concept is going to be used, the basic criterion should be related to the risk profile of the substance. Indeed, substances that do not have any recognised hazard profile should not be considered for any ban on their use. Moreover, substances with a potential hazard identified, yet posing a low risk throughout their life cycle should be as well excluded. It is noted that differentiations could be established between industrial and consumer uses, because for consumers even a low risk may be deemed unacceptable depending on the specific case under consideration.

It makes sense to regulate uses of most harmful chemicals. For these, uses should only be allowed if, first of all, the risk is reduced as much as possible; then, it would be necessary to prove that the use is necessary to grant an adequate protection for the health and safety of the population, to protect the environment, or to ensure an adequate functioning of society. In such cases, continuation of the use should be allowed if there is no viable alternative that can replace the substance concern.

We believe that this situation does not apply to fluoropolymers, because they do not pose significant risk during use, as demonstrated by their consideration of Polymers of Low Concern (PLC) following indications provided by the OECD on the subject. Furthermore, the risk management measures implemented in the production process, both our own and those of fluoropolymer producers, as well as developments in end-of-life treatment techniques of these materials, ensure that the (low) risk associated with the use of these materials throughout their entire life cycle can be adequately controlled. Still, we also assume that the uses of our fluoropolymer-based products would match any consideration of essentiality, because they are necessary to ensure health (e.g. by providing clean food transfer systems), safety (e.g. in vehicle brake systems), and there are no viable alternatives that can replace them.

In any event, a case-by-case analysis should be carried out for each of the substances included in the broad PFAS group, to consider the hazard classification and the risks associated with their use (considering the technical functions of the substance in each of its specific uses), rather than a general analysis of the PFAS group as a whole.

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

UNIGASKET supports the inclusion of the cost as an economic criterion in the definition of the "reasonably available" concept for PFAS alternatives, together with the volume/stock criteria.

We understand that alternatives are substances (but also new techniques or processes) that reduce, eliminate, or avoid adverse effects, can perform the same function (considering all of the properties provided by the substance to be replaced), are available in enough quantities, and are economically viable compared to the substance to be replaced.

Therefore, the cost needs to be considered (together with the other criteria) during the analysis of alternatives.

As an example related to our products, when considering stainless steel as an alternative to the fluoropolymer-based tubes and hoses in the Industrial, Automotive, and Food sectors of use, there are no advantages related to risk and hazard reduction (as both substances are not classified), the performance of the products decreases (stainless steel is less flexible and its vibration resistance is lower) and, although it is sufficiently available in volume terms, the cost of using this alternative may go up to **five times higher**. Therefore, even if a sufficient improvement in the other criteria were achieved (which is not the case), a thorough cost analysis would be necessary to verify that the alternative would be feasible.

As for the threshold of cost increase that would be considered reasonable, it is difficult to generalise and a case-by-case analysis would be more appropriate. The same cost increase applied to the same product used in different sectors of use, or to different products, can have very different impacts.

3) Should unique considerations be made for small businesses with regards to economic feasibility?

We believe that special consideration should always be given to small and medium-sized companies, since their resources in the face of changes and prohibitions are more limited, and the effect of cost increases is significantly larger than in big companies.

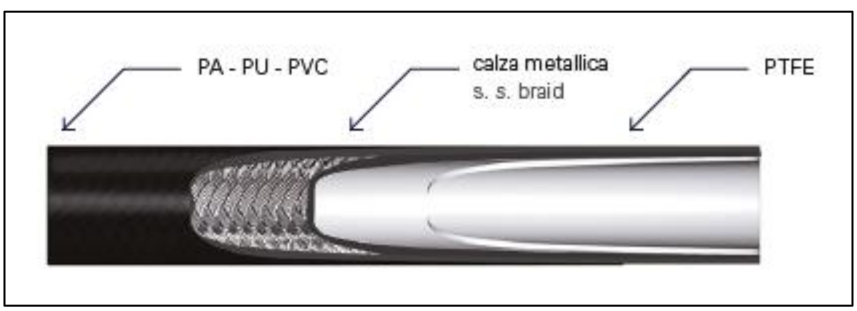
4) What criteria should be used to determine the safety of potential PFAS alternatives?

As commented in the response to question 1, the criteria that should be considered to determine the safety of potential PFAS alternatives would be the following:

- The hazard classification.
- The risk generated during the whole life cycle.

A substance that shows the same hazardous properties or worse than the substance to be replaced, cannot be considered as an alternative. In fact, this should be considered a regrettable substitution, as the potential adverse effects of the substance have been increased by the alternative rather than being eliminated or dampened.

On the other hand, if the use of an alternative increases the risk during the use of the product, it should not be regarded as such. An example related to our products is the substitution of stainless-steel braided hoses with inner PTFE tube by polyamide (PA) reinforced hoses in the brake system of vehicles.



Scheme of the different layers in a hydraulic brake hose.

The main technical problem of this substitution is that the thermal resistance of PA is lower than PTFE. Near the crimping area on the calliper side, it is possible to reach and maintain a temperature higher than the PA melting point temperature. It depends on the design of the vehicle (mainly in motorcycles), but if the brake hose is close to the engine or the exhaust, this situation could occur, representing an unacceptable risk for a safety component. In case that PA reaches the melting point temperature, the fluid could be spilled and not transmitted anymore, causing a sudden loss of the brake function, and compromising the safety of the rider.

In addition, using PA-reinforced brake hoses, even with the same intermediate layer material, at the same braided condition, and consuming the same brake fluid, the difference in water gain in the brake fluid before and after the tests is higher than using a brake hose with PTFE as inner material. This is due to the low moisture permeability of PTFE, which some studies estimate to be up to six times lower than that of PA. The presence of water in the brake fluid will affect the performance of the brake system, by decreasing the sensibility and, consequently, the brake performance of the vehicle in terms of the stopping distance, compromising the safety of operators, passengers, and third parties.

Finally, if the substitution leads to, for example, an increase in the volume of waste generated (because of a higher need for maintenance and replacement), or it worsens the recyclability possibilities (because recycling streams for that material do not exist or are very incipient), the substance should also not be considered as an alternative.

5) How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

UNIGASKET considers that CUU for fluoropolymers should be indefinitely maintained until real alternatives are available in the market.

Real alternatives mean those that comply with the following conditions:

- They can reduce, eliminate, or avoid adverse effects.
- They can perform the same function, providing the same properties.
- They are available in enough quantities.
- They are economically viable.

In order to verify that these alternatives are available, a re-evaluation of the state-of-the-art should be performed periodically, through open public consultation in which companies can provide scientific data and documents regarding the assessment of the hazard, performance, availability, and cost of the potential alternatives. It should be mandatory that any claim related to a potential alternative being available should be thoroughly supported with verified technical data that demonstrates equivalent performance to fluoropolymers at industrial scale (e.g. not just at lab tests). Likewise, a thorough hazard and risk assessment should be presented, in order to confirm that the potential alternative does not share similar or worse properties of concern compared to the material that it intends to substitute.

6) How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

To request the consideration of a use as CUU, stakeholders should provide MPCA with the following information:

- Information about the company and contact details.
- Type of product.
- Intended use or function of the product.
- Justification of the essentiality.
- Description of the role of PFAS in the product and its essentiality.
- Analysis of potential alternatives for this specific use.

MPCA could provide a format to standardise the request and compilation of this information.

After the evaluation of any CUU request (or groups of CUU requests), MPCA could publish it/them to be subject to a public consultation in which any stakeholder could provide information to support, supplement and reinforce, or oppose the proposed CUU.

7) In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

UNIGASKET produces and markets different stainless-steel braided products and also non-braided products, both based on fluoropolymers. According to the last version of the Harmonized Tariff Schedule (HTS) of the USA (Revision 1 - 2024), these products have been coded as:

- 3917.21.00 Tubes, pipes, and hoses, rigid: of polymers of ethylene
- 3917.29.00 Tubes, pipes, and hoses, rigid: of other plastics

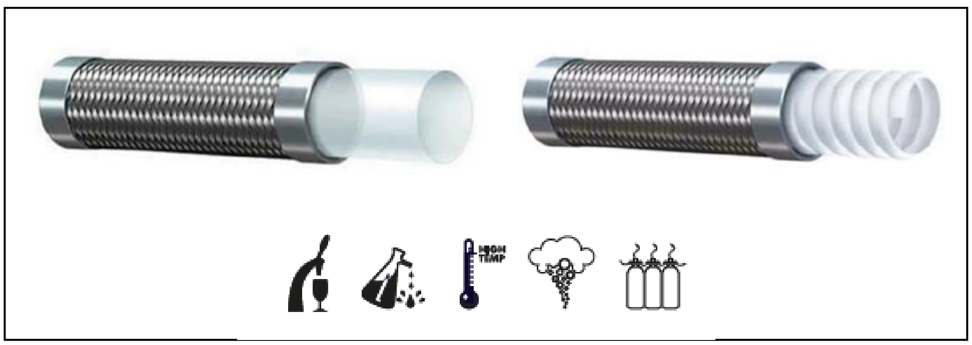
The stainless-steel braided products are marketed mainly in the **Automotive** sector of use, specifically for brake, engine, and cooling applications. The non-braided products are marketed mainly in the **Industrial**, **Food**, **Automotive**, and **Semiconductors** sectors of use, for many different applications.

Fluoropolymers are used as raw materials for the manufacture of our products due to their unique properties. It is the combination of properties that fluoropolymers provide that render fluoropolymer-based products the choice for all the above-mentioned sectors of use.

The main functional properties delivered by fluoropolymers in these sectors of use are the following:

Sector	Industrial	Food	Automotive	Semiconductors
Chemical resistance	X	X	X	X
Flexibility			X	
Low coefficient of friction	X	X		
Low permeability	X	X		
Low thermal expansion			X	
Mechanical resistance (durability)		X		
Purity				X
Temperature resistance (wide range)	X	X	X	

PTFE is the only material able to unify the main technical properties and safety standards in one solution for the **Automotive** sector of use. For this reason, PTFE braided hoses are the only solution able to unify the main required skills, such as reduced volumetric expansion (and therefore the high resistance to stress), temperature resistance, and chemical compatibility. The hoses in PTFE are also resisting better to vibrations and torsions.

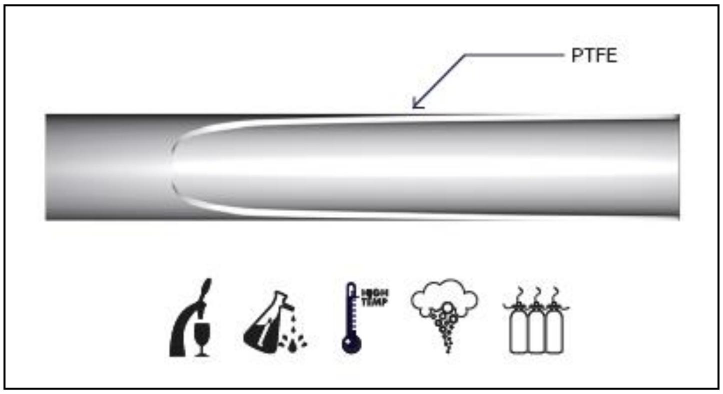


PTFE hoses with braided steel jacket (smooth or corrugated inner PTFE tube).

In the case of brake hoses, the inner tube is made with PTFE because this is the only material that is able to guarantee the thermal and chemical resistance that no other material can offer. The non-stick and smooth inside of the PTFE inner tube provides excellent oil flow. Furthermore, PTFE can resist the high temperature close to the calliper (around 250°C), provide the chemical resistance to withstand brake oil, deliver the low hygroscopic performance required, and support the working conditions (e.g., contact with UV Rays and Zinc Chloride on the road) which can affect the performance and safety. Finally, the stainless-steel braid ensures more protection of the inner PTFE and increases safety, while an external jacket in PVC/PA coating ensures better protection of the hose.

Our brake hoses are developed with brake calliper producers (e.g., Brembo Group) to offer the lowest volumetric expansion during the brake and, at the same time, the best safety performances in every working condition. This product meets and exceeds the requirements of multiple manufacturers of means of transport, ensuring that their vehicles always have full braking power.

On the other hand, the use of non-braided fluoropolymer-based products allows vehicle manufacturers to achieve high chemical and temperature resistance and good flexibility, which is not at the expense of stiffness and resistance, in a unique solution. PTFE tubes are manufactured according to high quality standards, such as BS EN ISO 13000-1:2021[1]. We extrude PTFE tubes with inner diameters from 1 mm to 100 mm.



PTFE flexible hoses without braided steel jacket.

Fluoropolymers offer higher performances to ensure the quality and safety of **Industrial** applications because there is no solution able to offer the same chemical and temperature resistances with the same flexibility of use. Our products (mainly hoses, pipes, and tubes) are used to handle aggressive media in industrial applications, offering flexibility in the use. They are used mainly in the chemical and pharmaceutical sectors, for which the properties of fluoropolymers are unique. They are also selected to be used in processes in which high or very low temperatures are reached, such as the steel, oil and gas, moulding of plastics, and cryogenic industries. In addition, they are the only solution in the new hydrogen industry due to their unique performances in terms of chemical resistance, flexibility, low permeation, and wide temperature range.

The fluoropolymer-based products that UNIGASKET manufactures for the **Industrial** sector of use are the following:

- Hoses for hydraulic applications used to transmit forces using hydraulic fluid;
- Tubing into the electrolyse cell for the production of the green hydrogen;
- Pipes used on robots equipped with grippers to transport aggressive fluids at high pressures and temperatures (-70°C to 260°C) thanks to the lack of absorption of humidity;

[1] BS EN ISO 13000-1:2021 – TC. Plastics. Polytetrafluoroethylene (PTFE) semi-finished products. Requirements and designation.

- Tubes with an internal non-stick core that do not contaminate the painting equipment and allow an excellent flow of air and pigment and in addition are able to withstand the vibrations and high operating temperatures typical of painting lines.
- Tubing used for the transport of compressed air, fluids, and gases at low pressure in the industrial field in contact with high temperatures.
- Tubing used to transfer particularly aggressive media with low pressure.

In the **Food** sector of use, PTFE is the only material that leads to optimal properties (chemical and temperature resistance, low coefficient of friction, and low permeability) to maintain the cleaning, sanitisation, and safety conditions of the food contact applications.

PTFE offers the highest performance to ensure quality and safety for the users (industrial, professional, and consumers). This fluoropolymer does not release any additives or elements into the media, so the use of PTFE tubes cannot be a source of chemical contamination in food or water. Furthermore, due to the non-stick properties of PTFE, food cannot adhere to the inside of the tube, preventing foodborne illnesses and cross-contaminations. Finally, due to its low permeability, it is not possible for food or water transported inside PTFE tubes to become contaminated from external sources and, at the same time, avoid odours and flavours from passing to water, beverages, and liquid food.

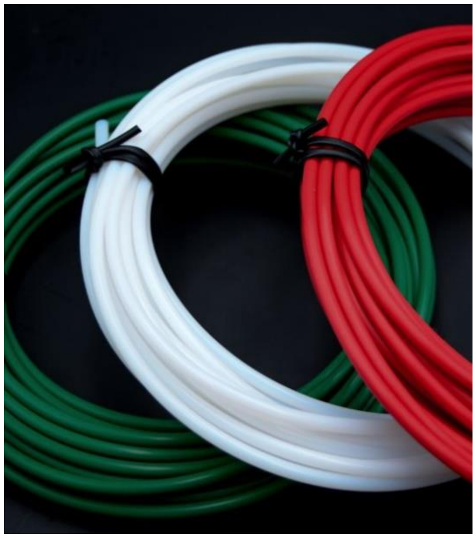
UNIGASKET offers a wide range of products using PTFE, FEP, and PFA able to meet the needs of those applications. These products are certified according to FDA regulations[2] and NSF standards[3]. We produce hoses that are used to handle food, water, and the cleaning media used in food processing machines or coffee machines for consumer, professional, and industrial use.

Due to the strict technical specifications on hygiene, sanitation, and working methods, manufacturers of coffee and food machines have chosen PTFE hoses as the best solution to guarantee high pressure and temperature to transfer hot water, or other food liquids, from the tank to the nozzle, guaranteeing the absence of contamination in the final product. This is due to the fact that fluoropolymers (mainly PTFE) combine the following characteristics:

- Food compatibility.
- It does not release odours and flavours.
- Temperature resistance.
- Chemical resistance to the chemical media used for sterilization and sanitization.
- Long operating life.

[2] PTFE tubes have been tested according to FDA 21 CFR 177.1550. The examined items meet the requirements and, therefore, the result of the tests is “Pass”. Test report 158250140c 001. TÜV Rheinland (Hong Kong) Ltd.
[3] Both PTFE and FPE used by UNIGASKET are “Authorized Registered Formulation (ARF)” according to NSF/ANSI Standard 51 – Food Equipment Materials.

Our special extruders allow UNIGASKET to produce PTFE thin wall tubes. The high tensile resistance and the high temperature resistance (up to 260°C) give the possibility to use our tube in food contact applications.



Thin wall extruded tubes in PTFE.

We extrude our tubing from 1mm internal diameter to 100mm. We could use special PTFE powders approved by FDA that allow to our hoses to be used in food and beverage industry. We have also tested our hoses according to the European Regulation 10/2011[4] and DM 174/2004[5] that have confirmed the possibility to use our tubing in water, food, and beverage contact.

The products that UNIGASKET manufactures based on fluoropolymers for the **Food** sector of use are the following:

- Food contact materials (e.g., pipes and gaskets for coffee machines) for consumer food preparation. The pipes are tasteless and odourless, free of phthalates, resistant to the liquids transported and to the products intended for cleaning, and able to comply with hygiene standards.
- Special gaskets, used in the production of big and little household appliances, are non-toxic, conductive, food compliant, and have a good performance at very high and very low temperatures.

[4] Commission Regulation (EU) No 10/2011 of 14 January 2011 on plastic materials and articles intended to come into contact with food. Last consolidated text: 31/08/2023. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02011R0010-20230831

[5] DECRETO 6 Aprile 2004, n. 174. Regolamento concernente i materiali e gli oggetti che possono essere utilizzati negli impianti fissi di captazione, trattamento, adduzione e distribuzione delle acque destinate al consumo umano. https://www.gazzettaufficiale.it/eli/id/2004/07/17/004G0204/sg

Fluoropolymers, PFA in particular, are the only materials able to offer the levels of purity required by the **Semiconductor** industry and, at the same time, to present a high chemical resistance in front of aggressive and corrosive media used in the production plant of microchips. In fact, they are currently the only raw materials approved for this type of application. For the **Semiconductor** industry it is absolutely essential to guarantee that the streams treated within the piping systems will remain with the highest possible purity. For this industry, levels of purity of part per trillion are required to ensure the highest possible quality, and to reduce production scrap rates for the user of high purity sulfuric acid. For this reason, any material to be used within this process must ensure an extremely low level of impurities, as well as a low level of leaching of the material used for the piping system into the product. For this reason, the semiconductor manufacturers have rejected all other alternatives due to technical problems that would prevent their production, which requires extreme purity, cleanliness, and zero contamination from other minerals or elements.

Cleanroom PFA tubes for Semiconductor applications.

During the last years, UNIGASKET has invested heavily with the aim of offering products with high added value which comply with the highest standards of cleanliness and hygiene particularly required in the hi-tech industry. Inside our ISO 7[6] certified cleanroom, we extrude tubes with high-purity fluoropolymers (in particular PFA and FEP) that are used in semiconductor applications.

[6] ISO 14644-1:2015. "Cleanrooms and associated controlled environments. Part 1: Classification of air cleanliness by particle concentration". According to this standard, cleanrooms certified as ISO-7 are required to have sixty air changes per hour of HEPA filtered air and less than 2,930 particles/meter^3 greater or equal to 5 microns.

8) Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

We understand that MPCA could define some initial CUU determinations considering the information received from companies during this process, provided that the information is considered enough and reliable to take this decision.

Regarding the uses and products presented by UNIGASKET in this document, we strongly believe that they qualify and meet the criteria to be considered CUUs. For this reason, we are at the disposal of the MPCA should any clarification of the information provided be necessary or should it be deemed necessary to complete it.

We also consider that, as previously explained, fluoropolymers are different from the other families of PFAS and, for this reason, there is no scientific, economic, or social basis to justify regulating them in the same way as all of the other PFAS. Therefore, as they are not hazardous materials and are considered as polymers of low concern, any industrial use of fluoropolymers should be considered CUU.

9) Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

Nothing to add.

RECEIVED
By: OAH on 2/29/2024
Callum Ross Attachment

Currently Unavoidable Uses of Per- and polyfluoroalkyl substances (PFAS) in Steam and Thermal Solution Products

Issue: 1
Date: 27-Feb-2024

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Executive Summary

Steam Thermal Solutions (part of Spirax Group) is a world-leading provider of steam and thermal solutions, offering a comprehensive range of products and services to help customers improve their energy efficiency, productivity, and environmental performance. Steam Thermal Solutions has over 100 years of experience and expertise in steam engineering and applications, serving industries such as food and beverage, pharmaceutical, chemical, oil and gas, power generation, and many more. Steam Thermal Solutions offers solutions for every stage of the steam and condensate loop, from steam generation, distribution, and utilization to condensate recovery and reuse. Steam Thermal Solutions also provides training, audits, consultancy, and digital services to help customers optimize their steam systems and achieve their sustainability goals.

Steam Thermal Solutions is committed to ensuring the safety and sustainability of its products and operations, as well as complying with the relevant regulations and standards in the markets where it operates. We are aware of the growing concern about the environmental and health impacts of per- and polyfluoroalkyl substances (PFAS), a group of chemicals that have been widely used in various industries for their water and oil repellency, heat resistance, and friction reduction properties. Steam Thermal Solutions thanks the Minnesota Department of Environmental Protection for the opportunity to share information on where and why fluoropolymers are used in our products and their applications, and where there are currently no suitable, available alternative materials that can meet the required performance characteristics.

Steam Thermal Solutions fully supports the restriction of specific, hazardous PFAS that pose a danger due to bioavailability, bioaccumulative and toxic properties. However, fluoropolymers (a group of polymers within the class of PFAS) meet the Organisation for Economic Co-operation and Development (OECD) criteria for polymers of low concern and are essential for various applications across multiple industries. Steam Thermal Solutions uses fluoropolymer materials in many products because of the very strong C-F bond as they are critical to achieve the chemical, heat and mechanical resistance required for the applications and industries that they are intended to support. One of the main applications of fluoropolymers in our industry is polytetrafluoroethylene (PTFE), a synthetic fluoropolymer that has exceptional chemical, thermal, and mechanical properties. PTFE is widely used as a sealant and in gaskets in various components and systems of Steam and Thermal Solution, such as valves, traps, regulators, pumps, meters, and controls. PTFE provides superior performance, reliability, and durability in high-pressure, high-temperature, and corrosive environments, which are essential for the efficient and safe operation of steam systems in various sectors, such as food and beverage, pharmaceutical, chemical, and power generation. Fluoroelastomer (FKM) is another fluoropolymer that is also used for the same rationale and has similar properties as PTFE. Furthermore, Steam Thermal Solutions' products that use PTFE and other fluoropolymer are supporting industrial process where the design and application of our products mean they have a prolonged longevity in use, and are not single use consumable products.

For the majority of these applications, there are currently no alternative materials. To the extent there are apparent alternatives, they are not sufficiently evaluated or approved for these applications, creating concerns on performance and safety, that can impact pharmaceutical, transport and food industries, amongst others. For these reasons, the products listed in this report and their associated applications should be considered Currently Unavoidable Uses (CUU).

We are not complacent or indifferent to the environmental and health concerns of PFAS. We are proactively engaging with our suppliers, subject matter experts, and industry partners to identify and evaluate potential alternatives to fluoropolymers in our steam and thermal solution products.

However, we also recognize the need for a careful and rigorous assessment of the technical feasibility, performance, safety, and environmental impact of any alternative material, to avoid any regrettable substitution that could compromise the quality and reliability of our products or pose similar or worse risks to human health and the environment as PFAS. Therefore, we urge the State of Minnesota to grant us additional time to conduct our research and testing, and to consider the specific needs and challenges of our industry, before imposing any restrictive or prohibitive measures on the use of PFAS.

Table of Contents

A summary of each Product Groups and the impact and availability of alternative materials is shown below. **Refer to Appendix A for details of product groups that are covered under each sections**.

Ball Valves

One of the key products that Steam and Thermal Solutions offers is ball valves, which are designed for control purposes and have characterized balls or seats, to give a predictable flow pattern. They are an economic means of providing control with tight shut-off for many fluids including steam.

Steam and Thermal Solutions Ball valves are used in a wide range of industries and sectors, such as chemical, pharmaceutical, food and beverage, oil and gas, power generation, pulp and paper, and water treatment. These industries and sectors rely on ball valves to control the flow of various fluids, gases, and vapours, as well as to isolate and regulate pressure and temperature. Ball valves are essential to the safety and smooth functioning of these industries and sectors, as they prevent leaks, overflows, explosions, and contamination, as well as optimize the efficiency, quality, and performance of the processes and products.

Ball Valves are crucial for Safety, and optimum operations.

Ball Valves are reliable shut-off valves designed to reduce maintenance time of the steam plant and create a safer environment. They provide reliable tight shut-off and require less maintenance. They are essential for controlling the flow of fluids in industrial applications, contributing to the safety and efficiency of operations. They are available in a wide range of sizes, materials, and body design options, providing a suitable model for any application. Their precision design provides compact valves. They are quick and easy to automate. They allow low pressure drop and high capacity. Their corrosion-resistant bodies ensure the long life of the product.

Fluoropolymer use in Ball Valves and how they are essential to the function.

The strategic use of PTFE (polytetrafluoroethylene) in Steam and Thermal Solutions ball valve components is essential for both functionality and safety. PTFE ensures smooth stem movement, creates tight seals, prevents fluid leakage, and enhances overall sealing performance. These properties collectively contribute to efficient valve operation, minimize risks of leaks, and maintain system integrity across various industries. In summary, PTFE's role in ball valve components is critical for reliable and safe valve functionality.

Non- Fluoropolymer Substitutes in Ball Valve Components

Research into non-Fluoropolymer substitutes for PTFE (Polytetrafluoroethylene) in ball valve components is progressing and demonstrating potential, although they have not yet been tested or applied in identical use-cases. These alternatives aim to replicate the unique properties of PTFE, including its ability to form tight seals, prevent fluid leakage, and enhance sealing performance. However, achieving the same performance as PTFE is challenging. PTFE's low friction, high temperature resistance, and chemical stability contribute to efficient valve operation and system integrity across various industries. Non-Fluoropolymer alternatives may not fully replicate these properties, potentially impacting their effectiveness in maintaining reliable and safe valve functionality. Therefore, while non-Fluoropolymer alternatives are being developed and show promise, they may not yet achieve the same performance as PTFE in all use-cases.

Safety Valves

Steam and Thermal Solutions Safety Valves are devices that protect pressurized systems by releasing a volume of fluid from within the plant when a predetermined maximum pressure is reached, thereby reducing the excess pressure in a safe manner. They are used in a wide range of industries and sectors, such as chemical, pharmaceutical, food and beverage, oil and gas, power generation, pulp and paper, and water treatment.

Safety Valves are crucial for Safety, and optimum operations.

Safety Valves are essential wherever a hazardous overpressure situation could occur. They safeguard against mechanical damage to equipment and surroundings, loss of product and production, damage to the environment, and injury and loss of life. They are used for boiler overpressure protection and other applications such as downstream of pressure reducing controls. Their primary function is to protect life and property. They are also used in process operations to prevent product damage due to excess pressure. Safety valves should be installed wherever the maximum allowable working pressure (MAWP) of a system or pressure-containing vessel is likely to be exceeded.

Fluoropolymer use in Safety Valves and how they are essential to the function.

PTFE (Polytetrafluoroethylene) and Viton or FKM, both types of Fluoropolymers, are used in various industrial applications due to their unique properties. In the context of Steam and Thermal Solutions Safety Valves, PTFE is used as Bush, providing a low friction surface, allowing for precise control over the valve operation. On the other hand, Viton is used in the soft seal disc Insert, O-ring. These components are critical for the valve’s operation, providing a seal that prevents leakage and ensures the valve operates correctly.

Non- Fluoropolymer Substitutes in Safety Valve Components

Research into non-Fluoropolymer substitutes for PTFE (Polytetrafluoroethylene) in Safety Valve components is progressing and demonstrating potential, although they have not yet been tested or applied in identical use-cases. These alternatives aim to replicate the unique properties of PTFE and Viton, including their ability to provide a low friction surface and form tight seals that prevent leakage. However, achieving the same performance as PTFE and Viton is challenging. The low friction, high temperature resistance, and chemical stability of PTFE and Viton contribute to precise control over valve operation and ensure the valve operates correctly. Non-Fluoropolymer alternatives may not fully replicate these properties, potentially impacting their effectiveness in maintaining reliable and safe valve functionality. Therefore, while non-Fluoropolymer alternatives are being developed and show promise, they may not yet achieve the same performance as PTFE and Viton in all use-cases.

Piston Actuated Valves

The function of the Steam and Thermal Solutions Piston Actuated Valve is to control the flow of fluid through the valve body by responding to a pneumatic control signal. Depending on the type of valve, the control signal can be either direct or reverse acting. A direct acting valve opens when the control signal increases and closes when the control signal decreases. Piston Actuators are used in a wide range of industries and sectors, such as chemical, pharmaceutical, food and beverage, oil and gas, power generation, pulp and paper, and water treatment.

Piston Actuated Valves are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Piston Actuated Valves are efficient, accurate, and easy to maintain stop valves for use on steam, condensate, and liquid systems. They are designed to reduce maintenance time of steam plants and create a safer environment. They provide reliable tight shut-off and require less maintenance. They are essential for controlling the flow of fluids in industrial applications, contributing to the safety and efficiency of operations.

Fluoropolymer use in Piston Actuated Valves and how they are essential to the function.

Steam and Thermal Solutions Piston Actuated Valves are constructed using a variety of materials, each selected for their unique properties. Fluoroelastomer (FKM) is employed in the O-rings and seals due to its resistance to high temperatures and excellent chemical stability. Polytetrafluoroethylene (PTFE) is used as seals. It provides a tight ANSI Class VI shutoff and contributes to the efficiency and reliability of the valve system. Lastly, Viton, a type of Fluoropolymer (a member of the PFAS family), is used as O-ring. It provides a robust and reliable seal in harsh environments. These materials collectively ensure the proper functioning and durability of Steam and Thermal Solutions valves.

Non- Fluoropolymer Substitutes in Piston Actuated Valve Components

Steam and Thermal Solutions Piston Actuated Valves utilize materials like, Polytetrafluoroethylene (PTFE), and Viton, a Fluoropolymer, for their unique properties. Alternatives to these Fluoropolymer materials could include other types of elastomers or plastics. However, these alternatives may not offer the same level of performance. For instance, FKM's high-temperature resistance and chemical stability, PTFE's contribution to efficiency and reliability with a tight ANSI Class VI shutoff, and Viton's robustness in harsh environments are characteristics that may not be matched by non-Fluoropolymer alternatives. Therefore, while alternatives exist, they may not provide the same durability and proper functioning as the Fluoropolymer materials used in Steam and Thermal Solutions valves.

DP Reducing Valves

Steam and Thermal Solutions DP reducing valves are devices that reduce the pressure of steam or other fluids by using a piston actuator. They are used in various industries, such as food and beverage, pharmaceutical, and chemical, to control the flow rate and temperature of processes. Reducing Valves are used in a wide range of industries and sectors, such as chemical, pharmaceutical, food and beverage, oil and gas, power generation, pulp and paper, and water treatment.

DP Reducing Valves are crucial for Safety, and optimum operations.

Steam and Thermal Solutions DP Reducing Valves accurately control downstream pressure, regardless of the upstream pressure or load variations. These valves are essential for well-designed steam systems that produce clean dry steam for delivery at high pressure. Lower pressure steam is usually needed at the point of use. Effective control demands an automatic valve that can reduce steam pressure accurately, reliably, and at a cost to suit the application.

Fluoropolymer use in DP Reducing Valves and how they are essential to the function.

Polytetrafluoroethylene (PTFE) is employed in the O-rings, seals, and stem seals of the valve, PTFE's high-temperature resistance and excellent chemical stability ensure a tight seal, preventing leaks and maintaining the efficiency of the valve system. It is essential to provide a reliable and durable seal that can withstand the high pressures and temperatures involved in these applications.

Non- Fluoropolymer Substitutes in DP Reducing Valve Components

DP Reducing Valve employs Polytetrafluoroethylene (PTFE) for their unique properties such as high temperature resistance and excellent chemical stability. Alternatives to these materials could include other types of elastomers or plastics. However, these alternatives may not offer the same level of performance. Therefore, while alternatives exist, they may not provide the same durability and proper functioning as the Fluoropolymer materials used in Steam and Thermal Solutions valves.

Blowdown Valves

Steam and Thermal Solutions Blowdown valves are designed for the removal of suspended/deposited solids and water from the bottom of steam boilers. It is used in conjunction with a Steam and Thermal Solutions blowdown timer to provide timed control of bottom blowdown, ensuring that the recommended boiler blowdown cycles occur with minimum heat loss, avoiding duplication or omission. Blowdown valves are used in a wide range of industries and sectors, such as chemical, pharmaceutical, food and beverage, oil and gas, power generation, pulp and paper, and water treatment.

Blowdown Valves are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Blowdown Valves are designed to accommodate blowdown water from the boiler and meet the Health, Safety & Environmental regulations. They are essential for maintaining plant safety and saving energy by eliminating stem seal leaks. Zero emissions are guaranteed which ensures these valves meet the most stringent worldwide emissions legislation.

Fluoropolymer use in Blowdown Valves and how they are essential to the function.

Steam and Thermal Solutions Blow Down Valves employ fluoropolymers such as PTFE and FKM. PTFE, a chemically inert polymer with a broad working temperature range, is used in valve components, making it ideal for seals exposed to wide-ranging chemicals and temperature extremes. FKM, characterized by its robust carbon-fluorine bonds, is a key component in the valve's O-rings, offering exceptional resistance to chemicals, heat, and oxidation. This makes it suitable for environments involving chemical handling, high temperatures, and explosives. In essence, the unique properties of both PTFE and FKM significantly enhance the functionality, safety, and efficiency of Steam and Thermal Solutions Blow Down Valves, enabling them to operate effectively under diverse conditions.

Non- Fluoropolymer Substitutes in Blowdown Valve Components

Steam and Thermal Solutions Blow Down Valves employ Polytetrafluoroethylene (PTFE) and Fluoroelastomer (FKM) for their unique properties. Alternatives to these Fluoropolymer materials could include other types of elastomers or plastics. However, these alternatives may not offer the same level of performance. For instance, PTFE's broad working temperature range and chemical inertness make it ideal for seals exposed to a wide range of chemicals and temperature extremes. FKM, characterized by its robust carbon-fluorine bonds, offers exceptional resistance to chemicals, heat, and oxidation, making it suitable for environments involving chemical handling, high temperatures, and explosives. These characteristics may not be matched by non- Fluoropolymer alternatives. Therefore, while alternatives exist, they may not provide the same durability and proper functioning as the Fluoropolymer materials used in Steam and Thermal Solutions valves.

BRV Valves

Steam and Thermal Solutions Body Relief valves (BRV) are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment. They are used in a wide range of industries and sectors, such as chemical, pharmaceutical, food and beverage, oil and gas, power generation, pulp and paper, and water treatment. They are essential for maintaining the quality and efficiency of the boiler system, as well as preventing scale formation and corrosion. BRV valves also help to control the pressure and temperature of the boiler by releasing excess steam and water.

BRV Valves are crucial for Safety, and optimum operations.

Steam and Thermal Solutions BRV are essential for maintaining safe operation of pressurised systems. They are properly installed, commissioned, used, and maintained by qualified personnel in compliance with the operating instructions. They are designed for use on steam, compressed air, and inert industrial gases. They protect life and property by preventing overpressure in plant.

Fluoropolymer use in BRV Valves and how they are essential to the function.

Steam and Thermal Solutions BRV, or Pressure Reducing Valves, are designed to control steam, compressed air, and inert industrial gases. They are constructed using a variety of materials for different components. The diaphragms are made from synthetic rubbers and fluoropolymers such as FPM (Fluorocarbon Elastomers), and FKM (Fluorocarbon Elastomers). These materials are known for their excellent heat, ozone, weather resistance, and resistance to oils, solvents, and chemicals. They provide a flexible and durable seal that can withstand high temperatures and pressures. The O-rings are made from FEPM (Fluoroelastomer) and PTFE (Polytetrafluoroethylene). FEPM is a type of rubber that is highly resistant to heat, chemicals, and aging. PTFE is a type of plastic known for its excellent chemical resistance, low friction, and high operating temperature range. They provide a tight and durable seal that can withstand harsh conditions. Other components such as the guide bush, protective films, pushrods assembly, and washer are made from PTFE, providing a durable and chemically resistant surface that can withstand harsh conditions.

Non- Fluoropolymer Substitutes in BRV Valve Components

Non- Fluoropolymer alternatives for Pressure Reducing Valves are being explored due to the potential environmental and health impacts of Fluoropolymer materials. However, these alternatives may not compare to the performance and safety of Fluoropolymer materials. Fluoropolymer materials, such as PTFE and FKM, are known for their outstanding chemical, thermal, and low-friction properties. They are used in various components of Pressure Reducing Valves due to their ability to withstand harsh conditions and provide durable seals. Non- Fluoropolymer materials may have different properties and might not work or have a shorter lifetime for certain products. Furthermore, they may not be easily available. Therefore, while non- Fluoropolymer alternatives are being developed, they currently do not match the performance and safety of Fluoropolymer materials.

Bellows Sealed Valves

Steam and Thermal Solutions Bellows Sealed Valves are environmentally sound solutions for steam systems and to guarantee zero emissions. The function of Bellows Sealed Valve is to provide reliable and leak-free isolation of steam and other fluids. The valve has a flexible metal bellows that seals the stem from the atmosphere and eliminates the need for gland packing. This prevents any emissions of steam or fluid and ensures safety and efficiency.

Bellows Sealed Valves are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Bellows Sealed Valves are engineered to maintain plant safety and save energy by eliminating stem seal leaks. Zero emissions are guaranteed which ensures these valves meet the most stringent worldwide emissions legislation. They are essential for maintaining plant safety and providing safe, well-made products.

Fluoropolymer use in Bellows Sealed Valves and how they are essential to the function.

The use of PTFE (Polytetrafluoroethylene) in the seat insert of Steam and Thermal Solutions Bellow Sealed Valves is crucial for their function. PTFE is known for its excellent chemical resistance, low friction, and high-temperature tolerance, making it an ideal material for valve seat inserts. In the

Bellow Sealed Valves, the PTFE seat insert plays a vital role in ensuring a tight seal when the valve is closed, thereby preventing leaks, and maintaining the efficiency of the system.

Non- Fluoropolymer Substitutes in Bellows Sealed Valve Components

Non- Fluoropolymer alternatives for Bellow Sealed Valves are being explored due to the potential environmental and health impacts of Fluoropolymer materials. However, these alternatives may not compare to the performance and safety of Fluoropolymer materials. Fluoropolymer materials, such as PTFE are known for their outstanding chemical, thermal, and low-friction properties. They are used as seat insert in Bellow sealed valves due to their ability to withstand harsh conditions and provide durable seals. Non- Fluoropolymer materials may have different properties and might not work or have a shorter lifetime for certain products. Furthermore, they may not be easily available. Therefore, while non- Fluoropolymer alternatives are being developed, they currently do not match the performance and safety of Fluoropolymer materials.

Float Traps

Steam and Thermal Solutions Float Traps are devices that automatically remove condensate and air from steam systems. It consists of a valve body, a seat, a float ball, and a lever mechanism. The float ball rises and falls with the level of condensate in the trap, opening and closing the valve.

Float Traps are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Float Traps are essential for maintaining a safe, lower carbon and energy-efficient steam system. They allow condensate to be removed from the steam system effectively, meaning that process efficiency can be optimised, equipment is protected, and the condensate can be re-used. They contribute to overall sustainability targets.

Fluoropolymer use in Float Traps and how they are essential to the function.

Fluoroelastomer (FKM) O-rings are a critical component in the function of Steam and Thermal Solutions Float Traps. These O-rings provide a robust seal that can withstand the high temperatures and pressures within the system, ensuring the efficient operation of the float trap. The FKM material is known for its excellent heat resistance and chemical stability, which makes it ideal for use in steam applications.

Non- Fluoropolymer Substitutes in Float Traps Components

Non-Fluoropolymer alternatives to Fluoroelastomer (FKM) O-rings are being developed and implemented. However, these alternatives may not achieve the same performance and safety as Fluoropolymer chemicals. The O-rings made of FKM are resistant from corrosion and heat damage, which is crucial for the function of Steam and Thermal Solutions Float Traps. While some non-fluorinated alternatives have shown to meet high specifications required for certain uses, more studies are needed to better understand their effects on humans and the environment. While the transition to non-Fluoropolymer alternatives is underway, it is important to ensure that these alternatives can meet the necessary performance and safety standards.

Sight Glasses and Gauges

Sight glasses monitor the discharge downstream of steam traps in pressurised condensate return lines. It is screwed directly into the steam trap providing a modular monitoring system, thus eliminating the need for a connecting nipple, minimising joints, and potential leak paths. The sight glass can also be installed in process lines to provide a visual indication of flow.

Sight Glasses and Gauges are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Sight Glasses and Gauges are used for quick and easy visual inspection throughout the system. They assess correct flow indication, detect blocked flow, identify any live steam, or vapour leakage, and inspect the colour of the product throughout the process. They are essential for maintaining plant safety and improving operational efficiency.

Fluoropolymer use in Sight Glasses and Gauges and how they are essential to the function.

PTFE (Polytetrafluoroethylene), commonly used in gaskets, Cap O-ring plays a crucial role in the functioning of Steam and Thermal Solutions Sight Glasses. These sight glasses allow for quick and easy visual inspection throughout the system. The PTFE gaskets/O-ring ensure a secure and tight seal, preventing any leakage of steam or vapour. In sanitary applications (such as pharmaceuticals, food processing, or biotechnology), maintaining hygienic conditions is crucial. PTFE’s unique conformity to deformation to ensure tight seal is essential. It ensures that there are no crevices or gaps where contaminants can accumulate.

Non- Fluoropolymer Substitutes in Sight Glasses and Gauges Components

Non-Fluoropolymer alternatives to PTFE gaskets/sealants are being explored. However, these alternatives may not achieve the same performance and safety as Fluoropolymer chemicals. Fluoropolymer are known for their water-resistant and non-stick properties, making them extraordinarily useful in various applications. They protect industrial equipment from contamination, corrosion, and heat damage, which is crucial for the function of Steam and Thermal Solutions Sight Glasses. While some non-fluorinated alternatives have shown to meet high specifications required for certain uses, more studies are needed to better understand their effects on humans and the environment. Therefore, while the transition to non-Fluoropolymer alternatives is underway, it is important to ensure that these alternatives can meet the necessary performance and safety standards.

PN Actuators

Steam and Thermal Solutions Actuators are devices that convert pneumatic or hydraulic pressure into linear motion. They are used on steam systems to control the flow of steam through valves, regulators, traps, and other components. Linear actuators can be adjusted to suit different operating conditions, such as pressure, temperature, and flow rate. Linear actuators are essential for maintaining the efficiency, safety, and reliability of steam systems, as they ensure that the steam is delivered at the right pressure and temperature to the end users.

PN Actuators are crucial for Safety, and optimum operations.

Steam and Thermal Solutions PN Actuators are essential for the operation of control valves. They accept a signal from the control system and, in response, move the valve to a fully open or fully closed position, or a more open or a more closed position. They are essential for maintaining safe operation of pressurised systems.

Fluoropolymer use in PN Actuators and how they are essential to the function.

Steam and Thermal Solutions PN Actuators employ PTFE and FKM materials in components like bearings and seals, that provides excellent fluid sealing, low friction, and resistance to wear and chemicals, ensuring the actuator’s durability and effective functioning. FKM is used in O-rings, providing chemical, thermal, and oxidation resistance, and a wide operational temperature range. This ensures a tight seal and prevents leaks in the actuator, even under high temperatures or when exposed to various chemicals.

Non-Fluoropolymer Substitutes in PN Actuators Components

It is understandable from Mainstream literature that research is underway for non- Fluoropolymer substitutes for PTFE and FKM. However, these alternatives might not match the performance and safety of Fluoropolymer chemicals. Fluoropolymers are renowned for their high temperature, water-resistant and low coefficient of friction properties, which are extremely beneficial in various applications. They safeguard industrial equipment from heat and corrosion damage, which is vital for Steam and Thermal Solutions PN Actuators. While some non-fluorinated alternatives have demonstrated the ability to meet certain high specifications, further research is required to fully understand their impact on humans and the environment. Therefore, it is crucial to ensure that these alternatives can meet the necessary performance and safety standards as the transition to non-Fluoropolymer alternatives continues.

Balanced Pressure Traps

Steam and Thermal Solutions Balanced Pressure Traps are maintainable thermostatic steam trap designed to remove condensate from clean (chemical free) steam systems with minimal condensate retention. They efficiently drain condensate from steam systems while preventing the loss of live steam. They work by using a flexible capsule that contains a liquid with a similar boiling point as steam. As the steam pressure changes, the capsule expands or contracts to open or close the valve. Traps are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Balanced Pressure Traps are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Balanced Pressure Traps adjust automatically to varying steam pressures. They have excellent air venting characteristics during plant start-up and during normal operation. They have large discharge capacities for their size. Their robust design of the internals gives a good life expectancy. They are essential for maintaining a safe, lower carbon and energy-efficient steam system.

Fluoropolymer use in Balanced Pressure Traps and how they are essential to the function.

In Steam and Thermal Solutions Balanced Pressure Traps, the optimal function of different components is ensured using specific materials. PTFE (Polytetrafluoroethylene), known for its excellent chemical resistance and low friction properties, is used in Seals, providing a tight seal and maintaining the efficiency of the steam traps. FKM (Fluoroelastomer), used in O-rings, is valued for its high temperature, oil, and chemical resistance, contributing to the durability and longevity of the O-rings, and enabling them to withstand harsh conditions within the steam traps.

Non-Fluoropolymer Substitutes in Balanced Pressure Traps Components

Non-Fluoropolymer alternatives for PTFE, FKM in Balanced Pressure Traps are being researched according to our understanding from the mainstream literature. However, these alternatives may not achieve the same performance and safety as Fluoropolymer chemicals. Fluoropolymers are known for their water-resistant and non-stick properties, making them extraordinarily useful in various applications. They protect industrial equipment from chemical, corrosion, and heat damage, which is crucial for the function of Steam and Thermal Solutions Balanced Pressure Traps. While some non-fluorinated alternatives have shown to meet high specifications required for certain uses, more studies are needed to better understand their effects on humans and the environment. Therefore, while the transition to non-Fluoropolymer alternatives is underway, it is important to ensure that these alternatives can meet the necessary performance and safety standards.

Direct Acting Pressure Reducing Valve (DRV)

Steam and Thermal Solutions DRV (Direct Acting Pressure Reducing Valve) works by balancing the downstream pressure via a pressure sensing pipe against a pressure adjustment control spring. The working principle of the Steam and Thermal Solutions DRV valve is based on the balance of forces acting on the diaphragm. DRV are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

DRV are crucial for Safety, and optimum operations.

DRV are essential for maintaining safe operation of pressurised systems. They are properly installed, commissioned, used, and maintained by qualified personnel in compliance with the operating instructions. They are designed for use on steam, compressed air, inert industrial gases and certain oils. They protect life and property by preventing overpressure in the plant.

Fluoropolymer use in DRV and how they are essential to the function.

PTFE (Polytetrafluoroethylene) material is used for the construction of components like Bearing bushes, Bushes, Pilot Seats, Pilot Valve Seats, ensuring the DRVs' safety and reliability. PTFE, known for its heat, electrical, and chemical resistance, low friction, durability, superior resistance to oil, and gas, thereby guaranteeing efficient performance even under demanding conditions.

Non-Fluoropolymer Substitutes in DRV Components

When considering non-Fluoropolymer alternatives, it is essential to recognize that they currently do not fully meet the performance and safety requirements established by Fluoropolymers. While these alternatives may offer advantages such as improved environmental profiles and reduced toxicity, they often fall short in terms of the unique combination of properties provided by Fluoropolymers. For instance, PTFE, known for its heat resistance, electrical insulation, chemical resistance, low friction, and durability, plays a crucial role in various DRV components, ensuring their reliability and long lifespan. There should be ongoing efforts aim to find safer alternatives, however, the current non-Fluoropolymer options do not match the unique performance characteristics and safety attributes of Fluoropolymer chemicals used in these critical products.

Liquid Drainers

One of the functions of liquid drainers is to remove condensate from compressed air systems without wasting any of the valuable compressed air. They are used to drain off water while preventing the escape of compressed air. Liquid Drainers are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Liquid Drainers are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Liquid Drainers are essential for maintaining operational efficiency. Condensate can cause corrosion, contamination, and energy loss if it is not drained properly. Liquid Drain Traps are built for the robust application of compressed air, providing precise control and greater efficiency.

Fluoropolymer use in Liquid Drainers and how they are essential to the function.

Fluoroelastomers (FKM) are employed in Liquid Drainer components particularly in the Valve Cones, and O-rings. FKM is characterized by its strong carbon-fluorine bonds, which give it exceptional chemical, thermal, and oxidation resistant properties. This makes it ideal for handling and transportation of chemicals and fuels, as well as high temperature and explosive environments. In the context of Steam and Thermal Solutions Liquid Drainers, these properties ensure the durability, safety, and reliability of the equipment, even under harsh conditions.

Non- Fluoropolymer Substitutes in Liquid Drainers Components

FKM, characterized by robust carbon-fluorine bonds, exhibits exceptional chemical, thermal, and oxidation resistance. This makes it suitable for handling and transporting chemicals, fuels, and operating in high-temperature and explosive environments, ensuring the durability and reliability of the equipment even under challenging conditions. It is important to note that non-Fluoropolymer alternatives currently do not fully match the performance and safety requirements set by Fluoropolymer chemicals. While these alternatives may offer certain advantages, such as improved environmental profiles or reduced toxicity, they often fall short in replicating the unique combination of properties of Fluoropolymers.

Air Eliminators

Steam and Thermal Solutions Air Eliminators are devices that remove air and other non-condensable gases from liquid systems. Air eliminators improve heat transfer efficiency, prevent corrosion, reduce noise, and prevent pump cavitation. They are essential for maintaining the quality and performance of the liquid system. Air Eliminators are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Air Eliminators are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Air Eliminators are essential for efficient running of the steam or liquid systems. They improve operational efficiency and reduce maintenance costs. They avoid leaving air in the system or wasting steam by venting air accurately.

Fluoropolymer use in Air Eliminators and how they are essential to the function.

Fluoroelastomers (FKM) are used in valve cones, valve heads, and O-rings of Steam and Thermal Solutions Air Eliminators due to their exceptional chemical, thermal, and oxidation resistant properties. FKM offers a wide operational temperature range, which is crucial for the efficient functioning of air eliminators. These properties make FKM an ideal choice for handling and transportation of chemicals and fuels, as well as high temperature and explosive environments.

Non- Fluoropolymer Substitutes in Air Eliminators Components

Fluoroelastomers (FKM) is employed in Steam and Thermal Solutions Air Eliminators. FKM, characterized by robust carbon-fluorine bonds, exhibits exceptional chemical, thermal, and oxidation resistance. This makes it suitable for handling and transporting chemicals, fuels, and operating in high-temperature and explosive environments, ensuring the durability and reliability of the equipment even under challenging conditions. It is important to note that non-Fluoropolymer alternatives currently do not fully match the performance and safety requirements set by Fluoropolymer chemicals. While these alternatives may offer certain advantages, such as improved environmental profiles or reduced toxicity, they often fall short in replicating the unique combination of properties of Fluoropolymers.

Hose Down Stations & Thermocirc

Hose Down Stations mix steam and cold water to economically produce hot water for hosing down. These products are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Hose Down Stations & Thermocirc are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Hose Down Stations mix steam & cold water to economically produce hot water for hosing down. They improve operational efficiency and have a compact design. They are crucial for safety and optimum operations in various industries that require hygienic and efficient cleaning of equipment and facilities. This reduces the risk of scalding, contamination, or corrosion, and ensures a consistent and reliable supply of hot water.

Fluoropolymer use in Hose Down Stations & Thermocirc and how they are essential to the function.

The Steam and Thermal Solutions Hose Down Station employs PTFE, FKM, Fluoropolymers known for their chemical resistance, low friction, and high-temperature tolerance.

Non- Fluoropolymer Substitutes in Hose Down Stations & Thermocirc Components

PTFE and other Fluoropolymers are known for their unique properties such as chemical resistance, low friction, and high-temperature tolerance, which make them ideal for use in various applications. Alternatives to PTFE, are being actively developed. However, currently they do not offer the same performance.

SA Control Valves

Steam and Thermal Solutions Self Acting (SA) Control Valves are devices that regulate the flow of fluids or gases in a pipeline. They work by opening or closing partially or fully, depending on the signal received from a controller. The controller monitors the pressure, temperature, level, or flow rate of the system and adjusts the valve position accordingly. The valve can be operated manually, electrically, pneumatically, or hydraulically. These valves are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

SA Control Valves are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Self Acting Control Valves are essential for various industries and applications that depend on precise and consistent control of fluids or gases. For example, they are used in the pharmaceutical industry to ensure the quality and sterility of the products, in the food and beverage industry to maintain hygiene and freshness, in the heating and cooling systems to optimize energy consumption and comfort, and in the water treatment and distribution to provide safe and clean water.

Fluoropolymer use in SA Control Valves and how they are essential to the function.

Steam and Thermal Solutions employes Fluoropolymers that are used in the construction of piston sealing rings due to their excellent heat resistance and low friction properties. These materials are crucial for maintaining the integrity and efficiency of the valve mechanisms. The piston sealing rings, made from fluoropolymers ensure a tight seal within the valve, preventing leakage and ensuring accurate control of steam, water, air, oil, and gases. This contributes to the robust design and precise control that are key features of Steam and Thermal Solutions Control Valves.

Non- Fluoropolymer Substitutes in SA Control Valves Components

Companies have been developing alternative non-fluoropolymers and metal-based solutions. However, these alternatives may not match the performance and safety of PFAS due to their unique properties. Additionally, the higher cost of non-fluorinated alternatives could limit their market adoption. Therefore, despite the existence and development of non-fluoropolymer alternatives, their use in applications such as piston sealing rings in control valves may face challenges related to performance, safety, and cost.

Gilflo Meters

Steam and Thermal Solutions Gilflo Meters are devices that measure the flow rate of steam, gas, or liquid in a pipe. These devices use a patented spring-loaded cone design that creates a differential pressure across the meter, which is proportional to the flow rate. Gilflo Meters are accurate, reliable, and easy to install and maintain.

Gilflo Meters are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Gilflo Meters can meter most industrial fluids, steams & gases. They ensure efficient running of the steam or liquid systems & reduce maintenance costs.

Fluoropolymer use in Gilflo Meters and how they are essential to the function.

Fluoropolymers are employed Gilflo meters for their unique properties, such as high temperature resistance, low friction, and excellent sealing capabilities, make it an ideal material for internal components. These materials ensure chemical as well as temperature resistance of Gilflo meters. It also contributes to the accuracy that is vital in various industrial applications where precise flow control and measurement are required.

Non- Fluoropolymer Substitutes in Gilflo Meters Components

Research into non-fluoropolymer substitution are becoming popular due to health and environmental concerns related to high fluorinated chemicals such as Fluoropolymer. However, they may not currently fully replicate or replace fluoropolymer’s unique properties, like its excellent sealing, heat and chemical inertness which are essential for applications like Gilflo meters. Despite their potential, these non-fluorinated alternatives are often more expensive, and some have been detected in the environment, potentially contributing to health risks. Therefore, more research is needed to ensure their safety and effectiveness across all applications.

EL Actuators

Electric (EL) Actuators are devices that convert electrical signals into mechanical movement. They are used to control the opening and closing of valves in steam systems, ensuring safety and optimal performance.

EL Actuators are crucial for Safety, and optimum operations.

Steam and Thermal Solutions EL Actuators regulate the flow of steam in different conditions and applications. They can handle high temperatures, pressures, and corrosive environments without compromising safety or efficiency. They also enable remote control and automation of valves, reducing manual labour and human error.

Fluoropolymer use in EL Actuators and how they are essential to the function.

Non- Fluoropolymer Substitutes in EL Actuators Components

In the construction of Steam and Thermal Solutions EL Actuators, PTFE (Polytetrafluoroethylene) and FKM (Fluoroelastomer) are employed in internal components including seals. Seal made of fluoropolymer such as PTFE, provides excellent chemical resistance and low friction properties, ensuring a tight seal and smooth operation, which are vital for the actuator's performance. Simultaneously, FKM is employed in O-rings, known for its high-temperature resistance and superior sealing capabilities, preventing leakage, and maintaining the actuator's integrity.

Air Vents

Air vents are designed to vent air from the system or to prevent wasting steam by venting air accurately.

Air Vents are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Air Vents are essential for efficient running of the steam or liquid systems. They improve operational efficiency and reduce maintenance costs. They avoid leaving air in the system or wasting steam by venting air accurately. Air Vents are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Fluoropolymer use in Air Vents and how they are essential to the function.

The use of fluoropolymer, mainly FKM, in O-rings is integral to the function of Steam and Thermal Solutions Air Vents. O-ring plays a crucial role in maintaining the integrity of the air vent, ensuring a tight seal, and preventing leaks. FKM makes O-ring resistant to a wide range of chemicals and temperatures, which is essential in steam systems where conditions can be harsh.

Non- Fluoropolymer Substitutes in Air Vents Components

Alternatives for Fluoropolymers are being explored due to environmental and health concerns associated with Fluoropolymers. However, they may not achieve the same performance and safety as Fluoropolymers chemicals, which are resistant to a wide range of chemicals and temperatures, essential in harsh conditions such as those in steam systems. Some non-fluoropolymer alternatives have been detected in the environment and may also pose health risks. Information on emerging fluoropolymer alternatives is often limited or lacking, and more studies are needed to better understand their effects. Therefore, while non-fluoropolymer alternatives are being developed, they may not yet match the performance and safety of Fluoropolymer chemicals in certain applications.

Hygienic Control Valves

Steam and Thermal Solutions Hygienic Control Valves are designed to regulate the flow of fluids in sanitary applications such as food, beverage, pharmaceutical, and biotechnology industries. Hygienic Control Valves ensure high levels of hygiene, accuracy, and reliability while minimizing contamination and energy loss.

Hygienic Control Valves are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Hygienic Control Valves are designed to meet the stringent requirements of hygienic processes. They are used in industries such as food and beverage, pharmaceuticals, and biotechnology where cleanliness and sterility are paramount. They help ensure product quality and safety.

Fluoropolymer use in Hygienic Control Valves and how they are essential to the function.

Fluorocarbon (FKM) and Polytetrafluoroethylene (PTFE) are vital to the functionality of Steam and Thermal Solutions Hygienic Control Valves. FKM, a fluoropolymer, is used in O-rings, Seal Washers, Body Seals, and Stem Seals. Its excellent resistance to media, ozone, and aging, stability in fuels, petroleum-based oils and greases, and aliphatic and aromatic hydrocarbons make it ideal for applications in the chemical and pharmaceutical industries with aggressive media and high process temperatures. PTFE, on the other hand, is used in Stem Bushes and Bearings in these valves, although specific references to its use in Steam and Thermal Solutions products were not found.

Non- Fluoropolymer Substitutes in Hygienic Control Valves Components

Steam and Thermal Solutions Hygienic Control Valves employ FKM and Polytetrafluoroethylene (PTFE), both types of Fluoropolymers, due to their unique properties such as excellent resistance to media, ozone, aging, and stability in various substances. These chemicals have unique desirable properties, such as stability under intense heat and the ability to repel water, oil, and stains, making them ideal for a wide range of applications, including those in the chemical and pharmaceutical industries. While non-fluoropolymer alternatives are being developed and show promise, currently they may not fully replicate the performance and safety of fluoropolymer chemicals in all applications.

TDS Blowdown

Steam and Thermal Solutions TDS Blowdown are devices that automatically remove excess dissolved solids from the boiler water, ensuring optimal boiler efficiency and preventing scale formation. They also help to prevent carryover of water and impurities into the steam, which can damage the equipment and affect the product quality. Devices are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

TDS Blowdown are crucial for Safety, and optimum operations.

Steam and Thermal Solutions TDS Blowdown Controls are used to control the level of Total Dissolved Solids (TDS) in the boiler water. High TDS levels can lead to damage and efficiency loss of the boiler and associated plant. Accurate blowdown methods are essential to maintain steam quality and system efficiency.

Fluoropolymer use in TDS Blowdown and how they are essential to the function.

TDS BlowDown system relies on the specific use of PFA, FKM, and PTFE in its components. PFA, or Perfluoroalkoxy alkanes, is used in Cable Insulation due to its excellent resistance to heat, electrical and chemical damage, and stress cracking. FKM, a type of synthetic rubber known as Fluoroelastomer, is used in Gasket Seals for its high resistance to heat, oil, and chemical exposure, which is crucial to withstand harsh operating conditions. PTFE, or Polytetrafluoroethylene, is used as seals. PTFE is known for its outstanding chemical resistance, wide temperature range, and low friction properties, making it an excellent choice for seals in solenoid valves and sensors, ensuring reliable operation even under the demanding conditions of a TDS BlowDown system.

Non- Fluoropolymer Substitutes in TDS Blowdown Components

Non-Fluoropolymer alternatives for PFA, FKM, and PTFE are being explored. These alternatives, that are currently not available, may not possess the same properties as Fluoropolymer chemicals, known for their excellent resistance to heat, electrical and chemical damage, and stress cracking. This could result in them not working as effectively or having a shorter lifespan for certain products. Despite these challenges, the development and use of non-fluoropolymer alternatives are crucial for environmental and health safety, necessitating further research to better understand the effects of emerging Fluoropolymer alternatives on humans and the environment.

Clean Steam Generators

Generates clean steam using demineralized water services and steam from standard boiler plant. Ultra compact clean steam generators are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Clean Steam Generators are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Clean Steam Generators provide high-quality clean steam, free from boiler chemicals. They are used in healthcare for sterilisation, ensuring the safety of medical instruments. They also help reduce the risk of wet packs during sterilisation.

Fluoropolymer use in Clean Steam Generators and how they are essential to the function.

PTFE (Polytetrafluoroethylene) plays a vital role in the efficient operation of Clean Steam Generators like those produced by Steam and Thermal Solutions. It is used in the gaskets and tubing of these generators, providing a reliable seal in feedwater lines which is crucial for their efficient functioning. PTFE's exceptional chemical resistance makes it suitable for handling demineralized water services, a key aspect of Clean Steam Generators' operation, and helps prevent contamination, ensuring the purity of the steam produced. Furthermore, PTFE maintains its integrity under high temperatures and pressures, conditions commonly found in steam generator tubes, ensuring the clean steam produced is not contaminated. Lastly, PTFE's non-stick properties, due to its low coefficient of friction, prevent adhesion and ensure smooth operation, which is vital for the efficient functioning of Clean Steam Generators.

Non- Fluoropolymer Substitutes in Clean Steam Generators Components

The exploration of non-fluoropolymer alternatives to PTFE is underway due to health and environmental concerns. These alternatives may not fully replicate PTFE's unique properties, such as exceptional chemical resistance, integrity under high temperatures and pressures, and non-stick properties, all of which are crucial for the operation of Clean Steam Generators. While the transition towards non-fluoropolymer alternatives is a positive step, it is essential to continue research and development to ensure these alternatives meet the necessary performance and safety standards for specific applications like Clean Steam Generators.

Vortex Meters

Steam and Thermal Solutions Vortex Meters measure the steam flow rate by detecting the frequency of vortices shed by a bluff body in the flow. They provide accurate, reliable, and cost-effective steam measurement for optimal energy efficiency and safety. Devices are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Vortex Meters are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Vortex Meters accurately measure and monitor the flow rate of electrically conductive liquids. They are used in various industries to improve energy efficiency and process accuracy.

Fluoropolymer use in Vortex Meters and how they are essential to the function.

Steam and Thermal Solutions Vortex Meters employ PTFE (Polytetrafluoroethylene) due to its unique properties. PTFE is known for its excellent chemical resistance, high-temperature stability, low friction, and superior sealing capabilities. These qualities make it an ideal material for various parts of the Vortex Meter, including the Packing Gland, Pressure Transducer Sealant, Body Cap Gasket, Cavity Filler, Seat, and Stem Seal. PTFE serves as an effective sealant, preventing leakage and ensuring the meter's accurate operation and prevent potential leaks that could affect the meter's functionality. When used as a Seat material, PTFE offers a durable and stable base, contributing to the meter's longevity.

Non- Fluoropolymer Substitutes in Vortex Meters Components

While PTFE's unique properties make it ideal for various parts of the Vortex Meter, rising health and environmental concerns over Fluoropolymers have led to a demand for alternatives. Several non-fluoropolymers alternatives are being developed. However, these alternatives may not fully match the performance and safety of PTFE, especially in harsh environments. Therefore, while PTFE-free materials are gaining popularity, they may not provide the same level of performance and safety in specific applications such as those found in Steam and Thermal Solutions Vortex Meters.

Other Boilerhouse

This Product Group contains devices including Water level gauges, which are devices that indicate the water level in a boiler or tank. They are essential for ensuring safe and efficient operation of boilers in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Other Boilerhouse are crucial for Safety, and optimum operations.

Steam and Thermal Solutions provides a range of boilerhouse products and systems that are essential for the safe and efficient operation of steam and hot water boilers These products contribute to plant safety, energy efficiency, and reliability.

Fluoropolymer use in Other Boilerhouse and how they are essential to the function.

The Steam and Thermal Solutions Water Level Gauge for Boilerhouses, crucial for monitoring liquid levels in tanks and process vessels, relies on the use of PTFE (Polytetrafluoroethylene) in its plastic tubes. PTFE's properties of high-temperature resistance, chemical inertness, and low friction make it ideal for the high-pressure, high-temperature environment of a boilerhouse. The gauge, which includes a tube available in both glass and PTFE plastic, is designed with packing seals and washers to prevent leakage. The PTFE tubes are essential as they can endure the boiler's high temperatures and pressures while offering a clear view of the water level.

Non- Fluoropolymer Substitutes in Other Boilerhouse Components

Non-fluoropolymer alternatives to PTFE are being explored for various applications due to their improved sustainability profiles. However, these alternatives may not fully replicate the unique properties of Fluoropolymers, such as extreme heat stability, chemical inertness, and low friction. In the context of the Steam and Thermal Solutions Water Level Gauge for Boilerhouses, the high-temperature resistance, chemical inertness, and low friction of PTFE are critical for enduring the boiler's high temperatures and pressures. Therefore, it is important to carefully evaluate the performance and safety of these alternatives in each specific use-case.

Quarter Turn & Rotary Control Valves

Quarter Turn & Rotary Control Valves are used to regulate the flow of steam, water, or other fluids in boiler systems. They offer precise and reliable control over a wide range of operating conditions, such as temperature, pressure, and flow rate. They also provide fast and easy operation, low maintenance, and high durability.

Quarter Turn & Rotary Control Valves are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Quarter Turn & Rotary Control Valves are used for diverting process media, facilitating maintenance, equipment removal, and shutdown. They provide a high degree of accuracy and repeatability for accurate temperature control.

Fluoropolymer use in Quarter Turn & Rotary Control Valves and how they are essential to the function.

The Steam and Thermal Solutions Quarter Turn & Rotary Control Valves use fluoropolymers such as PTFE and FKM. PTFE, or Polytetrafluoroethylene, is used in the seals due to its chemical resistance and low friction, ensuring a robust seal and smooth operation of the valve stem, which is crucial for preventing leakage and controlling flow precisely. FKM, or Fluoroelastomer, is used as O-rings. FKM's exceptional chemical, thermal, and oxidation resistance properties make it ideal for creating critical seals in various parts of the valve, preventing leakage, and ensuring effective operation under a wide range of conditions. In summary, PTFE and FKM are vital to the function, durability, reliability, and efficiency of these valves.

Non- Fluoropolymer Substitutes in Quarter Turn & Rotary Control Valves Components

Non-Fluoropolymer alternatives for PTFE and FKM are being explored in various industries. These alternatives, while promising, may not always achieve the same performance and safety as Fluoropolymer chemicals. The unique properties of PTFE and FKM, such as exceptional chemical, thermal, and oxidation resistance, low friction, and robust sealing capabilities, are vital to the function, durability, reliability, and efficiency of applications like the Quarter Turn & Rotary Control Valves from Steam and Thermal Solutions. Further development and testing may be required to ensure these non-fluoropolymer alternatives can match the performance of Fluoropolymer chemicals in all use-cases.

Electromagnetic Meters

Steam and Thermal Solutions Electromagnetic Meters are devices that measure the flow rate of conductive liquids, such as water, steam condensate, or chemical solutions. They work by applying a magnetic field to the liquid and measuring the voltage induced by the movement of the liquid through the field. Devices are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Electromagnetic Meters are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Electromagnetic Meters accurately measure and monitor the flow rate of electrically conductive liquids. They are used in various industries to improve energy efficiency and process accuracy.

Fluoropolymer use in Electromagnetic Meters and how they are essential to the function.

Steam and Thermal Solutions Electromagnetic Meters, which are designed to measure and monitor the flow rate of electrically conductive liquids such as impure water, pulps, and pastes, rely on the use of PTFE (Polytetrafluoroethylene) in their lining materials. The malleability of PTFE under pressure is a key characteristic that ensures the lining can withstand pressure changes within the meter without compromising its structural integrity. This not only contributes to the high performance of these meters but also enhances their reliability, making PTFE an indispensable component in the construction of these devices.

Non- Fluoropolymer Substitutes in Electromagnetic Meters Components

Steam and Thermal Solutions Electromagnetic Meters utilise PTFE (Polytetrafluoroethylene) for their lining materials, capitalising on its malleability under pressure for high performance and reliability. However, due to environmental and health concerns over Fluoropolymers such as PTFE, alternatives are being explored. Non-fluoropolymer is being developed but may not match the performance and safety of Fluoropolymer chemicals, particularly their heat stability. While these alternatives are environmentally safer, their adoption is challenging for industries reliant on Fluoropolymer unique properties.

Contamination

These products provide solutions to reduce the risk of product and process contamination. These systems detect changes in condensate conductivity and when a change occurs, a controller signals a dump valve to open, allowing the condensate to flow to drain.

Contamination is crucial for Safety, and optimum operations.

Steam and Thermal Solutions provides solutions to avoid food and drink contamination risk through steam. Unclean steam touching products risks contaminating them with rust, dirt, and chemical particles, making them unsafe for consumption. Steam and Thermal Solutions helps reduce potential food contamination risk in the process. These devices are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Fluoropolymer use in Contamination Air Vents and how they are essential to the function.

Steam and Thermal Solutions Contamination Control Systems employ Fluoroelastomer (FKM) gaskets. These gaskets are known for their resilience against aggressive fuels, chemicals, and a wide range of temperatures. This makes them particularly suitable for industries like oil and gas, and crucially, for contamination control systems. FKM gaskets help maintain system integrity by ensuring a tight seal and preventing leaks. Therefore, FKM's importance to Steam and Thermal Solutions Contamination Control Systems lies in its contribution to system reliability, safety, and integrity.

Non- Fluoropolymer Substitutes in Contamination Components

Non-Fluoropolymer alternatives to Fluoroelastomer (FKM) gaskets, polymer option for sealing applications, are emerging. However, these alternatives may not achieve the same performance and safety as Fluoropolymer chemicals, which are known for their water-resistant and non-stick properties. Furthermore, information on emerging Fluoropolymer alternatives is often limited or lacking, and more studies are needed to better understand their effects on humans and the environment.

Compressed Air Products

These products provide accurate monitoring and control of compressed air in a system. These products ensure air is delivered to the point of use at the right quantity and quality. They include a range of isolators, drain traps, and ancillaries specifically built for the robust application of compressed air. Devices are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Compressed Air Products are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Compressed Air Products ensure air is delivered to the point of use at the right quantity and quality. They include a range of isolators, drain traps, and ancillaries that prevent contamination, corrosion, and wastage of compressed air. They also ensure the pressure, temperature, and flow of the air are regulated and controlled according to the needs of the process. By using Steam and Thermal Solutions Compressed Air Products, customers can achieve safety, reliability, and efficiency in their compressed air systems.

Fluoropolymer use in Compressed Air Products and how they are essential to the function.

Steam and Thermal Solutions Compressed Air Products utilize seals made from PTFE (Polytetrafluoroethylene) in the design. The importance of PTFE in these seals lies in its unique properties. PTFE is known for its excellent chemical resistance which makes it suitable for use in a variety of environments. Furthermore, PTFE reduces friction which not only ensures a tight seal but also contributes to the longevity of the valve. This means that valves using PTFE seals can operate effectively, safely, and efficiently under various conditions for extended periods. Therefore, PTFE plays a crucial role in enhancing the performance and durability of Steam and Thermal Solutions Compressed Air Products.

Non- Fluoropolymer Substitutes in Compressed Air Products Components

Non-Fluoropolymer alternatives to PTFE are being developed. However, these alternatives may not currently fully replicate the unique combination of properties that PTFE offers, such as its exceptional chemical resistance, low friction, and longevity. Therefore, while non-fluoropolymer alternatives are promising, they may not achieve the exact performance and safety profile of chemicals like PTFE in all use-cases. It is important to note that the specific applications and performance can vary based on the product and its use within the compressed air systems of Steam and Thermal Solutions.

Sundries

A range of products are within this product group that collectively control the flow of media such as Steam, liquid in various applications. These devices are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Sundries are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Sundries products such as steam control products as well as packaging are crucial for safety and optimum operations because they allow precise and reliable control of the flow of media in various applications. They ensure that the pressure, temperature, and quality of the media are maintained at the desired levels, preventing leaks, damage, or contamination.

Fluoropolymer use in Sundries and how they are essential to the function.

PTFE and FKM are crucial to these products due to their unique properties. PTFE, used as seals, is known for its low friction, high-temperature resistance, and chemical inertness, ensuring smooth operation, preventing leaks, and enhancing overall performance and safety. FKM, used in O-rings, gaskets, is valued for its excellent resistance to high temperatures, oils, fuels, and other chemicals, making it ideal for components exposed to harsh conditions and requiring strong, durable seals. Together, these materials significantly contribute to the functionality and safety of these products.

Non- Fluoropolymer Substitutes in Sundries Components

In response to environmental and health concerns, alternatives to Fluoropolymer, including PTFE and FKM, are being explored. These alternatives, currently, may not match the performance and safety levels of Fluoropolymers, which are known for their excellent heat and chemical resistance, low friction, and strong, durable seals. These properties are crucial for the functionality and safety of these products Some novel alternatives have been found to have even longer half-lives in humans than PFOS and may also contribute to liver damage. Therefore, while the shift towards non-fluoropolymer alternatives is necessary, it presents challenges in terms of safety and performance.

Spiratrol

Steam and Thermal Solutions Spiratrol is a range of two-port control valves that regulate steam or water flow in various applications. They are designed to provide accurate and reliable control with minimal maintenance and low energy consumption. These devices are used in in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Spiratrol are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Spiratrol is a range of two-port self-acting temperature control valves, for steam applications. It is designed to be versatile and combine high flowrate capacity with wide rangeability and precise control.

Fluoropolymer use in Spiratrol and how they are essential to the function.

The Steam and Thermal Solutions Spiratrol is a two-port single seat globe valve that uses Polytetrafluoroethylene (PTFE) and Fluorocarbon (FKM) to enhance its safety, performance, and durability. PTFE, or Teflon, is used in the seals due to its heat, chemical, and electricity resistance, and its smoothness that reduces friction, ensuring smooth and reliable operation. FKM, or Viton, is used in the O-rings. Its high resistance to heat, oil, and chemical exposure makes it ideal for maintaining a tight seal, preventing leaks, and ensuring the valve's reliable operation, even under harsh conditions.

Non- Fluoropolymer Substitutes in Spiratrol Components

Non-Fluoropolymer alternatives are being explored for applications that currently use PTFE and FKM, such as the Steam and Thermal Solutions Spiratrol valve. These alternatives, including non-fluorinated polymers, aim to replace Fluoropolymer chemicals known for their heat stability and unique surfactant properties. However, these alternatives may not match the performance and safety levels of Fluoropolymer chemicals, particularly in terms of heat, chemical, and electrical resistance, and friction reduction. While the development of non-fluoropolymer alternatives is a step towards sustainability, it presents challenges in maintaining the performance and safety levels currently achieved with Fluoropolymer chemicals. Therefore, the transition to these alternatives needs careful consideration.

Boilerhouse Level Controls

Monitors boiler water levels safely and accurately. These controls monitor and maintain the water level in the boiler to ensure it stays constant at all loads. During periods of increased, sudden steam demand, the feedwater control valve open. These devices are used in in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Boilerhouse Level Controls are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Boilerhouse Level Controls are essential for the safe operation of steam boilers. They help meet the highly detailed and technical requirements surrounding the running of steam and pressure systems.

Fluoropolymer use in Boilerhouse Level Controls and how they are essential to the function.

In Steam and Thermal Solutions Boilerhouse Level Controls, PFA and PTFE are vital for functionality and safety. PFA, used as Insulation Sleeve, is known for its excellent heat and chemical resistance, providing insulation that protects the control system from high boiler temperatures, ensuring accurate readings and preventing damage. PTFE, used in Probe Sheathing, shares similar properties with PFA. It protects the probe from harsh boiler conditions, ensuring its longevity and reliability, which is crucial as the probe monitors and controls the boiler's water level.

Non- Fluoropolymer Substitutes in Boilerhouse Level Controls Components

Fluoropolymers, including PFA and PTFE, are commonly used in boilerhouse level controls due to their superior heat and chemical resistance. However, environmental and health concerns have prompted the search for alternatives. However, these alternatives may not be suitable for all applications, and their effectiveness can vary depending on the specific use-case. Moreover, non-fluoropolymer alternatives are often more expensive, which can limit their market uptake. Therefore, while non-Fluoropolymer alternatives exist, their adoption requires careful consideration of their performance, safety, cost, and environmental impact.

Mechanical Pump Packages

Steam and Thermal Solutions mechanical pump package are steam solutions that use the pressure of steam to create a vacuum and draw condensate from a steam system. The products can handle high temperatures and pressures, as well as corrosive or contaminated condensate. These Pumps are used in in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Mechanical Pump Packages are crucial for Safety, and optimum operations.

These pumps are designed to remove and recover condensate, using steam as their motive power. This helps to reduce maintenance costs and increase the efficiency of steam systems. These devices are used in in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Fluoropolymer use in Mechanical Pump Packages and how they are essential to the function.

PTFE (Polytetrafluoroethylene), a Fluoropolymer, is integral to the operation and safety of Steam and Thermal Solutions Mechanical Pumps. It is used in bushes and seals due to its unique properties like high heat resistance, low chemical reactivity, and electrical conductivity. In bushes, PTFE acts as an excellent lubricant, reducing friction and wear, which improves the pump's efficiency and longevity. Additionally, PTFE creates a secure seal, preventing fluid backflow and leakage, which is vital for the pump's performance and safety.

Non- Fluoropolymer Substitutes in Mechanical Pump Packages Components

In the context of Steam and Thermal Solutions Mechanical Pumps, the transition from Fluoropolymer chemicals like PTFE to non-fluoropolymer alternatives is a complex process. PTFE's unique combination of high heat resistance, low chemical reactivity, and electrical conductivity makes it an excellent lubricant and sealing material. Non-Fluoropolymer alternatives may mimic some of these properties but may not fully replicate them. While it is crucial to move towards more environmentally friendly options, it is equally important to ensure that these alternatives meet the necessary performance and safety standards. This transition also involves considering factors such as cost, availability, and regulatory compliance.

Isolation Valves Other

The product group contains valves that controls the flow of steam or condensate in a piping system. It allows for shutting off, diverting, or regulating the flow as needed. Isolation valves are essential for safety, maintenance, and optimal operations. Devices are used in in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Isolation Valves Other are crucial for Safety, and optimum operations.

These are essential for diverting flow or shutting down the system for safe maintenance of equipment. They also play a crucial role in maintaining plant safety and saving energy by eliminating stem seal leaks.

Fluoropolymer use in Isolation Valves Other and how they are essential to the function.

Steam and Thermal Solutions Isolation Valves utilize PTFE (Polytetrafluoroethylene) and FKM (Fluoroelastomer) as key components to enhance their functionality and safety. PTFE, used as seals, offers excellent sealing capabilities, providing a high level of shut-off tightness that ensures effective isolation of system sections when needed. On the other hand, FKM is employed in O-rings. These fluoropolymers can enhance shut-off under permissible system conditions, which is crucial for maintaining system integrity and preventing unwanted leaks.

Non- Fluoropolymer Substitutes in Isolation Valves Other Components

Steam and Thermal Solutions Isolation Valves currently utilize PTFE and FKM, both types of Fluoropolymers, to enhance their performance and safety. The development of non-fluoropolymer alternatives is underway, but these may not match the performance and safety levels of fluoropolymers. The strong carbon-fluorine bonds in fluoropolymers provide stability under high heat and resistance to degradation, making them ideal for applications requiring durability and heat resistance. Non-fluoropolymer alternatives may lack these properties, potentially impacting their performance. Transitioning to non-fluoropolymer alternatives also requires significant research and development, and their performance in real-world applications is yet to be fully understood. Therefore, while promising, non-fluoropolymer alternatives may not fully replicate the performance and safety characteristics of fluoropolymer chemicals in all use-cases.

Disc Check Valves

Steam and Thermal Solutions Disc Check valves are designed to prevent reverse flow of fluids in pipelines. They use a spring-loaded disc that opens when the flow is in one direction and closes when the flow is reversed. They are compact, lightweight, and reliable. Disc Check valves are used in in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Disc Check Valves are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Disc Check Valves prevent reverse flow in pipelines, contributing to the stability and efficiency of the system. They are particularly important in healthcare facilities, where they ensure the safe running of critical plant equipment.

Fluoropolymer use in Disc Check Valves and how they are essential to the function.

Fluoroelastomer (FKM) seals, play a crucial role in the operation and safety of Disc Check Valves. They are designed to endure high temperatures and pressures, preventing leakage, and ensuring the valve's effective and safe operation. The importance of FKM lies in its ability to withstand harsh conditions while maintaining the valve's performance and safety.

Non- Fluoropolymer Substitutes in Disc Check Valves Components

Non-Fluoropolymer alternatives to Fluoroelastomer (FKM) seals are emerging, offering customizable properties and potentially lower costs. However, these alternatives may not match the performance and safety of Fluoropolymer chemicals. Some of these alternatives have been detected in the environment, raising potential health concerns. Transitioning from Fluoropolymer to non-fluoropolymer alternatives can present technical challenges. Further investigation is needed to assess their performance, safety, and environmental impact.

Mechanical Pumps

Steam and Thermal Solutions Mechanical pump uses steam pressure to move condensate or other liquids through pipes. It has no moving parts and operates silently and reliably. It can handle high temperatures and pressures and reduce energy consumption. These pumps are used in in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Mechanical Pumps are crucial for Safety, and optimum operations.

These pumps are designed to remove and recover condensate, using steam as their motive power. This helps to reduce maintenance costs and increase the efficiency of steam systems.

Fluoropolymer use in Mechanical Pumps and how they are essential to the function.

PTFE (Polytetrafluoroethylene), a Fluoropolymer type, is integral to the operation and safety of Steam and Thermal Solutions Mechanical Pumps. It is used in bushes and seals due to its unique properties like high heat resistance, low chemical reactivity, and electrical conductivity. In bushes, PTFE acts as an excellent lubricant, reducing friction and wear, which improves the pump's efficiency and longevity. Additionally, PTFE creates a secure seal, preventing fluid backflow and leakage, which is vital for the pump's performance and safety.

Non- Fluoropolymer Substitutes in Mechanical Pumps Components

In the context of Steam and Thermal Solutions Mechanical Pumps, the transition from Fluoropolymer chemicals like PTFE to non-fluoropolymer alternatives is a complex process. PTFE's unique combination of high heat resistance, low chemical reactivity, and electrical conductivity makes it an excellent lubricant and sealing material. Non- fluoropolymer alternatives may mimic some of these properties but may not fully replicate them. While it is crucial to move towards more environmentally friendly options, it is equally important to ensure that these alternatives meet the necessary performance and safety standards.

Bimetallic Traps

Steam and Thermal Solutions Bimetallic Traps are devices that drain condensate from steam systems. They use two metal strips with different thermal expansion rates to open and close a valve according to the temperature of the condensate. This prevents steam loss and ensures efficient heat transfer. Traps are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Bimetallic Traps are crucial for Safety, and optimum operations.

Bimetallic steam traps can conserve energy by discharging sub-cooled condensate in applications that utilize sensible heat. They are robust and can withstand water hammer and corrosive condensate.

Fluoropolymer use in Bimetallic Traps and how they are essential to the function.

The devices’ robustness and reliability are attributed to use of Polytetrafluoroethylene (PTFE) in their seals. PTFE, with its low friction coefficient, high chemical resistance, and durability against a range of chemicals, is particularly beneficial in applications where seals must function in harsh or corrosive environments. Thus, PTFE plays a crucial role in the function and safety of these traps.

Non- Fluoropolymer Substitutes in Bimetallic Traps Components

Alternatives to Polytetrafluoroethylene (PTFE), a type of Fluoropolymer, have been developed due to concerns about PFAS's environmental and health impacts. However, these alternatives may not fully replicate the performance and safety of fluoropolymer chemicals, especially in applications where seals must function in harsh or corrosive environments. While these alternatives may offer similar properties, they might not provide the same level of robustness and reliability. Transitioning to these alternatives requires careful consideration of their environmental and health impacts, as well as regulatory requirements. Therefore, while non-fluoropolymer alternatives are available and continue to be developed, their adoption should be evaluated on a case-by-case basis.

Flash Vessels

Steam and Thermal Solutions Flash vessels are devices that separate the flash steam from the condensate in a steam system. They reduce the pressure and temperature of the condensate, allowing it to be reused or drained safely. Flash vessels also recover the flash steam, which can be used for heating or power generation. Devices efficiently prevent contamination of the boiler feedtank and / or heat transfer surfaces in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Flash Vessels are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Flash vessels are used to separate flash steam from hot condensate, which is essential to prevent contamination of the boiler feedtank and/or heat transfer surfaces. They also play a role in energy conservation.

Fluoropolymer use in Flash Vessels and how they are essential to the function.

Fluoroelastomer (FKM), a synthetic rubber, is crucial in Steam and Thermal Solutions Flash Vessels due to its remarkable resistance to heat, oils, and chemicals. FKM is used for O-rings these vessels, enhancing their durability and longevity. By withstanding high temperatures and pressures within the flash vessels, FKM contributes to the system's safety and efficiency, reducing the risk of leaks or failures that could lead to hazardous situations.

Non- Fluoropolymer Substitutes in Flash Vessels Components

FKM, a type of fluoropolymer, is crucial in applications like Steam and Thermal Solutions Flash Vessels due to its exceptional resistance to heat, oils, and chemicals. There are ongoing efforts to find non-fluoropolymer alternatives. However, these alternatives may not always achieve the same performance and safety as fluoropolymer chemicals. Some novel alternatives have been detected in the environment with potential health risks identified. Therefore, while non-fluoropolymer alternatives are being developed and show promise, they may not fully match the performance, safety, and cost-effectiveness of PFAS chemicals like FKM. Further research and development are needed to improve these alternatives and ensure their safety and effectiveness.

Blowdown Vessels & Heat Recovery

Steam and Thermal Solutions Blowdown Vessels & Heat Recovery products are devices that safely discharge the hot water and steam from boilers and capture the waste heat for reuse. They reduce energy consumption, lower emissions, and prevent boiler damage. Fluoropolymers are essential for their durability and corrosion resistance. Products are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Blowdown Vessels & Heat Recovery are crucial for Safety, and optimum operations.

Steam and Thermal Solutions Blowdown vessels accommodate blowdown water from the boiler, helping to meet health, safety, and environmental regulations. Heat recovery from boiler blowdown can reclaim large amounts of energy, reducing the need for boiler fuel.

Fluoropolymer use in Blowdown Vessels & Heat Recovery and how they are essential to the function.

PTFE (Polytetrafluoroethylene) plays a vital role in the functioning of Steam and Thermal Solutions Blowdown Vessels & Heat Recovery Systems, specifically in the seals. Its unique characteristics, including resistance to high temperatures, low friction, and superior sealing capabilities, make it a significant technology in these systems. The incorporation of PTFE contributes to the safe and efficient operation of these vessels and systems, even in extreme conditions.

Non- Fluoropolymer Substitutes in Blowdown Vessels & Heat Recovery Components

PTFE, a type of Fluoropolymer, is essential in many industrial applications, including blowdown vessels and heat recovery systems, due to its unique properties. However, environmental and health concerns have led to a demand for non-Fluoropolymer alternatives. Despite their promise, these alternatives may not always match the performance and safety of Fluoropolymer chemicals. More research is needed to understand their effects. Steam and Thermal Solutions is committed to exploring these non-Fluoropolymer alternatives for their products.

Separators

Steam and Thermal Solutions Separators remove condensate, dirt, and scale from steam lines, increasing the quality and efficiency of the steam. They also protect downstream equipment from corrosion and damage, reducing maintenance costs and downtime. Steam and Thermal Solutions Separators use Fluoropolymer coatings to resist erosion and abrasion. Separators are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Separators are crucial for Safety, and optimum operations.

Separators gather small water droplets from steam and separate them from the pipe flow. This reduces wet steam, maintains heat transfer efficiency, and reduces erosion and corrosion in the steam system.

Fluoropolymer use in Separators and how they are essential to the function.

Steam and Thermal Solutions Separators, which are engineered to collect small water droplets from steam and isolate them from the pipe flow, play a vital role in reducing wet steam, preserving heat transfer efficiency, and mitigating erosion and corrosion in the steam system. The incorporation of PTFE (Polytetrafluoroethylene), a type of Fluoropolymer known for its superior frictional properties, chemical resistance, and wide operational temperature range, is particularly significant. PTFE is commonly used in bushes within these separators, where it provides a low-friction, chemically resistant interface that ensures the smooth and dependable operation of the separator components, thereby enhancing the system's efficiency and safety.

Non- Fluoropolymer Substitutes in Separators Components

Steam and Thermal Solutions Separators currently use PTFE, a type of Fluoropolymer, due to its superior properties that ensure smooth and dependable operation. However, due to the environmental concerns associated with Fluoropolymer (a class of PFAS), known as "forever chemicals", there is an ongoing effort to find non-Fluoropolymer alternatives. These alternatives, while being developed and used, may not match the performance and safety levels of Fluoropolymer. The transition to non-Fluoropolymer alternatives is also complex, therefore, while the exploration and implementation of non-Fluoropolymer alternatives continue, matching the performance and safety of Fluoropolymer remains a challenge.

QL Series

QL Series is a range of 3-port control valves from Steam and Thermal Solutions. These valves are designed to regulate the flow of steam or water in various applications. QL Series are crucial for Safety, and optimum operations. They are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

QL Series are crucial for Safety, and optimum operations.

QL Series valves are designed to regulate the flow of steam or water in various applications, ensuring the safety and efficiency of the systems they are used in. Steam and Thermal Solutions, the manufacturer of QL Series valves, is committed to ensuring the safety and sustainability of its products and operations, as well as complying with relevant regulations and standards in the markets where it operates.

Fluoropolymer use in QL Series and how they are essential to the function.

The Steam and Thermal Solutions QL Series, a range of three-port control valves, relies on PTFE (Polytetrafluoroethylene) for its lining materials. PTFE is renowned for its superior chemical resistance, making it an optimal choice for control valves that encounter diverse media types. A key application of PTFE in these valves is the PTFE seal, which guarantees a secure closure, thereby preventing leaks and promoting the valve's safe and efficient functioning.

Non- Fluoropolymer Substitutes in QL Series Components

The Steam and Thermal Solutions QL Series of control valves traditionally use PTFE, a type of Fluoropolymer, for their lining materials due to its superior chemical resistance. However, due to environmental and health concerns related to Fluoropolymer, non-Fluoropolymer alternatives are being explored. However, these alternatives may not fully replicate the unique properties of Fluoropolymer chemicals, potentially impacting the performance and safety of applications such as the Steam and Thermal Solutions QL Series control valves.

Controls Packages

Steam and Thermal Solutions Control Packages are devices that regulate the flow, pressure, and temperature of steam in various applications. They are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Controls Packages are crucial for Safety, and optimum operations.

Controls are essential for maintaining safety, stability, and accuracy in steam systems. They help meet detailed and technical requirements surrounding the running of steam and pressure systems.

Fluoropolymer use in Controls Packages and how they are essential to the function.

Steam and Thermal Solutions Control Packages rely on Polytetrafluoroethylene (PTFE) for their guide bushes. PTFE's low friction, high-temperature resistance, and chemical inertness ensure smooth and consistent movement of the control valve stem, thereby enhancing the control package's accuracy and reliability. Furthermore, PTFE's chemical resistance safeguards the control packages from corrosion and wear, even in harsh industrial environments, thus extending their lifespan and reducing the need for frequent maintenance or replacement.

Non- Fluoropolymer Substitutes in Controls Packages Components

Steam and Thermal Solutions Control Packages utilize Polytetrafluoroethylene (PTFE) for its low friction, high-temperature resistance, and chemical inertness, which enhance the control valve stem's movement, accuracy, and reliability. PTFE's chemical resistance also extends the lifespan of the control packages and reduces maintenance needs by protecting them from corrosion and wear in harsh industrial environments. Non-Fluoropolymer alternatives aim to offer similar performance to PTFE, with some even demonstrating equal or improved performance in specific applications. Despite these advancements, non-Fluoropolymer alternatives may not always match the performance and safety characteristics of Fluoropolymer chemicals like PTFE in all use-cases.

Feedtank Ancillaries

Steam and Thermal Solutions Control Feedtank ancillaries in the context of Steam and Thermal Solutions refer to a range of additional equipment and components that support the operation of the feedtank in a steam system. These components work together to ensure the feedwater is in the best possible condition before it enters the boiler, improving the efficiency and longevity of the steam system. They are used in application such as clean steam, gas, and liquid supplies to centrifuges, freeze dryers, sterilisers, autoclaves, process tanks, humidifiers, and culinary equipment.

Feedtank Ancillaries are crucial for Safety, and optimum operations.

By ensuring the feedwater is in the best possible condition before it enters the boiler, Steam and Thermal Solutions Control Feedtank Ancillaries improve the efficiency and longevity of the steam system. They also help to prevent issues that could compromise safety, such as corrosion and equipment failure. Therefore, they are an essential part of maintaining a safe and optimally functioning steam system.

Fluoropolymer use in Feedtank Ancillaries and how they are essential to the function.

Feedtanks utilize Polytetrafluoroethylene (PTFE), a Fluoropolymer, is integral to the function and safety of Steam and Thermal Solutions Feedtank ancillaries. It is used in the plastic tubes, seals of feedtanks, which are critical components in the boiler house, serving as the junction for cold make-up water and condensate return. The use of PTFE ensures the durability and reliability of these systems, thereby enhancing their overall efficiency and safety.

Non- Fluoropolymer Substitutes in Feedtank Ancillaries Components

Alternatives may not match the performance and safety of Fluoropolymer chemicals. Non-fluorinated alternatives are not comparable to the performance of Fluoropolymer in terms of operating temperature, lubrication properties. The adoption of non-fluoropolymer alternatives is challenged by factors like performance, safety, and potential health risks.

Appendix A (Product Groups with Taric Codes)

Super Group	Product Group	Taric code
23 - BALL VALVES	167 - BALL VALVES MODEL 10/20	8481808190
23 - BALL VALVES	168 - M15 BALL VALVES	8481808190
23 - BALL VALVES	169 - M21 BALL VALVES	8481808190
23 - BALL VALVES	170 - M3	8481808190
23 - BALL VALVES	171 - M40 BALL VALVES	8481808190
23 - BALL VALVES	172 - M70 & M80	8481808190
23 - BALL VALVES	173 - OTHER BALL VALVES	
23 - BALL VALVES	667 - GBV-M10/20	
23 - BALL VALVES	668 - GBV-M3	
23 - BALL VALVES	669 - GBV-M40	
23 - BALL VALVES	708 - BALL VALVES MODEL 16	8481808190
23 - BALL VALVES	711 - M10M Ball Valve	8481808190
23 - BALL VALVES	F06 - Other Ball Valves	
23 - BALL VALVES	F07 - 510 Blowdown Ball Valve	
23 - BALL VALVES	F08 - Ball Valve/HANDELSWAR	
23 - BALL VALVES	F12 - ARGUS Ball Valves	
23 - BALL VALVES	F13 - MCCANNA Ball Valves	
23 - BALL VALVES	F14 - NAF Ball Valves	
23 - BALL VALVES	F15 - WORCESTER Ball Valves	

23 - BALL VALVES	F16 - PARKER HANNIFIN Products	
41 - SAFETY VALVES	261 - SV615	8481409090
41 - SAFETY VALVES	262 - SV607	8481401090
41 - SAFETY VALVES	263 - SV604	8481401090
41 - SAFETY VALVES	264 - SV60 H	8481401090
41 - SAFETY VALVES	265 - SV405&6	8481409090
41 - SAFETY VALVES	266 - SV73	8481401090
41 - SAFETY VALVES	267 - SV74	8481401090
41 - SAFETY VALVES	268 - SVL488	8481401090
41 - SAFETY VALVES	269 - SVL606	8481401090
41 - SAFETY VALVES	270 - SV80	8481401090
41 - SAFETY VALVES	271 - SV81	8481401090
41 - SAFETY VALVES	272 - SV56&57	8481409090
41 - SAFETY VALVES	273 - SV418	8481409090
41 - SAFETY VALVES	274 - SV17	
41 - SAFETY VALVES	275 - LESER (All Non-group Models)	
41 - SAFETY VALVES	276 - OTHER Safety Valve ASME	
41 - SAFETY VALVES	277 - Other safety valve Non ASME	
41 - SAFETY VALVES	709 - SV47H	8481401090
41 - SAFETY VALVES	710 - SV44H	8481401090
41 - SAFETY VALVES	L01 - GSV	
41 - SAFETY VALVES	L02 - Safety Valve	
41 - SAFETY VALVES	L03 - COMEVAL Products	
55 - PISTON ACTUATED VALVES	433 - M&M PAV	8481809990
55 - PISTON ACTUATED VALVES	434 - OTHER PAV	
38 - DP REDUCING VALVES	240 - DP27	8481101990
38 - DP REDUCING VALVES	241 - DP143	8481101990
38 - DP REDUCING VALVES	242 - DP163	8481101990

38 - DP REDUCING VALVES	243 - SDP143	8481101990
38 - DP REDUCING VALVES	244 - OTHER DP	
80 - BLOWDOWN VALVES	548 - DFG	
80 - BLOWDOWN VALVES	549 - BCV	
80 - BLOWDOWN VALVES	550 - BBV	
80 - BLOWDOWN VALVES	551 - KBV	
80 - BLOWDOWN VALVES	552 - ABV	
80 - BLOWDOWN VALVES	553 - OTHER LINEAR BLOWDOWN VALVES	
80 - BLOWDOWN VALVES	554 - OTHER ROTARY BLOWDOWN VALVES	
80 - BLOWDOWN VALVES	755 - BBV46	
80 - BLOWDOWN VALVES	S59 - PA 110	
80 - BLOWDOWN VALVES	S60 - PA 46	
80 - BLOWDOWN VALVES	S61 - PA 47	
80 - BLOWDOWN VALVES	S62 - BA 210	
80 - BLOWDOWN VALVES	S63 - BA 211	
80 - BLOWDOWN VALVES	S64 - BA 46	
80 - BLOWDOWN VALVES	S65 - BA 47	
80 - BLOWDOWN VALVES	S66 - Other PA/BA	
80 - BLOWDOWN VALVES	S67 - MPA 110	
80 - BLOWDOWN VALVES	S68 - MPA 46	
80 - BLOWDOWN VALVES	S69 - MPA 47	
80 - BLOWDOWN VALVES	S70 - BAE 36	
80 - BLOWDOWN VALVES	S71 - BAE 46	
80 - BLOWDOWN VALVES	S72 - BAE 47	
80 - BLOWDOWN VALVES	S73 - BAE 210	
80 - BLOWDOWN VALVES	S74 - BAE 211	
80 - BLOWDOWN VALVES	T14 - MPA 48	

80 - BLOWDOWN VALVES	T15 - PA48	
80 - BLOWDOWN VALVES	T62 - PA/MPA,BA Engineered	
39 - BRV	245 - BRV	8481101990
39 - BRV	246 - BRV7	8481101990
39 - BRV	247 - LRV2	8481109990
39 - BRV	248 - SRV2	8481101990
39 - BRV	249 - SRV46	8481101990
39 - BRV	250 - SRV66	8481101990
39 - BRV	251 - HITER SERIES RC REGULATOR	
39 - BRV	252 - Other Bellows Direct Acting	
39 - BRV	K02 - Other BRV	
22 - BELLOWS SEALED VALVES	159 - BSA1	8481807100
22 - BELLOWS SEALED VALVES	160 - BSA2	8481807100
22 - BELLOWS SEALED VALVES	161 - BSA3	8481807390
22 - BELLOWS SEALED VALVES	162 - BSA3HP	8481807390
22 - BELLOWS SEALED VALVES	163 - BSA6	8481807390
22 - BELLOWS SEALED VALVES	164 - A3	8481807390
22 - BELLOWS SEALED VALVES	165 - SAFEBLOC DOUBLE BLOCK	8481807390
22 - BELLOWS SEALED VALVES	166 - OTHER BS STOP VALVES	
22 - BELLOWS SEALED VALVES	F01 - GAV 36F	
22 - BELLOWS SEALED VALVES	F02 - GAV 46F/46AF	
22 - BELLOWS SEALED VALVES	F03 - GAV 36	
22 - BELLOWS SEALED VALVES	F04 - GAV 54F/56F	
22 - BELLOWS SEALED VALVES	F05 - Other GAV	
22 - BELLOWS SEALED VALVES	F21 - GAV63F	
22 - BELLOWS SEALED VALVES	F22 - GAV64F/65F	
22 - BELLOWS SEALED VALVES	F23 - GAV66F	
22 - BELLOWS SEALED VALVES	F24 - GAV66A	

2 - FLOAT TRAPS	20 - FT12	8481809990
2 - FLOAT TRAPS	21 - FT/FTI 15, 30, 75, 125, 150, 200	8481809990
2 - FLOAT TRAPS	22 - FT14	8481809990
2 - FLOAT TRAPS	23 - FT23	8481809990
2 - FLOAT TRAPS	24 - FT43	8481809990
2 - FLOAT TRAPS	25 - FT44	8481809990
2 - FLOAT TRAPS	26 - FT450	8481809990
2 - FLOAT TRAPS	27 - FT46	8481809990
2 - FLOAT TRAPS	28 - FT47	8481809990
2 - FLOAT TRAPS	29 - FT53	8481809990
2 - FLOAT TRAPS	30 - FT54	8481809990
2 - FLOAT TRAPS	31 - FT55	8481809990
2 - FLOAT TRAPS	32 - FT57	8481809990
2 - FLOAT TRAPS	33 - FT62	8481809990
2 - FLOAT TRAPS	34 - FTB	8481809990
2 - FLOAT TRAPS	35 - FTC32	8481809990
2 - FLOAT TRAPS	36 - FTC80	8481809990
2 - FLOAT TRAPS	37 - IFT	8481809990
2 - FLOAT TRAPS	38 - OTHER FT	
2 - FLOAT TRAPS	39 - UFT32	8481809990
2 - FLOAT TRAPS	712 - UFT14	8481809990
2 - FLOAT TRAPS	A07 - Other UNA	
2 - FLOAT TRAPS	A08 - UNA 23 h	8481809990
2 - FLOAT TRAPS	A09 - UNA 23 v	8481809990
2 - FLOAT TRAPS	A10 - UNA 23 ph	8481809990
2 - FLOAT TRAPS	A11 - UNA 26 h	8481809990
2 - FLOAT TRAPS	A12 - UNA 26 v	8481809990
2 - FLOAT TRAPS	A13 - UNA 26 h 1.4408	8481809990

2 - FLOAT TRAPS	A14 - UNA 25 pk	8481809990
2 - FLOAT TRAPS	A15 - UNA 25 ps	8481809990
2 - FLOAT TRAPS	A16 - UNA 25 h	8481809990
2 - FLOAT TRAPS	A17 - UNA 25 v	8481809990
2 - FLOAT TRAPS	A18 - UNA Spezial PN16	8481809990
2 - FLOAT TRAPS	A19 - UNA Spezial PN25	8481809990
2 - FLOAT TRAPS	A20 - UNA Spezial PN63	8481809990
2 - FLOAT TRAPS	A21 - UNA 39 (1.7335)	8481809990
2 - FLOAT TRAPS	A22 - UNAMAX 39 (1.7335)	8481809990
2 - FLOAT TRAPS	A23 - UNA 27	8481809990
2 - FLOAT TRAPS	A24 - UNA 38 h	8481809990
2 - FLOAT TRAPS	A25 - UNA 38 v	8481809990
2 - FLOAT TRAPS	A26 - UNA 45 h	8481809990
2 - FLOAT TRAPS	A27 - UNA 45 v	8481809990
2 - FLOAT TRAPS	A28 - UNA 46 h	8481809990
2 - FLOAT TRAPS	A29 - UNA 46 v	8481809990
2 - FLOAT TRAPS	A30 - UNA 46	8481809990
2 - FLOAT TRAPS	A31 - UNA 46 av	8481809990
2 - FLOAT TRAPS	A32 - UNA 43 h	8481809990
2 - FLOAT TRAPS	A33 - UNA 43 v	8481809990
2 - FLOAT TRAPS	A34 - UNA 14 h	8481809990
2 - FLOAT TRAPS	A35 - UNA 14 v	8481809990
2 - FLOAT TRAPS	A36 - UNA 14 ph	8481809990
2 - FLOAT TRAPS	A37 - UNA 14 pv	8481809990
2 - FLOAT TRAPS	A38 - UNA 16 h	8481809990
2 - FLOAT TRAPS	A39 - UNA 16 v	8481809990
2 - FLOAT TRAPS	A40 - UNA 16 h (stainless)	8481809990
2 - FLOAT TRAPS	A41 - UNA 16 v (stainless)	8481809990

2 - FLOAT TRAPS	A79 - UNA 46h DN80-DN150	8481809990
2 - FLOAT TRAPS	A80 - UNA 46v DN80-DN150	8481809990
2 - FLOAT TRAPS	A81 - UNA 47 h	8481809990
2 - FLOAT TRAPS	A82 - UNA 47 v	8481809990
8 - SIGHT GLASSES AND GAUGES	89 - SG	9026108900
8 - SIGHT GLASSES AND GAUGES	90 - SG13	9026108900
8 - SIGHT GLASSES AND GAUGES	91 - SG253	9026108900
8 - SIGHT GLASSES AND GAUGES	92 - SG40	9026108900
8 - SIGHT GLASSES AND GAUGES	93 - SC	9026108900
8 - SIGHT GLASSES AND GAUGES	94 - OTHER SIGHT GLASSES	
8 - SIGHT GLASSES AND GAUGES	B01 - VK 14	9026108900
8 - SIGHT GLASSES AND GAUGES	B02 - VK 16	9026108900
8 - SIGHT GLASSES AND GAUGES	B03 - Other Sight Glasses	
8 - SIGHT GLASSES AND GAUGES	B04 - GSG	9026108900
49 - PN ACTUATORS	356 - PN91	9032810000
49 - PN ACTUATORS	357 - PN92	9032810000
49 - PN ACTUATORS	358 - PN93	9032810000
49 - PN ACTUATORS	359 - PN94	9032810000
49 - PN ACTUATORS	360 - PN99	9032810000
49 - PN ACTUATORS	361 - TN2030	9032810000
49 - PN ACTUATORS	362 - TN2100	9032810000
49 - PN ACTUATORS	363 - TN2200	9032810000
49 - PN ACTUATORS	364 - TN2300	9032810000
49 - PN ACTUATORS	365 - TN2400	9032810000
49 - PN ACTUATORS	366 - PNS3	9032810000
49 - PN ACTUATORS	367 - PNS4	9032810000
49 - PN ACTUATORS	368 - HITER ACTUATORS	
49 - PN ACTUATORS	369 - OTHER PN ACTUATORS	

49 - PN ACTUATORS	370 - BVA BALL VALVE ACTUATORS	8481808190
49 - PN ACTUATORS	686 - GCV-PN91	
49 - PN ACTUATORS	687 - GCV-PN92	
49 - PN ACTUATORS	688 - GCV-PN93	
49 - PN ACTUATORS	689 - GBV BVA BALL VALVE ACTUATORS	
49 - PN ACTUATORS	N02 - Control Valve PN	8481900090
49 - PN ACTUATORS	N08 - AUTOMAX Pneumatic Actuators	8481900090
49 - PN ACTUATORS	N11 - NORBRO Pneumatic Actuators	8481900090
49 - PN ACTUATORS	N16 - PW Products	8481900090
4 - BALANCED PRESSURE TRAPS	51 - BP13	8481809990
4 - BALANCED PRESSURE TRAPS	52 - MST21	8481809990
4 - BALANCED PRESSURE TRAPS	53 - TSS21	8481809990
4 - BALANCED PRESSURE TRAPS	54 - BPM21L	8481809990
4 - BALANCED PRESSURE TRAPS	55 - BP32	8481809990
4 - BALANCED PRESSURE TRAPS	56 - IBP32	8481809990
4 - BALANCED PRESSURE TRAPS	57 - SBP30	8481809990
4 - BALANCED PRESSURE TRAPS	58 - UBP32	8481809990
4 - BALANCED PRESSURE TRAPS	59 - BTM7	8481809990
4 - BALANCED PRESSURE TRAPS	60 - BTS7	8481809990
4 - BALANCED PRESSURE TRAPS	61 - BT6	8481809990
4 - BALANCED PRESSURE TRAPS	62 - NUMBER 8	8481809990
4 - BALANCED PRESSURE TRAPS	63 - OTHER BP	
4 - BALANCED PRESSURE TRAPS	A43 - Other MK	
4 - BALANCED PRESSURE TRAPS	A44 - MK 20	8481809990
4 - BALANCED PRESSURE TRAPS	A45 - MK 35/3	8481809990
4 - BALANCED PRESSURE TRAPS	A46 - MK 45	8481809990
4 - BALANCED PRESSURE TRAPS	A47 - MK 25/2	8481809990
4 - BALANCED PRESSURE TRAPS	A48 - MK 25/2 S	8481809990

4 - BALANCED PRESSURE TRAPS	A49 - MK 35/2S	8481809990
4 - BALANCED PRESSURE TRAPS	A50 - MK 35/2S3	8481809990
4 - BALANCED PRESSURE TRAPS	A51 - MK 45A (stainless)	8481809990
4 - BALANCED PRESSURE TRAPS	A52 - MK 36/51, ..52	8481809990
4 - BALANCED PRESSURE TRAPS	A53 - MK 35/3 (1.4541)	8481809990
4 - BALANCED PRESSURE TRAPS	A54 - MK 36A-7	8481809990
4 - BALANCED PRESSURE TRAPS	A55 - SMK 22	8481809990
4 - BALANCED PRESSURE TRAPS	A56 - SMK 22-51	8481809990
4 - BALANCED PRESSURE TRAPS	A57 - SMK 22-81	8481809990
40 - DRV	253 - DEP 4	8481101990
40 - DRV	254 - DEP 7	8481101990
40 - DRV	255 - DRV 4	8481101990
40 - DRV	256 - DRV 7	8481101990
40 - DRV	257 - DLV	8481101990
40 - DRV	258 - WATER SEAL POT	8481900090
40 - DRV	259 - 595/596	
40 - DRV	260 - Other Diaphragm Direct Acting	
40 - DRV	K03 - 5801 (0.7043)	
40 - DRV	K04 - 5801 (1.0619)	
40 - DRV	K05 - 5801 (1.4581)	
40 - DRV	K06 - 5610 (0.7043)	
40 - DRV	K07 - 5610 (1.0619)	
40 - DRV	K08 - DMS	
40 - DRV	K09 - Factured Products	
40 - DRV	K10 - Other DRV	
11 - LIQUID DRAINERS	100 - CA14	8481809990
11 - LIQUID DRAINERS	101 - CA44	8481809990
11 - LIQUID DRAINERS	102 - CA46	8481809990

11 - LIQUID DRAINERS	103 - 200 SERIES LIQUID DRAINER	8481809990
11 - LIQUID DRAINERS	104 - AIRODYN	8481809990
11 - LIQUID DRAINERS	105 - FA	8481809990
11 - LIQUID DRAINERS	106 - OTHER LIQUID DRAINERS	
11 - LIQUID DRAINERS	99 - CA10S	8481809990
11 - LIQUID DRAINERS	B05 - Other AK	
11 - LIQUID DRAINERS	B06 - AK 45	8481809990
7 - AIR ELIMINATORS	81 - AE30	8481809990
7 - AIR ELIMINATORS	82 - AE36	8481809990
7 - AIR ELIMINATORS	83 - AE10S	8481809990
7 - AIR ELIMINATORS	84 - AE14	8481809990
7 - AIR ELIMINATORS	85 - AE50S	8481809990
7 - AIR ELIMINATORS	86 - AE44	8481809990
7 - AIR ELIMINATORS	87 - 13WS	8481809990
7 - AIR ELIMINATORS	88 - OTHER AIR ELIMINATORS	
10 - HOSE DOWN STATIONS& THERMOCIRC	97 - HOSE DOWN STATIONS	8424908080
10 - HOSE DOWN STATIONS& THERMOCIRC	98 - OTHER HOSE DOWN STATIONS	
43 - SA CONTROL VALVES	281 - BX	8481805100
43 - SA CONTROL VALVES	282 - KA3	8481805100
43 - SA CONTROL VALVES	283 - KA43	8481805100
43 - SA CONTROL VALVES	284 - KA51	8481805100
43 - SA CONTROL VALVES	285 - KA6	8481805100
43 - SA CONTROL VALVES	286 - KB3	8481805100
43 - SA CONTROL VALVES	287 - KB43	8481805100
43 - SA CONTROL VALVES	288 - KB51	8481805100
43 - SA CONTROL VALVES	289 - KC31	8481805100
43 - SA CONTROL VALVES	290 - KC43	8481805100

43 - SA CONTROL VALVES	291 - KC51	8481805100
43 - SA CONTROL VALVES	292 - KC63	8481805100
43 - SA CONTROL VALVES	293 - KX3	8481805100
43 - SA CONTROL VALVES	294 - KX43	8481805100
43 - SA CONTROL VALVES	295 - KX51	8481805100
43 - SA CONTROL VALVES	296 - KY3	8481805100
43 - SA CONTROL VALVES	297 - KY43	8481805100
43 - SA CONTROL VALVES	298 - KY51	8481805100
43 - SA CONTROL VALVES	299 - NS	8481805100
43 - SA CONTROL VALVES	300 - BM	8481805100
43 - SA CONTROL VALVES	301 - SB	8481805100
43 - SA CONTROL VALVES	302 - TW	8481805100
43 - SA CONTROL VALVES	303 - TYPE 58	8481805100
43 - SA CONTROL VALVES	304 - 37D	8481805100
43 - SA CONTROL VALVES	305 - OTHER SA CONTROL VALVES	
43 - SA CONTROL VALVES	M01 - BW 31	
43 - SA CONTROL VALVES	M02 - BW 31A	
43 - SA CONTROL VALVES	M03 - CW 41	
43 - SA CONTROL VALVES	M04 - CW 44	
43 - SA CONTROL VALVES	M05 - Other BW/CW	
43 - SA CONTROL VALVES	M06 - TYP L1S,L2S	
43 - SA CONTROL VALVES	M07 - TYP M1F,M2F	
43 - SA CONTROL VALVES	M08 - TYP H1F,H2F	
43 - SA CONTROL VALVES	M09 - TYP G1F,G2F	
43 - SA CONTROL VALVES	M10 - TYP M3F,G3F,H3F,L3S,L3F	
43 - SA CONTROL VALVES	M11 - Manual Adjustment Device	
43 - SA CONTROL VALVES	M12 - Thermostate	
43 - SA CONTROL VALVES	M13 - DUOSTAT Type 4.05	

43 - SA CONTROL VALVES	M14 - DUOSTAT Type 4.10	
43 - SA CONTROL VALVES	M15 - Self Acting Temperature	
66 - GILFLO METERS	480 - ILVA	9026102100
66 - GILFLO METERS	481 - ILVA COMPACT STEM	9026102100
66 - GILFLO METERS	482 - GILFLO	9026102100
66 - GILFLO METERS	483 - OTHER GILFO	
66 - GILFLO METERS	662 - ILVA20	9026102100
48 - EL ACTUATORS	344 - AEL3	8501109990
48 - EL ACTUATORS	347 - EL3500	
48 - EL ACTUATORS	348 - EL7200	
48 - EL ACTUATORS	349 - EL4000 (Genice)	
48 - EL ACTUATORS	350 - BELIMO ACTUATORS	
48 - EL ACTUATORS	351 - SAUTER ACTUATORS	
48 - EL ACTUATORS	352 - HONEYWELL ACTUATORS	
48 - EL ACTUATORS	353 - ROTORK ACTUATORS	
48 - EL ACTUATORS	354 - HORA ACTUATORS	
48 - EL ACTUATORS	355 - OTHER EL ACTUATORS	
48 - EL ACTUATORS	713 - AEL7	Various - See Electric Actuactor file
48 - EL ACTUATORS	714 - AEL8	
48 - EL ACTUATORS	N01 - Other EL Actuators	
48 - EL ACTUATORS	N10 - LIMITORQUE Electrical Actuator	
48 - EL ACTUATORS	N17 - ROTORK Actuators	
6 - AIR VENTS	76 - AV13	8481809990
6 - AIR VENTS	77 - AV32	8481809990
6 - AIR VENTS	78 - AV45	8481809990
6 - AIR VENTS	79 - AVM7	8481809990
6 - AIR VENTS	80 - OTHER AIR VENTS	

47 - HYGIENIC CONTROL VALVES	341 - STERI-TROL	8481805990
47 - HYGIENIC CONTROL VALVES	342 - HYGI-TROL	8481805990
47 - HYGIENIC CONTROL VALVES	343 - OTHER HYGIENIC CONTROL VALVES	8481805990
47 - HYGIENIC CONTROL VALVES	695 - STERI-TROL ASEPTIC	8481805990
77 - TDS BLOWDOWN	524 - BC3150	
77 - TDS BLOWDOWN	525 - BC3250	
77 - TDS BLOWDOWN	526 - CP10	
77 - TDS BLOWDOWN	527 - CP30	
77 - TDS BLOWDOWN	528 - CP32	
77 - TDS BLOWDOWN	529 - SC20	
77 - TDS BLOWDOWN	530 - SSC20	
77 - TDS BLOWDOWN	531 - OTHER TDS BLOWDOWN	
77 - TDS BLOWDOWN	694 - BCS CONTROLS (GESTRA)	
77 - TDS BLOWDOWN	S24 - Blowdown Timer	
77 - TDS BLOWDOWN	S25 - 3MF 88.9	
77 - TDS BLOWDOWN	S26 - Boiler House Mechanical Accessories	
77 - TDS BLOWDOWN	S27 - Conductivity Probes (old)	
77 - TDS BLOWDOWN	S28 - Conductivity Control	
77 - TDS BLOWDOWN	S29 - Conductivity Control (old)	
77 - TDS BLOWDOWN	S30 - Conductivity Switch (old)	
77 - TDS BLOWDOWN	T30 - BCR3150 (GES)	
77 - TDS BLOWDOWN	T31 - BCR3250 (GES)	
77 - TDS BLOWDOWN	T32 - CP40 (GES)	
77 - TDS BLOWDOWN	T33 - CP42 (GES)	
77 - TDS BLOWDOWN	T53 - BCR 3250 + BHD50 (SXS)	
77 - TDS BLOWDOWN	T54 - ERL	
77 - TDS BLOWDOWN	T55 - LRG 12-2	

77 - TDS BLOWDOWN	T56 - LRG 1x-1	
77 - TDS BLOWDOWN	T57 - LRS 1-5	
77 - TDS BLOWDOWN	T58 - LRS 1-7	
77 - TDS BLOWDOWN	T59 - MF1162	
77 - TDS BLOWDOWN	T60 - PRS7	
77 - TDS BLOWDOWN	T61 - TA x	
87 - CLEAN STEAM GENERATORS	581 - CSM-C	8402199000
87 - CLEAN STEAM GENERATORS	582 - CSM-K	8402199000
87 - CLEAN STEAM GENERATORS	583 - CSM-CE	8402199000
87 - CLEAN STEAM GENERATORS	584 - mCSG	8402199000
87 - CLEAN STEAM GENERATORS	585 - CSG OTHER STANDARD LOCAL SOLUTION	8402199000
87 - CLEAN STEAM GENERATORS	586 - CSG BESPOKE LOCAL SOLUTION	8402199000
87 - CLEAN STEAM GENERATORS	663 - CSG HEALTHCARE	8402199000
87 - CLEAN STEAM GENERATORS	664 - CSG F&B	8402199000
87 - CLEAN STEAM GENERATORS	665 - CSG HUMIDIFICATION	8402199000
87 - CLEAN STEAM GENERATORS	715 - Chromalox Electric Steam Generator	8402199000
87 - CLEAN STEAM GENERATORS	718 - CSG F&B-HP	8402199000
72 - VORTEX METERS	501 - VLM20 VORTEX METER	
72 - VORTEX METERS	502 - VIM20 INSERTION VORTEX METER	
72 - VORTEX METERS	503 - OTHER VORTEX METERS	
72 - VORTEX METERS	736 - VLM30 Vortex Meter	
72 - VORTEX METERS	R08 - Flow Metering	
82 - OTHER BOILERHOUSE	560 - OTHER BOILERHOUSE	
82 - OTHER BOILERHOUSE	561 - ABCO SUNDRIES	
82 - OTHER BOILERHOUSE	562 - B850	
82 - OTHER BOILERHOUSE	563 - BOILERHOUSE TEST EQUIPMENT	
82 - OTHER BOILERHOUSE	H01 - CR	8413810090

82 - OTHER BOILERHOUSE	S75 - Pump Control	
82 - OTHER BOILERHOUSE	S76 - Power Supply	
82 - OTHER BOILERHOUSE	S77 - Other Boilerhouse	
82 - OTHER BOILERHOUSE	S78 - Component EL	
82 - OTHER BOILERHOUSE	T08 - Other Electronics	
82 - OTHER BOILERHOUSE	T09 - Other Boilers	
82 - OTHER BOILERHOUSE	T34 - Spare Parts BHC (GES)	
82 - OTHER BOILERHOUSE	T63 - URN2	
82 - OTHER BOILERHOUSE	T64 - VRM	
53 - QUARTER TURN & ROTARY CONTROL VALVES	422 - RS	8481808190
53 - QUARTER TURN & ROTARY CONTROL VALVES	423 - OTHER QUARTER TURN AND ROTARY CONTROL VALVES	
53 - QUARTER TURN & ROTARY CONTROL VALVES	424 - BUTTERFLY VALVES	8481808590
53 - QUARTER TURN & ROTARY CONTROL VALVES	425 - OTHER ELECTRIC ROTARY ACTUATORS	
53 - QUARTER TURN & ROTARY CONTROL VALVES	426 - OTHER PNEUMATIC ROTARY ACTUATORS	
53 - QUARTER TURN & ROTARY CONTROL VALVES	427 - HITER SERIES VT-N V-NOTCH	
53 - QUARTER TURN & ROTARY CONTROL VALVES	428 - HITER SERIES RPH ECCENTRIC CAM	
53 - QUARTER TURN & ROTARY CONTROL VALVES	429 - HITER SERIES 87B BUTTERFLY	8481808590
53 - QUARTER TURN & ROTARY CONTROL VALVES	655 - M SERIES + BVA ACTUATOR	8481808190
53 - QUARTER TURN & ROTARY CONTROL VALVES	656 - HITER OTHER BUTTERFLY VALVES	
53 - QUARTER TURN & ROTARY CONTROL VALVES	692 - GBV + ACTUATOR	
53 - QUARTER TURN & ROTARY CONTROL VALVES	N09 - DURCO Plug Valves	

53 - QUARTER TURN & ROTARY CONTROL VALVES	N12 - NORDSTROM Plug Valves	
53 - QUARTER TURN & ROTARY CONTROL VALVES	N13 - SERCK AUDCO Plug Valves	
64 - ELECTROMAGNETIC METERS	475 - ELM	9026102100
64 - ELECTROMAGNETIC METERS	476 - OTHER ELECTROMAGNETIC METERS	
64 - ELECTROMAGNETIC METERS	R09 - Gestra Electromagnetic Meters	
76 - CONTAMINATION	521 - TURBIDITY	
76 - CONTAMINATION	522 - CCD	
76 - CONTAMINATION	523 - OTHER CONTAMINATION	
76 - CONTAMINATION	657 - Gas Analysers	
76 - CONTAMINATION	S97 - Turbidity Monitor	
76 - CONTAMINATION	T41 - Other Turbidity Monitor	
76 - CONTAMINATION	T51 - OR52	
76 - CONTAMINATION	T52 - ORGS11	
56 - COMPRESSED AIR PRODUCTS	435 - FR75	8481100590
56 - COMPRESSED AIR PRODUCTS	436 - MPC	8481100590
56 - COMPRESSED AIR PRODUCTS	437 - MONNIER FILTERS	8421392590
56 - COMPRESSED AIR PRODUCTS	438 - MONNIER REGULATORS	8481109990
56 - COMPRESSED AIR PRODUCTS	439 - MONNIER LUBRICATORS	8481809990
56 - COMPRESSED AIR PRODUCTS	440 - MONNIER DRAIN TRAP	8421392590
56 - COMPRESSED AIR PRODUCTS	441 - IPM	8481100590
56 - COMPRESSED AIR PRODUCTS	442 - MPM	8481100590
56 - COMPRESSED AIR PRODUCTS	443 - OTHER COMPRESSED AIR PRODUCTS	
96 - SUNDRIES	618 - RAW MATERIALS	
96 - SUNDRIES	619 - BOLTS, SCREWS, STUDS & NUTS	
96 - SUNDRIES	620 - SPECIAL BOUGHT IN	
96 - SUNDRIES	621 - OTHER SUNDRIES	

96 - SUNDRIES	658 - FREIGHT	
96 - SUNDRIES	659 - PACKAGING	
96 - SUNDRIES	660 - OTHER COSTS	
45 - SPIRATROL	314 - JE43	8481805990
45 - SPIRATROL	315 - JE63	8481805990
45 - SPIRATROL	316 - JE83	8481805990
45 - SPIRATROL	317 - JEA43	8481805990
45 - SPIRATROL	318 - JEA63	8481805990
45 - SPIRATROL	319 - JEA83	8481805990
45 - SPIRATROL	320 - KE4	8481805990
45 - SPIRATROL	321 - KE6	8481805990
45 - SPIRATROL	322 - KE7	8481805990
45 - SPIRATROL	323 - KEA4	8481805990
45 - SPIRATROL	324 - KEA6	8481805990
45 - SPIRATROL	325 - KEA7	8481805990
45 - SPIRATROL	326 - LE3	8481805990
45 - SPIRATROL	327 - LE4	8481805990
45 - SPIRATROL	328 - LE6	8481805990
45 - SPIRATROL	329 - LEA3	8481805990
45 - SPIRATROL	330 - LEA4	8481805990
45 - SPIRATROL	331 - B SERIES	8481805990
45 - SPIRATROL	332 - C SERIES	8481805990
45 - SPIRATROL	333 - SEOJEON VALVES	8481805990
45 - SPIRATROL	334 - HITER VALVES	8481805990
45 - SPIRATROL	335 - OTHER CONTROL VALVES	
45 - SPIRATROL	670 - GCV-KE4	8481805990
45 - SPIRATROL	671 - GCV-KE7	8481805990
45 - SPIRATROL	672 - GCV-KEA4	8481805990

45 - SPIRATROL	673 - GCV-LEA3	8481805990
45 - SPIRATROL	696 - SPIRA-TROL C DOUBLE LIFE VALVE	8481805990
45 - SPIRATROL	742 - Food+ Spira-trol	8481805990
74 - BOILERHOUSE LEVEL CONTROLS	506 - LC2250	
74 - BOILERHOUSE LEVEL CONTROLS	507 - LC2650	
74 - BOILERHOUSE LEVEL CONTROLS	508 - LC3050	
74 - BOILERHOUSE LEVEL CONTROLS	509 - LC1350	
74 - BOILERHOUSE LEVEL CONTROLS	510 - APS1	
74 - BOILERHOUSE LEVEL CONTROLS	511 - PA420	
74 - BOILERHOUSE LEVEL CONTROLS	512 - PA20	
74 - BOILERHOUSE LEVEL CONTROLS	513 - LP20	
74 - BOILERHOUSE LEVEL CONTROLS	514 - LP10-4	
74 - BOILERHOUSE LEVEL CONTROLS	515 - LP30	
74 - BOILERHOUSE LEVEL CONTROLS	516 - LP31	
74 - BOILERHOUSE LEVEL CONTROLS	517 - OTHER BOILERHOUSE LEVEL CONTROLS	
74 - BOILERHOUSE LEVEL CONTROLS	693 - LCS CONTROLS (GESTRA)	
74 - BOILERHOUSE LEVEL CONTROLS	S03 - ER 77 (continuous)	
74 - BOILERHOUSE LEVEL CONTROLS	S05 - Water Level Limiter Switch (old)	
74 - BOILERHOUSE LEVEL CONTROLS	S06 - Water Level Controller (old)	
74 - BOILERHOUSE LEVEL CONTROLS	S07 - VR Amplifier & Combinations	
74 - BOILERHOUSE LEVEL CONTROLS	S08 - SRL	
74 - BOILERHOUSE LEVEL CONTROLS	S09 - KRR	
74 - BOILERHOUSE LEVEL CONTROLS	S17 - Water Level Limiter Probes (old)	
74 - BOILERHOUSE LEVEL CONTROLS	S19 - Water Level Limiter Special	
74 - BOILERHOUSE LEVEL CONTROLS	S20 - Level Probes Marine Application	
74 - BOILERHOUSE LEVEL CONTROLS	S21 - NRG - other	
74 - BOILERHOUSE LEVEL CONTROLS	S22 - NRG 16-36	

74 - BOILERHOUSE LEVEL CONTROLS	S23 - FREI	
74 - BOILERHOUSE LEVEL CONTROLS	T17 - LCR2250 (GES)	
74 - BOILERHOUSE LEVEL CONTROLS	T18 - LCR2251 (GES)	
74 - BOILERHOUSE LEVEL CONTROLS	T19 - LCR2652 (GES)	
74 - BOILERHOUSE LEVEL CONTROLS	T20 - LCR2652 & BCR3250 (GES)	
74 - BOILERHOUSE LEVEL CONTROLS	T21 - LCS3050 (GES)	
74 - BOILERHOUSE LEVEL CONTROLS	T22 - LCS3051 (GES)	
74 - BOILERHOUSE LEVEL CONTROLS	T23 - LCS1350 (GES)	
74 - BOILERHOUSE LEVEL CONTROLS	T24 - PA420 (GES)	
74 - BOILERHOUSE LEVEL CONTROLS	T25 - LP21 (GES)	
74 - BOILERHOUSE LEVEL CONTROLS	T26 - LP11-4 (GES)	
74 - BOILERHOUSE LEVEL CONTROLS	T27 - LP40 (GES)	
74 - BOILERHOUSE LEVEL CONTROLS	T28 - LP41 (GES)	
74 - BOILERHOUSE LEVEL CONTROLS	T46 - ER	
74 - BOILERHOUSE LEVEL CONTROLS	T47 - NRG 1x-11	
74 - BOILERHOUSE LEVEL CONTROLS	T48 - NRG 1x-12	
74 - BOILERHOUSE LEVEL CONTROLS	T49 - NRS 1-7	
74 - BOILERHOUSE LEVEL CONTROLS	T50 - SRL 63	
28 - MECHANICAL PUMP PACKAGES	210 - APT10-PPU	8413810090
28 - MECHANICAL PUMP PACKAGES	211 - APT14-PPU	8413810090
28 - MECHANICAL PUMP PACKAGES	212 - MFP14-PPU	8413810090
28 - MECHANICAL PUMP PACKAGES	213 - PIVOTROL PPU	8413810090
28 - MECHANICAL PUMP PACKAGES	214 - OTHER MECHANICAL PUMP PACKAGES	
28 - MECHANICAL PUMP PACKAGES	743 - UNA PK Station	8413810090
28 - MECHANICAL PUMP PACKAGES	744 - FPS Station	8413810090
25 - ISOLATION VALVES OTHER	177 - HV3	8481807990
25 - ISOLATION VALVES OTHER	178 - WAKMET ISOLATION VALVES	

25 - ISOLATION VALVES OTHER	179 - OTHER ISOLATION VALVES	
25 - ISOLATION VALVES OTHER	F09 - Other Isolation Valves	
25 - ISOLATION VALVES OTHER	F10 - Tank Valves	
25 - ISOLATION VALVES OTHER	F11 - Other Stop Valves	
25 - ISOLATION VALVES OTHER	F19 - Manual Pressure Seal Valves	
25 - ISOLATION VALVES OTHER	F20 - Actuated Pressure Seal Valves	
19 - DISC CHECK VALVES	142 - DCV1	8481309990
19 - DISC CHECK VALVES	143 - DCV3	8481309199
19 - DISC CHECK VALVES	144 - DCV4	8481309199
19 - DISC CHECK VALVES	145 - DCV41	8481309199
19 - DISC CHECK VALVES	146 - DCV6	8481309199
19 - DISC CHECK VALVES	147 - DCV8	8481309199
19 - DISC CHECK VALVES	148 - DCV10	8481309199
19 - DISC CHECK VALVES	149 - SDCV3	8481309199
19 - DISC CHECK VALVES	150 - SDCV4	8481309199
19 - DISC CHECK VALVES	151 - SDCV7	8481309199
19 - DISC CHECK VALVES	152 - SDCV8	8481309199
19 - DISC CHECK VALVES	153 - CVS10	8481309199
19 - DISC CHECK VALVES	154 - OTHER DISC CHECK VALVES	
19 - DISC CHECK VALVES	751 - Food+ DCV3	8481309199
19 - DISC CHECK VALVES	752 - Food+ DCV41	8481309199
19 - DISC CHECK VALVES	E01 - Other Disc Check Valves	
19 - DISC CHECK VALVES	E02 - SBO 11	8481309990
19 - DISC CHECK VALVES	E03 - SBO 21	8481309990
19 - DISC CHECK VALVES	E04 - SBO 31	8481309990
19 - DISC CHECK VALVES	E05 - MB 14	8481309990
19 - DISC CHECK VALVES	E06 - RK 70	8481309990
19 - DISC CHECK VALVES	E07 - RK 71	8481309990

19 - DISC CHECK VALVES	E08 - RK 86	8481309199
19 - DISC CHECK VALVES	E09 - RK 41	8481309990
19 - DISC CHECK VALVES	E10 - RK 44	8481309990
19 - DISC CHECK VALVES	E11 - RK 46A	
19 - DISC CHECK VALVES	E12 - RK 49	8481309199
19 - DISC CHECK VALVES	E13 - RK 66	
19 - DISC CHECK VALVES	E14 - RK 29A	8481309199
19 - DISC CHECK VALVES	E15 - RK 44S	8481309990
19 - DISC CHECK VALVES	E16 - RK 26A	8481309199
19 - DISC CHECK VALVES	E17 - RK 66 A	
19 - DISC CHECK VALVES	E18 - RK 16 C	8481309199
19 - DISC CHECK VALVES	E19 - RK 16 A	8481309199
19 - DISC CHECK VALVES	E20 - RK 16	8481309199
19 - DISC CHECK VALVES	E21 - RK 76	8481309199
19 - DISC CHECK VALVES	E22 - RK 86A	8481309199
19 - DISC CHECK VALVES	E23 - RK 16 M	8481309199
19 - DISC CHECK VALVES	E24 - RK 16 B	8481309199
19 - DISC CHECK VALVES	E25 - RK 16 T	8481309199
19 - DISC CHECK VALVES	E26 - RB (EA)	
19 - DISC CHECK VALVES	E27 - SRK 22A	
19 - DISC CHECK VALVES	E48 - RKE 86	
19 - DISC CHECK VALVES	E49 - RKE 86A	
27 - MECHANICAL PUMPS	203 - APT10	8413810090
27 - MECHANICAL PUMPS	204 - APT 14	8413810090
27 - MECHANICAL PUMPS	205 - MFP14	8413810090
27 - MECHANICAL PUMPS	206 - EPM	9026102100
27 - MECHANICAL PUMPS	207 - PIVOTROL	8413810090
27 - MECHANICAL PUMPS	208 - PPEC	8413810090

27 - MECHANICAL PUMPS	209 - OTHER MECHANICAL PUMPS	
27 - MECHANICAL PUMPS	H06 - Condensate Pumps KH	8413810090
5 - BIMETALLIC TRAPS	64 - SM32	8481809990
5 - BIMETALLIC TRAPS	65 - ISMC32	8481809990
5 - BIMETALLIC TRAPS	66 - USM32	8481809990
5 - BIMETALLIC TRAPS	67 - SM45	8481809990
5 - BIMETALLIC TRAPS	68 - USM21	8481809990
5 - BIMETALLIC TRAPS	69 - SP SERIES	8481809990
5 - BIMETALLIC TRAPS	70 - ABL SERIES	8481809990
5 - BIMETALLIC TRAPS	71 - HP SERIES	8481809990
5 - BIMETALLIC TRAPS	72 - PBX SERIES	8481809990
5 - BIMETALLIC TRAPS	73 - T3	8481809990
5 - BIMETALLIC TRAPS	74 - BYDRAIN	8481809990
5 - BIMETALLIC TRAPS	75 - OTHER SM	
5 - BIMETALLIC TRAPS	A58 - Other BK	
5 - BIMETALLIC TRAPS	A59 - BK 45	8481809990
5 - BIMETALLIC TRAPS	A60 - BK 46	8481809990
5 - BIMETALLIC TRAPS	A61 - BK 27N	8481809990
5 - BIMETALLIC TRAPS	A62 - BK 28 (DIN)	8481809990
5 - BIMETALLIC TRAPS	A63 - BK 29 (DIN)	8481809990
5 - BIMETALLIC TRAPS	A64 - BK 212 (DIN)	8481809990
5 - BIMETALLIC TRAPS	A65 - BK 15	8481809990
5 - BIMETALLIC TRAPS	A66 - BK 37 (ASTM)	8481809990
5 - BIMETALLIC TRAPS	A67 - BK 37 (DIN)	8481809990
5 - BIMETALLIC TRAPS	A68 - TK 23	8481809990
5 - BIMETALLIC TRAPS	A69 - TK 24	8481809990
5 - BIMETALLIC TRAPS	A70 - BK 36A-7	8481809990
5 - BIMETALLIC TRAPS	A71 - UBK 46	8481809990

5 - BIMETALLIC TRAPS	A72 - BK 28 (ASTM)	8481809990
5 - BIMETALLIC TRAPS	A73 - BK 29 (ASTM)	8481809990
5 - BIMETALLIC TRAPS	A74 - BK 212 (ASTM)	8481809990
5 - BIMETALLIC TRAPS	A75 - BK 212 (F91)	8481809990
5 - BIMETALLIC TRAPS	A76 - Bimetallic	8481809990
5 - BIMETALLIC TRAPS	A77 - Other TK	
18 - FLASH VESSELS	140 - FLASH VESSELS	8404100000
18 - FLASH VESSELS	141 - OTHER FV	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	541 - BLOWDOWN VESSEL	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	542 - FLASH VESSEL - NOT IN USE	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	543 - MANIFOLD	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	544 - VHT	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	545 - VH	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	546 - VENT HEAD OTHER	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	547 - OTHER BLOWDOWN	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	R13 - KSB Products	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S33 - Drain Valve Type 17/2	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S34 - SW	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S35 - DMS	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S36 - Manometer Set	

79 - BLOWDOWN VESSELS & HEAT RECOVERY	S37 - Water Gauge Valve	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S38 - KMS	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S39 - Thermometer	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S40 - Solenoid Valve	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S41 - Coupling Globe Valve	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S42 - SDL	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S43 - ED/BD	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S44 - VDM	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S45 - MF	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S46 - KH	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S47 - FPS	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S48 - PK	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S49 - SDR	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S50 - TD, TP	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S51 - VD	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S52 - VD11,12,13	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S53 - VD23,26	

79 - BLOWDOWN VESSELS & HEAT RECOVERY	S54 - CP	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S55 - Vessels	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S56 - Other Heat Recovery	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S57 - Condensate Recovery and Return Systems (steel)	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	S58 - GRDE	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	T10 - Mixing Coolers	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	T36 - ED/BD (Standard)	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	T37 - MF (Standard)	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	T38 - FPS (Standard)	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	T39 - TD, TP (Standard)	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	T40 - Condensate Recovery and Return Systems (Standard)	
79 - BLOWDOWN VESSELS & HEAT RECOVERY	T94 - GESTRAheat	
17 - SEPARATORS	128 - S1	8421298090
17 - SEPARATORS	129 - S2	8421298090
17 - SEPARATORS	130 - S12	8421298090
17 - SEPARATORS	131 - S3	8421298090
17 - SEPARATORS	132 - S13	8421298090
17 - SEPARATORS	133 - S5	8421298090
17 - SEPARATORS	134 - S6	8421298090
17 - SEPARATORS	135 - S7	8421298090
17 - SEPARATORS	136 - S8	8421298090

17 - SEPARATORS	137 - CS10	8421298090
17 - SEPARATORS	138 - IJ - NOT IN USE	8421298090
17 - SEPARATORS	139 - OTHER SEPARATORS	
17 - SEPARATORS	750 - Food+ S8F	8421298090
17 - SEPARATORS	D04 - Steam Dryers	8421298090
46 - QL SERIES	336 - QL33	8481805990
46 - QL SERIES	337 - QL43	8481805990
46 - QL SERIES	338 - QL63	8481805990
46 - QL SERIES	339 - QL73	8481805990
46 - QL SERIES	340 - OTHER THREE PORT	
46 - QL SERIES	674 - GCV-QL33	8481805990
46 - QL SERIES	675 - GCV-QL73	8481805990
57 - CONTROLS PACKAGES	444 - DP PRV PACKAGES	8404100000
57 - CONTROLS PACKAGES	445 - DRV PRV PACKAGES	8404100000
57 - CONTROLS PACKAGES	446 - 25 SERIES PRV PACKAGES	8404100000
57 - CONTROLS PACKAGES	447 - OTHER ENGINEERED SYSTEM	
57 - CONTROLS PACKAGES	O01 - DMS	
57 - CONTROLS PACKAGES	O02 - Other Heat Recovery	
78 - FEEDTANK ANCILLARIES	532 - STEAM INJECTORS	
78 - FEEDTANK ANCILLARIES	533 - DCV BOILER CHECK VALVES	
78 - FEEDTANK ANCILLARIES	534 - MIXING UNIT	
78 - FEEDTANK ANCILLARIES	535 - WG2 WATER LEVEL GAUGE	
78 - FEEDTANK ANCILLARIES	536 - IM INJECTORS	
78 - FEEDTANK ANCILLARIES	537 - PRESSURISED DEAERATORS	
78 - FEEDTANK ANCILLARIES	538 - ATMOSPHERIC DEAERATORS	
78 - FEEDTANK ANCILLARIES	539 - FEEDTANKS	
78 - FEEDTANK ANCILLARIES	540 - OTHER FEEDTANK ANCILLARIES	
78 - FEEDTANK ANCILLARIES	S31 - NDR	

78 - FEEDTANK ANCILLARIES	S32 - Other Feedtank Ancillaries	
78 - FEEDTANK ANCILLARIES	T13 - Gestra Steam Deaerators	

Table i Taric Codes assigned against each Product Groups

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By: OAH on 2/29/2024
Ron Phillips Attachment

ANIMAL HEALTH INSTITUTE
Representing manufacturers of animal health products

March 1, 2024

Animal Health Institute (AHI) Response to Request for Comments on: Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

Thank you for the opportunity to provide feedback to the Minnesota Pollution Control Agency (MPCA) on its planned new rules governing currently unavoidable use products. AHI is the U.S. trade association for research-based manufacturers of animal health products – the medicines that keep pets and livestock healthy. While some PFAS chemistries are known to be harmful, the active ingredients in animal health products are just the opposite: they have gone through federally required, rigorous safety testing before reaching the market, including evaluating the safety effects on the animal, humans, and the environment.

AHI members develop, manufacture, and distribute a range of animal health products, including pharmaceuticals, biologics (including vaccines), flea and tick preventatives, and medical devices (including diagnostics), to veterinarians, pet owners, and food animal livestock owners. PFAS, when broadly defined as a class of fluorinated organic chemicals containing at least one fully fluorinated carbon atom, can include the active ingredient in oral flea and tick medications, anesthetics used for routine as well as complex surgery, anti-inflammatory drugs, federally regulated packaging components of biologics and medical devices, as well as the active ingredients in topical flea and tick products and collars.

The broad definition of PFAS used in the Minnesota law encompasses both large-volume industrial uses as well as many much smaller and beneficial uses. It encompasses thousands of chemical substances that are not homogeneous. Large industrial, well-characterized chemicals that clearly pose human health threats should not be treated or regulated the same as small use chemicals whose properties are different, including the rates of degradation. While these small use compounds match the criteria set by the OECD for PFAS, they are not technically considered polyfluorinated or perfluorinated (they mostly have only one or a few terminal fluorinated methyl groups added to a much larger molecule) and do not fall under the criteria of concern in a technical sense as outlined by the competent authorities proposing to regulate PFAS.

There is a need for definition and clarity around the term "essential for health, safety or the functioning of society," whether that be specific criteria or more general guidance. The challenge for the MPCA will be crafting criteria/guidance that applies evenly and consistently to a broad range of uses and industries and that is flexible enough to accommodate these differences.

The MPCA poses several questions regarding alternatives to PFAS. In the animal health industry, there are several factors that come into play when discussing potential alternatives. As an overarching feature, however, it should be noted that the animal health products in view here are all strictly regulated by federal agencies, including the specific composition of the product, the way the product is manufactured and the labelling of the product. To the extent PFAS is used in any of these phases, it is the result of these chemistries being uniquely able to meet federal requirements regarding the product, its manufacturing and distribution. Thus, when contemplating alternatives manufacturers must consider the requirements imposed by these federal regulatory agencies.

MPCA asks discrete questions about the cost and safety aspect of alternatives. Alternatives should be evaluated on a cost/benefit basis. In theory it is possible to impose a de facto ban by requiring cost-prohibitive alternatives.

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It is likely the threshold costs will vary considerably among industries and products. Under the federal regulations governing veterinary medicines and other animal health products (and unlike for the industrial chemicals), evaluation of their safety is a solid pillar of the approval process and this includes a.o. demonstration of safety for the user, the target animal species to be treated, and the environment ***before*** these products can enter the market.

In view of specific species, breed and individual animal sensitivities to medication, veterinarians need a wide range of products to treat a given condition or disease, but this is usually not the case in practice and treatment options may be limited. Finding suitable alternatives for active ingredients qualifying as PFAS under the definition is not an easy task.

The length of time for a CUU determination for a regulated health product, either animal or human, likely needs to be measured in decades, at least 20 years. There are no alternatives currently in sight for many of these veterinary uses. The known timescale for transitioning to alternatives in the animal pharmaceuticals space in general is lengthy, as basic research must be followed by generation of data to support the change, followed by regulatory approval from the governing federal agency.

For substances used in manufacturing equipment, in general, alternatives should be shown to quantitatively reduce risk. This will be complicated since each of the PFAS chemicals have a different risk profile and most have not even been characterized. However, the vast majority of those used for animal health products are fluoropolymers, which are considered to be of low concern by the OECD.[1]

A further complication for veterinary medicines is the information on the feasibility of alternatives can be very use-specific and regarded as business confidential. This makes screening and assessing the availability of alternatives a challenge. Over-reliance on publicly available information and little knowledge of the exact function of the substance, could mean that the conclusion "alternative = available" is too easily drawn. Any information on alternatives, in particular when provided by third parties other than manufacturer or downstream user, should be carefully assessed before being accepted and made available. The third party could be providing inaccurate information which fails to consider sectoral specific aspects such as performance and competitiveness. Making regulatory decisions on the assumption that alternatives exist, where this assumption is based on incorrect or incomplete information, risks leading to undesirable policy outcomes.

We believe the following groups of veterinary products should receive the CUU designation. Further, these designations should be made in the rulemaking, based on the most basic criteria that these are subject to rigorous federal regulatory oversight. These products are subject to a strict regulatory framework that requires data be submitted to the federal agency demonstrating consumer safety, user safety, target animal safety, proper manufacturing as well as environmental safety. Only products that meet all the requirements and demonstrate a positive benefit are allowed to be marketed. These federal regulatory frameworks that have considered the risks should not be overruled by the assessment of a broad grouping of chemicals where thousands of chemicals with vastly different risk profiles are treated homogenously.

Products to be designated CUU:

a. Any veterinary product intended for use in or on animals including diagnostic equipment or test kits and their components, or any product that is a veterinary medical device or a drug, biologic or parasiticide, or that is otherwise used in a veterinary medical setting or in veterinary medical

[1] Polymers of Low Concern - OECD

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applications that are regulated by, or are under the jurisdiction of, the United States Food and Drug Administration pursuant to the Federal Food, Drug, and Cosmetic Act, 21 U.S.C. §§ 301 et seq., the United States Department of Agriculture pursuant to the Federal Virus-Serum-Toxin Act, 21 U.S.C. §§ 151-159, or the United States Environmental Protection Agency pursuant to the Federal Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. §§ 136 et seq. and all raw materials, intermediates, active pharmaceutical ingredients (APIs), and reagents in the broad sense required to synthesize and manufacture such veterinary products.

b. Manufacturing equipment for any veterinary product described in (a) that contains PFAS chemicals. Included in this category would be gaskets, O-rings, filters, membranes, tubes, inner layers of chemical reactors, primary packaging materials, tubes in analytical equipment or tape used to build inert laboratory scale equipment.

In conclusion, any veterinary medicine or product federally regulated to restore or protect the health and welfare of animals and the processes used to produce that medicine or product and control its quality should be considered as essential for health, safety, and the functioning of society for which alternatives are not reasonably available and therefore considered a currently unavoidable use. This designation should include the entire manufacturing process and not only the final product. We therefore respectfully request the Agency take this into account when publishing the rule.

Should you have questions regarding these comments please contact Ron Phillips, Senior Vice President, Policy, rphillips@ahi.org.

 RECEIVED
By: OAH on 2/29/2024

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Industry PFAS CUU Project

PFAS Currently Unavoidable Uses Proposals (CUU)
Fifty-three (53) Proposals

Submission by Industry

This document is the guidance document to fifty-three (53) PFAS Currently Unavoidable Uses proposals being submitted by industry. Each CUU proposal is separate, but listed together in an orderly fashion for clarity and the convenience of regulators. Most of the proposals are for widespread uses of PFAS. These uses span across all industry segments and were included together. If required, they can be separated, but they would create between 300 and 400 separate proposals for regulators to review (for the 53 fundamental uses).

The Industry PFAS CUU project is made up of >50 companies that span consumer, professional, medical, industrial, and laboratory uses of PFAS. The CUUs listed here are based on very detailed work by each member of the project combined with tens of thousands of parts tested by Claigan Environmental in 2023 and 2024.

This submission should be the most comprehensive list of Currently Unavoidable Uses in physical products (articles), with detailed justifications and comparisons of alternatives.

The full CUU proposals and justifications are listed in detail in the accompanying spreadsheet PFAS Currently Unavoidable Uses Proposals - Feb 2024.xlsx.

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Table of Contents

1. Summary

This report is a submission by Claigan Environmental Inc. (Claigan) on behalf of the Industry PFAS Submission Project ("PFAS Submission Project"). The PFAS submission project is made up of 50+ companies from a wide range of industries (consumer, professional, industrial, medical, oil and gas, laboratory equipment, textiles, electronic components, and retail sales.)

The PFAS Submission Project is focused primarily on the needs of complex products (articles). Claigan is both a restricted materials consultancy and a high-volume restricted materials testing laboratory. Each of the PFAS Submission Project submissions are based on contributions from all major sectors of industry, and 2023 and 2024 PFAS testing data from tens of thousands of parts.

The detailed justification of each CUU is covered in the accompanying spreadsheet PFAS Currently Unavoidable Uses Proposals - Feb 2024.xlsx.

Each CUU entry includes

- A brief description of the Currently Unavoidable Use of PFAS
- A brief description of the type of product including industries and example products with HTS codes.
- A description of the intended use of the product and explanations on how it is essential for health, safety, or the functioning of society.
- A description of how the specific use of PFAS in the product is essential to the function of the product. If this use of PFAS is required by federal or state law or regulation, citations will be provided for that requirement.
- A description of whether there are reasonably available alternatives for this specific use of PFAS.
- Plus
    - Whether the PFAS use includes PFOA or Long Chain Perfluoroalkyl Carboxylic Acids (LC-PFCA). Many of these PFAS uses do not include (nor degrade into) any PFAS found in drinking water and humans.

- PFOA / LC-PFCA presence is based on tens of thousands of parts tested in 2023 and 2024.

Important note 1 - due to the short timeline for the PFAS Currently Unavoidable Use consultation, each justification is only in brief with a detailed comparison of alternatives. Each justification can be further elaborated upon if needed.

Important note 2 - the regulation of chemical substances in medical devices is governed by the FDA. It is generally assumed that this preempts restrictions of PFAS in medical devices under state regulation, “A product for which federal law governs the presence of PFAS in the product in a manner that preempts state authority”. However, for completeness and until this question is fully solved, currently unavoidable uses of PFAS in medical devices are also included in this submission.

Important note 3 - The States of Maine and Minnesota adopted a broad definition for PFAS substances. The vast majority of PFAS substances, as defined by Maine and Minnesota, that are found in products are not found in the environment. The broad definition impacts PFAS use in multiple categories of products and equipment needed to make products. PFAS substances are used in these applications because they have unique properties that impart specific performance characteristics making them essential to a product’s function. The accompanying spreadsheet provides a detailed comparison of fluoropolymer, fluoroelastomer, and alternative materials for each application. The reason for the use of the fluoropolymer or fluoroelastomer is generally fairly obvious when you look at the application and the alternatives.

2. Related documents

2.1. PFAS Currently Unavoidable Uses Proposals spreadsheet - Industry PFAS Submission Project

2.1.1. PFAS Currently Unavoidable Uses Proposals - Feb 2024.xlsx

3. Definitions

3.1. ***Currently Unavoidable Use of PFAS (CUU)*** - a use of PFAS that is essential for the health, safety, or functioning of society and for which alternatives are not reasonably available.

3.2. ***Widespread Use*** -

3.2.1. For essential uses of a PFAS-containing product, uses that are very high volume with widespread use are identified.

3.2.1.1. For example - fluoroelastomers and perfluoroelastomers have very widespread use in professional/industrial products (> 10M products per year sold in the US).

3.2.2. **For consumer uses** - Over 100 Million products sold in the US each year use this Currently Unavoidable Use of PFAS, or

3.2.3. **For industrial uses (including professional uses)** - Over 10 Million products sold in the US each year use this Currently Unavoidable Use of PFAS.

3.3. ***Forever chemicals***

3.3.1. *Substances that are either*

3.3.1.1. ***vPvB*** - Very persistent and very bioaccumulative

3.3.1.2. ***PBT*** - Persistent, bioaccumulative, and toxic

3.4. ***Machinery***

3.4.1. *Machinery includes all aspects of machinery including (but not limited to) manufacturing, construction, clean energy, water treatment, and forestry*

3.5. ***Laboratory***

3.5.1. *Laboratory includes all aspects of laboratory equipment including (but not limited to) water testing, life sciences, research and development, and medical testing.*

4. Key notes

4.1. Importance of PFAS

4.1.1. > 500 million products containing PFAS are sold in the US each year

4.1.2. Banning PFAS would eliminate

4.1.2.1. Laptops

4.1.2.2. The internet (unless servers are moved offshore)

4.1.2.3. Food processing

4.1.2.4. Water processing and treatment

4.1.2.5. Forestry

4.1.2.6. Life sciences

4.1.2.7. Oil and gas industry

4.1.2.8. Heart surgeries and biopsies

4.1.3. Banning PFAS without exception for Currently Unavoidable Uses would likely create the largest recession in the history of the United States.

4.2. Sources PFOA / LC-PFCA in Products

4.2.1. Most fluoropolymers and virtually all fluoroelastomers do not contain PFOA or LC-PFCA

4.2.2. The follow sections are based on 2022 - 2024 testing of products for PFOA / LC-PFCA and include explanation of how these substances are formed in very specific situations.

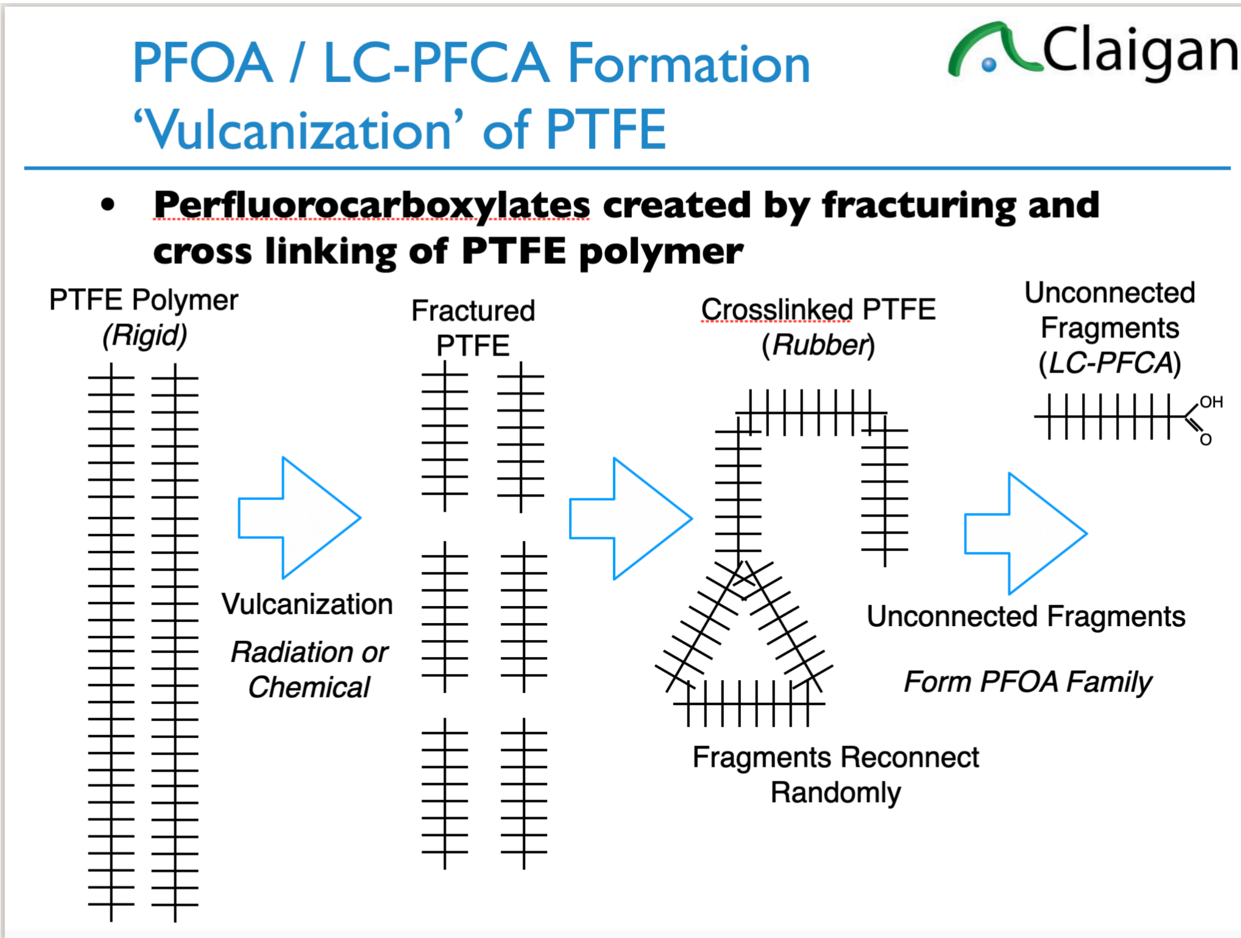
4.2.3. **Cause #1** of unintentional PFOA / LC-PFCA - Formation of LC-PFCA during vulcanization of rigid PTFE (or PVDF) into cross-linked rubber

4.2.3.1. Vulcanization / crosslinking of PTFE involves

4.2.3.1.1. Fracturing of long rigid PTFE polymer through radiation or chemical means

4.2.3.1.2. Reconnecting of fragments of PTFE in random directions (creating rubber instead of rigid polymer)

4.2.3.1.3. Some fragments react instead with air and create random sizes of perfluorocarboxylates.



4.3. **Cause #2** of unintentional PFOA / LC-PFCA - PFAS polymers (such as PFA or fluoroacrylates) that have a fluoromonomer side chain with a fragile C-O-C (carbon-oxygen-carbon) bond.

4.3.1. Formation of perflluorocarboxylates

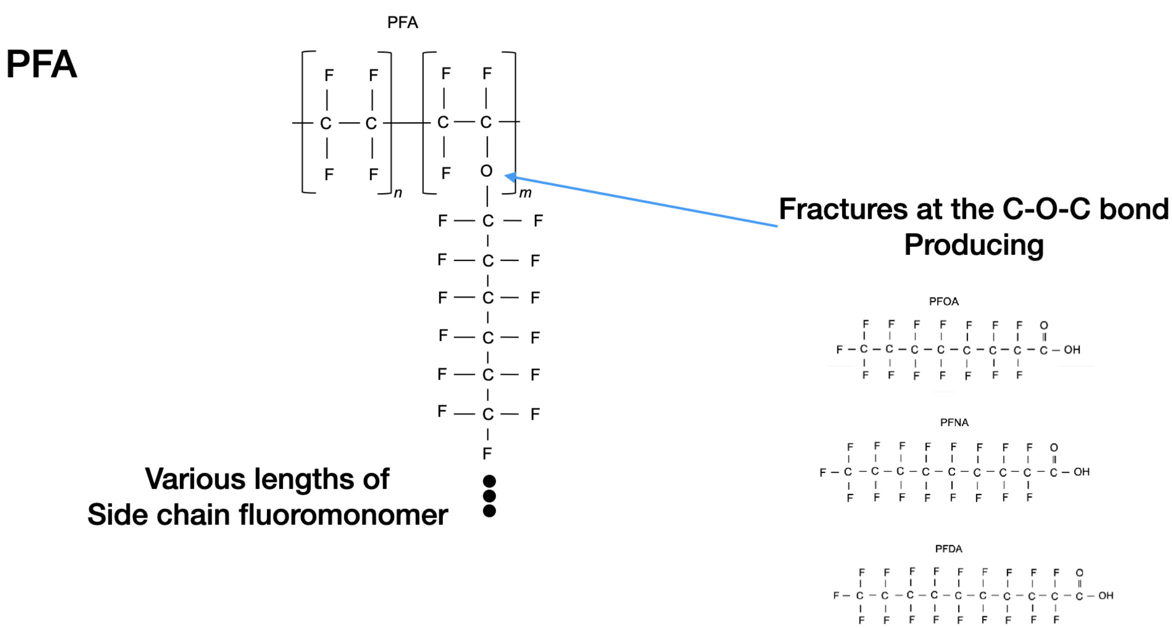
4.3.1.1. Fragile C-O-C bonds fracture during initial manufacturing and over time.

4.3.1.2. Fluoromonomer fragments are ‘fluorotelomers’, PFOA-like molecules with an extra 2 carbon hydrogens (such as 8:2 FTOH).

4.3.1.3. The fluorotelomer fragments react with air and water to slowly form perfluorocarboxylates

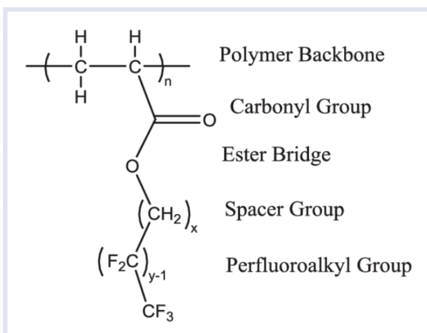
4.3.1.4. The lengths of eventual perfluorocarboxylates depend on the lengths of side chain monomers on the original PFA or fluoroacrylate polymer.

Formation of PFOA / LC-PFCA PFA (Perfluoroalkoxy Alkane Polymer)

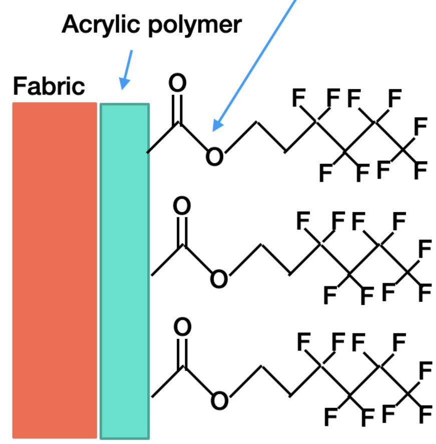


PFOA / LC-PFCA Formation Fluoroacrylates

- Fluoroacrylates have a 'side chain polymer'
  - Acrylic or other polymer
    - With chains of PFAS extending from polymer
    - *PFOA may be present as an impurity from PFAS side chain*
  - Example - water repellant coatings



Side chain PFAS



Side Chain PFAS

4.4. Perfluorocarboxylates and Perfluorosulfonates Found in Fluoropolymers and Fluoroelastomers

4.4.1. Presence of perfluorocarboxylates and perfluorosulfonates

4.4.2. 2022 to 2024 testing data by Claigan Environmental

Comparison	PTFE	PVDF	ETFE	Crosslinked PTFE	ePTFE	PFA	Fluoroelastomers	Fluoroacrylates	Fluorophosphates
Short Chain Perfluorocarboxylates (C4-C7)	Never	Never	Never	Commonly	Commonly	Commonly	Commonly	Commonly	Commonly

Long Chain Perfluorocarboxylates (C8-C14)	Never	Never	Never	Commonly	Commonly	Commonly	Never	Commonly	Commonly
Short Chain Fluorotelomers (C4-C7)	Never	Never	Never	Never	Never	Never	Never	Commonly	Commonly
Long Chain Fluorotelomers (C8-C14)	Never	Never	Never	Never	Never	Never	Never	Commonly	Commonly
Short Chain Fluoroacrylates (C4-C7)	Never	Never	Never	Never	Never	Never	Never	Commonly	Never
Long Chain Fluoroacrylates (C8-C14)	Never	Never	Never	Never	Never	Never	Never	Commonly	Never
Short Chain Fluorosulphonates (C4-C7)	Never	Never	Never	Never	Never	Never	Never	Never	Never
Long Chain Fluorosulphonates (C8-C14)	Never	Never	Never	Never	Never	Never	Never	Never	Never
Short Chain Fluorotelomer Sulphonates	Never	Never	Never	Never	Never	Never	Commonly	Never	Never
Long Chain Fluorotelomers Sulphonates	Never	Never	Never	Never	Never	Never	Never	Never	Never

4.5. PFAS in Drinking Water and Humans

4.5.1. From this project and related testing data

4.5.1.1. ~99% of PFAS found in drinking water and humans is from <0.1% of products (primarily legacy fire extinguisher fluid and legacy foundation/concealer (C9-C15 fluoroalkyl phosphate in personal care products)).

4.5.1.2. ~99.99% of PFAS found in drinking water and humans is from <1% of products (a slight additional contribution from washing of waterproof fabrics contain fluoroacrylates).

4.5.1.3. The average silicone part has 100X more forever chemicals than the worst fluoropolymer (ePTFE). 200 ppm vs 2 ppm.

4.5.1.4. Based on ISO 10993-18 medical biocompatibility testing: Silicone, ABS, polystyrene, PVC, nylon, and polyurethane leak more dangerous chemicals into humans than fluoropolymers

4.5.1.5. Fluoropolymers are used because they are safer and more effective than their alternatives.

4.6. PFAS and Drinking Water - Kentucky 2023 PFAS testing of all drinking water sites

4.6.1. Kentucky 2023 drinking water sites testing

4.6.1.1. https://eec.ky.gov/Environmental-Protection/Water/Reports/Reports/2023-PFASFinishedDrinkingWaterResults.pdf

4.6.1.2. Kentucky was chosen because

4.6.1.2.1. Modern data (2023)

4.6.1.2.2. Comprehensive PFAS testing of each drinking water site

4.6.2. Sources of PFAS in drinking water

4.6.2.1. Based on the comparison of drinking water testing results and laboratory testing results of products

4.6.2.2. Legacy fire fighting foam

4.6.2.2.1. Fire fighting foam that uses C8 fluoro surfactants

4.6.2.2.2. Generally phased out of products a decade ago

4.6.2.2.3. Testing characteristic

4.6.2.2.3.1. Always - PFOS

4.6.2.2.3.2. Majority of situations - PFOA

4.6.2.2.3.3. Would not have - PFNA or PFDA (higher-length PFOA substances)

4.6.2.3. Modern fire fighting foam

4.6.2.3.1. Fire fighting foam that uses C4 or C6 fluoro surfactants

4.6.2.3.2. Common in modern fire fighting foam

4.6.2.3.3. Testing characteristic

4.6.2.3.3.1. Always - at least one of 6:2 FTS, PFHxS, PFBS

4.6.2.3.3.2. Majority of situations - PFHxA, PFBA

4.6.2.3.3.3. Would not have - PFOS, PFOA, PFNA, or PFDA

4.6.2.4. Cosmetics (Foundation and Concealer)

4.6.2.4.1. Foundation and concealer using C9-C15 Fluoroalkylphospate

4.6.2.4.1.1. Degrades over time into high concentration of PFOA, PFNA, and PFDA

4.6.2.4.2. Phased out in 2021/2022

4.6.2.4.3. Testing characteristic

4.6.2.4.3.1. Always - PFNA and PFDA (PFDA not included in Kentucky testing)

4.6.2.4.3.2. Majority of situations - PFOA

4.6.2.4.3.3. Would not have - PFOS or any sulphonate, or short-length fluoro carboxylates (PFBA, PFPeA, PFHxA).

4.6.2.5. Physical products

4.6.2.5.1. Primarily fluoroacrylate coatings of water-resistant fabric

4.6.2.5.1.1. Would release all lengths of perfluorocarboxylic acids during washing in detergent.

4.6.2.5.2. Common today

4.6.2.5.3. Testing characteristic

4.6.2.5.3.1. Always - All lengths of perfluorocarboxylates from PFBA to PFDA.

4.6.2.5.3.2. Would not have - PFOS or any sulphonate.

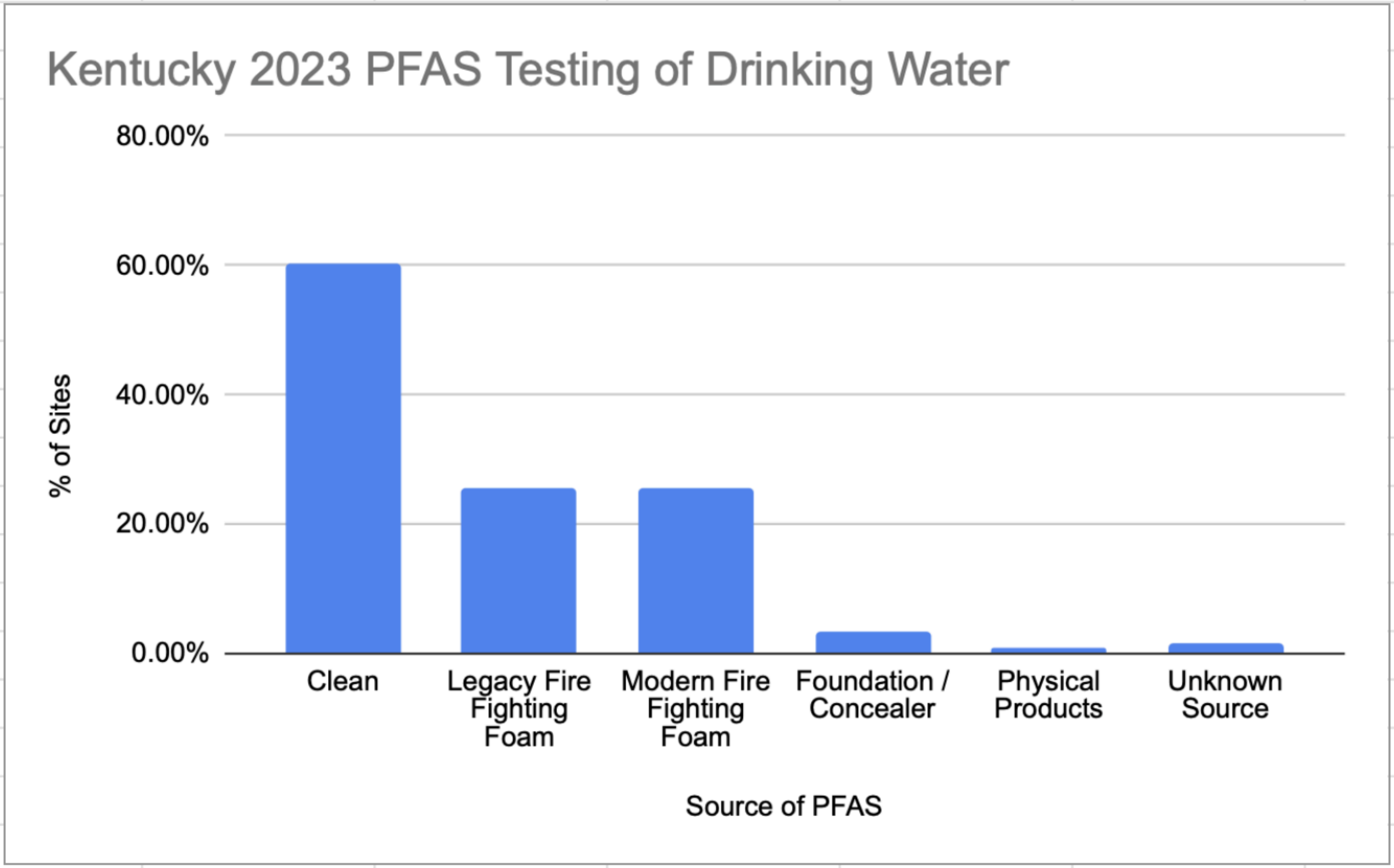
4.6.2.6. Unknown

4.6.2.6.1. Testing results from water are not consistent with any known product.

4.6.3. Chart of Projected Sources of PFAS in 2023 Kentucky drinking water site testing

4.6.3.1. 113 sites tested in Kentucky in 2023

4.6.3.2. Note - some sites could be listed under more than one source. The total should be above 100%


Kentucky 2023 PFAS Testing of Drinking Water
80.00%
60.00%
40.00%
20.00%
0.00%
% of Sites
Clean
Legacy Fire Fighting Foam
Modern Fire Fighting Foam
Foundation / Concealer
Physical Products
Unknown Source
Source of PFAS

Claigan Environmental Inc.
10 Brewer Hunt Way, Suite 200
Kanata, ON, Canada, K2K 2B5

5. PFAS Currently Unavoidable Uses

5.1. The full details are contained in the accompanying spreadsheet PFAS Currently Unavoidable Uses Proposals - Feb 2024.xlsx.

5.1.1. The comparisons are too large and detailed for a Word document and are instead summarized in an Excel file.

5.2. This document features several tabs with tables containing details about ***CUU's***.

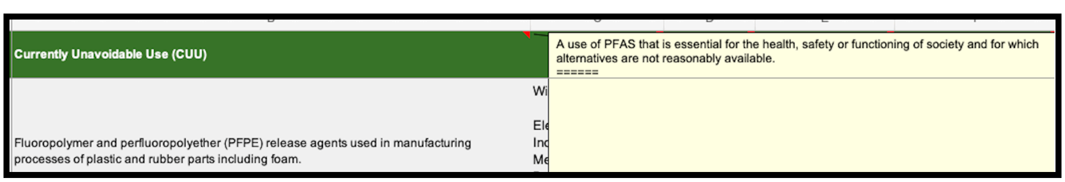
5.2.1. The CUU tab provides details about the specific ***CUU's*** as well as where and why they are specifically used.

5.2.2. The remaining tabs are the Alternative tabs. They provide the evaluation of alternative materials across a range of criteria applicable to the relevant use, which is labelled on the tab at the bottom of the document.

5.3. The core data is found within the tables, while further explanatory notes are found in the applicable column and row headers.

5.4. Cells with a red triangle in the top right corner have additional information pertinent to their respective row or column. They are found in Row 1 of the CUU tab and Column A of the Alternatives tabs. For example:

5.5. Additional details are revealed by hovering the mouse cursor over the cell (without clicking it). For example:



5.6. Additionally, this same information is captured in the document below.

6. Explanation of Currently Unavoidable Use (CUU) Proposal Tab

6.1. Columns A and B (CUU Number and Description) provide the numbering and descriptions for each ***CUU***.

6.2. Column C (Products) provides an overview of the applicable product families that require the listed Currently Unavoidable Use.

6.3. Column D (HS Codes) provides a list of HS Codes of products that require the listed ***CUU***. Some uses are so pervasive that the entire HS Code (Customs Code) chapters are listed.

6.4. Column E (Example Products) details a list of example products that require the applicable ***CUU.*** This list is representative and is not intended to be exhaustive.

6.5. Column F (Essential Use of Product) describes the intended use of the product and explains how it is essential for health, safety, or the functioning of society. It also describes if products using this CUU are ***Widespread*** or ***Industrial***.

6.6. Column G (Essential Use of PFAS) describes how the specific use of PFAS in the product is essential to the function of the product.

6.7. Column H (Comparison of Alternatives) describes reasonably available alternatives for this specific use of PFAS and compares them to the applicable ***CUU***. For further details, refer to the relevant Alternatives tab.

6.8. Column I (PFOA) identifies if this CUU contains any PFOA or Long Chain Perfluoroalkylcarboxylates (LCPFCAs). This column is based on 2023 and 2024 testing data of hundreds of representative parts for PFOA and LC-PFCAs.

6.9. Column J (Alternatives Tab) provides a direct link within the document to the identified tab comparing the performance of PFAS materials and alternative materials.

7. Alternatives Tabs

7.1. Row 1 (Comparison) identifies the alternative materials being evaluated.

7.2. Low Friction

7.2.1. Excellent - The material has a low coefficient of static friction. It is nearly frictionless.

7.2.2. Decent - The material has a lower coefficient of static friction but has some friction in use.

7.2.3. Poor - The material has a high coefficient of static friction. It displays strong friction during use and is not suitable for applications requiring low friction.

7.3. ***Chemical Resistance*** - the resistance to acids or bases may not be uniform for a material. The rating reflects the general potential applications of the material

7.3.1. Excellent - The material has superior resistance to acids and bases. Acid and bases have no discernible effect on the material.

7.3.2. Decent - The material is resistant to acids and bases but does exhibit some degradation. It should not be in extended contact with, or subject to, high concentrations of acids or bases.

7.3.3. Poor - The material is not resistant to acids and/or bases.

7.4. Water Resistance

7.4.1. Excellent - The material is hydrophobic (*i.e.* it is impermeable to water even as a coating).

7.4.2. Decent - The material is resistant to water, but not completely hydrophobic or waterproof.

7.4.3. Poor - The material is permeable to water.

7.5. Oil Resistance

7.5.1. Excellent - The material is oleophobic (*i.e.* it is impermeable to oil even as a coating).

7.5.2. Decent - The material is resistant to oil, but not completely oleophobic, oil-proof, or stain-resistant.

7.5.3. Poor - The material is permeable to oil.

7.6. Temperature Resistance

7.6.1. Excellent - The material can withstand temperatures above 150°C.

7.6.2. Decent - The material can withstand temperatures above 100°C, but is impacted by temperatures above 150°C.

7.6.3. Poor - The material is impacted by temperatures above 100°C.

7.7. Fire Resistance

7.7.1. Excellent - The material meets stringent fire/flame resistance standards.

7.7.2. Decent - The material has fire/flame resistance but does not meet the most stringent standards.

7.7.3. Poor - The material is not fire/flame resistant.

7.8. Flexibility

7.8.1. Excellent - The material exhibits good flexibility and is useful in most applications requiring flexibility.

7.8.2. Decent - The material has some rigidity, but still exhibits some flexibility.

7.8.3. Poor - The material is rigid and is not suitable for applications requiring flexibility.

7.9. Forever Chemicals (Initial)

7.9.1. Excellent - The material does not contain any substances with an EU harmonized classification of vPvB or PBT after manufacturing.

7.9.2. Decent - The material contains trace amounts (<1 ppm) of substances with an EU harmonized classification of vPvB or PBT after manufacturing.

7.9.3. Poor - The material contains amounts (> 1ppm) of substances with an EU harmonized classification of vPvB or PBT after manufacturing

7.10. Forever Chemicals (Over Time)

7.10.1. Excellent - The material does not degrade into substances with an EU harmonized classification of vPvB or PBT.

7.10.2. Decent - The material degrades lightly into substances (<1 ppm) with an EU harmonized classification of vPvB or PBT over time.

7.10.3. Poor - The material degrades into substances (> 1ppm) with an EU harmonized classification of vPvB or PBT over time.

7.11. Bio-compatibility

7.11.1. Excellent - The material passes US FDA and EU MDR biocompatibility testing and does not normally require toxicological justification.

7.11.2. Decent - The material passes US FDA and EU MDR biocompatibility testing but often requires toxicological justification.

7.11.3. Poor - The material does not generally pass US FDA or EU MDR biocompatibility testing or it requires significant toxicological justification.

7.12. Insulation

7.12.1. Excellent - The material has a low dielectric constant and is suitable for most insulating or electronics purposes.

7.12.2. Decent - The material has a medium dielectric constant and is only suitable for some insulating or electronics purposes.

7.12.3. Poor - The material has a high dielectric constant and is not normally suitable as an insulating material in electronics.

7.13. High-Density Applications

7.13.1. Excellent - The material is usable in applications requiring thin layers or high density.

7.13.2. Decent - The material is usable in applications that do not require thin materials, but it is not suitable for very fine or dense applications.

7.13.3. Poor - The material is not feasible as a thin film or in high-density applications.

7.14. Polymer Additive

7.14.1. Excellent - The material can be added to a wide range of polymers to provide additional properties.

7.14.2. Decent - The material can be added to some polymers to provide some level of additional properties.

7.14.3. Poor - The material is not suitable as a polymer additive.

7.15. Porous

7.15.1. Excellent - The material is permeable to air.

7.15.2. Decent - The material is partially permeable to air but is resistant to airflow.

7.15.3. Poor - The material is not permeable to air.

7.16. Durability

7.16.1. Excellent - The material has superior resistance to wear.

7.16.2. Decent - The material is partially resistant to wear but is not suitable for high-wear situations.

7.16.3. Poor - The material is not suitable for situations where wear resistance is required.

7.17. Optical Transparency

7.17.1. Excellent - The material is optically transparent.

7.17.2. Decent - This material has some optical transparency but is not suitable for applications requiring clarity and high transparency.

7.17.3. Poor - This material is not normally optically transparent

7.18. Structural

7.18.1. Excellent - The material is rigid with the ability to support its weight and any weight of the fluid it is transporting. It also has superior fatigue resistance.

7.18.2. Decent - The material can support its weight, but it is not as reliable for additional weight or fatigue.

7.18.3. Poor - The material cannot rigidly support its weight.

7.19. Radiation Resistance

7.19.1. Excellent - The material has superior resistance to gamma and e-beam radiation and does not exhibit degradation due to radiation.

7.19.2. Decent - The material has some resistance to gamma and e-beam radiation but exhibits degradation with repeat or high dosage exposure.

7.19.3. Poor - The material degrades in gamma or e-beam radiation.

7.20. Acceptable

7.20.1. A material is deemed acceptable if it receives an excellent or decent rating in non-critical properties. The material must receive an excellent rating in critical properties to be deemed acceptable.

7.20.1.1. Critical properties are identified where ratings (excellent, decent, poor) are shown in bold.

8. Acknowledgements

Special thank you to Nials Everett, Chris Scully, Julie Van Moorsel, Dr Tim Holt, and the entire Claigan Environmental staff and students for their contributions. And thank you to all of our industry members who contributed so much in such little time.

RECEIVED
By: OAH on 2/29/2024
Kevin Farnam Attachment

GARMIN

Garmin International, Inc.
1200 E. 151st Street
Olathe, KS 66062

Letter of Support

Garmin International, Inc. stands firmly behind efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. However, we express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. It's important to acknowledge that PFAS play a vital role in ensuring product functionality and meeting stringent safety standards.

In line with our commitment to finding balanced solutions, Claigan Environmental has developed a comprehensive Currently Unavoidable Uses (CUU) proposal, which is being submitted to the states of Maine and Minnesota. This proposal is founded upon rigorous laboratory testing and incorporates valuable insights gathered from diverse stakeholders. By engaging experts from various industries, Claigan Environmental has adopted a collaborative approach to address this complex issue.

Garmin International, Inc. actively participated in the consultation process and supports Claigan Environmental's submission. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS while mitigating adverse impacts on businesses, communities, and public health.

Kevin G. Farnam

Kevin G. Farnam
Environmental Product Compliance Program Director
1200 E. 151st Street | Olathe, KS 66062 | *913.440.2894*

RECEIVED
By: OAH on 2/29/2024

HITACHI
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Hitachi Energy Response to Minnesota Proposal

Current Unavoidable Uses (CUU) for Minnesota State - Chapter 60, H.F n°2310

In response to the Minnesota Pollution Control Agency (MPCA) plan for new rules governing how the MPCA determines and establish currently unavoidable uses of per- and polyfluoroalkyl substances (PFAS) in products, Hitachi Energy (HE) is committed to providing the most accurate and comprehensive information currently available for this response.

Questions made by Minnesota Pollution Control Agency (MPCA)

1. **Should criteria be defined for "essential for health, safety, or the functioning of society"?**
   If so, what should those criteria be?

Hitachi Energy supports MPCA initiative to protect human health, society, and the environment by controlling emissions of substances with known toxicological concerns. This goal needs to be achieved by employing a fact driven and risk-based regulatory approach in a sustainable manner, ensuring product reliability, and achieving critical targets such as the safety of the grid and the green energy transition. The group of PFAS is a large and inhomogeneous group of substances with very different physical and chemical properties, coming with vastly different levels of hazards. The human health, society and environmental implications of those substances are also different and depend on the nature and level of control of their use. Thus, sustainable regulation of PFAS should identify differentiated risk management measures in consideration of the risk of a specific substance in a specific use with its relevance for society.

We support the definition as outlined by the State of Maine's "Essential for Health, Safety or the Functioning of Society" and would encourage Minnesota to consider taking a similar approach/definition for efficiency and to harmonize the implementation of PFAS regulations.

According to Maine 38 M.R.S. §1614 (1) (B), the definition of "Essential for Health, Safety or the Functioning of Society" means: *"Products or product components that if unavailable would result in a significant increase in negative healthcare outcomes, an inability to mitigate significant risks to human health or the environment, or significantly interrupt the daily functions on which society relies. Products or product components that are Essential for Health, Safety or the Functioning of Society include those that are required by federal or state laws and regulations.*
Essential for the Functioning of Society includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, and construction."

This could work efficiently as a model for Minnesota as well. In reference to the specific context of the energy sector, we believe that the following considerations should be included in the criteria:

“*A secure supply of electricity is essential for the health and safety of society. Electrical power grids additionally support the integration of renewable technologies and enable green electricity to be accessed. Therefore, products used under harsh environmental conditions and high voltage like transformers High-power semiconductors etc. should be considered as critical for the safety and functioning of society.* “

2. Should costs of PFAS alternatives be considered in the definition of “reasonably available”? What is a “reasonable” cost threshold?

A non-comprehensive list of factors that will contribute to the reasonable availability of suitable PFAS replacements are as follows:

- The ability to perform safely and reliably. Maintain functionality under conditions of high temperature, pressure, and adherence, while also meeting requirements for chemical compatibility and inertness.
- Society and environment effects of the replacement material including potential design changes of devices/equipment in size, complexity, etc. including the related carbon footprint and other environmental impacts.
- Scale of production and the level of industrialization of these alternatives. Availability of the alternative in the sufficient quality and quantity to support green transition happening in US and across the globe.
- Economic viability and product size and cost are an important factor to take into account in the alternative assessments.
- The compatibility of the replacement material with the currently installed product base.

Therefore, the transition to PFAS-free alternatives is a complex process that goes beyond just identifying technically suitable substitutes.

Based on the above criteria, we support the definition outlined by Maine for “Reasonably available” be used as a model for Minnesota.

Pursuant to Maine 38 M.R.S. §1614 (1) (B), “reasonably available” means: *“PFAS alternative which is readily available in sufficient quantity and at a comparable cost to the PFAS it is intended to replace and performs as well as or better than PFAS in a specific application of PFAS in a product or product component.”*

3. Should unique considerations be made for small businesses with regards to economic feasibility?

We shall not provide any comments on this question.

4. **What criteria should be used to determine the safety of potential PFAS alternatives?**

PFAS alternatives should not endanger the operation of power generation or power supply to people in the United States. PFAS alternatives should be able to withstand the harsh temperature, pressure, and chemical inertness properties required for reliability of the power grids.

PFAS replacements would need to meet standard rules and regulations as all other chemicals in the market used in electrical power systems do. Any alternative material must undergo vigorous testing and certification processes to ensure there is no risk to the functioning of the grid and thus of society.

Condition of use and full material lifecycle, as well as application type (e.g. consumer or industrial product) shall be taken into account in assessing the risks of the material with respect to health and environmental impact.

5. **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?**

The longevity of "currently unavoidable use" (CUU) determinations is a critical consideration. We firmly advocate for a reasonable and pragmatic timeframe that aligns with the lifespan of critical energy infrastructure.

We would highlight for certain applications that there are no alternative technologies and such discussions on replacements can only take place when technological advancements occur. In general terms, given the complexity of the electricity systems and the required lead times for developing alternative materials, new designs or construction of necessary updates/replacements, the development time may according to our experience last a couple of decades, if at all possible. We justify this time as finding appropriate PFAS replacements require scientific experimentation, alternative technology development, engineering feasibility operational processing, supplier qualification, quality assurance testing, and field testing by end-users.

Because of uncertainty of alternatives feasibility and very long development time needed even in best case, it is recommended to review the decisions depending on the progress in the technologies.

6. **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? (I) Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? (II) What information should be submitted in support of such requests? (III)**

- Question (I)

Ideally, regulatory standards around exceptional use cases of CUU of PFAS should be harmonized within the United States as much as practicable.

The determination of CUU should also differentiate between the industries making the request. Efforts to reduce PFAS from consumer goods is strongly encouraged, as there is significant contact with humans and high likeliness to be disposed of in landfills and waterways. Conversely, in highly specialized electrical grid equipment all PFAS are handled by trained and adequately protected professionals, our products have long use lifetimes, and our facilities will be decommissioned by professionals at the end of life.

- Question (II)

We do not recommend that stakeholders in other organizations should be able to make a PFAS unable to be claimed by CUU criteria. PFAS are used in many different ways and for different purposes. Such a per se request does not consider appropriately such variety and potential other criteria affecting health, safety and environment, i.e., the potential availability of alternative solutions must be seen in context of additional aspects and their damage potential. In turn, the availability of such a request could trigger the misuse of the regulation to gain an unfair competitive advantage promoting seemingly alternative solutions, which however may overall bear other and higher risks for health, safety and environment. This would eliminate competitive solutions within the industries to the disadvantage of the end consumers, and with the risk of additional damage for health, safety and environment.

- Question (III)

The following information should be used in support of CUU determination:

- Properties of specific PFAS.
- Use(s) of specific PFAS and fact-based impacts on health, safety, and environment.
- Technical alternatives and impacts on health, safety, and environment.
- Socioeconomical impacts of PFAS removal.
- The use of solid-state fluoropolymers in non-consumer products.
- No intent to release the PFAS into the environment.

7. **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why.**

   Note: There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

Electrical grid equipment including high voltage switchgear, transformers, HVDC equipment, monitoring devices, power electronics semiconductors and other power grid components use specific types of PFAS materials in order to meet quality and reliability requirements essential for grid operation in supplying electricity within the United States.

The primary specifications these materials must meet are long product lifetimes (often 40 years in operation), high material endurance, chemical inertness, material stability under extremely high temperature, pressure, and voltage. The mentioned product requirements are not easily substituted and in many cases there are currently no alternative technologies, thus defining Current Unavoidable Uses (CUU) by Minnesota Authorities is critical to our business and ensuring a high functioning electrical grid system in the United States.

Hitachi Energy acknowledges and fully supports the risk management of substances which are detected as environmental pollutants and potentially linked to negative effects on human health and the environment. The PFAS used in our electrical power equipment differ highly in risk level and properties compared with the PFAS which have been determined to be harmful to human health and the environment such as PFOS, PFOA, PFHxS, PFNA, or C9-C14 PFCAs. The majority of PFAS used in our products are either fluoropolymers or insulating gases. The amount of material used in our products is limited. More than 96% of globally used fluoropolymers, including PTFE and fluorinated elastomers used in electrical grid equipment, fulfill the widely accepted criteria for polymers of low concern as per OECD definitions.[1,2,3] We proved instructions that define how to properly recycle or incinerate such materials, e.g., PTFE components at end of life or at decommissioning. The fluorinated insulation gases used (e.g., Heptafluorobutyronitrile, C4-FN), replaces environmentally harmful sulfur hexafluoride (SF_6). C4-FN is classified as non-toxic through professional toxicological and ecotoxicological assessments as it does not accumulate in water, plants, or the soil and has an average atmospheric lifetime of 30 years.[4,5]

By design, electric power components from Hitachi Energy containing PFAS materials are secured on, or enclosed within associated products and where gas-tightness is assured in order to fulfill the product function and required by international standards.[5] Gas holding equipment is additionally monitored constantly through sensors to ensure functional integrity of the equipment. Release of such PFAS to the environment during normal use is then either not possible or extremely unlikely. PFAS release due to solid fluoropolymers during the 40 years of service life is not at all expected. Electric power grid products are exclusively maintained by trained professionals. Hitachi Energy also provides training and strict guidance to users of the products regarding safe and environmentally responsible means to dispose of the products as the end of life, in accordance with prevailing legislative requirements.

8. Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

Yes, CUU determination is critical to the operation of Electrical grids and power supply to people in the United States.

CUU determination as part of the rulemaking process could provide clarity and certainty for manufacturers and other stakeholders.

OECD concludes that PFAS as a definition only describes a class of diverse molecular structures with diverse physical, chemical, and biological properties and recommends that such diversity be properly recognized and communicated in a clear, specific and descriptive manner. Using PFAS as a descriptor is broad and generic and does not inform whether a compound is harmful[6]. While the lack of information for the majority of PFAS presents challenges for risk assessment, PFAS should not be grouped together for risk assessment purposes. “Persistence” alone is not sufficient for grouping PFAS for the purposes of assessing human health risk and it is inappropriate to assume equal toxicity/potency for PFAS without confirmatory information. CUU determination would enable to see the nuances between certain PFAS compounds, giving deeper understanding on the associated risks and rewards of certain compounds and gain a better understanding on a diverse class of compounds.

9. Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

Hitachi Energy recognizes the need to avoid emissions of substances with known toxicological concerns in order to best protect human health, society, and the environment. This goal needs to be achieved by employing a risk-based regulatory approach in a sustainable manner, ensuring product reliability, and achieving critical targets such as the safety of the grid and the green energy transition. To do so, any restriction of PFAS needs to be appropriately differentiated: the group of PFAS is a large and inhomogeneous group of substances with very different physical and chemical properties, coming with vastly different levels of hazards. The human health, society and environmental implications of those substances are also different and depend on the nature and level of control of their use. Thus, sustainable regulation of PFAS should identify differentiated risk management measures in consideration of the risk of a specific substance in a specific use with its relevance for society.

We suggest that Minnesota consider taking a unified approach for confidential business information (CBI) determination, based on the CBI determination made under Toxic Substance Control Act (TCSA).

These provide a broad approach of what is considered CBI and is well defined and used throughout the states.

In general, we agree that:

Confidential claims shall be asserted (and substantiated as necessary) at the time of submission.

CBI shall refer to sensitive information that business may want to keep confidential to protect their competitive position.

Additionally, we agree that:

Companies may claim certain information as CBI when:

- Specific information describing the processes used in the mass production or manufacturing process.
- Specific marketing and sales information.
- Information regarding specific characteristics of our products or details about how substances are used on them.
- Technical and R&D business information.

Contact information

Hitachi Energy USA Inc.

Judi Sobecki

Head of Legal and Secretary, North America

Email: judi.sobecki@hitachienergy.com

Attention: Minnesota Pollution Control Agency

Revisor's ID number R-4837

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RECEIVED
By: OAH on 2/29/2024
Javaneh Tarter Attachment

R·MOR™ PROTECTIVE WEAR By Lac·Mac

March 1, 2024

Katrina Kessler, Commissioner
Minnesota Pollution Control Agency (MPCA)
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

Re: Comments on MPCA Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

Dear Ms. Kessler,

Lac-Mac Limited (Lac-Mac) appreciates the opportunity to provide these comments[1] in response to MPCA's Planned New Rules Governing "Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837." This rulemaking is referred to as the PFAS in Products Currently Unavoidable Use Rule. The purpose of this rulemaking is to establish criteria and processes for MPCA to make decisions on what if any uses of intentionally added PFAS will qualify as currently unavoidable uses in products sold, offered for sale, or distributed in Minnesota.

Located in Canada, Lac-Mac is North America's leading manufacturer of reusable protective clothing for blood borne pathogen protection (surgical protection), liquid chemical splash protection, flame resistant/ARC protection for utilities, and high-visibility liquid-proof protection. We specialize in quality, high-performance, liquid-proof, breathable personal protective equipment (PPE) products. We sell our products in the United States, including in the state of Minnesota.

Minnesota's PFAS in Products Law bans the sale and distribution of certain products containing intentionally added PFAS starting in 2025 (e.g., carpets and rugs, cleaning products, cookware, textile furnishings, etc.), and then *all* products containing intentionally added PFAS starting in 2032. MPCA has the authority to exempt "currently unavoidable uses" of PFAS, which are uses that MPCA has determined to be "essential for health, safety, or the functioning of society and for which alternatives are not reasonably available." MPCA is seeking comment now on any relevant issues related to what should be "currently unavoidable uses" and, thus, exempt from this ban.

As MPCA develops its PFAS in Products Currently Unavoidable Use Rule, **we urge MPCA to determine, by rule, that PPE products like the products we sell are "currently unavoidable uses" of PFAS** and, therefore, would be exempt from any future prohibitions on the sale or distribution of PFAS-containing products in the State of Minnesota.

PPE is essential for the health, safety and functioning of society and for which alternatives are not reasonably available. PPE products provide critical protection for workers who are exposed to various physical and chemical hazards in the workplace. Particularly in chemical facilities and in healthcare settings, it is vital for safety and public health to ensure the workforce in Minnesota has continued access to necessary PPE. Our concern is that without an exemption for "currently

[1] Comments have been submitted electronically to: https://www.pca.state.mn.us/get-engaged/pfas-in-products-currently-unavoidable-use.

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unavoidable uses," PPE manufacturers like Lac-Mac or other companies will be forced to no longer sell its products in Minnesota and leave thousands of workplaces with far more limited options for available protective clothing, creating a public health emergency or exposing workers to more risks in the workplace. This is contrary to the intent of Minnesota's PFAS law, which is to protect individuals from exposures to chemicals.

Further, there is legal precedent for Minnesota to adopt this approach. The two other states that have enacted similar prohibitions on the sale of PFAS in apparel or textiles, California and New York, have provided exclusions for PPE:

> California Health & Safety Code 108970[2]: The law prohibits the manufacture, sale or distribution of textile articles containing regulated PFAS starting January 1, 2025. The law excludes from the definition of apparel "personal protective equipment."

> New York Env. Chapter 43-B, 37-0121[3]: The law prohibits the sale of apparel containing intentionally-added PFAS starting January 1, 2025. The law excludes from the definition of apparel "professional uniforms that are worn to protect the wearer from health or environmental hazards, including personal protective equipment."

The state of Maine's PFAS and Products Law, 38 MRSA 1614[4], which prohibits all products containing intentionally added PFAS starting January 1, 2030, also allows for exemptions for "currently unavoidable uses" of PFAS and defines this term the same as Minnesota's law. Maine is still developing its regulations to implement the law.[5] We have provided similar comments about PPE being classified as a "currently unavoidable use" to Maine's Department of Environmental Protection.

Therefore, Minnesota would be aligning with other states in exempting the use of PFAS in PPE from any ban so that essential medical supplies and worker safety garments will continue to be available for employers and workers.

We have also provided feedback in response to MCPA's questions in this rulemaking:

In developing the currently unavoidable use rule, the MPCA would appreciate comments on the following questions:

> 1**) Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?** Criteria should consider whether the presence of PFAS contributes directly to the functional performance for delivering safety (such as PPE) which also provides an important health function.

> **2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?** Yes, to the extent a PFAS alternative solution will render the product non-competitive in the market (i.e., will the solution be economically viable?).

> **3) Should unique considerations be made for small businesses with regards to economic feasibility?** Considerations and viable solutions should be for all, whether large or small businesses.

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[2]https://leginfo.legislature.ca.gov/faces/codes_displayText.xhtml?lawCode=HSC&division=104.&title=&part=3.&chapter=13.5.&article=.
[3] https://www.nysenate.gov/legislation/laws/ENV/37-0121.
[4] https://legislature.maine.gov/statutes/38/title38sec1614.html.
[5] Lac-Mac is submitting similar comments to the Maine Department of Environmental Protection for consideration as it develops rules to implement its PFAS in Products Law.

4) What criteria should be used to determine the safety of potential PFAS alternatives? Solutions should meet the same industry standards as the current PFAS containing product.

5) How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation? In our experience, 5 years is the minimum duration of time required to develop and fully test a new solution when changing a high-performance protective product. While most manufacturers are avidly working on solutions for a PFAS replacement, an appropriate window of time should be permitted to successfully deliver a safe and viable solution.

6) How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests? Consider whether the PFAS contributes directly to the protective performance attributes with no comparable alternative available. Consider whether the PFAS additive is a topical treatment or in solid state.

7) In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination. PPE which provides the highest level of protection from BloodBorne Pathogens for surgical teams. Garments which provide protection from a host of hazards such as; Exposure to Electric Arc Flash, Organic and Inorganic Chemical Exposure and Protection from Flammable Hazards to name a few.

8) Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria? We would like to see MPCA include consideration for excluding personal protective equipment (PPE) which are essential for health and safety currently containing PFAS when evaluating unavoidable use determinations.

Thank you for the opportunity to comment and please contact Shelley Petrovskis if you would like more information from us.

Sincerely,

S. Petrovskis

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RECEIVED
By: OAH on 2/29/2024

HARC

March 1, 2024

Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

Submitted online via OAH Rulemaking eComments Website

Re: Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl Substances (PFAS), Revisor's ID Number R-4837

Disclaimer: Nothing in this submission relates to firefighting foams or the chemical agents used in firefighting foam.

Note on Terminology: In this submission we use the term halogenated clean agents (HCAs) to refer to the fluorinated chemicals used in total flooding fire suppression systems and portable fire extinguishers. HCAs used in total flooding fire suppression systems are also commonly referred to as gaseous fire extinguishing agents.

The Halon Alternatives Research Corporation, Inc. (HARC) appreciates the opportunity to provide information to the Minnesota Pollution Control Agency (MPCA) in response to its request for comments on planned new rules on currently unavoidable uses of PFAS. HARC is a non-profit trade association formed to promote the development and approval of halon alternatives that serves as an information clearinghouse and focal point for cooperation between government and industry on issues of importance to special hazard fire protection. HARC members encompass all levels of the fire protection industry including agent manufacturers, equipment manufacturers, distributors/installers, recyclers, and end-users.

The fire protection industry has a strong record of taking voluntary actions and supporting regulations to reduce the environmental impact of halogenated clean agents (HCAs). In the early 1990s when informed that halons were potent ozone depleting substances (ODS), the industry immediately stopped any testing and training with halons, developed a voluntary code of practice for halon use, and supported the accelerated 1994 phaseout of halon production under the Montreal Protocol. To reduce the impact of the high global warming potential (GWP) hydrofluorocarbons (HFCs) used as alternatives to halons the industry developed a voluntary code of practice to minimize emissions[1] and a recycling code of practice[2], created a data collection program to estimate emissions[3], and supported the phasedown of HFC production under the Kigali Amendment to the Montreal Protocol. The HFC phasedown under the AIM Act has significantly reduced the use of HFCs in new fire suppression systems.

Need for a Currently Unavoidable Use determination for HCAs used in fire suppression

The HCAs used for fire protection that meet the definition of PFAS in the Minnesota law are FK-5-1-12, HFC-227ea, HFC-125, HFC-236fa, 2-BTP and HCFC Blend B. While there are non-PFAS alternatives for HCAs that have been available for several decades and are widely used, we write to inform MPCA that there are important uses of HCAs in facility, aviation and military applications for which non-PFAS alternatives do not exist and are not currently in development. As such we expect there to be continuing uses of HCAs for fire suppression well beyond January 1, 2032.

The development of new substances has been aggressively pursued within this sector for more than 30 years, well before the phaseout of halons, with millions of dollars and extensive time and efforts of myriad private and public organizations spent on development with limited success. An expectation that new options not already considered in the past can be developed and brought to market in 5, 10, or 20 years is not supported by historical experience. Several important fire risk applications (for example civil aviation and nuclear power plants) still require halon even after pursuing alternatives for 30 years.

It is this history that leads to the consensus within the fire protection community that it is highly unlikely new non-PFAS alternatives will suddenly be discovered. Below is a quote from the 2023 Progress Report of the United Nations Environment Program (UNEP) Technology and Economic Assessment Panel (TEAP) that sums up this consensus:[4]

"Furthermore, all known candidate clean agent chemical groups have already been researched, such that discovering alternatives that are zero ODP, low GWP, and non-PFAS is highly unlikely. Based on these factors, there is little to no financial incentive for companies to invest in the research and development of potential new fire suppression agents. As there are no new candidate fire suppressants available for consideration that are not PFAS under these broad definitions, it is anticipated that the only options that will be available after the 12-year derogation are the same ones available today."

The 12-year derogation mentioned in the above quote refers to the current proposal in the European Union (EU) Universal PFAS REACH restriction report for an exemption for "clean fire suppressing agents where current alternatives damage assets to be protected or pose a risk to human health" that would extend to around 2039.[5]

Possible wording of a Currently Unavoidable Use determination for HCAs used in fire suppression

Historically it has proven difficult to define a list of uses of HCAs for fire suppression that are essential/critical or in the case of the Minnesota PFAS law "currently unavoidable." The diversity of applications and the unique requirements of individual facilities makes it very challenging to claim that an alternative, non-PFAS technology is viable across a general use category such as data centers or control rooms. Each data center, for example, will have different criteria and requirements for the fire protection technology selected.

HARC would recommend that MPCA adopt language similar to what is in the EU F-gas regulation,[6] where HFC fire protection equipment can be sold after the January 1, 2025, prohibition if it is “required to meet safety requirements.” Tying the currently unavoidable use determination only to situations where alternatives do not meet safety requirements would significantly limit the future use of HCAs for fire suppression in Minnesota.

Below is proposed wording for a Currently Unavoidable Use determination for HCAs that combines language used in the Universal PFAS REACH restriction report and the EU F-gas regulations:

“Clean fire suppression agents where necessary to meet safety requirements”

Definition of product

The definition of “product” in the Minnesota PFAS law “means an item manufactured, assembled, packaged, or otherwise prepared for sale to consumers…” Fire protection equipment containing HCAs is not sold to consumers and is limited to commercial, industrial and military uses. The meaning of the second part of the definition that refers to “its product components, sold or distributed for personal, residential, commercial, or industrial use” is not clear. HARC is not aware that the product components of HCA-based fire protection equipment are used to produce other products that are sold to consumers. HARC would ask that MPCA clarify in the proposed rule whether the PFAS restrictions would cover total flooding fire suppression systems and portable fire extinguishers sold only for commercial, industrial and military use.

Recycling and emissions

Emissions of HCAs from modern fire protection equipment are extremely low. The Montreal Protocol Fire Suppression Technical Options Committee (FSTOC) 2022 Assessment Report uses an annual emission rate for HCAs of 3%.[7] This is a worldwide estimate that would include both developed and developing countries. The latest installment of the US EPA Vintaging Model, which estimates use and emissions of ODS alternatives in the United States, uses a 1.5% emission rate for HCAs in total flooding fire protection systems installed between 2003–2019 and 1% after 2019.[8]

Due in part to their low emission rates and high value, HCAs used in fire protection have historically enjoyed very high levels of recycling. Evidence of this can be seen in the continued availability of significant quantities of recycled halons for critical uses such as aviation even though it has been 30 years since production ended in the United States and 14 years since it ended worldwide. An EPA draft report on the HFC reclamation market contains a good discussion of halon and halon alternative recycling.[9] HARC agrees with EPA that the management of halons in the United States over the last several decades has demonstrated a model of collaboration between industry, government, and users. HARC believes this management model extends beyond halons so that most HCAs installed in fire protection equipment are recovered from decommissioned equipment and reused.

The Minnesota PFAS law contains an exemption in Subd. 8 for “the sale or resale of a used product." HARC is interpreting this to mean that recycled HCAs and fire protection equipment containing recycled HCAs could continue to be sold after January 1, 2032. Most of the servicing of HCA-based fire protection equipment is already performed using recycled agent and by 2032 we expect that most if not all new HFC-based fire protection equipment will be initially filled with recycled agent.[10] The combination of low emissions and the use of recycled agent for servicing and new equipment will significantly limit the size and environmental impact of a Currently Unavoidable Use determination for HCAs used in fire protection.

Overview of PFAS clean agents

The following Annex provides an overview of the PFAS chemicals used for fire suppression and their alternatives. Also enclosed is a technical note published by the FSTOC that lists all HCAs used for fire protection and provides information on their efficacy, physical characteristics, toxicity, environmental impacts, and international standards for their use. In addition, the report provides comparable information on non-PFAS alternatives to HCAs such as inert gases, powders, and water mist systems.

Conclusion

HARC is an advocate for human health and the environment, as shown by our 30-year history of taking voluntary actions and coordinating industry compliance with environmental regulations. We fully support efforts to reduce the use and emissions of PFAS. A Currently Unavoidable Use determination for HCAs used in fire protection that is limited to situations where alternatives cannot meet safety requirements would result in minimal PFAS emissions while continuing to provide for life safety and protection for high-value assets critical to society.

Please let us know if you have any questions or would like to discuss these issues in further detail.

Respectfully submitted,

Thomas Cortina
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ANNEX: OVERVIEW OF PFAS CLEAN AGENTS AND ALTERNATIVES

The following overview of PFAS chemicals used for fire suppression and their alternatives is broken down into three use categories: total flooding fire suppression, onboard aircraft fire suppression, and military.

OVERVIEW OF TOAL FLOODING FIRE SUPPRESSION

Background

HCA fire suppressants occupy a specialty market where there is a need to protect items that otherwise would be damaged by a fire extinguishing agent itself or a slow extinguishment process, and in enclosed spaces where many other fire suppressants would pose a risk to human health and safety. These specialty applications have unique challenges to providing fire and life safety. Clean agent fire systems are not normally required by code. They are an added expense to mitigate an unacceptable risk of losing assets, data or incurring downtime for a high-tech or historical preservation facility as a result of a fire. This risk analysis includes high value assets and business continuity, but also societal impact and security with the loss of critical services in the event of fire. In the interconnected electronic world, loss of telecommunications and internet access can pose significant societal impacts. This makes the grouping of applications for regulation within the category very difficult. In some cases, the assets within the protected hazard are critical, in others it is the function of those assets within the protected space that are of value, not necessarily the assets themselves.

PFAS used in total flooding fire suppression

The HCAs used for total flooding fire suppression that are defined as PFAS in the Minnesota law are: FK-5-1-12, HFC-227ea, and HFC-125. The chemical, physical, and thermodynamic properties, especially vapor pressure, differ among these agents and affect their storage, transport, atomization, and vaporization characteristics. These agents are stored as liquids in nitrogen-pressurized containers. Upon actuation of the fire extinguishing system, agent liquid is released into a pipe distribution system and discharged from nozzles into the protected enclosure as a vaporizing spray forming a uniform gaseous agent-air mixture throughout, thus the term “total flooding” fire extinguishing. Widely accepted standards require that the discharge time for systems using HCAs be completed in 10 seconds or less, which assures rapid flame extinguishment thereby minimizing damage to protected assets. The minimum design concentration (MDC) of agent in an enclosure is based on test procedures for the hazard type, described in an applicable national standard such as NFPA 2001[11] and is further tested and validated by approval agencies such UL and FM.

Fire extinguishing systems containing HCAs are used to protect a wide array of asset types, including:

1. Server rooms
2. Power supply rooms

3. Electrical switch gear rooms
4. Hospital (e.g., MRI labs)
5. Document storage vaults.
6. Cultural heritage structures
7. Anechoic chambers.
8. Chemical storage rooms
9. Flammable liquids
10. Battery Energy Storage Systems (BESS)
11. Marine
12. Oil and gas exploration
13. Military
14. Naval ships
15. Aerospace
16. Nuclear powerplant control rooms

Non-PFAS clean agent alternatives

Inert gases

Several inert gases (IG-01, IG-100, IG-55, and IG-541) are approved for use in total flooding fire extinguishing systems in occupied spaces. Inert gas agents are stored in high-pressure cylinders at pressures up to 300-bar or gas generated by a chemical reaction (energetics). Standards require that inert-gas fire extinguishing systems discharge in at most 120 seconds for Class A hazards (solid substances), and in at most in 60 seconds for Class B hazards (flammable liquids). Use of inert gas agents is permitted for occupied spaces provided that exposure of personnel to reduced oxygen concentrations is limited to 5 minutes where oxygen concentrations are 12% or greater.

Technical limitations affecting use of inert gas agents in place of HCAs are mainly due to (1) increased space and weight burden of inert gas cylinders, (2) where the inert gas agent concentration exceeds 62 percent at sea level equivalent they cannot be used in occupied areas.

Carbon dioxide (CO_2)

Carbon dioxide has a long history as an effective gaseous fire extinguishing agent in limited circumstances to protect against class B hazards. It is used in both total flooding and local-application fire extinguishing systems. However, carbon dioxide is fatally toxic at fire extinguishing concentrations, which severely limits its use in normally occupied enclosures except where certain requirements are met (NFPA 12).[12]

Not-in-kind alternatives to PFAS clean agents

Water-based systems

Sprinkler systems and water mist systems are both fire suppression systems and are widely used in hazard spaces where water is available at an adequate supply rate and quantity. Note that sprinkler systems are not tested and approved as fire “extinguishing“ systems. Ordinary sprinkler systems are intended to protect the facility and not necessarily the assets contained in it. Collateral damage to protected spaces and assets by water itself is, in some cases, a significant risk.

There are tested and approved total flooding type water mist fire extinguishing systems. Water mist systems are special hazard systems developed for the protection of specific hazards. There are no generally accepted design criteria for water mist systems, thus their effectiveness must be proven by fire testing on the hazard of interest. Collateral damage to assets by water itself is, in some cases, a significant risk.

Hybrid systems (water and inert gas)

These systems simultaneously discharge a fine water mist and inert gas such as nitrogen. They are approved for use as fire extinguishing systems in normally occupied spaces. The inert gas effects extinguishment through the dilution of oxygen while the fine water droplets provide cooling which also contributes to fire extinguishment. As with inert gas systems, personnel exposure times to reduced oxygen concentrations is limited to 5 minutes where oxygen concentrations are 12% or greater (NFPA 770).[13] Collateral damage to protected spaces and assets by water itself is, in some cases, a significant risk.

Powdered aerosol agents

A powdered aerosol fire extinguishing unit discharges a fixed amount of fine extinguishing powder, forming a flame-extinguishing powder cloud, which acts in a *total-flooding* manner. Powdered agents, as such, are not “clean” agents and can damage certain assets such as electronics. Under the US EPA SNAP program, two powdered aerosols are listed as acceptable for use in occupied spaces.

Applicability of alternatives to PFAS agents

For an alternative agent to be an acceptable replacement for a PFAS fire extinguishing agent (a “clean” agent) in an application it must be able to meet the critical regulatory requirements including:

1. Safe for human exposure at the agent fire suppression design concentration.
    a. At or below the No Observable Adverse Effect Level (NOAEL) concentration exposure to gaseous agents is limited to 5 minutes.
2. Extinguishment time at the minimum design concentration compliant with applicable standards.
    a. Class A fire (involving ordinary combustible materials, such as wood, cloth, and paper): Extinguishment time of 10 minutes or less.
    b. Class B fire (involving flammable or combustible liquids, petroleum greases, tars, oils, oil-based paints, solvents, lacquers, and alcohols): Extinguishment time of 30 seconds or less.

Other non-regulatory requirements may be deemed essential in some applications including:

1. Agent must be "clean," i.e., electrically non-conducting volatile liquid or gaseous agent which leaves no residue (liquid or solid).
2. The physical size of installed equipment (agent containers, piping, control equipment) must be able to fit in the available space.
3. The weight of the installed equipment must be less than the maximum allowed floor loading or vehicle capacity, as applicable.
4. The agent must be able to achieve the required "hold-time," i.e. the duration of protection after the end of agent discharge.

OVERVIEW OF ONBOARD AIRCRAFT FIRE SUPPRESSION

Background

Although the incidence of in-flight fires is low, the consequences in terms of loss of life are potentially devastating, and the use of HCAs to help guard against such events has been a key aspect of aircraft fire safety for over 50 years. Aviation applications are among the most demanding and critical uses of the fire suppression agents and require every one of their beneficial characteristics. Particularly important are the following:

- dispersion and suppression effectiveness, which must be maintained even at the low temperatures encountered at high altitude,
- minimal toxic hazard to the health and safety of ground maintenance staff and passengers and flight crew, who could be exposed to the agent and any decomposition products for periods as long as several hours, and
- weight and space requirements of the agent and associated fire protection system.

Also significant are short- and long-term damage to aircraft structure or contents resulting from the following:

- the agent or from its potential decomposition products in a fire,
- avoidance of clean-up problems,
- suitability for use on live electrical equipment,
- effectiveness on the hidden fire (the ability to indirectly extinguish fires), and
- the installed cost of the system and its maintenance over its life.[7]

Historically halons were used in active fires suppression systems to protect lavatories, engines nacelles, auxiliary power units (APUs) and cargo compartments, and in handheld extinguishers in the passenger cabin. After 30 years of research, testing and standard development, Halon 1301 systems are still being installed in the cargo compartments, engine nacelles and APUs of all new production aircraft. With the runout date for supplies of recycled halons possibly less than 10 years away, it is critical that alternatives begin being used as soon as possible. At a time when airframe manufacturers and OEMs have been acting with urgency and are close to gaining approval for halon replacements, the PFAS issue has the potential to set those efforts back several decades. Below is a quote from the 2023 Progress Report of the Montreal Protocol Technology and Economic Assessment Panel (TEAP) that expresses this concern:[4]

"A new factor that may affect the halon 1301 and 1211 run-out dates is the proposed PFAS regulations. There are many fluorine containing fire suppression agents which may be regulated under the pending PFAS regulations that only have halon as an alternative. Destruction of PFAS fire suppressants in lieu of recovery and re-use or a reluctance to decommission existing halon systems and convert to alternatives that would be considered PFAS may put additional pressure to continue reliance on halons."

PFAS used for onboard aircraft fire suppression and alternatives

HFCs

HFC-227ea and HFC-236fa are currently used in lavatory fire suppression systems on commercial aircraft as a replacement for Halon 1301. There are other HCAs in development for this use, but no non-PFAS alternatives have passed the Federal Aviation Administration (FAA) minimum performance standard (MPS). Based on the nature of the hazard and the small size of the required system, it is possible that a non-PFAS agent such as inert gas or water could be made to work in this application, however, no testing of these agents for this application has been successfully completed to date. Given the long lead times required to gain approval for the use of a new fire suppressant on aircraft, HFCs are likely to still be installed in lavatories on commercial aircraft after January 1, 2032.

2-BTP

Handheld extinguishers containing 2-BTP (2-bromo 3,3,3-trifluoropropene) are currently being installed on most new production aircraft as a replacement for Halon 1211, and some existing aircraft are expected to be retrofitted to 2-BTP extinguishers in the future. International Civil Aviation Organization (ICAO) standards called for all new production aircraft to be installed with handheld extinguishers containing a Halon 1211 replacement by 2018.[14] There are currently no other candidate agents for this use that are not also PFAS. Non-PFAS alternatives such as CO2, dry powder, and water have been tested for this use and failed to pass the handheld extinguisher MPS tests.

2-BTP is also under development to replace Halon 1301 in cargo compartments of commercial aircraft as part of a blend with CO_2. The FAA completed proof-of-concept testing for the 2-BTP/CO_2 blend in 2018[15] and cargo MPS testing was successfully conducted by the FAA in 2019.[16] Additional testing to an updated cargo MPS multiple fuels fire (flammable liquid / lithium battery / class A) was successfully completed in 2023. A non-PFAS alternative in the form of a hybrid water mist/inert gas system using nitrogen passed a previous cargo MPS in 2017, but has not been subjected to the latest version of the MPS and would require modification to pass the newer test standards.[17] Further detailed information on the status of efforts to replace Halon 1301 in cargo fire extinguishing systems is available in the International Coordinating Council of Aerospace Industries Associations (ICCAIA) Aircraft Halon Replacement Working Paper presented at the 41st Assembly of the International Civil Aviation Organization (ICAO) in 2022.[18]

OVERVIEW OF MILITARY FIRE SUPPRESSION

Background

Military fire protection systems are unique in that they must protect personnel and platforms from the consequences of combat damage and also protect against ‘peacetime’ fires. Fires due to combat events are generally very fast-growing and relatively large. Fire protection systems are required to counter these threats, often while allowing occupants to remain in the affected spaces. A point to consider when choosing extinguishing agent for spaces that are normally occupied is whether the enclosure must remain operational during combat operations or can be evacuated. If the enclosure must stay occupied during a fire event, then a limited number of agents are available for consideration due to toxicity concerns. However, if evacuation of the enclosure is an option, a wider range of agents is available similar to commercial applications.[7]

PFAS used for military fire suppression and alternatives

The full range of HCAs and non-PFAS alternatives have been investigated for military applications, including CO2, inert gases, HFCs, dry chemicals, and other gaseous chemicals. For some of these specialized applications, HFCs have been the only alternatives demonstrated to meet these stringent requirements. HFC-125, HFC-227ea and to a lesser extent HFC-236fa are used for fire and explosion suppression in critical military applications including the following:

- Protection of engine and crew compartments on military ground vehicles
- Protection of machinery spaces, engine spaces, command centers, fuel pump rooms and flammable liquid storage compartments on naval ships and submarines
- Protection of crew compartments and engines on military aircraft

Like civil aviation, 2-BTP is currently replacing Halon 1211 in handheld extinguishers on military aircraft.

Significant research has shown that there are no alternatives to HCAs that meet all military performance requirements. Thus, many of today’s fielded weapon systems and support equipment will remain in service for the foreseeable future. Barring mandatory decommissioning, these mission-critical HCA-based fire protection systems will need to be supported to at least 2050 and likely beyond. Fire protections systems on military vehicles, ships and aircraft can realistically only be replaced when major maintenance or modifications/upgrades are carried out since they are normally in service and operating all over the world. Given that the military sector is not a significant user of these chemicals in terms of global demand, industry sources have informed militaries that they have no plans to invest additional resources to develop alternative chemicals specifically for these unique applications. Therefore, military investigations into alternatives are limited to those chemicals that are used for other commercial applications.

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MONTREAL PROTOCOL
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THE OZONE LAYER

REPORT OF THE
HALONS TECHNICAL OPTIONS COMMITTEE
DECEMBER 2018

TECHNICAL NOTE #1 – REVISION 5
FIRE PROTECTION ALTERNATIVES TO HALONS, HCFCS AND HFCS

UN environment
United Nations
Environment Programme

Montreal Protocol
on Substances that Deplete the Ozone Layer

Report of the
Halons Technical Options Committee

December 2018

Technical Note #1 – Revision 5

FIRE PROTECTION ALTERNATIVES TO HALONS, HCFCS AND HFCS

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Preface

Technical Note #1, *Fire Protection Alternatives to Halons, HCFCs and HFCs*, supplements Chapter 3, of the same title, of the 2018 Assessment Reports of the UNEP Halon Technical Options Committee (HTOC). The Halon Technical Options Committee elected to take this approach as much of the information that, while important to understand when developing strategies for selecting alternatives to halons, has been largely reported in prior editions of Assessment Reports. The Assessment Reports contain important new updates on evolving technologies, but this usually forms only a small portion of the chapter content. As such, it was deemed by the HTOC to make the *Alternatives* subject a stand-alone document that is referenced by future Assessment Reports. By this approach those having particular interest in the technical aspects of the *Alternatives* subject can access a self-contained document addressing those issues.

Following the Kigali Amendment to the Montreal Protocol, the role of the HTOC has broadened in that it now has to cover alternatives to high-GWP HFCs as well as halons, HCFCs and their alternatives. Therefore, the contents of this technical note have been expanded accordingly.

Table of Contents

List of Tables

1 Introduction

Halons were remarkably good fire extinguishants; following their production phase-out, only 25% of system applications were “in-kind” (vaporizing liquids that left no residue and acceptable toxicity), the other 75% being various other “not-in-kind” solutions (e.g., sprinklers, water mist, foam, dry chemical, carbon dioxide (CO_2)). For portable extinguishers, the split is approximately 20% “in-kind”, 80% “not-in-kind”.

There are several in-kind alternatives to halons. These started with hydrochlorofluorocarbons (HCFCs) and perfluorocarbons (PFCs), followed closely by hydrofluorocarbons (HFCs) and inert gases (IGs), and more recently by a fluoroketone (FK). The HCFCs and PFCs are no longer used in new total flooding fire extinguishing systems and their use is limited to supporting existing systems. Today, for all practical purposes, there are three types of in-kind alternatives to the ozone-depleting fire extinguishants (halons and HCFCs) used in new fire extinguishing systems - these are HFCs, inert gases and an FK. The FK and inert gases also represent low-Global Warming Potential (GWP) and no-GWP alternatives to the halons, PFC’s, HCFCs and high-GWP HFCs. The status of each class of gaseous fire extinguishing agent is summarized in Table 1.1 below.

Table 1.1: Alternatives to Halons, PFCs, HCFC and HFCs

Agent type	ODP	GWP	Status as alternative
Halons	High	High	N/A
PFCs	Zero	High	Can be viewed as halon alternatives, but only to support existing systems
HCFCs	Low	Low	Can be viewed as halon alternatives, but only to support existing systems
HFCs	Zero	High	Can be viewed as halon, PFC & HCFC alternatives
FK	Zero	Low	Can be viewed as halon, PFC, HCFC & HFC alternatives
HBFOs	Very low	Very low	Can be viewed as halon, PFC, HCFC & HFC alternatives
Inert Gas	Zero	Zero	Can be viewed as halon, PFC, HCFC & HFC alternatives

Since the 2014 Assessment Report, no substantial progress on potential alternatives has been reported. A hydrochlorofluoro-olefin, HCFO-1233zd(E), was proposed but has subsequently been withdrawn. More recently, the manufacturer has proposed a blend of this agent with the fluoroketone FK-5-1-12. Nevertheless, the HTOC is of the opinion that although research to identify potential new fire protection agents continues, it could be several years before a viable agent could possibly have significant impact on the fire protection sector. This could be as little as five years if the agent has undergone some development (e.g. CF_3I) or as much as ten years if the agent is only in the research and development phase.

1.1 Overview

Halons 1301, 1211, and 2402 are highly effective, important fire extinguishing chemicals. Unfortunately, halons are potent ozone depleting substances (ODSs), and, as such, were phased out of production, beginning in the mid-1990s under the terms of the Montreal Protocol and its amendments. Availability of halons today relies entirely on recovered and recycled materials. Several non-(ODSs) have been introduced for use as fire extinguishant alternatives. Technical Note #1 addresses several technical aspects of halon, HCFC and HFC alternatives. To begin, it is useful to understand different types of fires as they relate to selection of the best available alternative extinguishing agents.

1.1.1 Fire types and classification

There are several categories of fire types based on the physical or chemical nature of the fuel involved. The designation of the classification of fuel types varies by region and is summarized below.

Table 1.2: Classifications of fuel types by region

	Fuel Type Classification	
Region	United States	Europe, Australia & Asia
Ordinary combustibles (wood, paper, plastics, etc.)	Class A	Class A
Flammable liquids	Class B	Class B
Flammable gases	Class B	Class C
Electrical equipment	Class C	Class E
Combustible metals	Class D	Class D
Cooking oil or fat	Class K	Class F

1.1.2 Considerations in selecting a fire extinguishing agent

Halons, HCFCs and HFCs were not, and are not, used on fires involving combustible metals, nor for fire extinguishment in commercial cooking applications (hot cooking oils). These agents were commonly used for fire protection in applications involving the other listed fire classes - ordinary combustibles, flammable liquids, flammable gases, and electrical equipment. Each fire protection application involving one or more of these fire types has distinct characteristics that must be considered in selecting the best alternative fire protection technology. Examples of important application characteristics include:

- temperature, pressure, and altitude above sea level of the protected object or space;
- temperature of the location of the agent storage tanks;
- whether or not the space may be occupied at the time a fire occurs;
- whether fire extinguishing is to be achieved by directing agent directly onto or about a protected object or surface (local application);
- whether fire extinguishing is to be achieved by creation of a fire extinguishing atmosphere throughout a defined volume (total flooding);

- pressure strength of the enclosure;
- availability of a water supply;
- asset or operational value of objects and spaces being protected;
- ability to minimize collateral damage and thereby limit downtime of equipment;
- sensitivity of protected objects and spaces to collateral damage by water or combustion gases (including agent decomposition gases, if applicable).

Halons, as defined in Group II of Annex A of the Montreal Protocol, form a class of halogenated chemicals containing bromine that have been, and in some instances, continue to be used as gaseous extinguishing agents in a wide range of fire and explosion protection applications. As previously noted, halons are potent stratospheric ozone depleting chemicals when released to the atmosphere. Halons have been phased out of production under the Montreal Protocol. The phase-out of halon production has had a dramatic impact on the fire and explosion protection industry. Halons are clean (do not leave non-volatile residues), non-conductive, and highly effective. Halon 1301, in particular, is safe to breathe at concentrations typically employed for total flooding fire extinguishing systems and explosion prevention (inerting) applications. HFCs, the FK and the inert gases developed to replace halons are also clean, non-conductive and are safe to breathe at the concentrations employed. There are some cases where only the original halon or a high-GWP HFC are the only choices to meet fire protection requirements, e.g., crew spaces of armoured vehicles and low temperature inerting.

Halon 1211 was widely employed as a “streaming agent” in hand-portable and wheeled fire extinguishing units. Alternatives include HCFC Blend B (HCFC-123, PFC-14 and argon), HFC-236fa and the FK, which also represents a low-GWP alternative to halon 1211, HCFC Blend B, and the high-GWP HFC-236fa, in some applications. Non-ODS alternatives exist for most applications but there are some cases where only the original halon or the HCFC Blend B or a high-GWP HFC are the only choices to meet fire protection requirements, e.g., for halon 1211 and HCFC Blend B - Aircraft Rescue and Fire Fighting vehicles on airport ramps; for halon 1211 and HFC-236fa . Halon 2402 has been used in both total flooding and streaming agent applications and its alternatives are the same as for halons 1301 and 1211.

Selection of the best fire protection method in the absence of halons, while also avoiding HCFCs and HFCs, is often a complex process. Either alternative gaseous fire extinguishing agents, or other agent types or extinguishing methods, may be used, but the decision is driven by the details of the hazard being protected, the characteristics of the gaseous agent or alternative method, and the risk management philosophy of the user.

Gaseous extinguishing agents that are electrically non-conductive and which leave no residue are referred to as “clean” agents. (By this definition, carbon dioxide is also a “clean” agent. However, carbon dioxide is fatally toxic to people at concentrations in air that are well below fire-extinguishing concentrations and, therefore, cannot be deployed in spaces where people may be exposed.) Several alternative clean agents, and “not-in-kind” alternative technologies, have been introduced to the market to serve fire protection applications once served by halons. With the impending phase-out of HCFCs and the phase-down of HFCs under the Montreal Protocol, the purpose of this technical note is to provide a brief review of the alternatives to halons, HCFCs and HFCs that are available, including information on physical and chemical characteristics, fire protection capabilities, toxicity, and key environmental parameters.

1.1.3 Standards

There are numerous national and international fire protection standards that affect some of the measures of performance and guidelines for minimum concentrations of gaseous agents, depending on hazard type. Two of the most widely-adopted are NFPA 2001 and ISO 14520 and these standards do not agree exactly for each type of fire hazard. The minimum design concentrations for the various fire-hazard types are outlined below.

- Class A combustibles surface fire
    - NFPA 2001 and ISO 14520 have adopted different standards for the minimum design concentration for extinguishment of a Class A surface fire.
    - ISO 14520. The minimum extinguishing concentration for a Class A surface fire hazard shall be the greater of the extinguishing concentration values determined by the wood crib and polymeric sheet fire tests described in ISO 14520 Annex C of the agent-specific part. The minimum design concentration for a Class A fire shall be the extinguishing concentration increased by a safety factor of 1.3.
    - NFPA 2001. The minimum extinguishing concentration for a Class A surface fire hazard shall be the greater of the extinguishing concentration values determined by the wood crib and polymeric sheet fire tests described in NFPA 2001 Annex A. The minimum design concentration for a Class A fire shall be the greater of the following:
    - The Class A extinguishing concentration times a safety factor of 1.2; or
    - The minimum extinguishing concentration for heptane as determined by the cup burner method.
- ISO 14520 “Higher Hazard Class A” applications.
    - This classification of Class A hazards includes examples such as: cable bundles greater than100 mm in diameter; cable trays with a fill density greater than 20 % of the tray cross-section; horizontal or vertical stacks of cable trays (closer than 250 mm); equipment energized during the extinguishment period where the collective power consumption exceeds 5 kW.
    - The minimum design concentration for Higher Hazard Class A applications shall be the higher of the minimum design concentration for either Surface Class A combustibles surface fire, or 95 % of the minimum design concentration Class B fuel fire.
- Class B fuel fire
    - Both NFPA 2001 and ISO 14520 are now in harmony with respect to requiring a minimum safety factor of 1.3 applied to the greater of the heptane extinguishing concentrations determined by the cup-burner method[1] or a pan-fire test[2] where the fire hazard is due to Class B combustibles.
- NFPA 2001 Class C fire hazard – electrified equipment
    - Equipment operating at less than 480 volts.
        - The minimum agent design concentrations is 1.35 times the Class A extinguishing concentration.

---

[1] See NFPA 2001 Annex B or ISO 14520 Annex B.

[2] See NFPA 2001, Annex A or ISO 14520 Annex C.

- Equipment operating at greater than 480 volts.
  - The minimum design concentration for spaces containing energized electrical hazards supplied at greater than 480 volts that remain powered during and after discharge shall be determined by testing, as necessary, and a hazard analysis NFPA

The following two subsections provide an overview of toxicity and environmental aspects of alternatives to halons, and the same principles apply to alternatives to HCFCs and HFCs. More detailed information on these topics and other agent properties is presented later, addressing total flooding and streaming agents, respectively.

1.1.4 Agent Toxicity

In general, personnel should not be exposed unnecessarily to atmospheres into which gaseous fire extinguishing agents have been discharged. Mixtures of air and halon 1301 have low toxicity at fire extinguishing concentrations and there is little risk posed to personnel that might be exposed in the event of an unexpected discharge of agent into an occupied space. The acceptance of new agents for use in total flooding fire protection in normally occupied spaces has been based on criteria that have evolved over the period of introduction of new technologies into the marketplace. In the case of inert gas agents, the usual concern is the residual oxygen concentration in the protected space after discharge. For chemical agents, the primary health issue is cardiac effects as a consequence of absorption of the agent into the blood stream. The highest agent concentration for which no adverse effect is observed is designated the “NOAEL” for “no observed adverse effect level”. The lowest agent concentration for which an adverse effect is observed is designated the “LOAEL” for “lowest observed adverse effect level”. This means of assessing chemical agents has been further enhanced by application of physiologically based pharmacokinetic modelling, or “PBPK” modelling, which accounts for exposure times. Some agents have their use concentration limits based on PBPK analysis. The approach is described in more detail in ISO 14520-1, Annex G, (2016). Health issues for the other alternatives (e.g. CO_2, water mist, fine solid particulate) are described in more detail later in this document.

1.1.5 Environmental Factors

The primary environmental factors to be considered for halogenated gaseous agents[3] are ozone-depletion potential (ODP), global-warming potential (GWP), and atmospheric lifetime, values of which are noted in Tables 2.1, 2.2, 2.5, 2.12, 3.1, 3.2, 3.3 and 4.1. It is important to select the fire protection choice with the lowest environmental impact that will provide the necessary fire protection performance for the specific application. The use of any synthetic compound that accumulates in the atmosphere carries some potential risk with regard to atmospheric equilibrium changes. Perfluorocarbons (PFCs), in particular, represent an unusually severe potential environmental impact due to the combination of extremely long atmospheric lifetime and high

[3] Halogenated gaseous agents, include hydrochlorofluorocarbons (HCFCs), hydrofluorcarbons (HFCs), perfluorocarbons (PFCs), a fluoroketone (FK), a fluoroiodocarbon (FIC), a hydrobromofluoro-olefin (HBFO) and potentially a hydrochlorofluoro-olefin (HCFO), that are used for fire-fighting applications. Each of these chemicals is stored either as a liquefied compressed gas or as a liquid at room temperature, is electrically non-conductive, and leaves no residue upon vaporisation.

GWP. PFCs are no longer used as primary extinguishants in new systems, though a small amount of CF_4, less than 2 %, is used as an additive in HCFC Blend B, a streaming agent. PFC use in legacy systems is diminishing. Thus, PFC agents are not considered to be viable alternatives and are not addressed further. International agreements and individual actions by national governments may affect future availability of several compounds and subsequent support for installed fire protection systems that utilize them. Some examples are presented below:

- HCFCs are scheduled for a production and consumption[4] phase-out for fire protection uses under the Montreal Protocol in 2020 in non-Article 5 **(non-A5)** parties and 2030 in Article 5 **(A5)** parties. In November 2018, the parties to the Montreal Protocol agreed to adjust the Protocol and adopted a corresponding Decision XXX/2 to allow the use of newly produced HCFCs for the servicing of niche applications such as fire suppression and fire protection equipment existing on 1 January 2020 for the period 2020-2029 for non-A5 parties and also on existing equipment in 1 January 2030 for the period 2030-2039 for A5 parties.
- The United Nations Framework Convention on Climate Change (UNFCCC) has identified carbon dioxide, methane, nitrous oxide and the fluorochemicals HFCs, PFCs and SF_6 as the basket of long-lived (>1 year) gases primarily responsible for anthropogenic changes to the greenhouse effect and potentially subject to emission controls. All uses of fluorochemicals represent 4–5% of current worldwide greenhouse gas emissions from long-lived gases on a carbon equivalent basis and fire protection uses represent less than 1% of those fluorochemical emissions.
- In October 2016, at the 28th Meeting of the parties in Kigali, Rwanda, Decision XXVIII/1 contained an amendment to add HFCs to the Montreal Protocol and slowly phase down their production and consumption. Unlike the controls on ODS that require a complete phase-out of production and consumption of controlled uses, the controls on HFCs are intended to only significantly reduce production (on a carbon dioxide equivalent basis), but not eliminate it. Under the Kigali Amendment, the production phase down would begin in most non-A5 parties with a 10% reduction in 2019 and end with an 85% reduction in 2036. For most A5 parties, the phase down would begin with a production freeze in 2024 and end with an 80% reduction in 2045. The amendment provides for a slight delay in the phase-down schedules for a group of parties in Eastern Europe and a group of parties with high ambient temperatures.

- In the EU, Regulation (EU) No. 517/2014 (known as the F-Gas Regulation), establishes rules on containment, use, recovery and destruction of fluorinated greenhouse gases in order to protect the environment. Related ancillary measures impose conditions on the placing on the market of specific products and equipment that contain, or whose functioning relies upon, fluorinated greenhouse gases, and establishes quantitative limits for the placing on the market of HFCs.

[4] Consumption equals production plus imports minus exports for an individual country.

2 Total flooding agents

A "total flooding" agent is any of several inert gases or volatile chemicals that, when dispersed throughout a protected volume, creates a fire extinguishing atmosphere. A number of fire extinguishing agent technologies have been commercialized for use in total flooding applications. Attributes of these are summarized, below.

Several agents have been incorporated into consensus standards, specifically NFPA 2001, ISO-14520 and other national standards, for use in normally occupied spaces. These agents include certain inert gases, HFCs and an FK. These agents may be used for total flooding fire protection in normally occupied spaces provided that the design concentration is below the safe exposure threshold limits shown in Tables 2.1, 2.2, 2.4 and 2.8. In addition, these standards include an FIC, but due to its higher toxicity this agent is not approved for normally occupied spaces.

The United States Environmental Protection Agency (US EPA), under the Significant New Alternatives Policy (SNAP) program, has reviewed a number of materials as substitutes for halons as fire extinguishing agents. The approval status in the US of a number of such alternatives for use in total flooding systems are included as Annex A.

Agencies of other countries administer their own regulations on suitability of alternatives to halons. One example is in Germany, the Berufsgenossenschaftliche.

2.1 Halogenated Gaseous agents

The tables below summarize key attributes of commercially available, technically proven halogenated gaseous agents for total flooding fire protection using fixed systems. The attributes addressed relate to efficacy, toxicity, volatility, environmental and relative cost characteristics. Cost effectiveness is represented by an index that is benchmarked against carbon dioxide total flooding systems, averaged over a wide range of application sizes, exclusive of the cost of pipe, fittings and installation and is based on 2003 data. Owing to commercial confidentiality, it has not been possible to use more current data, but nevertheless the indices are believed to be relatively accurate.

Table 2.1: Non-ODS halogenated gaseous agents

Agent	FK-5-1-12	HFC-23	HFC-125	HFC-227ea
Efficacy	For use in occupied spaces MDC(A) = 5.3 vol% MDC(B) = 5.9 vol% (1)	For use in occupied spaces MDC(A) = 16.3 vol% MDC(B) = 16.4 vol% • Suitable for "inerting" some otherwise flammable atmospheres at concentrations below the LOAEL value. • Suitable for use at low temperatures (below -20 °C).	For use in occupied spaces MDC(A) = 11.2 vol% MDC(B) = 12.1 vol%	For use in occupied spaces MDC(A) = 7.9 vol% MDC(B) = 9.0 vol%
Toxicity	NOAEL = 10 vol% LOAEL > 10 vol%	NOAEL = 30 vol% LOAEL > 30 vol%	NOAEL = 7.5 vol% LOAEL = 10 vol% Approved for use in occupied spaces at up to 11.5 vol% based on PBPK modelling.	NOAEL = 9 vol% LOAEL = 10.5 vol% Approved for use in occupied spaces at up to 10.5 vol% based on PBPK modelling.
	Some acidic decomposition products are formed when a halogenated fire extinguishing agent extinguishes a fire.			
Safety Characteristics	Liquid at 20 °C B.P. = 49.2 °C	Liquefied compressed gas. B.P. = -82 °C	Liquefied compressed gas. B.P. = -48.1 °C	Liquefied compressed gas. B.P. = -16.4°C
Environmental Characteristics (2)	ODP = 0 GWP = <1	ODP = 0 GWP = 12 400	ODP = 0 GWP = 3170	ODP = 0 GWP = 3350
Cost-Effectiveness, avg. for 500 to 5000 m^3 volume (2003 data)	~1.7 to 2.0	~2.0 to 2.3	Not available	~1.5

Note 1: MDC(A) and MDC(B) refer to the minimum design concentration for a Class A or Class B fire hazard.
Note 2: Source: IPCC 5^{th} WGI Assessment Report, 2013: http://www.climatechange2013.org/

The agents addressed in Table 2.2 are ODS. While use of these agents is permitted for use in new fire extinguishing systems in many jurisdictions, the practice at present is primarily to use these agents to recharge legacy systems and to choose non-ozone-depleting agent for new systems.

Table 2.2: HCFC agents

Agent	HCFC Blend A 82 weight% HCFC 22 9.5 weight% HCFC 124 4.75 weight% HCFC 123 3.75 weight% isopropenyl-1-methylcyclohexane	HCFC-124
Efficacy	For use in occupied spaces MDC(A) = 7.9 vol% MDC(B) = 9.0 vol%	For use in unoccupied spaces MDC(A) = (1) MDC(B) = 8.7 vol%
Toxicity	NOAEL = 10 vol% LOAEL > 10 vol%	NOAEL = 1 vol% LOAEL = 2.5 vol%
	Some acidic decomposition products are formed when a halogenated fire extinguishing agent extinguishes a fire.	
Safety Characteristics	B.P. = -38.2 °C	B.P. = -12.1 °C
Environmental Characteristics (2)	ODP GWP HCFC-22 0.055 1,760 HCFC 124 0.022 527 HCFC-123 0.02 79	ODP = 0.022 GWP = 527
Cost-Effectiveness, avg. for 500 to 5000 m^3 volume (2003 data)	Varies from 1 to 2	Varies from 1 to 2

Note 1: Not reported
Note 2: Source: IPCC 5th WGI Assessment Report

The table below summarizes key physical properties of halogenated gaseous agents including vapour pressure, vapour density, and liquid density at 20 ºC, and the constants k_1 and k_2 that are used to calculate agent vapour specific volume (*s*) as a function of temperature at one-atmosphere pressure (1.013 bar) using the following equation: $s = k_1 + k_2 \cdot t$ where *t* is in ºC and *s* has the units m^3/kg

Table 2.3: Physical properties (20 °C) of gaseous fire extinguishing agents used in total flooding applications (1)

Generic Name	Vapour Pressure (bar)	Liquid Density (kg/m^3)	k_1 (m^3/kg) (2)	k_2 (m^3/kg-ºC) (2)	s, Vapour Specific Volume (m^3/kg)	Vapour Density (kg/m^3)
Halon 1301 (a)	14.3	1,574	0.14781	0.000567	0.1592	6.283
HCFC Blend A	8.25	1,200	0.2413	0.00088	0.2589	3.862
HFC-23	41.8	807	0.3164	0.0012	0.3404	2.938
HFC-125	12.05	1,218	0.1825	0.0007	0.1965	5.089
HFC-227ea	3.9	1,41	0.1269	0.000513	0.1372	7.29
HFC-236fa	2.3	1,377	0.1413	0.0006	0.1533	6.523
FK-5-1-12	0.33	1,616	0.0664	0.000274	0.0719	13.912
HFC Blend B (b)	12.57	1,190	0.2172	0.0009	0.2352	4.252

Note 1: All values from ISO 14520 (2015) except where noted: (a) NFPA 12A (2018) and Thermodynamic Properties of Freon 13B1 (DuPont T-13B1); (b) American Pacific Corp.

Note 2: Agent vapour specific volume is calculated as $s = k_1 + k_2 \cdot t$ at standard atmospheric pressure, 1.013 bar, where *t* is the vapour temperature in ºC. Vapour density = $1/s$.

The table below summarizes for halogenated gaseous agents the minimum extinguishing concentrations for Class A and Class B fires, as determined by standardized tests, the minimum inerting concentration to prevent flame propagation in a mixture of methane and air, and the NOAEL and LOAEL toxicity limits.

Table 2.4: Halogenated gaseous agents used in total flooding applications – minimum extinguishing concentrations and agent exposure limits

Generic Name ISO 14520 reference	Minimum Design Conc., Class A Fire vol % (1)	Minimum Design Conc., Class B Fire vol % (1)	Inerting Conc. Methane /Air, vol %	NOAEL vol % (2)	LOAEL vol % (2)	Maximum Conc. for 5 min. Exposure, vol % (6)
Halon 1301	5.0 (3)	5.0 (3)	4.9	5	7.5	-
HCFC Blend A ISO 14520-6	13.0 (7)	13.0	20.5	10	>10	10
HFC-23 ISO 14520-10	16.3	16.4	22.2	30	>50	30
HFC-125 ISO 14520-8	11.2	12.1	-	7.5	10	11.5
HFC-227ea ISO 14520-9	7.9	9.0	8.8	9	10.5	10.5
HFC-236fa ISO 14520-11	8.8	9.8	-	10	15	12
FK-5-1-12 ISO 14520-5	5.3	5.9	8.8	10	>10	10
HFC Blend B (4)	14.7 (5)	14.7	-	5	7.5	5

Note 1: Minimum design concentration as given in Table 5 of ISO 14520-(agent-specific volume), where available.

Note 2: A halocarbon agent may be used at a concentration up to its NOAEL value in normally occupied enclosures provided the maximum expected exposure time of personnel is not more than five minutes. A halocarbon agent may be used at a concentration up to the LOAEL value in normally occupied and normally unoccupied enclosures provided certain criteria are met that depend on agent toxicity and egress time. The reader is referred to NFPA 2001-1.5 (2018) and ISO 14520-G.4.3 (2015) for details of the recommended safe exposure guidelines for halocarbon agents.

Note 3: Exceptions, halon 1301 design concentration is taken as the historical employed value of 5%.

Note 4: Not approved for use in occupied spaces.

Note 5: Agent manufacturer did not provide Class A extinguishing concentration data. Class A design concentration in this case was taken as Class B design concentration.

Note 6: Agent exposure guidance is as indicated in ISO 14520-1 (2015) Annex G.

The table below summarizes the environmental attributes of halocarbon agents including ODP, 100-year GWP, and atmospheric lifetime.

Table 2.5: Halogenated gaseous agents used in total flooding applications – environmental factors

Generic Name	Ozone Depletion Potential (1)	Global Warming Potential, 100 yr. (2)	Atmospheric Life Time, yr. (2)
Halon 1301	10	7,140	65
HCFC-22 (component in HCFC Blend A)	0.055	1,760	11.9
HCFC-124 (component in HCFC Blend A)	0.022	527	5.9
HCFC-123 (component in HCFC Blend A)	0.02	79	1.3
HFC-23	0	12,400	222
HFC-125	0	3,170	28.2
HFC-227ea	0	3,350	38.9
HFC-236fa	0	8,060	242
FK-5-1-12	0	< 1	7 days
HFC-134a (component in HFC Blend B)	0	1,300	13.4
HFC-125 (component in HFC Blend B)	0	3,170	28.2

Note 1: Source: Montreal Protocol Handbook (2012)
Note 2: Source: IPCC 5th WGI Assessment Report http://www.climatechange2013.org/

The table below summarizes information relating relative agent efficacy for Class A total flooding fire protection applications including agent quantities per unit volume of protected space, typical cylinder fill densities, cylinder storage volume relative to halon 1301, and typical cylinder charging pressures.

Table 2.6: Halogenated gaseous agents used in total flooding applications – agent quantity requirements (20 °C) for Class A combustible hazard applications (1, 2)

Generic Name	Agent Mass, kg/m^3 of Protected Volume	Mass Relative to Halon 1301	Agent Liquid Volume litre/m^3 of Protected Volume	Maximum Cylinder Fill Density, kg/m^3 (3)	Cylinder Storage Volume Relative to Halon 1301 (4)	Cylinder Pressure @ 20°C, bar
Halon 1301 (5)	0.331	1.000	0.210	1,121	1.00	25 or 42
HCFC Blend A	0.577	1.74	0.481	900	2.17	25 or 42
HFC-23	0.572	1.73	0.708	860	2.25	43
HFC-125	0.701	1.93	0.525	929	2.33	25
HFC-227ea	0.722	1.89	0.444	1,150	1.84	25 or 42
HFC-236fa	0.629	1.91	0.459	1,200	1.78	25 or 42
FK-5-1-12	0.779	2.35	0.482	1,480	1.78	25, 34.5, 42 or 50
HFC Blend B (6,7)	0.733	2.22	0.616	929	2.67	25 or 42

Note 1: Agent quantities based on a safety factor of 1.3. Nominal maximum discharge time is 10 seconds in all cases.

Note 2: Mass and volume ratios based on Minimum Class A Fire Design Concentrations. See Table 2.4.

Note 3: Fill density based on 25 bar pressurization except for HFC-23.

Note 4: Agent cylinder volume per m^3 protected volume = (Agent Mass, kg/m^3 protected volume)/ (Maximum Fill Density, kg/m^3 cylinder) = ($V_{CYL}/V_{ProtVol}$). For halon 1301 cylinder volume per m^3 hazard = (0.331 kg/m^3 hazard)/ (1,121 kg/m^3 cylinder) = 0.0002953 m^3 cylinder /m^3 protected volume.

Note 5: NFPA 12A; ASTM D5632.

Note 6: Agent manufacturer did not supply complete Class A extinguishing data, hence no Class A MDC established; the heptane MDC was employed in this table.

Note 7: NFPA 2001 (2018).

The table below summarizes information relating relative agent efficacy for Class B total flooding fire protection applications including agent quantities per unit volume of protected space, typical cylinder fill densities, cylinder storage volume relative to halon 1301, and typical cylinder charging pressures.

Table 2.7: Halogenated gaseous agents used in total flooding applications - agent requirements for Class B fuel applications (1, 2)

Generic Name	Agent Mass, kg/m^3 of Protected Volume	Mass Relative to Halon 1301	Agent Liquid Volume litre/m^3 of Protected Volume	Maximum Cylinder Fill Density, kg/m^3 (3)	Cylinder Storage Volume Relative to Halon 1301 (4)	Cylinder Pressure @ 20°C, bar
Halon 1301	0.331	1.00	0.210	1,121	1.00	25 or 42
HCFC Blend A	0.577	1.74	0.481	900	2.17	25 or 42
HFC-23	0.575	1.74	0.713	860	2.27	43
HFC-125	0.698	2.11	0.573	929	2.55	25
HFC-227ea	0.720	2.18	0.512	1,150	2.12	25 or 42
HFC-236fa	0.711	2.15	0.516	1,200	2.01	25 or 42
FK-5-1-12	0.872	2.63	0.540	1,480	2.00	25, 34.5, 42 or 50
HFC Blend B	0.733	2.22	0.616	929	2.67	25 or 42

Note 1: Agent quantities based on a safety factor of 1.3. Nominal maximum discharge time is 10 seconds in all cases.
Note 2: Mass and volume ratios based on "Minimum Class B Fire Design Concentrations." See Table 2.4.
Note 3: Fill density based on 25 bar pressurization except for HFC-23.
Note 4: Agent cylinder volume per m^3 of protected volume = (Agent Mass, kg/m^3 of protected volume)/(Maximum Fill Density, kg/m^3 cylinder) = ($V_{CYL}/V_{ProtVol}$). For halon 1301 cylinder volume per m^3 of protected volume = (0.331 kg/m^3 hazard)/ (1,121 kg/m^3 cylinder) = 0.0002953 m^3 cylinder/m^3 of protected volume.

2.2 Inert gas agents

Inert gas clean agents have zero ODP and zero GWP.[5] There have been at least four inert gases or gas mixtures commercialized as clean total flooding fire suppression agents. Inert gas agents are typically used at design concentrations of 35 vol % to 50 vol %, which reduces the ambient oxygen concentration to between 14 vol % to 10 vol %, respectively. Reduced oxygen concentration (hypoxia) is the principal human safety risk for inert gases except for carbon dioxide which has serious human health effects at progressive severity as its concentration increases above 4 vol %. Inert gas agents mixed with air lead to flame extinguishment by

[5] Inert gas agent IG-541 contains 8 vol % carbon dioxide.

physical mechanisms only. The inert gas agents commercialized since 1990 consist of nitrogen, argon, and blends of nitrogen and argon. One blend contains 8 % carbon dioxide. The features of the commercialized inert gas agents are summarized in Tables 2.8 and 2.9.
These agents are electrically non-conductive, clean fire suppressants. The inert gas agents containing nitrogen or argon differ from halogenated gaseous agents in the following ways:

- Inert gases can be supplied from high pressure cylinders, from low pressure cryogenic cylinders, or from pyrotechnic solids. High pressure systems use pressure reducing devices at or near the discharge manifold. This reduces the pipe thickness requirements and alleviates concerns regarding high pressure discharges.
- High pressure system discharge times are on the order of one to two minutes. This may limit some applications involving very rapidly developing fires.
- Inert gas agents are not subject to thermal decomposition and hence form no hazardous by-products.

The table below summarizes key attributes of inert gas agents.

Table 2.8: Inert gas agents

Agent	IG-01	IG-100	IG-55	IG-541
Efficacy	For use in occupied spaces MDC(A) = 41.9 vol% MDC(B) = 51 vol %	For use in occupied spaces MDC(A) = 40.3 vol% MDC(B) = 43.7 vol %	For use in occupied spaces MDC(A) = 40.3 vol% MDC(B) = 47.5 vol %	For use in occupied spaces MDC(A) = 39.9 vol% MDC(B) = 41.2 vol %
Toxicity	Discharge of an inert gas system results in a significant reduction in the oxygen concentration within the protected area. See Table 2.10 regarding concentration and exposure limits for inert gas systems in normally occupied areas.			
Safety Characteristics	High-pressure compressed gas up to 300 bar			
Environmental Characteristics	No adverse characteristics			
Cost-Effectiveness, avg. for 500 to 5000 m^3 volume (2003 data)	~1.8	~1.8	~1.8	~1.8

The table below summarises the main characteristics of inert gas agents including composition, environmental factors, physical properties, and minimum extinguishing concentrations for Class A and Class B fires.

Table 2.9: Properties of inert gas agents for fixed systems

ISO Designation	IG-01	IG-100	IG-55	IG-541
ISO 14520 Part	14520-12	14520-13	14520-14	14520-15
Agent composition				
Nitrogen		100 %	50 %	52 %
Argon	100 %		50 %	40 %
Carbon dioxide				8 %
Environmental factors				
Ozone depletion potential	0	0	0	0
Global warming potential, 100 yr.	0	0	0	0
Physical properties				
k_1, m^3/kg (1)	0.5612	0.7998	0.6598	0.65799
k_2, m^3/kg-°C (1)	0.00205	0.00293	0.00242	0.00239
Specific Volume, m^3/kg	0.602	0.858	0.708	0.697
Gas Density, 20 ºC, 1 atm, kg/m^3	1.661	1.165	1.412	1.434
Extinguishing (2)				
Min. Class A fire design conc., vol %	41.9	40.3	40.3	39.9
Oxygen conc. at min. Class A design conc., vol %	12.2	12.5	12.5	12.6
Min. Class B fire design conc., vol %	51	43.7	47.5	41.2
Oxygen conc. at min. Class B design conc., vol %	10.3	11.8	11.0	12.3
Inerting design conc., Methane/Air, vol %	61.4	-	-	47.3
Oxygen conc. at min. inerting design conc., vol %	8.1	-	-	11.0

Note 1: Agent vapour specific volume = $k_1 + k_2 \cdot t$, m^3/kg at an atmospheric pressure of 1.013 bar where t is the vapour temperature in °C. Vapour density = 1/s.
Note 2: Extinguishing and design concentration values from ISO 14520 (2015).

2.2.1.1 Physiological effects of inert gas agents

The primary health concern relative to the use of the inert gas agents containing nitrogen or argon is the effect of reduced oxygen concentration on the occupants of a space. The use of reduced oxygen environments has been extensively researched and studied. Many countries have granted health and safety approval for use of inert gases in occupied areas in the workplace. One product contains 8 vol % carbon dioxide[6], which is included to increase blood oxygenation and cerebral blood flow in low-oxygen (hypoxic) atmospheres.

The table below contains exposure guidelines for non-liquefied inert gas agents that are described in detail in ISO 14520-1 (2015), Annex G.

Table 2.10: Exposure limits for inert gas agents

Inert Gas Concentration	Concentration Residual Oxygen Concentration	Permitted Occupancy	Exposure Time Limit
< 43 vol %	> 12 vol %	Normally occupied	5 min
43 to 52 vol %	10 to 12 vol %	Normally occupied	3 min
52 to 62 vol %	8 to 10 vol %	Normally occupied	30 sec
> 62 vol %	< 8 vol %	Normally unoccupied	-

2.2.1.2 Agent exposure limits and system features for inert gas agents

The table below summarises the maximum agent concentration limits for personnel exposure up to 5 minutes, agent requirements for Class A and Class B fires, and some common system features.

[6] Inert gas agent IG-541 contains 8% carbon dioxide and is approved by the U.S. EPA SNAP rules as a safe alternative to halon 1301 in total flooding fire protection systems. At elevated concentrations, however, carbon dioxide is not safe for human exposure and is lethal at fire extinguishing concentrations.

Table 2.11: Inert gas agents - fixed system features

ISO Designation	IG-01	IG-100	IG-541	IG-55
Agent exposure limits				
Max agent concentration where exposure is less than 5 min., vol % (1)	43	43	43	43
Max agent concentration where exposure is less than 3 min, vol % (2)	52	52	52	52
System requirements per m^3 of protected volume				
Class A hazard				
Agent gas volume, m^3 (3)	0.407	0.387	0.381	0.387
Cylinder storage volume, litre (4)	3.01	2.87	3.38	3.44
Cylinder volume relative to halon 1301 (5)	9.90	9.40	11.1	11.2
Class B hazard				
Agent gas volume, m^3 (3)	0.712	0.575	0.577	0.644
Cylinder storage volume, litre (4)	3.95	3.19	3.84	4.30
Cylinder volume relative to halon 1301 (5)	13.0	10.4	12.6	14.0
System Features				
Available cylinder sizes (typical), litre	16;67;80	16;67;80	16;67;80	16;67;80
Available cylinder pressures, bar	150 to 300	150 to 300	150 to 300	150 to 300
Nominal Discharge Time, seconds	60	60	60	60

Note 1: Corresponds to a residual oxygen concentration of 12 vol %.
Note 2: Corresponds to a residual oxygen concentration of 10 vol %.
Note 3: Based on minimum design concentrations in ISO14520, Parts 12 to 15 (2015).
Note 4: Approximate, for the 200 bar cylinder pressure.
Note 5: Halon 1301 cylinder volume per m^3 hazard. See Note 4 of Table 2.6.

2.3 Carbon dioxide

Carbon dioxide was used widely for fire protection prior to the introduction of halons. Due to its toxicity, use of carbon dioxide in occupied or occupiable spaces requires the implementation of significant safety measures. Nonetheless, carbon dioxide has seen a resurgence in use subsequent to the halon production phase-out, particularly in new commercial ship construction where halon 1301 once had a significant role. Minimum design concentrations for carbon dioxide are specified in national and international standards such as NFPA 12 and ISO 6183. The minimum design concentration for carbon dioxide systems is, typically, 35 vol % for Class B fuels and 34 vol % for Class A applications.

2.3.1 Carbon dioxide toxicity

Carbon dioxide is essentially chemically inert as a fire extinguishing gas. Carbon dioxide does, however, have significant adverse physiological effects when inhaled at concentrations above 4 vol %. The severity of physiological effects increases as the concentration of carbon dioxide in air increases. Exposure to carbon dioxide at concentrations exceeding 10 vol % poses severe health risks including risk of death. As such, atmospheres containing carbon dioxide at fire extinguishing concentrations are always lethal to humans. Precautions must always be taken to ensure that occupied spaces are not put at risk by ingress of carbon dioxide from a space into which the agent has been discharged.

The use of carbon dioxide is not recommended for total flooding of normally occupied spaces. NFPA 12 (2018) includes new restrictions on the use of carbon dioxide in normally occupied spaces. Safety precautions related to the use of carbon dioxide may also be found in ISO 6183 (2009).

2.3.2 Environmental effects of carbon dioxide

The carbon dioxide used in fire protection applications is not produced for this use. Instead, it is captured from an otherwise emissive use temporarily sequestering it until it is released. Thus, carbon dioxide from fire protection uses has no net effect on the climate. The table below summarizes key attributes of carbon dioxide.

Table 2.12: Carbon dioxide

Agent	Carbon dioxide, CO_2
Efficacy	For use in unoccupied spaces Basic design concentration = 34 vol% for a "material factor" of 1. Design concentrations for specific combustible materials are determined by multiplying the basic design concentration by an applicable material factor. (1)
Toxicity	Progressively more severe physiological effects as exposure concentration increases, especially above 10 vol%. Carbon dioxide concentrations that exceed 17 vol% present an immediate risk to life. (2) Pre-discharge alarm and discharge time delay required.
Safety Characteristics	Liquefied compressed gas Storage pressure: High-pressure cylinder: 55.8 bar at 20 °C Low-pressure tanks (refrigerated): 21 bar at -18 °C Sublimes at -78.5 °C at atmospheric pressure; cold exposure hazard. Vapours are denser than air and can accumulate in low-lying spaces.
Environmental Characteristics	GWP = 1
Cost-Effectiveness, avg. for 500 to 5000 m^3 volume (2003 data)	1

Note 1: See ISO 6183:2009
Note 2: See U.S. Environmental Protection Agency, "Carbon Dioxide as a Fire Suppressant: Examining the Risks," February 2000.

2.4 Water mist technology

Water mist fire suppression technologies are described in national and international standards such as NFPA 750 *Standard on Water Mist Fire Protection Systems* and the FM Approvals Standard No. 5560 *Water Mist Systems.*

Water mist system technologies strive to generate and distribute within a protected space very small water mist droplets which serve to extinguish flames by the combined effects of cooling and oxygen dilution by steam generated upon water evaporation. Technologies used to generate fine water mists include:

- Low pressure single fluid atomization
- High pressure single fluid atomization
- Dual-fluid atomization
- Hot water steam generation

Briefly, fine water mist relies on sprays of relatively small diameter droplets (less than 200 μm) to extinguish fires. The mechanisms of extinguishment include the following:

- Gas phase cooling
- Oxygen dilution by steam formation
- Wetting and cooling of surfaces, and
- Turbulence effects

The table below summarizes key attributes of water mist technology.

Table 2.13: Water mist technology

Agent	Water mist
Efficacy	For use in occupied spaces. Uses approximately 10 % of the total water quantity discharged by traditional sprinkler system to suppress fires, where tested.
Toxicity	None
Safety Characteristics	No adverse safety characteristics
Environmental Characteristics	No adverse characteristics
Cost-Effectiveness, avg. for a 3 000 m^3 application space	~2

Water mist systems offer some advantages due to their low environmental impact, ability to suppress three-dimensional flammable liquid fires under defined conditions, and reduced water application rates relative to automatic sprinklers in certain applications. More recent innovations include use of nitrogen with water mist to achieve inert gas extinguishing effects and use of bi-fluid (air-water) nozzles to achieve ultrafine droplets and adjustable spray patterns (by varying the air-water ratio). The use of relatively small (10-100 μm) diameter water droplets as a gas phase extinguishing agent has been established for at least 40 years. Advances in nozzle design and improved theoretical understanding of fire suppression processes has led to the development of at least nine technologies for use in water mist fire suppression systems. Several systems have been approved by national authorities for use in relatively narrow application areas. To date, these applications include shipboard machinery spaces, combustion turbine enclosures, flammable and combustible liquid storage spaces as well as light and ordinary hazard sprinkler application areas.

Theoretical analysis of water droplet suppression efficiencies has indicated that a liquid water volume concentration on the order of 0.1 litre of water per cubic meter of protected space is sufficient to extinguish fires. This represents a potential of two orders of magnitude efficiency improvement over application rates typically used in conventional sprinklers. The most important aspect of water mist technology is the extent to which the mist spray can be mixed and distributed throughout a compartment versus the loss rate by water coalescence, surface deposition, and gravity dropout. The suppression mechanism of water mist is primarily cooling of the flame reaction zone below the limiting flame temperature. Other mechanisms are important in certain applications; for example, oxygen dilution by steam has been shown to be important for suppression of enclosed 3-D flammable liquid spray fires.

The performance of a particular water mist system is strongly dependent on its ability to generate sufficiently small droplet sizes and distribute adequate quantities of water throughout the compartment. Factors that affect the ability of achieving that goal include droplet size and velocity, distribution, and spray pattern geometry, as well as the momentum and mixing characteristics of the spray jet and test enclosure effects. Hence, the required application rate varies by manufacturer for the same hazard. Therefore, water mist must be evaluated in the combined context of a suppression system and the risk it protects and not just an extinguishing agent.

There is no current theoretical basis for designing the optimum droplet size and velocity distribution, spray momentum, distribution pattern, and other important system parameters. This is quite analogous to the lack of a theoretical basis for nozzle design for total flooding, gaseous systems, or even conventional sprinkler and water spray systems. Hence, much of the experimental effort conducted to date is full-scale fire testing of particular water mist hardware systems which are designed empirically. This poses special problems for standards making and regulatory authorities.

There are currently two basic types of water mist suppression systems: single and dual fluid systems. Single fluid systems utilize water delivered at 7-200 bar pressure and spray nozzles which deliver droplet sizes in the 10 to 100 μm diameter range. Dual systems use air, nitrogen, or another gas to atomize water at a nozzle. Both types have been shown to be promising fire suppression systems. The major difficulties with water mist systems are those associated with design and engineering. These problems arise from the need to distribute and maintain an adequate concentration of mist throughout the space while momentum of hot fire gases, ventilation, gravity and water deposition loss on surfaces deplete the concentration. Engineering analysis and experimental programmes for specific mist products (with unique droplet distribution and concentration) are employed to minimize the uncertainty.

2.4.1 Physiological Effects of water mist.

At the request of the US EPA, manufacturers of water mist systems and other industry partners convened a medical panel to address questions concerning the potential physiological effects of inhaling very small water droplets in fire and non-fire scenarios. Disciplines represented on the Panel included inhalation toxicology, pulmonary medicine, physiology, aerosol physics, fire toxicity, smoke dynamics, and chemistry, with members coming from commercial, university, and military sectors. The Executive Summary (draft “Water Mist Fire Suppression Systems Health Hazard Evaluation;” Halon Alternatives Research Corporation (HARC), U.S. Army, NFPA; March 1995) states the following: “The overall conclusion of the Health Panel’s review is that...water mist systems using pure water do not present a toxicological or physiological hazard and are safe for use in occupied areas. Thus, EPA is listing water mist systems composed of potable water and natural sea water as acceptable without restriction. However, water mist systems comprized of mixtures in solution must be submitted to EPA for review on a case-by-case basis”.

2.4.2 Environmental factors of water mist.

Water mist does not contribute to stratospheric ozone depletion or to greenhouse warming of the atmosphere. Water containing additives may, however, have other environmental contamination risks, e.g., foams, antifreeze and other additives.

2.5 Inert gas generators

Inert gas generators are pyrotechnic devices that utilize a solid material which oxidises rapidly, producing large quantities of carbon dioxide and/or nitrogen. Recent innovations include generators that produce high purity nitrogen or nitrogen and water vapour with little particulate content. The use of this technology to date has been limited to specialized applications such as dry bays on military aircraft. This technology has demonstrated excellent performance in these applications with space and weight requirements equivalent to those of halon 1301 and is currently being utilized in some US Navy aircraft applications. The table below summarizes key attributes of inert-gas generator agents.

Table 2.14: Inert gas generators

Agent	Inert gas by pyrotechnic generator
Efficacy	For use in occupied or unoccupied spaces depending on properties of emitted agent.
Toxicity	Toxicity depends on the type of gas generator. Guidance related to oxygen concentration reduction applicable to inert gas systems must be followed. Additional safety considerations required where discharged gas contains carbon dioxide.
Safety Characteristics	Potentially hot-gas discharge; potential hot surfaces of generator body. Insulating consideration required by generator manufacturer. Discharge of inert gases into an enclosure will cause a rise in pressure to a level that depends on enclosure venting characteristics.
Environmental Characteristics	No adverse characteristics
Cost-Effectiveness	Not available

Physiological effects of inert gas generator agents. The precise composition and properties of the gas produced will affect the response of exposed persons and are determinant factors regarding application in occupied or unoccupied areas. US EPA SNAP has listed as acceptable a gas generator that produces relatively pure nitrogen for use in normally occupied spaces.

Environmental effects of inert gas generator agents. Gases emitted by these products do not contribute to stratospheric ozone depletion or to greenhouse warming of the atmosphere except to the extent that they emit carbon dioxide, if any.

2.6 Fine solid particulate technology

Another category of technologies being developed and introduced are those related to fine solid particulates and aerosols. These take advantage of the well-established fire suppression capability of solid particulates, with potentially reduced collateral damage associated with traditional dry chemicals. This technology is being pursued independently by several groups and is proprietary. To date, a number of aerosol generating extinguishing compositions and aerosol extinguishing means have been developed in several countries. They are in production and are used to protect a range of hazards. The table below summarizes key attributes of fine solid particle agents (powders).

Table 2.15: Fine solid particles (powders)

Agent	Fine solid particles
Efficacy	For use in normally unoccupied spaces on Class B fires.
Toxicity	Precautions require evacuation of spaces before discharge.
Safety Characteristics	For establishments manufacturing the agent or filling, installing, or servicing containers or systems to be used in total flooding applications, U.S. EPA recommends the following: - adequate ventilation should be in place to reduce airborne exposure to constituents of agent; - an eye wash fountain and quick drench facility should be close to the production area; - training for safe handling procedures should be provided to all employees that would be likely to handle containers of the agent or extinguishing units filled with the agent; - workers responsible for clean-up should allow for maximum settling of all particulates before re-entering area and wear appropriate protective equipment Discharge of associated inert gases into an enclosure will cause a rise in pressure to a level that depends on enclosure venting characteristics.
Environmental Characteristics	No adverse characteristics
Cost-Effectiveness	Not available

One principle of these aerosol extinguishants is in generating solid aerosol particles and inert gases in the concentration required and distributing them uniformly in the protected volume. Aerosol and inert gases are formed through a burning reaction of the pyrotechnic charge having a specially proportioned composition. An insight into an extinguishing effect of aerosol compositions has shown that extinguishment is achieved by combined action of two factors such as flame cooling due to aerosol particles heating and vaporizing in the flame front as well as a chemical action on the radical level. Solid aerosols must act directly upon the flame. Gases serve as a mechanism for delivering the aerosol towards the seat of a fire.

A number of enterprises have commercialized the production of aerosol generators for extinguishing systems that are installed at stationary and mobile industrial applications such as nuclear power station control rooms, automotive engine compartments, defence premises, engine compartments of ships, telecommunications/electronics cabinets, and aircraft nacelles.

Fine particulate aerosols have also been delivered in HFC/HCFC carrier gases. A wide range of research into aerosol generating compositions has been carried out to define their extinguishing properties, corrosion activity, toxicity, and effect upon the ozone layer as well as electronics equipment.

Solid particulates and chemicals have very high effectiveness/weight ratios. They also have the advantage of reduced wall and surface losses relative to water mist, and the particle size distribution is easier to control and optimize. However, there is concern of potential collateral damage to electronics, engines, and other sensitive equipment. Condensed aerosol generators, which produce solid particulates through combustion of a pyrotechnic material, are unsuitable for explosion suppression or inerting since pyrotechnic/combustion ignited aerosols can be re-ignition sources. These agents also have low extinguishing efficiency on smouldering materials. Technical problems including high temperature, high energy output of combustion generated aerosols and the inability to produce a uniform mixture of aerosol throughout a complex geometry remain to be solved.

Additional information on fine solid particulate technologies may be found in NFPA 2010 *Standard for Fixed Aerosol Fire Extinguishing Systems*.

2.6.1 Physiological effects of fine particle agents

There are several potential problems associated with the use of these agents. These effects include inhalation of particulate, blockage of airways, elevated pH, reduced visibility, and the products of combustion from combustion generated aerosols, such as HCl, CO, and NO_x. For these reasons, the majority of these technologies are limited to use in only unoccupied spaces.

2.6.2 Environmental effects of fine particle agents

Fine particulate aerosols themselves and associated inert gases from generators do not contribute to stratospheric ozone depletion or to greenhouse warming of the atmosphere. There may be ozone depletion or greenhouse gas effects, however, where aerosols are delivered with carrier gases that are halogenated gaseous agents.

2.7 System design considerations for total flooding agents

Care must be taken throughout the design process to ensure satisfactory system performance. Hazard definition, nozzle location and design concentration must be specified within carefully defined limits. Further, a high degree of enclosure integrity is required. Design requirements are provided by national and international standards such as NFPA 2001 and ISO 14520. An outline of factors to be taken into consideration is given below:

2.7.1 Definition of the hazard

- Fuel type(s)
- Fuel loading
- Room integrity (openings, ventilation, false ceilings, subfloors)
- Dimensions and Net Volume of the room
- Temperature extremes
- Barometric pressure (altitude above sea level for gas systems)

2.7.2 Agent selection

- Statutory approvals
- Personnel safety
- Minimum concentration required (cup burner/full scale tests)
- Design concentration required with factor of safety
- NOAEL/LOAEL or limiting oxygen concentration. Is the agent design concentration within safe exposure limits over the range of feasible hazard temperatures and net volumes?
- Decomposition characteristics
- Replenishment availability

2.7.3 System selection

- System intended for use with the agent selected
  - Pressures, elastomers, gauges, labels
- System has appropriate approvals as the result of third party testing
  - Strength tests (containers, valves, gauges, hoses, etc.)
  - Leakage tests
  - Cycle testing of all actuating components
  - Corrosion tests
  - Cylinder mounting device tests
  - Aging tests for elastomers
  - Flow tests (software verification, balance limitations)
  - Fire tests (nozzle area coverage, nozzle height limitations)
- System has documented design, installation, maintenance procedures

2.7.4 System design

- Automatic detection and control
  - Type of detection (smoke, heat, flame, etc.)
  - Logic (cross zoned, priority designated)
  - Control system features
  - Local and remote annunciation
  - Start up and shut down of auxiliary systems
  - Primary and back-up power supply
  - Manual backup and discharge abort controls
- Central agent storage, distributed or modular
- Electrical, pneumatic or electrical/pneumatic actuation
- Detector location
- Alarm and control devices location
- Electrical signal and power cable specifications
- Nozzle selection and location
- Piping distribution network with control devices
- Piping and other component hangers and supports
- Agent hold time and leakage
- Selection of an appropriate design concentration
- Agent quantity calculations
- Flow calculations
- Pipe size and nozzle orifice determination

2.7.5 System installation

- Installed per design
- System recalculated to confirm "as built" installation
- Correct piping
  - Size
  - Routing
  - Number and placement of fittings
  - Pipe supports
  - Correct type, style, orifice size nozzle in each location
- Fan test to confirm tightness of protected volume and adequacy of pressure relief venting
- Acceptance functional test of full system without discharge
  - Test each detector's operation

  - Test system logic with detection operation
  - Test operation of auxiliary controls
  - Test local and remote annunciation
  - Test signal received at system valve actuators
  - Test system manual operators
- Test system abort discharge abilities

2.7.6 Post-installation follow up

- Integrity of the protected space does not change
  - Walls, ceiling and floor intact
  - Any new openings sealed properly
- Net volume and temperature range of the space does not change
- Regular maintenance for detection, control, alarm and actuation system
- Regular verification of the agent containers' charged weight
- Regular cleaning of the detection devices
- Confirmation of back-up battery condition

3 Local application (streaming) agents

3.1 General

Local application agents, also referred to as streaming agents, are used in portable fire extinguishers and fixed extinguisher units designed to protect specific hazards. The tables below summarize commercially available, technically proven agents for local application fire protection using portable or fixed systems. Cost effectiveness is represented by an index benchmarked against the approximate cost of a portable carbon dioxide extinguisher unit that has a UL 10B rating. Acceptability of substitutes for halons, HCFCs and HFCs as streaming fire extinguishing agents is also regulated by national agencies.

The US EPA, under the SNAP program, has reviewed a number of materials as substitutes for halons as streaming fire extinguishing agents. The approval status in the US of a number of such alternatives for use in total flooding systems may be found Annex B.

3.2 Carbon dioxide

Carbon dioxide extinguishers use CO_2 stored as a liquefied compressed gas. Carbon dioxide is most suitable for use on fires involving flammable liquids. Carbon dioxide does not conduct electricity and can be used safely on fires involving live electrical circuits. In general, carbon dioxide extinguishers are less effective for extinguishing fires of ordinary combustibles such as wood, paper and fabrics. The table below summarizes key attributes of carbon dioxide as a streaming agent.

Table 3.1: Carbon dioxide streaming agent

Agent	Carbon dioxide, CO_2
Efficacy	For use on Class B fires Can be used on most electrically energized equipment fires.
Toxicity	High exposure risk where carbon dioxide gas accumulates in confined spaces that may be entered by personnel.
Safety Characteristics	Liquefied compressed gas Storage pressure: 55.8 bar at 20 °C Solid CO_2 (“dry ice”) sublimes at -78.5 °C at atmospheric pressure. Presents a cold-exposure hazard. Vapours usually flow to floor level so personnel exposure risk is normally low.
Environmental Characteristics	GWP = 1
Cost-Effectiveness	1 (baseline)

3.3 Halogenated gaseous agents

Halogenated gaseous streaming agents can be used to effectively extinguish fires of ordinary combustibles (wood, paper, plastic) and combustible liquids, and agent vapours permeate well thereby avoiding secondary damage. However, in general, they are more expensive than traditional fire protection agents and, generally, more agent is required than would be for halon 1211. The table below summarises type, composition, and environmental properties of halogenated gaseous streaming agents, also included for reference, for use as local application agents.

Table 3.2: Halogenated gaseous streaming agents - type, composition, and environmental properties

Generic Name	Group	Storage State	Chemical Composition		Environmental Factors		
			Weight %	Species	ODP	100-year GWP (1)	Atmospheric Lifetime yr.
Halon 1211	Halon	LCG	100 %	CF_2ClBr	3	1,750	16
HFC-236fa	HFC	LCG	100 %	$CF_3CH_2CF_3$	0	8,060	242
HFC-227ea	HFC	LCG	100 %	CF_3CHFCF_3	0	3,350	38.9
FK-5-1-12	FK	Liquid	100 %	$C_6F_{12}O$	0	< 1	7 days
FIC-13I1	FIC (2)	LCG	100 %	CF_3I	.0001	0.4	0.005
HCFC Blend B	HCFC & PFC blend	CGS	> 96 %	HCFC-123	0.02	79	1.3
			< 4 %	Ar	0	0	n/a
			< 2 %	CF_4	0	6,630	> 50,000

LCG - Liquefied Compressed Gas; ODP - Ozone Depletion Potential; GWP - 100-year Global Warming Potential; CGS - Compressed Gas in Solution
Note 1: Source: IPCC 5th WGI Assessment Report http://www.climatechange2013.org/
Note 2: FIC-13I1 has B.P. = -23 °C.

3.3.1 Toxicity of halogenated gaseous streaming agents

The toxicity of streaming agents is assessed based on the likely exposure of the person using the extinguisher. This is sometimes measured using breathing zone samples. All of the streaming agents in Table 18 are considered safe for normal use in non-residential and unoccupied applications. Use of some of these agents in confined spaces may be a cause for concern. In particular, FIC-13I1 has a NOAEL of 0.2 vol % and a LOAEL of 0.4 vol % and, as such, poses risks to personnel in confined spaces.

3.3.2 Environmental factors of halocarbon streaming agents

The environmental factors for halogenated gaseous streaming agents are the same as those discussed for halogenated gaseous total flooding agents. Information on ODP, GWP and atmospheric lifetime are presented in the table below. Traditional streaming agents (e.g., water, aqueous salt solutions, dry chemical, and foam) do not present environmental concerns in the areas of ODP, GWP, or atmospheric lifetime but may offer other environmental risks associated with the use of additives, e.g., fluorosurfactants. The table below summarizes main performance attributes of halogenated gaseous chemical streaming agents.

Table 3.3: Halocarbon streaming agents - main performance attributes

Agent	HCFC Blend B 96% HCFC-123 < 2% CF_4 < 4% Argon	HFC-236fa	HFC-227ea	FK-5-1-12	FIC-13I1[7]
Efficacy	For use on Class A fires For use on Class B fires For use on fires involving electrified equipment				
Toxicity	Vapour toxicity low to moderate.				Vapour toxicity moderate to high.
	Vapour exposure risk usually low. Some halogen acids form upon application to a fire. Dense vapour can accumulate in low spaces				
Safety Characteristics	Pressurized hand-held container.				
Environmental Characteristics (1)	ODP / GWP HCFC-123: 0.02 / 79 CF_4: 0 / 6,630 Argon: 0 / 0	ODP: 0 GWP: 8,060	ODP: 0 GWP: 3,350	ODP: 0 GWP: <10	ODP: 0.4 GWP: 0.0001
Cost-Effectiveness	Varies from about 1 to about 2				

Note 1: Source: IPCC 5th WGI Assessment Report http://www.climatechange2013.org/

3.4 Dry chemical agents

Dry chemical extinguishers are of two types. “Ordinary” dry chemicals, usually formulations based on sodium or potassium bicarbonate, are suitable for fires involving flammable liquids and gases. “Multipurpose” dry chemicals, usually formulations of monoammonium phosphate (MAP), are suitable for use on fires of ordinary combustibles such as wood, paper and fabrics and fires involving flammable liquids and gases. Both ordinary and multipurpose dry chemicals may be safely used on fires where electrical circuits are present; however, after application dry chemical residue should be removed because in the presence of moisture it could provide an electrical path that would reduce insulation effectiveness.

One important aspect is that the two types of dry chemicals must never be mixed (e.g. during filling or re-charge) as they react liberating water and CO_2. This can cause corrosion of the cylinder, and the resultant increase in pressure can then become a safety hazard.

[7] Principal known use of FIC-13I1 is used for fire protection of rim seals on floating roof petroleum tanks.

The table below summarizes key attributes of dry chemical streaming agents.

Table 3.4: Dry chemical streaming agents - main performance attributes

Agent	Dry chemicals
Efficacy	For use on Class A fires: Multipurpose dry chemical For use on Class B fires: Ordinary dry chemical or multipurpose dry chemical For use on fires involving electrified equipment Dry chemical applied to some electrical or sensitive equipment may cause damage otherwise not caused by a fire.
Toxicity	Low. Precautions required to avoid inhalation of agent particles.
Safety Characteristics	Pressurized containers
Environmental Characteristics	Low environmental risk
Cost-Effectiveness	~ 0.2

3.5 Water, straight stream

Straight stream water is suitable for use on fires of ordinary combustibles such as wood, paper and fabrics only. This type of extinguisher is unsuitable for use in extinguishing fires involving liquids or gases and in fact could spread a flammable liquid fuel. Straight stream water extinguishers are unsafe for use on fires where energized electrical circuits are present. The table below summarizes key attributes of straight-stream water as a streaming agent.

Table 3.5: Water, straight stream

Agent	Water, straight-stream, ~9 litre
Efficacy	For use on Class A fires not involving electrified equipment or materials that are reactive with water (e.g. metals). Not suitable for Class B fires. Water applied to some electrical or sensitive equipment may cause damage otherwise not caused by a fire.
Toxicity	Non-toxic
Safety Characteristics	No adverse characteristics. Not suitable for use on electrified equipment.
Environmental Characteristics	No significant risk
Cost-Effectiveness	~0.5

3.6 Water mist (spray)

Water spray extinguishers are most suitable for use on fires of ordinary combustibles such as wood, paper and fabrics. This type of extinguisher may be less effective on deep-seated fires. The spray stream is generally more effective on burning embers and may provide a limited capability for fires involving combustible liquid fuels. Some water spray extinguishers can be used on fires where live electrical circuits are present. Users should ensure that the extinguisher has been tested and certified before use on live electrical circuits. Some manufacturers have introduced "water mist" fire extinguishers into commerce. The table below summarizes key attributes of water mist or spray as a streaming agent.

Table 3.6: Fine water spray as a streaming agent

Agent	Water, fine spray
Efficacy	For use on Class A fires including use on electrified equipment up to 10 kV. Not suitable for use on materials that are reactive with water (e.g. metals). Not suitable for Class B fires. Water applied to some electrical or sensitive equipment may cause damage otherwise not caused by a localized fire.
Toxicity	Non-toxic
Safety Characteristics	No adverse characteristics
Environmental Characteristics	No significant risk
Cost-Effectiveness	~ 0.6 (~ 9 litre extinguisher unit; cost index compared to a 10B-rated CO_2 unit)

3.7 Aqueous salt solutions

Aqueous solutions of certain salts are used in fire protection for certain types of hazards. Water containing certain dissolved salts has been found to be more effective than water alone in the extinguishment of fires. Potassium salts are usually employed. Examples include potassium acetate, potassium citrate, potassium formate, potassium lactate, and others, sometimes in combination, and with additives to inhibit corrosion, promote aqueous film-forming action to suppress vapor evolution from flammable liquids, and solution stability. Applications for aqueous salt solutions include fire protection for commercial cooking equipment and industrial vehicles. Some attributes of aqueous salt solution agents are summarized in the table below.

Table 3.7: Aqueous salt solutions streaming agents

Agent	Aqueous salt solutions, fine spray
Efficacy	For use on Class A fires not involving electrified equipment or materials that are reactive with water (e.g., metals). Suitability for use on Class B fires depends on formulation and means of delivery. Used on cooking oil fires where nozzle design limits splatter of hot oil. Salt solutions may cause damage to some electrical equipment not otherwise damaged by fire.
Toxicity	Varies from low to moderate.
Safety Characteristics	pH is usually basic, varying from 8 to 13. Possible short-exposure skin irritation depending on duration of exposure if wetted with agent.
Environmental Characteristics	No significant risk
Cost-Effectiveness	~0.7 to 1 (~9 litre extinguisher unit; cost index compared to a 10B-rated CO_2 unit)

3.8 Aqueous film-forming foam (AFFF)

Extinguishers using water and AFFF additives may be more effective than those using water alone on fires of ordinary combustibles such as wood, paper and fabrics. Additionally, water with AFFF additives will have improved ability, over water alone, to extinguish fires involving flammable or combustible liquids. Also, this agent has the ability to reduce the likelihood of ignition when applied to the liquid surface of an unignited spill. The AFFF reduces vapour propagation from the flammable liquid.

Depending upon the stream pattern, this type of extinguisher may not be safe for use on fires where live electrical circuits are present.

The table below summarizes key attributes of streaming agents employing AFFF. It should be noted that some currently-available AFFF agents contain surfactants consisting of perfluorinated eight-carbon (C8) molecular chains that are known to be bio-persistent and bio-accumulative once released to the environment. The environmental impact of using AFFF agents containing C8 fluorosurfactants must be weighed against the potential gain in efficacy when selecting a portable extinguisher for each specific application. A number of manufacturers ceased production in 2015 of fluorosurfactants containing the problematic C8 species. The performance properties of AFFF agents using reformulated fluorosurfactants should be verified.

Table 3.8: Aqueous film-forming foam as a streaming agent

Agent	Aqueous film-forming foam (AFFF)
Efficacy	For use on Class A fires not involving electrified equipment or materials that are reactive with water (e.g. metals). For use on Class B fires.
Toxicity	Moderate.
Safety Characteristics	pH is approximately neutral, varying between about 6.5 and 8.
Environmental Characteristics	Uncontained run-off of agent poses risks of contamination of soil, streams, and rivers.
Cost-Effectiveness	~0.6 (~9 litre extinguisher unit; cost index compared to a 10B-rated CO_2 unit)

3.9 Streaming agents for residential use

Distinctions are often made by national bodies as to the acceptability of certain agent types in commercial and residential applications. Agents that have the potential of forming toxic byproducts in a fire are usually deemed unsuitable for residential use.[8] Based on this premise the suitability of agents for residential use is summarized in the table below.

[8] For example, the US EPA defines residential use to mean use by a private individual of a chemical substance or any product containing the chemical substance in or around a permanent or temporary household, during recreation, or for any personal use or enjoyment. Use within a household for commercial or medical applications is not included in this definition, nor is use in automobiles, watercraft, or aircraft.

Table 3.9: Suitability of fire extinguishing agent alternatives for use in local application fire protection in residential applications

Substitute	Constituents	Suitable for Residential Use?
Surfactant Blend A	Mixture of organic surfactants and water	Yes
Carbon dioxide (1)	CO_2	Yes
Water	H_2O	Yes
Water Mist Systems	H_2O	Yes
Foam	Aqueous film-forming foam (AFFF)	Yes
Dry Chemical	Formulations based on either monoammonium phosphate (MAP) or sodium bicarbonate	Yes
Gelled Halocarbon/Dry Chemical Suspension	Halocarbon plus dry chemical plus gelling agent	Yes
HFC-227ea	CF_3CHFCF_3	No
HFC-236fa	$CF_3CH_2CF_3$	No
FK-5-1-12	$CF_3CF_2C(O)CF(CF_3)_2$	No
Hydrofluoro-polyethers	Hydrofluoro-polyethers	No
HCFC Blend B	HCFC-123, 95 mol% min; argon, 0.2 mol% min; CF_4, 0.4 mol% min	No

Note 1: Avoid use in confined spaces.

3.8.1 Assessment of alternative streaming agents

The important features of streaming agent alternatives, manually applied fire extinguishing agents, are described below. In general, portable extinguishers are only used on actual fires and can be readily directed at the burning material.

3.8.2 Effectiveness on ordinary combustibles

This parameter considers the ability of the agent to extinguish fires in ordinary solid combustibles, including cellulosic materials. These are called Class A fires and the extinguisher should carry a rating categorising its Class A performance.

3.8.3 Effectiveness on liquid fuel fires

This parameter considers the ability of the agent to extinguish liquid fuel fires (Class B). The extinguisher should carry a Class B rating.

3.8.4 Electrical conductivity

Minimal conductivity is important in fighting fires where electricity is involved.

3.8.5 Ability to permeate

This parameter reflects the ability of the agent to extinguish fires in locations where direct application to the fuel surface or flame reaction zone is not possible, for example, in the hidden void space in a commercial airliner.

3.8.6 Range

This parameter reflects the ability of the agent to maintain a coherent effective stream over a distance.

3.8.7 Effectiveness to weight ratio

This parameter considers the relative fire suppression capability across all fuels per unit weight of agent.

3.8.8 Secondary damage

This category refers to the “clean agent” aspects of the agents, i.e., secondary damage caused by the suppressant agent itself.

3.8.9 Selection of an alternative streaming agent

The relative ratings for each parameter have not been rigorously derived and final selection depends on detailed knowledge of the risk to be protected. Some characteristics of several types of streaming agents are summarized in the table below.

Table 3.10: Portable fire extinguisher capability comparison

Agent Type	Class A Materials	Class B Flammable Liquids	Suitable for Energized Electrical Hazards	Ability to Permeate	Stream Range	Effective Weight	Secondary Damage
CO_2	Poor	Fair	Yes	Good	Fair	Poor	Good
Multi-purpose Dry Chemical	Good	Good	Yes	Fair	Good	Good	Poor
AFFF	Good	Fair	No	Poor	Good	Poor	Poor
Water Stream	Good	Poor	No	Poor	Good	Poor	Poor
Water Mist	Good	Fair	Yes	Fair	Fair	Fair	Fair
Halocarbon	Good	Good	Yes	Good	Good	Good	Good
Halon 1211	Good	Good	Yes	Good	Good	Good	Good
Sodium Bicarbonate Dry Chemical	Poor	Good	Yes	Fair	Good	Good	Poor
Potassium Bicarbonate Dry Chemical	Poor	Good	Yes	Fair	Good	Good	Poor

4 New and emerging technologies

Manufacturers of fire extinguishing agents and systems continue to develop and offer innovative products to serve for total flooding and local application uses.

4.1 HCFO-1233zd(E)

In 2016, Honeywell, a chemical manufacturer, made an application to ISO TC 21 / SC 8 for recognition of HCFO-1233zd(E), as a new total flooding agent. Its chemical name is trans-1-chloro-3,3,3-trifluoropropene and has CAS number 102687-65-0. The chemical received US EPA SNAP approval for this use in October 2016.[9] The manufacturer subsequently suspended support of this chemical as a single-component total flooding agent.

4.2 Halocarbon Blend 55

In September 2018, Honeywell, a chemical manufacturer, made an application to ISO TC 21/SC 8 for recognition of a new agent designated "Halocarbon Blend 55." The agent is a 50 / 50 weight % mixture of FK-5-1-12 and HFO-1233zd(E). The agent was reported to have the following characteristics:

M.W. = 184.7 g/mol B.P. = 20.7 °C NOAEL = 10 %

GWP (100 years) = 1 ODP = 0.000

Class A Minimum Extinguishing Concentration = 4.4 vol %

Class B Minimum Extinguishing Concentration = 6.0 vol %

ISO TC 21/SC 8 has agreed to register the project as preliminary work item (PWI) pending satisfactory completion of an administrative requirements.

4.3 Trifluoroiodomethane

Trifluoroiodomethane, or CF_3I, (CAS Number 2314-97-8), has a Class B minimum extinguishing concentration similar to halon 1301. Due to its LOAEL value of 0.4 vol % it is approved for non-occupied areas only and thus has found limited acceptance in extinguishing applications. However, there has been a resurgence in interest in use of this chemical as an extinguishing agent for use in aircraft engine nacelles and auxiliary power units (APUs). For more information on this agent refer to Volume 2 of the Report of the Halons Technical Options Committee, Supplementary Report #1, Civil Aviation, December 2018, HTOC (2018).

4.4 Updates from 2014 report

4.4.1 2-BTP

The chemical 2-bromo-3,3,3-trifluoro-prop-1-ene, CAS 1514-82-5 has been the subject of study as a fire extinguishant since before 2000. For brevity this chemical is referred to as "2-BTP." The

[9] See https://www.gpo.gov/fdsys/pkg/FR-2016-10-11/pdf/2016-24381.pdf . Note: SNAP approval of substitutes for halons are reviewed on the basis of environmental and health risks, including factors such as ozone depletion potential, global warming potential, toxicity, flammability, and exposure potential. Fire extinguishing effectiveness is not an element of a SNAP review.

agent has received regulatory approval in both the EU and the US EPA SNAP program for use as a streaming agent. While 2-BTP does contain bromine, as do halons, this chemical has a very short atmospheric lifetime (about 7 days), an ODP of 0.0028 and a GWP of 0.26. As such, this chemical is not deemed as a potentially significant contributor to ozone depletion or global warming. This product has been the subject of study for use as a streaming agent in aircraft portable extinguishers. As of 2017, 2-BTP has been approved for use in commercial aircraft handheld fire extinguishers and at least two aircraft manufacturers are fitting 2-BTP extinguishers to new-build aircraft.

4.4.2 C7 Fluoroketone, FK-6-1-14

There is no new information since the 4th edition of this document.

This substitute is a blend of two C7 isomers: 55 – 65% of 3-pentanone, 1,1,1,2,4,5,5,5-octafluoro-2,4-bis(trifluoromethyl), CAS 813-44-5, with balance consisting of 3-hexanone, 1,1,1,2,4,4,5,5,6,6,6-undecafluoro-2-(trifluoromethyl), CAS 813-45-6. This product has been found acceptable under the U.S. EPA SNAP program for use as a streaming agent subject to narrow use limits that require that C7 fluoroketone be used only in non-residential applications.

4.4.3 Low GWP Chemicals

There is no new information since the 4th edition of this document.

One manufacturer announced development of three low-GWP chemicals for possible use as fire extinguishants. The manufacturer has not announced the chemical identities of these products but has disclosed some information summarized in Table 4.1. There is no new information since the 4th edition of this document.

Table 4.1: Properties of developmental halogenated gaseous agents with low GWP

Product	Flooding agent	Streaming agent #1	Streaming agent #2
Boiling point, °C	31	31	18
Liquid density, kg/m^3	1300	1380	1300
MDC, Class A, vol %	5.6	6.1	4.8
MDC, Class B, vol %	6.9	6.9	6.2
NOAEL, vol %	10	1.25	2.5
LOAEL, vol %	12.5	2.5	> 2.5
ODP	0	0	0
100 yr. GWP (est.)	< 2	< 20	< 20

4.4.4 Phosphorous tribromide

There is no new information since the 4^{th} edition of this document.

PBr_3 is a clear liquid with a boiling point of 173 °C. It reacts vigorously with water liberating HBr and phosphoric acid and is, therefore, a highly toxic substance at ambient conditions.

Though the agent contains bromine, it poses little risk to stratospheric ozone. The agent decomposes rapidly in the atmosphere and the HBr formed is quickly eliminated by precipitation. PBr_3 is an effective fire extinguishant due to its high bromine content. Given its high boiling point, and low volatility, this agent must be delivered as a spray or mist into the fire zone in order to be effective. It has been commercialized for use as a fire extinguishant in one small aircraft engine application.

4.4.5 Water mist technologies

Water mist technologies continue to evolve. Recently commercialized innovations include:

- New atomization technology using two-fluid system (air and water) to create ultrafine mist with spray features that are adjustable by changing the flow ratio of water to air or nitrogen.
- Water mist combined with nitrogen to gain extinguishing benefits of both inert gas and water mist

Each approach to generating fine water mists has its own advantages and drawbacks. Additional comments on water mist systems are given in Sections 2.4 and 3.6.

5 Conclusions

There are several in-kind alternatives to halons. These started with HCFCs and PFCs, followed closely by HFCs and inert gases, and more recently by an FK. The HCFCs and PFCs are no longer used in new total flooding fire extinguishing systems and their use is limited to supporting existing systems. Today, for all practical purposes, there are three types of in-kind alternatives to the ozone-depleting fire extinguishants (halons and HCFCs) used in new fire extinguishing systems - these are HFCs, inert gases and an FK. The FK and inert gases also represent low-GWP and no-GWP alternatives to the halons, PFC's, HCFCs and high-GWP HFCs.

Alternative extinguishing agents and technologies are available for nearly all new fire protection applications that previously employed halons, albeit for some applications the only alternatives are the original halon or a high-GWP HFC. A current exception is the fire protection in cargo bays of civil aviation, where no halogenated agents have passed the International Aircraft Systems Fire Protection Working Group Minimum Performance Standard (MPS) for cargo bays. Additionally, some legacy systems (used by the military and in oil and gas production facilities) still require halon as retrofit with current alternatives is not technically or economically feasible at this time.

6 Sources

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Annex A U.S. EPA Significant New Alternatives Policy (SNAP) Substitutes in Total Flooding Agents

Substitutes are reviewed on the basis of environmental and health risks, including factors such as ozone depletion potential, global warming potential, toxicity, flammability, and exposure potential. Lists of **Acceptable** and **Unacceptable** substitutes are updated several times each year. The list of substitutes is shown below.

Note: SNAP-related information published in the Federal Register takes precedence over all information on this page.

The SNAP Listing Dates shown in https://www.epa.gov/snap/substitutes-total-flooding-agents contain hyperlinks to U.S. Federal Register publications.

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
2-bromo-3,3,3-trifluoropropene (2-BTP)	0.0028	0.23-0.26	1-Dec-16	**Acceptable with Use Conditions:** For use only in engine nacelles and auxiliary power units (APUs) on aircraft.	
[HCFC Blend] A (NAF S-III)	0.048	1,546	18-Mar-94	**Acceptable**	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. See additional comments 1, 2, 3, 4, 5.
ATK OS-10	0	<1	2-Jan-09	**Acceptable**	EPA recommends that users consult Section VIII of the Occupational Safety & Health Administration (OSHA) Technical Manual for information on selecting the appropriate types of Personal Protective Equipment (PPE). EPA recommends that use of this system should be in accordance with the safe exposure guidelines for inert gas systems in the latest edition of NFPA 2001, specifically the requirements for residual oxygen levels, and should be in accordance with the relevant operational requirements in NFPA Standard 2010 for Aerosol

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
					Extinguishing Systems. See additional comments 1 and 5.
C3F8 (PFC-218, CEA-308)	0	8,830	13-Jun-95; 28-Apr-99	**Acceptable with Narrowed Use Limits:** Acceptable for non-residential uses where other alternatives are not technically feasible due to performance or safety requirements: (a) because of their physical or chemical properties, or (b) where human exposure to the extinguishing agents may result in failure to meet safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Extinguishing Systems. See rule for detailed conditions.	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. The comparative design concentration based on cup burner values is approximately 8.8%. Users should observe the limitations on PFC acceptability by taking the following measures: - conduct an evaluation of foreseeable conditions of end use; - determine that the physical or chemical properties or other technical constraints of the other available agents preclude their use; - determine that human exposure to the other alternative extinguishing agents may result in failure to meet applicable use conditions; Documentation of such measures should be available for review upon request. The principal environmental characteristic of concern for PFCs is that they have high GWPs and long atmospheric lifetimes. Actual contributions to global warming depend upon the quantities of PFCs emitted. For additional guidance regarding applications in which PFCs may be appropriate, users should consult the description of potential uses which is included in the March 18, 1994, final rule (59 FR 13044). See additional comments 1, 2, 3, 4, 5.
C4F10 (PFC-410, CEA-410)	0	8,860	28-Apr-99; 20-Dec-02	**Acceptable with Narrowed Use Limits:** Acceptable for non-residential uses where other alternatives are not technically feasible due to performance or safety requirements: (a) because of their physical or chemical properties, or (b) where human exposure to the extinguishing agents may result in failure to meet safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Extinguishing Systems. See rule for detailed	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. The comparative design concentration based on cup burner values is approximately 6.6%. Users should observe the limitations on PFC acceptability by taking the following measures:

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
				conditions.	- conduct an evaluation of foreseeable conditions of end use; - determine that the physical or chemical properties or other technical constraints of the other available agents preclude their use; - determine that human exposure to the other alternative extinguishing agents may result in failure to meet applicable use conditions; - Documentation of such measures should be available for review upon request. The principal environmental characteristic of concern for PFCs is that they have high GWPs and long atmospheric lifetimes. Actual contributions to global warming depend upon the quantities of PFCs emitted. For additional guidance regarding applications in which PFCs may be appropriate, users should consult the description of potential uses which is included in the March 18, 1994, final rule (59 FR 13044). See additional comments 1, 2, 3, 4, 5.
C6-perfluoroketone [1,1,1,2,2,4,5,5,5-nonafluoro-4-(trifluoromethyl)-3-pentanone] (Novec 1230)	0	6 to 100	20-Dec-02	**Acceptable**	Use of the agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. For operations that install and maintain total flooding systems using this agent, EPA recommends the following: - install and use adequate ventilation; clean up all spills immediately in accordance with good industrial hygiene practices; and provide training for safe handling procedures to all employees that would be likely to handle containers of the agent or extinguishing units filled with the agent. See additional comments 1, 2, 3, 4, 5.

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
Carbon Dioxide	0	1	18-Mar-94	**Acceptable**	System design must adhere to OSHA 1910.162(b)(5) and NFPA Standard 12
CF3I	0.008	0.4	13-Jun-95; 29-Jan-02	**Acceptable with Narrowed Use Limits:** For use in normally unoccupied areas only.	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. See additional comments 1, 2, 3, 4, 5.
Chlorobromomethane (Halon 1011)	0.07 to 0.15	N/A	28-Apr-99	**Unacceptable**	Other alternatives exist with zero or lower ODP; OSHA regulations prohibit its use as extinguishing agent in fixed extinguishing systems where employees may be exposed. See 29 CFR 1910.160(b)(11).
Firebane® 1179	0	0	4-Oct-11	**Acceptable**	Follow the manufacturer's guidelines in the MSDS.
Foam A [formerly Water Mist / Surfactant Blend A] (Phirex+)	N/A	N/A	5-Sep-96	**Acceptable**	This agent is not a clean agent, but is a low-density, short duration foam.
Gelled Halocarbon /Dry Chemical Suspension (Envirogel) with any additive other than ammonium polyphosphate or sodium bicarbonate	N/A	N/A	29-Jan-02	**Acceptable with Narrowed Use Limits:** For use in normally unoccupied areas only.	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems, for whichever hydrofluorocarbon gas is employed. See additional comments 1, 2, 3, 4, 5.
Gelled Halocarbon /Dry Chemical Suspension with sodium bicarbonate (Envirogel B25 + 36)	N/A	N/A	27-Sep-06	**Acceptable with Use Conditions:** Use of whichever hydrofluorocarbon gas (HFC-125, HFC-227ea, or HFC-236fa) is employed in the formulation must be in accordance with all requirements for acceptability (i.e., narrowed use limits) of that HFC under EPA's SNAP program.	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems, for whichever hydrofluorocarbon gas is employed, and the latest edition of the NFPA 2010 standard for Aerosol Extinguishing Systems. Sodium bicarbonate release in all settings should be targeted so that increased blood pH level would not adversely affect exposed individuals. Users should provide special training, including the potential hazards associated with the use of the HFC agent and sodium bicarbonate, to individuals required to be in environments protected by Envirogel with sodium bicarbonate additive extinguishing systems. Each

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
					extinguisher should be clearly labeled with the potential hazards from use and safe handling procedures. See additional comments 1, 2, 3, 4, 5.
HBFC-22B1 (FM-100)	N/A	N/A		**UnAcceptable**	HBFC-22B1 is a Class I ozone-depleting substance with an ozone depletion potential of 0.74. The manufacturer of this agent terminated production of this agent January 1, 1996, except for critical uses, and removed it from the market because it is a fetal toxin.
HCFC-124 (FE-241)	0.022	609	18-Mar-94	**Acceptable**	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. See additional comments 1, 2, 3, 4, 5.
HCFC-22	0.055	1,810	18-Mar-94; 20-Jul-15	**UnAcceptable** as of September 18, 2015.	
HFC Blend B (Halotron II®)	0	1,598	29-Jan-02	**Acceptable with Narrowed Use Limits:** For use in normally unoccupied areas only.	See additional comments 1, 2, 3, 4, 5.
HFC-125 (FE 25)	0	3,500	18-Mar-94	**Acceptable**	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. See additional comments 1, 2, 3, 4, 5.
HFC-125 with 0.1% d-limonene (NAF S-125)	0	3,500 (HFC-125); 10 (d-limonene)	21-Aug-03	**Acceptable**	Use of the agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. Extinguisher bottles should be clearly labeled with the potential hazards associated with the use of HFC-125 and d-limonene, as well as handling procedures to reduce risk resulting from these hazards. See additional comments 1, 2, 3, 4, 5.
HFC-134a	0	1,430	18-Mar-94	**Acceptable**	Use of blends containing this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. The NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems gives guidelines

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
					for blends that contain HFC-134a or HCFC-22 and other **Acceptable** total flooding agents, rather than referring to HFC-134a or HCFC-22 alone. See additional comments 1, 2, 3, 4, 5.
HFC-227ea (FM-200, FE-227)	0	3,220	18-Mar-94	**Acceptable**	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. See additional comments 1, 2, 3, 4, 5.
HFC-227ea with 0.1% d-limonene (NAF S 227)	0	3,220 (HFC-227ea); 10 (d-limonene)	1-Oct-04	**Acceptable**	Use of the agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. Extinguisher bottles should be clearly labeled with the potential hazards associated with the use of HFC-227ea and d-limonene, as well as handling procedures to reduce risk resulting from these hazards. See additional comments 1, 2, 3, 4, 5.
HFC-23 (FE-13)	0	14,800	18-Mar-94	**Acceptable**	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. See additional comments 1, 2, 3, 4, 5.
HFC-236fa (FE-36)	0	9,810	28-Apr-99; 29-Jan-02	**Acceptable with Narrowed Use Limits:** Acceptable when manufactured using any process that does not convert perfluoroiso-butylene (PFIB) directly to HFC–236fa in a single step:—for use in explosion suppression and explosion inertion applications, and —for use in fire suppression applications where other non-PFC agents or alternatives are not technically feasible due to performance or safety requirements: (a) because of their physical or chemical properties, or (b) where human exposure to the extinguishing agents may result in failure to meet applicable use conditions.	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. The comparative design concentration based on cup burner values is approximately 6.4%. Users should observe the limitations on HFC-236fa acceptability by taking the following measures: - conduct an evaluation of foreseeable conditions of end use; - determine that the physical or chemical properties or other technical constraints of the other available agents preclude their use; - determine that human exposure to the other alternative

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
					extinguishing agents may result in failure to meet applicable use conditions; - Documentation of such measures should be available for review upon request. Feasible for use in a normally occupied area. The principal environmental characteristic of concern for HFC-236fa is its high GWP of 9400 and long atmospheric lifetime of 226 years. Actual contributions to global warming depend upon the quantities emitted. See additional comments 1, 2, 3, 4, 5.
HFC-32	0	675		**UnAcceptable**	This agent is flammable.
HFC227-BC	0	3,800	27-Jan-03	**Acceptable with Use Conditions:** Sodium bicarbonate release in all settings should be targeted so that increased pH level would not adversely affect exposed individuals. Users should provide special training to individuals required to be in environments protected by HFC227–BC extinguishing systems. Each HFC227–BC extinguisher should be clearly labeled with the potential hazards from use and safe handling procedures.	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. See additional comments 1, 2, 3, 4, 5.
IG-01 (Argotec; formally Inert Gas Blend C)	0	0	28-Jul-95	**Acceptable**	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. See additional comments 1, 2, 5.
IG-100 (NN 100)	0	0	26-Apr-00	**Acceptable**	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. See additional comments 1, 2, 5.
IG-541 (Inergen)	0	0	18-Mar-94	**Acceptable**	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
					for Clean Agent Fire Extinguishing Systems. This agent contains CO2, which is intended to increase blood oxygenation and cerebral blood flow in low oxygen atmospheres. The design concentration should result in no more than 5% CO2. See additional comments 1, 2, 5.
IG-55 (Argonite; formally Inert Gas Blend B)	0	0	28-Jul-95	**Acceptable**	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems. See additional comments 1, 2, 5.
Inert Gas/Powdered Aerosol Blend (FS 0140)	0	1	13-Jun-95	**Acceptable with Use Conditions:** For use in normally unoccupied areas only. Any employee who could possibly be in the area must be able to escape within 30 seconds. The employer shall assure that no unprotected employees enter the area during discharge.	The manufacturer's SNAP application requested listing for use in unoccupied areas only. See additional comment 2.
N2 Towers® System	0	<1	4-Oct-11	**Acceptable**	EPA recommends that use of this system should be in accordance with the safe exposure guidelines for inert gas systems in the latest edition of NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems, specifically the requirements for residual oxygen levels, and use should be in accordance with the NFPA Standard 2010 for Aerosol Extinguishing Systems.
Phosphorus tribromide (PhostrEx)	0.01 - 0.08	0	27-Sep-06	**Acceptable with Use Conditions:** For use only in aircraft engine nacelles.	For establishments manufacturing the agent or filling, installing, or servicing containers or systems, EPA recommends the following: adequate ventilation should be in place and/or positive pressure, self-contained breathing apparatus (SCBA) should be worn; training for safe handling procedures should be provided to all employees that would be likely to handle containers of the agent or extinguishing units filled with the agent; and all spills should be cleaned up immediately in accordance with good industrial hygiene practices. See additional comments 1, 2, 3, 4, 5.
Powdered Aerosol A (SFE)	N/A	N/A	18-Mar-94	**Acceptable**: For use in normally unoccupied areas only.	

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
Powdered Aerosol C (PyroGen, Soyuz)	N/A	N/A	8-Feb-96	**Acceptable**: For use in normally unoccupied areas only.	
Powdered Aerosol D (Aero K/Stat X)	0	N/A	27-Sep-06; 21-Oct-14; 1-Dec-16	**Acceptable**	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2010 standard for Aerosol Extinguishing Systems. For establishments manufacturing the agent or filling, installing, or servicing containers or systems to be used in total flooding applications, EPA recommends the following: adequate ventilation should be in place to reduce airborne exposure to constituents of agent; an eye wash fountain and quick drench facility should be close to the production area; training for safe handling procedures should be provided to all employees that would be likely to handle containers of the agent or extinguishing units filled with the agent; workers responsible for clean up should allow for maximum settling of all particulates before reentering area and wear appropriate protective equipment; and - all spills should be cleaned up immediately in accordance with good industrial hygiene practices. See additional comments 1, 2, 3, 4, 5.
Powdered Aerosol E (Fire Pro)	0	N/A	27-Sep-06	**Acceptable with Use Conditions:** For use in normally unoccupied areas only.	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2010 standard for Aerosol Extinguishing Systems. For establishments manufacturing the agent or filling, installing, or servicing containers or systems to be used in total flooding applications, EPA recommends the following: adequate ventilation should be in place to reduce airborne exposure to constituents of agent; an eye wash fountain and quick drench facility should be close to the production area; training for safe handling procedures should be provided to all employees that would be likely to handle containers of the agent or extinguishing units filled with the agent; workers responsible for clean up should allow for maximum settling of all particulates before reentering area and wear appropriate protective equipment; and - all spills should be cleaned up immediately in accordance with good industrial hygiene practices. See additional comments 1, 2, 3, 4, 5.

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
Powdered Aerosol F (KSA®)	0	0	19-Sep-12	**Acceptable with Use Conditions:** For use in normally unoccupied areas only.	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2010 standard for Aerosol Extinguishing Systems. For establishments filling, installing, servicing, using, or disposing of containers or systems to be used in total flooding applications, EPA recommends the following: appropriate protective clothing (e.g., goggles, particulate removing respirators, and gloves) should be worn during the installation and maintenance of the extinguishing units filled with the agent or during clean up and disposal of this agent; training should be provided to all employees that would be likely to handle containers of the agent or extinguishing units filled with the agent, required to clean up after discharge or required to work near spaces protected by Powdered Aerosol F. Releases in all settings should be limited to an appropriate design concentration for the protected space so that increased blood pH level would not adversely affect exposed individuals. Exposed individuals should be given an electrolyte solution to drink afterwards to restore the pH within the appropriate range. Each extinguisher should be clearly labeled with the potential hazards from use and safe handling procedures. In the case of an accidental spill, the area should be well-ventilated, and workers should wear protective equipment while following good industrial hygiene practices for clean-up and disposal. See additional comments 1, 2, 4, 5.
Powdered Aerosol G (Dry Sprinkler Powdered Aerosol (DSPA) Fixed Generators)	0	<1	19-Sep-12	**Acceptable with Use Conditions:** For use in normally unoccupied areas only.	Use of this agent should be in accordance with the safety guidelines in the latest edition of the NFPA 2010 standard for Aerosol Extinguishing Systems. DSPA generators produce combustion byproducts (micron-sized dry particles and a gaseous mixture), that mix together into a uniform fire-extinguishing aerosol before being released into the protected area. The propellant components of the system generates inert gases, which function to physically extinguish the fire by the combined effects of straining the burning flame front and reducing the heat of the combustion sources. The small aerosol particles have a

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
					high surface area-to-volume ratio, which increases their ability to rapidly distribute throughout enclosed areas and to act as heat sinks. For establishments filling, installing, servicing, using or disposing of generator units or systems in total flooding applications, EPA recommends the appropriate protective clothing (e.g., goggles, particulate removing respirators, and gloves) should be worn during the installation and maintenance of the extinguishing units filled with the agent or during clean up and disposal of this agent. Powdered Aerosol G should be collected by hand (e.g., with a dustpan and duster or a vacuum cleaner); waste should be collected in suitable drums for disposal and the area should be washed clean with sufficient quantities of water; and training should be provided to all employees that would be likely to handle the agent or generator units filled containing the agent, required to clean up after discharge or required to work near spaces protected by Powdered Aerosol G fixed generator total flooding systems. In accordance with Department of Health and Human Services regulations (42 CFR Part 84), safety glasses and a NIOSH/CDC-approved N99 respirator are required for individuals installing Powdered Aerosol G fixed systems. Each generator unit should be clearly labeled with the potential hazards from use and safe handling procedures. In the case of an accidental discharge, the area should be well-ventilated, and workers should wear protective equipment while following good industrial hygiene practices for clean-up and disposal. See additional comments 1, 2, 4, 5, 6.
SF6	0	22,800	29-Jan-02	**Acceptable with Narrowed Use Limits:** Only for use as a discharge agent in military applications and in civilian aircraft.	Users should limit testing only to that which is essential to meet safety or performance requirements. This agent is used only to test new Halon 1301 systems.
Solution of 50% potassium acetate and 50% water (K-Ace)	0	0	17-May-13	**Acceptable**	EPA recommends that use of this system should be in accordance with the manufacturer's MSDS. EPA recommends that users consult Section VIII of the OSHA Technical Manual for information on selecting the appropriate types of personal protective equipment for all

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
					listed fire suppression agents. EPA has no intention of duplicating or displacing OSHA coverage related to the use of personal protective equipment (e.g., respiratory protection), fire protection, hazard communication, worker training or any other occupational safety and health standard with respect to EPA's regulation of halon substitutes. Use must conform to relevant OSHA requirements, including 29 CFR Part 1910, subpart L, sections 1910.160 and 1910.162.
Surfactant Blend A (Cold Fire®)	0	0	10-Aug-12	**Acceptable**	Observe recommendations in the manufacturer's MSDS and guidance for using this substitute.
Trans-1-chloro-3,3,3-trifluoroprop-1-ene (Solstice® FS)	0.00024 – 0.001512	4.7-7	11-Oct-16	**Acceptable**	Use of this agent should be in accordance with the safety guidelines in the latest edition of the National Fire Protection Association (NFPA) 2001 Standard on Clean Agent Fire Extinguishing Systems. Safety features that are typical of total flooding systems such as pre-discharge alarms, time delays, and system abort switches should be provided, as directed by applicable OSHA regulations and NFPA standards. See additional comments 1, 2, 3, 4, 5.
Uni-light Advanced Fire Fighting Foam 1% water mist system (Uni-light AFFF 1%)	0	Negligible	29-Mar-06	**Acceptable**	This agent is intended for use onboard ships and in off-shore installations. It may be used both in normally occupied and unoccupied areas. Appropriate personal protective equipment should be worn during manufacture or in the event of a release. Personal protective equipment should include safety goggles, protective gloves, and a self-contained breathing apparatus. Supply bottles for the foam should be clearly labeled with the potential hazards associated with the use of the chemicals in the foam, as well as handling procedures to reduce risk resulting from these hazards. Use should conform with relevant OSHA requirements, including 29 CFR1910, Subpart L, Sections 1910.160
Victaulic Vortex Systems	0	0	2-Jan-09	**Acceptable**	EPA recommends that users consult Section VIII of the Occupational Safety & Health Administration (OSHA) Technical Manual for information on selecting the appropriate types of Personal Protective Equipment (PPE). EPA recommends that use of this system should be

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
					in accordance with the safe exposure guidelines for inert gas systems in the latest edition of NFPA 2001, specifically the requirements for residual oxygen levels, and should be in accordance with the relevant operational requirements in NFPA 750 Standard on Water Mist Fire Protection Systems.
Water	0	0	18-Mar-94	**Acceptable**	

Additional Comments

1. Must conform with OSHA 29 CFR 1910 Subpart L Sections 1910.160 and 1910.162.
2. Per OSHA requirements, protective gear (SCBA) must be available in the event personnel must reenter the area.
3. Discharge testing should be strictly limited only to that which is essential to meet safety or performance requirements.
4. The agent should be recovered from the fire protection system in conjunction with testing or servicing, and recycled for later use or destroyed.
5. EPA recommends that users consult Section VIII of the OSHA Technical Manual for information on selecting the appropriate types of personal protective equipment for all listed fire suppression agents. EPA has no intention of duplicating or displacing OSHA coverage related to the use of personal protective equipment (e.g., respiratory protection), fire protection, hazard communication, worker training or any other occupational safety and health standard with respect to EPAs regulation of halon substitutes.
6. The NFPA 2001 Standard for Clean Agent Fire Extinguishing Systems gives guidelines for blends that contain HFC-134a or HCFC-22 and other **Acceptable** total flooding agents, rather than referring to HFC-134a or HCFC-22 alone.

Annex B U.S. EPA Significant New Alternatives Policy (SNAP) Substitutes in Streaming Agents

Substitutes are reviewed on the basis of environmental and health risks, including factors such as ozone depletion potential, global warming potential, toxicity, flammability, and exposure potential. Lists of acceptable and Unacceptable substitutes are updated several times each year. The list of substitutes is shown below.

Note**:** SNAP-related information published in the Federal Register takes precedence over all information on this page.

The SNAP Listing Dates shown in https://www.epa.gov/snap/substitutes-streaming-agents contain hyperlinks to U.S. Federal Register publications.

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
2-bromo-3,3,3-trifluoropropene (2-BTP)	0.0028	0.23-0.26	1-Dec-16	**Acceptable with Use Conditions:** For use only in handheld extinguishers in aircraft.	
[HCFC Blend] B (Halotron 1)	0.0098	77	March 18, 1994	**Acceptable:** For non-residential uses only.	
[HCFC Blend] C (NAF P-III)	N/A	N/A	August 26, 1994	**Acceptable:** For non-residential uses only.	
[HCFC Blend] D (Blitz III)	N/A	N/A	August 26, 1994	**Acceptable:** For non-residential uses only.	
[HCFC Blend] E (NAF P-IV)	0.02	N/A	April 26, 2000	**Acceptable with Narrowed Use Limits:** For non-residential uses only.	As with other streaming agents, EPA recommends that potential risks of combustion byproducts be labeled on the extinguisher (see UL 2129). Discharge testing and training should be strictly limited only to that which is essential to meet safety or performance requirements. The agent should be recovered from the fire protection system in conjunction with testing or servicing, and recycled for later use or destroyed.
[HCFC Blend] B (Halotron 1)	0.0098	77	March 18, 1994	**Acceptable:** For non-residential uses only.	

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
[HCFC Blend] C (NAF P-III)	N/A	N/A	August 26, 1994	**Acceptable:** For non-residential uses only.	
[HCFC Blend] D (Blitz III)	N/A	N/A	August 26, 1994	**Acceptable:** For non-residential uses only.	
[HCFC Blend] E (NAF P-IV)	0.02	N/A	April 26, 2000	**Acceptable with Narrowed Use Limits:** For non-residential uses only.	As with other streaming agents, EPA recommends that potential risks of combustion byproducts be labeled on the extinguisher (see UL 2129). Discharge testing and training should be strictly limited only to that which is essential to meet safety or performance requirements. The agent should be recovered from the fire protection system in conjunction with testing or servicing, and recycled for later use or destroyed.
Surfactant Blend] A [Cold Fire, FlameOut, Fire Strike]	N/A	N/A	March 18, 1994	**Acceptable**	
C_6-perfluoroketone [1,1,1,2,2,4,5,5,5-nonafluoro-4-(trifluoromethyl)-3-pentanone] (Novec 1230)	0	6 to 100	January 27, 2003	**Acceptable with Narrowed Use Limits:** For non-residential uses only.	For operations that fill canisters to be used in streaming applications, EPA recommends the following**:** - install and use adequate ventilation ; - clean up all spills immediately in accordance with good industrial hygiene practices; and - provide training for safe handling procedures to all employees that would be likely to handle containers of the agent or extinguishing units filled with the agent. Discharge testing and training should be strictly limited only to that which is essential to meet safety or performance requirements. The agent should be recovered from the fire protection system in conjunction with testing or servicing, and recycled for later use or destroyed. As with other streaming agents, EPA recommends that potential risks of combustion by-products be labeled on the extinguisher (see UL 2129). EPA has no intention of duplicating or displacing OSHA coverage related to the use of personal protective equipment (e.g., respiratory protection), fire protection, hazard communication, worker training or any other occupational safety and health standard with respect to halon substitutes.

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
C_6F_{14} (PFC-614, CEA-614)	0	9,300	April 28, 1999	**Acceptable with Narrowed Use Limits:** For non-residential uses where other alternatives are not technically feasible due to performance or safety requirements**:** a. because of their physical or chemical properties, or b. where human exposure to the extinguishing agents may result in failure to meet applicable narrowed use limits.	Users should observe the limitations on PFC acceptability by making reasonable effort to undertake the following measures**:** - conduct an evaluation of foreseeable conditions of end use; - determine that the physical or chemical properties or other technical constraints of the other available agents preclude their use; and - determine that human exposure to the other alternative extinguishing agents may result in failure to meet applicable narrowed use limits; Documentation of such measures should be available for review upon request. The principal environmental characteristic of concern for PFCs is that they have high GWPs and long atmospheric lifetimes. Actual contributions to global warming depend upon the quantities of PFCs emitted. For additional guidance regarding applications in which PFCs may be appropriate, users should consult the description of potential uses which is included in the March 18, 1994, Final Rule (59 FR 13044). Discharge testing and training should be strictly limited only to that which is essential to meet safety or performance requirements. The agent should be recovered from the fire protection system in conjunction with testing or servicing, and recycled for later use or destroyed.
C_7 Fluoroketone	0	1	September 19, 2012	**Acceptable with Narrowed Use Limits:** For non-residential uses only.	Use of this agent should be in accordance with the latest edition of NFPA Standard 10 for Portable Fire Extinguishers. For operations that fill canisters to be used in streaming applications, EPA recommends the following**:** –Adequate ventilation should be in place; –All spills should be cleaned up immediately in accordance with good industrial hygiene practices; and –Training for safe handling procedures should be provided to all employees that would be likely to handle

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
					containers of the agent or extinguishing units filled with the agent. This substitute is a blend of 3-pentanone,1,1,1,2,4,5,5,5-octafluoro-2,4-bis(trifluoromethyl) (Chemical Abstracts Service Registry Number [CAS Reg. No.] 813-44-5) and 3-hexanone,1,1,1,2,4,4,5,5,6,6,6-undecafluoro-2-(trifluoromethyl) (CAS Reg. No. 813-45-6). See additional comments 1,2,3,4.
Carbon Dioxide	0	1	March 18, 1994	**Acceptable**	
CF_3I	0.008	0.4	May 22, 1996	**Acceptable with Narrowed Use Limits:** For non-residential uses only.	
CFC-11	1	4,750		**Unacceptable**	This agent has been suggested for use on large outdoor fires for which non-ozone depleting alternatives are currently available. In addition, CAA section 610 bans the use of CFCs in portable extinguishers.
Dry Chemical	0	0	March 18, 1994	**Acceptable**	
Firebane® 1115	0	0	October 4, 2011	**Acceptable**	Follow the manufacturer's guidelines in the MSDS. EPA recommends that use of these systems be in accordance with the latest edition of NFPA 10 Standard for Portable Extinguishers.
Firebane® 1170	0	0	October 4, 2011	**Acceptable**	Follow the manufacturer's guidelines in the MSDS. EPA recommends that use of these systems be in accordance with the latest edition of NFPA 10 Standard for Portable Extinguishers.
Firebane® 1179	0	0	October 4, 2011	**Acceptable**	Follow the manufacturer's guidelines in the MSDS. EPA recommends that use of these systems be in accordance with the latest edition of NFPA 10 Standard for Portable Extinguishers.
Firebane® All-Weather 1115	0	0	October 4, 2011	**Acceptable**	Follow the manufacturer's guidelines in the MSDS. EPA recommends that use of these systems be in accordance with the latest edition of NFPA 10 Standard for Portable Extinguishers.
Foam	N/A	N/A	March 18, 1994	**Acceptable**	

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
Gelled Halocarbon / Dry Chemical Suspension	N/A	N/A	August 26, 1994	**Acceptable**	Allowable in the residential use market.
H Galden HFPEs	0	2,790 - 6,230	January 27, 2003	**Acceptable with Narrowed Use Limits:** For non-residential uses only.	For operations that fill canisters to be used in streaming applications, EPA recommends the following**:** - install and use adequate ventilation ; - clean up all spills immediately in accordance with good industrial hygiene practices; and - provide training for safe handling procedures to all employees that would be likely to handle containers of the agent or extinguishing units filled with the agent. Discharge testing and training should be strictly limited only to that which is essential to meet safety or performance requirements. The agent should be recovered from the fire protection system in conjunction with testing or servicing, and recycled for later use or destroyed. As with other streaming agents, EPA recommends that potential risks of combustion by-products be labeled on the extinguisher (see UL 2129). EPA has no intention of duplicating or displacing OSHA coverage related to the use of personal protective equipment (e.g., respiratory protection), fire protection, hazard communication, worker training or any other occupational safety and health standard with respect to halon substitutes.
HCFC-123 (FE-232)	0.02	77	March 18, 1994	**Acceptable:** For non-residential uses only.	
HCFC-124 (FE-241)	0.022	609	August 26, 1994	**Acceptable:** For non-residential uses only.	
HFC-227ea (FM 200)	0	3,220	April 28, 1999	**Acceptable with Narrowed Use Limits:** For non-residential uses only.	Discharge testing and training should be strictly limited only to that which is essential to meet safety or performance requirements. The agent should be recovered from the fire protection system in conjunction with testing or servicing, and recycled for later use or destroyed.

Substitute	ODP	GWP	SNAP Listing Date	Listing Status	Further Information
HFC-236fa (FE-36)	0	9,810	April 28, 1999	**Acceptable with Narrowed Use Limits:** Acceptable in non-residential uses when manufactured using any process that does not convert perfluoroisobutylene (PFIB) directly to HFC-236fa in a single step.	Discharge testing and training should be strictly limited only to that which is essential to meet safety or performance requirements. The agent should be recovered from the fire protection system in conjunction with testing or servicing, and recycled for later use or destroyed. Acceptable for local application systems inside textile process machinery.
Water	0	0	March 18, 1994	**Acceptable**	
Water Mist Systems using Potable or Natural Sea Water	0	0	July 28, 1995	**Acceptable**	

Additional Comments

1. Discharge testing and training should be strictly limited only to that which is essential to meet safety or performance requirements.

2. The agent should be recovered from the fire protection system in conjunction with testing or servicing, and recycled for later use or destroyed.

3. As with other streaming agents, EPA recommends that potential risks of combustion by-products be labeled on the extinguisher (see UL 2129)

4. EPA has no intention of duplicating or displacing OSHA coverage related to the use of personal protective equipment (e.g., respiratory protection), fire protection, hazard communication, worker training or any other occupational safety and health standard with respect to halon substitutes.

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By: OAH on 2/29/2024

PCB PIEZOTRONICS
AN AMPHENOL COMPANY

ENDEVCO
AN AMPHENOL COMPANY

PFAS Current Unavoidable Uses
For PCB Piezotronics, Inc. and its Subsidiaries

Exemptions needed for PFAS applications necessary for PCB Piezotronics Companies' without effective substitutes

Submission Date: February 29, 2024

This submission is in response to Minnesota session Law on PFAS and Currently Unavoidable Uses proposed for a restriction pursuant to 2023, Chapter 60, H.F. No. 2310.It is respectfully submitted on behalf of PCB Piezotronics, Inc. ("PCB") and its subsidiaries set forth on Exhibit A attached hereto (collectively, PCB and its subsidiaries are referred to herein as the "PCB Companies"). This document is in submission for all Schedule B numbers in Exhibit B. which PCB Companies considers testing electronics as a product group. The PCB Companies are committed to continuously improving the environmental performance and safety of all products they place on the market.

In this document we expect to answer the submission requirements of the following:

1. Provide a brief description of the type of product including, if applicable, the Global Product Classification (GPC) brick category and code, or if GPC is not applicable then the Harmonized Tariff System (HTS) code.
2. Describe the intended use of the product and explain how it is essential for health, safety or the functioning of society.
3. Describe how the specific use of PFAS in the product is essential to the function of the product. If this use of PFAS is required by federal or state law or regulation, provide citations to that requirement.
4. Describe whether there are alternatives for this specific use of PFAS which are reasonably available.
5. Provide contact information for the submission.

1. Provide a brief description of the type of product including, if applicable, the Global Product Classification (GPC) brick category and code, or if GPC is not applicable then the Harmonized Tariff System (HTS) code.

PCB products are filled with a potting or an epoxy agent that encapsulates our components that creates a protected environment which makes break down very slow or impossible. These are commercial products that are mainly used in business sectors and generally not available to consumers. PCB uses an exhaustive list of HTS codes. Our most popular categories (the first four digits) are listed below. An addendum of our exact exhaustive list of HTS codes that have used in the past as of this document are provided in a supplemental document labeled Exhibit B.

- 9031 (Measuring or checking instruments, appliances and machines, not specified or included elsewhere in this chapter; profile projectors; parts and accessories thereof)
- 9026 (Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases (for example, flow meters, level gauges, manometers, heat meters),

- 8504 (Electrical transformers, static converters (for example, rectifiers) and inductors; parts thereof)

- 8518 (Microphones and stands therefor; loudspeakers, whether or not mounted in their enclosures; headphones and earphones, whether or not combined with a microphone, and sets consisting of a microphone and one or more loudspeakers; audio-frequency electric amplifiers; electric sound amplifier sets; parts thereof)

- 9024 (Machines and appliances for testing the hardness, strength, compressibility, elasticity or other mechanical properties of materials (for example, metals, wood, textiles, paper, plastics), and parts and accessories thereof)

- 8544 (Insulated (including enameled or anodized) wire, cable (including coaxial cable) and other insulated electric conductors, whether or not fitted with connectors; optical fiber cables, made up of individually sheathed fibers, whether or not assembled with electric conductors or fitted with connectors)

2. Describe the intended use of the product and explain how it is essential for health, safety or the functioning of society.

Sensors and equipment manufactured by PCB Companies play a crucial role in enhancing safety testing and condition monitoring across various sectors, including consumer products, automotive, aerospace, infrastructure, industrial, and military applications. When used for consumer product testing, PCB sensors find extensive use in both the development and testing phases of a broad spectrum of products, from everyday household appliances to specialized sports equipment our units test it all. In the automotive industry, they are indispensable in crash testing to improve vehicle safety, as well as informing electric vehicle design to enhance fuel efficiency. In the aerospace and energy sectors, PCB sensors ensure gas turbines run more efficiently, to cut down on greenhouse gas emissions. In the sports industry, PCB sensors play a critical role providing force impact data that contributes to the design of personal protective gear. PCB acoustic sensors are employed to mitigate noise pollution in heavy noise areas including around airports.

Sensors for condition monitoring are pivotal in preventing catastrophic equipment failures, unplanned downtime, and costly repairs particularly in the energy and industrial sectors. This proactive approach not only safeguards machinery but also ensures industrial workers operate in a safe environment. Within military applications, such as ballistics testing and ground vehicle development, PCB sensors provide critical data for optimizing performance and ensuring the safety and effectiveness of defense systems.

Given the widespread application of PCB's sensors in vital areas such as safety enhancement, environmental protection, and the safeguarding of human life, the company should qualify for an exemption.

The below table answers 3. and 4. are together.

3. Describe how the specific use of PFAS in the product is essential to the function of the product. If this use of PFAS is required by federal or state law or regulation, provide citations to that requirement.

4. Describe whether there are alternatives for this specific use of PFAS which are reasonably available.

Products of the PCB Companies are considered complex products (articles) and have anywhere from 10 to 500 components in each individual product. Further, the PCB Companies have thousands of active model numbers, each with separate bills of material. This submission is based on a detailed review of our products and supply chain, including internal review by the PCB Companies, review by an independent outside expert, Claigan Environmental Inc. ("Claigan Environmental"), and a review of our supply chain. The complexity of the supply chain, and the intermediate and final products manufactured by PCB Companies does not easily lend itself to gathering credible and accurate information on all essential chemicals and materials embedded in electronics manufacturing processes and products. Claigan Environmental was able to do a full analysis of our industry as found in Exhibit C.

Current Unavoidable Use CUU	**Example Articles in our Products**	**Essential Use of PFAS**	**Comparison of Alternatives**
Fluoroacrylic and PFA coatings (and solvents) for encapsulation of capacitors or semiconductor components.	Capacitors and integrated circuits used in computers, servers, Industrial, Machinery, and laboratory equipment	Very thin fluoroacrylic and PFA coatings provide water resistance at high temperature to sensitive electronics.	**Alternative non-fluorinated materials do not have adequate chemical, water, and heat resistance in a high density / thin film application.**
Lubricants: threads, O-rings, plungers, hammer shaft (assembly and maintenance)	Gaskets, O-rings, and molded rubber parts in electronics, pumps,	Release agents are required to release rubber parts from their molds	**Superior to other release agents. May be replaceable in the future by silicone. Wide verification and validation required.** **Silicone has higher friction and adhesion than fluoropolymer based**
PTFE used as an additive drip agent in plastics to meet flammability safety requirements	Widespread use. Including plastic components, fans, processing equipment ect. Used in the vast majority of complex electronics on the market.	Provide required anti-drip flame retardancy required by fire regulation and standards. currently no effective replacements for PTFE as an anti-drip additive. Virtually all electronics use PTFE anti-drip agents in one or more parts. Restriction of PTFE anti-drip agents would create a significant safety risk for electronics and require the redesign and re-qualification of safety of virtually every electronic product on the US market	**Only additive widely approved for use to meet strict anti-drip flame retardancy requirements in plastics**
PTFE, ETFE, PFA, PVDF, and FEP as a wire insulator.	Wires	Provide temperature resistance with electrical insulation	**Other materials do not have sufficient temperature resistance, feasibility in dense electronics (too thick), and electrical insulation**
Fluoropolymers (PTFE, ETFE, FEP, and PFA) used for electrical insulation purposes except wiring.	Coaxial cables, ports, hoses, and antennas	Fluoropolymers have the best in class dielectric constants / electrical insulation while maintaining flexibility.	**Other polymers do not provide sufficient electrical insulation (poorer dielectric constants).** **Ceramics can provide sufficient**

		This includes both electrical isolation but also in static dissipation and related safety activities.	**dielectric constant for some RF applications, but do not have the flexibility required for most applications.**
Fluoroelastomers (including perfluoroelastomers), fluorosilicone, and amorphous fluoro resins as a sealing and packing material in situations requiring chemical resistance, oil resistance, oxidation resistance, decompression resistance, high temperature (over 150C), or low temperature (<-20C).	Rubbers, Seals, Aerospace, equipment for extreme environments	Products using fluoroelastomer seals can be found in virtually every industrial or machinery application worldwide. Without fluoroelastomer seals, virtually all industrial applications would no longer be viable.	**No other rubbers have equivalent hydrophobic and oleophobic properties, oxidation resistance, and chemical safety over a range of low and high temperatures as fluoroelastomers. Fluoroelastomers are also very resistant to explosive decompression.** **Fluoroelastomer use can extend product life/service intervals thereby reducing potential chemical releases/exposures. Alternative materials would need to be replaced monthly, as they begin to leak.** **PTFE has similar environmental properties, but is a plastic and is not suitable for applications requiring the conformity of a 'rubber' seal. Fluoroelastomers also have a higher coefficient of friction than PTFE and create a superior 'seal' in most applications.**
PTFE tape for moisture insulation, or joining of fluid or gas components.	Widespread use. PTFE tape for plumbing, Industrial, Machinery with fluids or gasses, and other equipment requiring piping to be sealed together.	PTFE rubber tape has best in class water and oil resistance in a thin applicable tape.	**Alternative materials do not provide the same water or oil seal in a thin tape.**
PTFE tape for reduction of friction.	Self-adhesive tape, PTFE tape provide a thin coating to reduce friction between moving parts.	PTFE rubber tape has very low friction reduce the wear and extending the lifetime of moving parts.	**No other tape materials have as low friction as PTFE tape and the ability to conform to uneven surfaces.** **Replacement of PTFE tape in a low friction application will affect product performance issues and reduced lifetime of the product - causing earlier disposal or replacement of the product using the PTFE tape.**

Fluorocoating of rubber, metal, and plastic seals in high temperature, professional, or industrial applications where chemical resistance is required	Rubber components in contact with chemicals	Most standard rubbers are high friction (nitrile rubber, styrene rubber, EPDM) and require a fluorocoating for low friction. This is necessary for rubber parts likely to encounter friction in operation.	**Alternative materials do not sufficiently reduce the friction of rubber to allow for the necessary movement of the rubber part.** **No other coating material provides the same environmental protection to rubber and metal seals.**
PTFE, ETFE, and PFA coating of metal for environmental or temperature resistance not in contact with food or drinking water	Coatings on parts to resist harsh or outdoor environments	Fluoropolymer coatings provide environmental resistant to metal parts. Resistance to water, acids, and oils extends the lifetime of the parts in outdoor and harsh environments.	**No other coating materials provide the same environmental (water, oil, acid, and chemical) protection to metals.** **Replacement PTFE and PFA environmental coatings for metals will reduce the corrosion resistance (in particular over temperature) of many metals resulting in failure of these metals and/or reduced product lifetime (resulting in more products entering end of life disposal sooner).**
Fluorocoatings on labels on products (excluding textiles) necessary for environmental resistance	Labels	Clear labels that do not degrade over time are required for safety and regulatory reasons on most electronic, professional, and industrial products. A thin fluorocoating protects the label from the environment, maintaining the legibility of the label..	**Alternative coatings do not have equivalent water or oil resistance.** **Or, in the case of nitrile or EPDM rubber, do not have the required transparency to read the label's writing.** **PVC has nearly equivalent water and oil resistance, but has risks of other regulated substances (such as phthalates) and does not withstand temperature ranges as well as fluoropolymers.**
PTFE, PFA, FEP, PVDF, ETFE, and fluoroelastomer (including perfluoroelastomer) tubing not in contact with drinking water.	Tubing	Fluoropolymers have flexibility, biocompatibility (low chemical reactivity), optical transparency, and high temperature resistance. For electronics, the flexibility and high temperature resistance is critical for power applications such as the leads in transformers. For medical devices, the flexibility, transparency, and low chemical reactivity are critical for human or laboratory processes.	**Alternative polymers do not have equivalent low chemical reactivity, optical transparency, flexibility, and temperature resistance.** **Polyurethane and PVC tubing can be used in some applications, but have poor resistance to acids and bases, can release chemicals (isocyanates or phthalates) into the fluid, and both have poor temperature stability.**

PVDF and PTFE as the cathode binder in lithium batteries	Batteries in electronics including for Wi-Fi models used in applications like windmills	Fluoropolymer binders have high heat resistance and excellent electrical insulation - improving performance lithium batteries and reducing delamination of the electrodes in the battery.	**Alternative polymers do not have as good temperature resistance and/or electrical insulation, reducing the performance and lifetime of lithium batteries.** **Other polymers could not maintain the rigorous performance requirements of a binder in a high-density lithium battery.** **Pb acid batteries have similar performance to lithium batteries, but can release Pb at the end of life and have a weight that makes them unusable for mobile applications including electrical vehicles.**
PVDF, PTFE, TFE, and sulfonated PTFE as a binder or spacer in capacitors	Capacitors, Electronics, Vehicles, Industrial, Machinery	Fluoropolmer binders and spacers provide the electrical insulation and temperature resistance needed in high capacitance capacitors.	**Alternative polymers do not have as good temperature resistance and/or electrical insulation, reducing or preventing the performance of the high-performance capacitors**
PTFE, PCTFE, PVDF, FEP, ePTFE, PFA, and TFE (including copolymers) as a sealing or spacer material.	Plastic seals, Building Products, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	Fluoropolymers have the acid, heat, water, and oil resistance needs for industrial sealing applications.	**Alternatives do not provide sufficient resistance to acid, chemicals, water, oils, and temperature.** **In most of the applications listed in this entry, alternative sealing materials were tested, and no materials and closure systems showed positive results.**
PTFE in coatings of labels for security or tamper evidence.	Tamper proof labels	PTFE coatings provide tamper proof protection for labels. PTFE cannot be modified chemicals and shows physical wear if tampered.	**For security - no other polymer provides the same tamper proof properties (chemical resistance) as PTFE as a coating. Use of another polymer would reduce the security of devices especially those for financial transactions or personal identification.** **For tamper evidence - PTFE material film (plus an adhesive) is used in the label in order to provide evidence. Other plastics do not have the combination of chemical resistance and visibility of tampering than irradiated (soft) PTFE.**
Fluoroacrylic and PFA coatings (and solvents) for encapsulation of capacitors or semiconductor components.	Capacitors and integrated circuits used in computers, servers, Industrial, and Machinery	Very thin fluoroacrylic and PFA coatings provide water resistance at high temperature to sensitive electronics.	**Alternative non-fluorinated materials do not have adequate chemical, water, and heat resistance in a high density / thin film application.**

Ionic fluoro fluids as electrolytes in capacitors or batteries	Super Capacitors in electronics, portable electronic equipment	Fluoro ionic fluids provide a great surfactant power, chemical/biological inertness, easy recovery and recyclability, low surface tension, extreme surface activity, no flammability, and high thermal stability. The surface active and high thermal stability are excellent for high performance lithium batteries and super capacitors.	**Other ionic fluids can be used, but these fluids do not exhibit either/or the performance or flammability resistance of FILs.**
PVDF polymers and PVDF terpolymers for ferroelectric films.	Films, electronics	PVDF and similar films are fundamental to the specialize use of ferro electric films. Without PVDF, ferroelectric films would not be possible.	**Specialized PVDF films have the highest dielectric constant of polymers, are new innovations, and are not replaceable with other materials.**
Fluorosilicone used as a surfactant or anti-foaming agent in semiconductor materials	Integrated circuits used in computers, servers, Industrial, Machinery, and laboratory equipment	The fluorosilicone surfactants are used in a manufacturing step for a microscopic material internal to a semiconductor device. The resulting chemical is only used in the manufacturing of the product and will not be present above 50 ppm organic fluorine in the final product.	**Other surfactants are not as effective for this high precision application or as inert. In semiconductor manufacturing this surfactant cannot react without other materials.**
F2 gas fluorinated plastics in capacitors and microchips	Integrated circuits used in computers, servers, Industrial, Machinery, and laboratory equipment	A microlayer of fluorinated material is created in capacitors and semiconductor devices by F2 gas fluorination (usually plasma fluorination) of a plastic such as polyethylene or polyphenylene sulfide The thin layer has amorphous fluorinated alkane molecules. This very thin internal fluorinated layer provides specialized capacitance curves and is useful in specialized applications.	**Thin fluorinated plastics provide capacitance performance advantages not available in other materials.**
PTFE filled die attach material for semiconductor devices	Integrated circuits used in computers, servers, Industrial, Machinery, and laboratory equipment	PTFE provides a chemical inertness and temperature resistance to microchip die attach material.	**No other polymer powder is as chemically inert and have as high temperature resistance as PTFE powder.**
PFBS (Perfluorobutane sulfonate) and its salts - for the purposes of optical clarity in flame retarded polymers.	Refrigerator, computer display, kiosk terminal. Optically clear and flame retarded displays are important for displays used by consumers.	Flame retarded clear plastic tends to be slightly cloudy, reducing the transparency of the screen. By adding <0.01% PFBS, the plastic of the displays is 'clarified', and can be used easily and safety.	**No information is available on a potential replacement for PFBS. Currently is it the only material effective for its specialized application.**

PTFE as an additive up to 25% in plastics for the purposes reduced friction and wear	Plastics and electronics	PTFE additive provides greatly reduced friction and wear in plastic parts. This properly greatly extends their lifetime and time before replacement.	**Alternatives do not have equivalent low friction or compatibility as an additive.** **No other additives are as effective to safely reduce the coefficient of friction of plastics. Restriction of PTFE additives in plastics for friction reduction would reduce the lifetime of many products, resulting in products going to waste or landfall sooner and more often.** **In addition, PTFE added plastics extend product life/service intervals thereby reducing potential fluid and gas releases/exposures. They also reduce power consumption compared to non-PTFE added counterparts.**
PTFE, ETFE, and PCTFE for professional, industrial, or high temperature applications (>150C) requiring reduced friction, or chemical inertness.	Electronics, Oil and gas, Industrial applications	Fluoropolymers have tremendous chemical and temperature resistance combined with low friction. All three are essential of operation and safety in industrial environments.	**No other materials have the same low friction and chemical inertness properties as PTFE, ETFE and PCTFE at regular temperatures and at high temperature (150C).** **PTFE and PCTFE extend product life/service intervals thereby reducing potential chemical releases/exposures. They also can reduce power consumption compared to non-PTFE/PCTFE counterparts.**
Fluorosilicone and nano-fluorocoatings for anti-smudge and antireflective coatings for plastics and glass.	LCD screens and windows.	Anti-smudge and anti-reflective coatings are necessary to maintain optical clarity in products that are touched by humans or are exposed to the environment. Fluorinated coatings provide hydrophobic (water repellant) and oleophobic (oil repellant) properties to glass and plastics while maintaining optical transparency. Without anti-smudge and anti-reflective coatings, safety and functionality could be compromised by lack of visibility.	**Alternative materials do not have equivalent water or oil resistance with the necessary optical clarity. In particular, oil (fingerprint) repellency of other materials are not equivalent.** **Other anti-fingerprint coatings exist, such as perylene, but they do not adhere to plastic substrates as effectively as fluoropolymer side chain polymers and have lower thermal stability.**

The PCB Companies are committed to replacing PFAS in products and processes where feasible and in a responsible manner. Due to the widespread and varied nature of PFAS used in electronics in performance materials, broad generalizations on alternatives are not reasonable or valuable to eliminating these substances in products. Replacement of these substances must be undertaken on a case-by-case basis as they are selected for their specific properties that ensure product reliability, safety, and efficiency. For most uses of PFAS in PCB Company products, there are no drop-in solutions which provide the same properties as PFAS-containing materials. Because of this, more research must be conducted on alternatives based on use case and industry must have more time to investigate alternatives. The use of PFAS in electronics materials is currently necessary for the key functionalities and properties it provides.

The PCB Companies respectfully request an exemption for the above PFAS products. Differentiating specific uses and exploring non-PFAS options is our ongoing plan. As noted above, many individual parts go into our thousands of products, and PFAS currently is an unavoidable substance to making our products function properly. Our products do not easily break down and are not a risk to the water systems as such. We request an exemption to mitigate unintended consequences and will continue to aim for the removal of all PFAS in our products as substitutes become available.

5. Provide contact information for the submission.

Wendy Willard
Regulatory Affairs and Product Certification Coordinator
WWillard@pcb.com
3425 Walden Avenue
Depew, NY 14043
Phone 716-684-0002 x102420

Exhibit A

This exemption request is submitted on behalf of PCB Piezotronics, Inc., Depew, NY, a New York (USA) corporation together with its subsidiaries, including the following entities:

PCB Piezotronics of North Carolina, Inc., Halifax, NC, a Delaware (USA) corporation

Accumetrics, Inc., Latham, NY, a New York (USA) corporation

The Modal Shop, Inc., Cincinnati, OH, an Ohio (USA) corporation

Exhibit B

Description including but not limited to	Customs Schedule B number
Sensors	9031.80.8080
Sensors Parts and Accessories	9031.90.0000
Accelerometer mounting studs and washers	7318.15.50xx
Pressure Sensors (PCB and Endevco)	9026.20.0000
Pressures Sensor Parts and Accessories (PCB and Endevco)	9026.90.0000
Electronic Conditioners and Parts	8504.90.0080
Modal Hammers	9024.80.0000
Modal Hammer accessories	9024.90.0000
Microphones	8518.10.0000
Microphone adaptors and accessories	8518.90.3000
Repair / Recal	9801.10.0000
Adaptors / Enclosures	8536.90.8085
Junction boxes	8536.90.8030
Coax Cables	8544.20.0000
Cables, non-coax, with connectors	8544.42.0000
Cabling, non coax without connectors (not exceeding 80 volts)	8544.49.9000
Antenna and parts (Wireless system)	8529.10.4000
Mechanical Switches (685A07, 685A08, 685A09, 685A18, 685A19, 685A29)	8536.50.9040
Electrical Switches (all 685Bs, 685A01, 685A11, 686s)	8536.50.7000
Computer	8471.41.0150
Repackaged Software	8523.49
Connectors Only (coaxial connectors only)	8536.69.4010
Electrical Connectors Cylindrical Multi- Contact	8536.69.4020
Electrical Connectors Rack and Panel Type	8536.69.4030
Electrical Connectors Printed Circuit Type	8536.69.4040
Cases	3923.10.0000
Soft foam inserts for kit cases	3921.13.0000
Batteries general	8507.20.0040
(NiCad) (LD Model BAT007)	8507.30.0000
(NiMH) (LD Model BAT010)	8507.50.0000
LITHIUM BATTERY & LFP (LD Model BAT019)	8507.60.0000

Exhibit B

Lubricants	3403.99.0000
Adhesives	3506.99.0000
Petro Wax (Bees Wax)	3404.90.5160
Magnets	8505.11.9000
Spark Plug	8511.10.0000
Printed Catalogs	4911.10.0050
Advertising Material and manuals (not including catalogs)	4911.10.0090
Advertising Posters	4911.91.0020
Crystals	8541.90.0000
Plexiglass	6909.90.0000
Metal Braid around 052 cable	7306.50.1000
Bolts/studs of steel	7318.15.5030
Electrical Machinery and Equipment	8527.99.3060
Repackaged Software	8523.49.2010
# 61566-01 fixed, multilayer ceramic capacitor	8532.24.0040
Mouse pads	4016.99.6000
Key Pad	8471.60.2000
Acrylic Plaque	3926.40.0000
*SPARK 703 NOISE DOSIMETER (HOLD)	9027.50.1000
TYPE 2 SLM ENV NOISE ANALYZER	9027.80.8000
POWER DISTRIBUTION 4 POS ANDERSON PP	9027.90.8950
SOFTWARED WITH CABLE	8523.49.4000
10' cable for 1502B01GC15PSIA	8544.42
HIGH STRENGTH MAGNETIC BASE	8505.11.0000
power distribution block	8536.41.0030
12 CH MULTIPLEXER/ 7-PIN LEMO	8518.40.2000
PRECISION TYPE 1 SLM DUAL CHAN	9027.80.4560
730 Event Sound Recordings	8523.80.2000
800B FOR RESALE	9027.80.3500
UNUSED	9027.90.8400
OPTION 831 MEMORY 1GB INTERNAL UPGRADE	8523.51.0000
8440 KIT WITH ALL OPTIONS	9027.80.8950
MICROPHONE ATTACHMENT CLIP	8518.10.1000
HEADSET, SLM VOICE INPUT & OUTPUT	8518.30.2000
SUPPRESSOR, SURGE INLINE 120V/240V	8535.40.0000
HEATSINK FOR FITPC2	8473.30.0002
MOUNT, VAISALA TO TRP003	8518.9
CABLE GROMMET REPLACEMENTS	3923.90.0000

Exhibit B

*SOURCE SPEAKER DODECAHEDRAL+CABLE	8518.21.0000
BA SOURCE SYSTEM COMPLETE 220-240 VAC	8519.81.3000
MARTEL SOFT POUCH FOR PRN003	8443.91.3000
*PIMENTO CALIBRATION WITH CAL/HW UPDATE	4901.99.0050
ANTENNA, RUBBER DUCK, 2.5 dBi SMA	8523.29.9000
ANTENNA. OMNI 3.2" TALL 18" CABLE SMA-M	8517.18.0000
GX450 GATEWAY FOR AT&T	8517.62.0010
LS300 MODEM DC PWR *MUST ORDER CARRIER	8517.69.0000
IOgear GUIP201 Intranet USB extender	8471.80.1000
MODEM WITH CUSTOM SETTINGS	8517.62.0050
*HEATER, 60W, 6" LONG, 40 DEGREES F	8516.10.0080
AC Power Cord - 50 feet	9902.16.96
Handheld Weather Station Kestrel 3000	9025.80.5050
Portable Camera Canon Powershot ELPH 180	9006.40.90
MASSPORT HARDWARE FOR NEW 045 SYS	9027/90.8950
Amazon FIRE HD with a 10 inch display	8471.30.0100
FEMALE IDC CONNECTOR PACK	8536.69.5050
DSS QUAD SOURCE MODULE	8543.20.0000
EXTERNAL 3 1/2" FLOPPY DISK DRIVE - OBS	8471.70.4035
*IFSYS-8004 USB TO IR INTERFACE ADAPTER	9027.50.0000
NOISETUTOR BATTERY BYPASS KIT	8504.31.2000
EPS048 AC UPGRADE UK PLUG	8504.31.4035
EPS048 SOLAR UPGRADE	8540.40.1050
15 FOOT CABLE WITH LOCKS FOR EPS	8301.10.0000
KIT, HVM100 W/ WHOLE BODY FILTER	9027.80.35
*MANUAL CD ADP002,005, 006 AND 090	9027.90.0050
INTERFACE WEATHER SENSORS-870	9015.80.8080
Tripp Lite ISOBAR4ULTRA surge suppressor	8536.30.8000
CUSTOM BACK PANEL FOR MAC/MSP	9027.80.8400
*RAVEN XE ATT HSUPA WITH AC SUPPLY	8517.62.0000
POCKETJET 200 W/SERIAL OR INFRARED CABLE	8443.32.1050
*PRINTER THERMAL USB MARTEL MCP7870	8443.19.3000
SOLAR PANEL W/MOUNTING HDWRE	8541.40.6020
ADAPTER 100-240VAC TO 12V 1.6A DC	8504.31.0000
*WIND MONITOR, SPEED AND DIRECTION	9026.80.0000
Keypad	8471.60.2000.
USB WITH G4 AND DNA SOFTWARE	8523.49.4001
^VT DS5 BLAZE PELICAN CASE	9024.80.4560

Exhibit B

REPAIR OF THE PIMENTO UNDER WARRANTY	9801.00.1090
WINDSCREEN, 1/2" PREAMP HOUSING	9027.90.8951
SPARTAN 730 WINDSCREEN	9027.90.8952
001A5410	3923.10
001A5411	8536.90
001A5414	9031.90
009M192	8544.42
010200-31269	8204.20
010200-31629	9031.80
010304-37062	8204200000
061700-00300	8504.90
080910-01000	9024.90.0000
089120-01000	8501.10
089400-00606	8501.32.2000
089504-10000	8443.32
08CLEC-0CTRL	8504.40
091525-37463	8544.20
093210-49587	8544.59
097000-34445	8544.42.9000
100135-10000	9031.20
102145-00001	8431.39
102145-G1000	8024.20
102410-33470	8205.70.00
109175-37698	9024.10
1403-01A/LCS-FoMoCo4	9801.10
180-012A	8518.10
21170-0007P2	8507.80
291525-37977	8544.49
38165-000001	4802.20
38180-000960	4202.92
7122R-04352A	8533.90
8179-CUR00A	8517.62
D-32004A	8479.90
M1403-03ADB	9024.80
AS3000 (ABB Motors) Limited Production	9030.33.0040
AT-6000 (GDS)	8536.30.0000
AT-8000 (EFM)	8536.30.0000
AS/AT Model Numbers	9030.33.0080

Exhibit B

BT /ST/M/FT/UT Numbers	9030.90.8060
Non-coaxial cables w/ connectors	8544.42.0000
BT50001 Amplifier	8543.70.99.10
PT80014 EFREM Receiver Board w/ 4-20mA	8504.90.0080
M0004141 Microcontroller	8542.31.0000
AT8000 Main assembly measures voltage current, etc. Holds boards such as PT80014 and PT80050.	9030.39.0100
164373	7318158020
177230-02-01-05	8543704500

Additional Descriptions	**HTS number**
Bridge/Charge/ICP Sig Cond	8504.90.7500
Petro Wax	3404.90.1000
Transportation Case	3923.10.9000
9110D Quick Start Guide	4911.10.0080
Power Supply	8504.90.7500
Signal Conditioner	8504.90.7500
Power Supply	8507.50.0000
Acoustic Comparison Calibration Kit	8518.10.8030
9155 Shaker Selector	8518.10.8040
9917C Microphone Calibration Coupler	8518.10.8040
9110F Top Panel Kit	8518.29.8000
9535C Controller	8518.40.2000
75 lbf Modal Shaker Kit	8523.80.2000
PVC Grounding Lug	8535.90.8020
Wiring harness fan	8536.90.8530
100 lbf Modal Shaker Kit	8543.20.0000
25 lbf Modal Shaker	8543.20.0000
60lb Modal Shaker	8543.20.0000
9155D Calibration System	8543.20.0000
Air Bearing Shaker Kit	8543.20.0000
Miniature Shaker 4.5 lbf	8543.20.0000
Miniature Shaker 7lbf	8543.20.0000
Portable Vibration Calibrator	8543.20.0000
Shock Calibration System	8543.20.0000
Power Amplifier 110V	8543.70.9810
Power Amplifier 230V	8543.70.9810
SmartAmp Power Amp 100W	8543.70.9810
Prox Probe Calibration Target	8543.90.8885

Exhibit B

Trunnion for 2110E Shaker	8543.90.9000
Coaxial Cable BNC to BNC	8544.20.0000
Adaptor cable	8544.42.9090
Sensor Cable	8544.42.9090
LAN2 Shielded Ethernet Cable	8544.49.2000
NDT-RAM Semi-auto Test System	9024.10.0000
NDT-RAM Test System	9024.10.0000
RAM-DROP Industrial Computer	9024.10.0000
Automated Industrial Impact Hammer	9024.80.0000
RAM-AUTO Light Curtain Kit	9024.90.0000
NDT-RAM Automated Conveyor System	9024.90.0080
Pressure Calibration System	9026.20.0000
9155D 903	9026.20.4000
9155D 905 Auto	9026.20.4000
9155D-913 Pressure Calibration	9026.20.4000
Auto PneuShock System	9026.90.2000
Pressure Cal System	9026.90.2000
9535C Controller	9026.90.2000
1/2" 2CC Coupler	9027.89.8090
LaserTach Kit	9029.20.4080
Accelerometer Calibration Workstation	9031.80.8080
333D03 Soft Protective Storage Case	9031.80.8085
9350C ESA Calibration	9031.80.8085
K9905D Auto Exciter	9031.80.8085
Laser Primary	9031.80.8085
Linear Power Amplifier for 2500E	9031.90.0000
2129E Long-stroke Shaker	9031.90.9195
9110F Accessories	9031.90.9195
9919C Exciter	9031.90.9195

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Exhibit C

Industry PFAS CUU Project

PFAS Currently Unavoidable Uses (CUU)

Submission by Industry

The Industry PFAS CUU project is made up of ~50 companies that span consumer, professional, medical, industrial, and laboratory uses of PFAS. The CUUs listed here are based on very detailed work by each member of the project combined with tens of thousands of parts tested by Claigan Environmental in 2023 and 2024.

This submission should be the most comprehensive list of Currently Unavoidable Uses in physical products (articles) with detailed justifications and comparisons of alternatives.

The full justifications are available in detail in the accompanying spreadsheet PFAS Currently Unavoidable Uses - Feb 2024.xls.

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Exhibit C

Table of Contents

Exhibit C

1. Summary

This report is a submission by Claigan Environmental Inc. (Claigan) on behalf of the Industry PFAS Submission Project ("PFAS Submission Project"). The PFAS submission project is made up of 50+ companies from a wide range of industries (consumer, professional, industrial, medical, oil and gas, laboratory equipment, textiles, electronic components, and retail sales.)

The PFAS Submission Project is focused primarily on the needs of complex products (articles). Claigan is both a restricted materials consultancy and a high-volume restricted materials testing laboratory. Each of the PFAS Submission Project submissions are based on contributions from all major sectors of industry, and 2023 and 2024 PFAS testing data from tens of thousands of parts.

The detailed justification of each CUU is covered in the accompanying spreadsheet PFAS Currently Unavoidable Uses - Feb 2024.xls.

Each CUU entry includes

- A brief description of the Currently Unavoidable Use of PFAS.
- A brief description of the type of product including industries and example products with HTS codes.
- A description of the intended use of the product and explanations on how it is essential for health, safety, or the functioning of society.
- A description of how the specific use of PFAS in the product is essential to the function of the product. If this use of PFAS is required by federal or state law or regulation, citations will be provided for that requirement.
- A description of whether there are reasonably available alternatives for this specific use of PFAS.
- Plus
    - Whether the PFAS use includes PFOA or Long Chain Perfluoroalkyl Carboxylic Acids (LC-PFCA). Many of these PFAS uses do not include (nor degrade into) any PFAS found in drinking water and humans.
    - PFOA / LC-PFCA presence is based on tens of thousands of parts tested in 2023 and 2024.

Exhibit C

Important note 1 - due to the short timeline for the PFAS Currently Unavoidable Use consultation, each justification is only in brief with a detailed comparison of alternatives. Each justification can be further elaborated upon if needed.

Important note 2 - the regulation of chemical substances in medical devices is governed by the FDA. It is generally assumed that this preempts restrictions of PFAS in medical devices under state regulation, "A product for which federal law governs the presence of PFAS in the product in a manner that preempts state authority". However, for completeness and until this question is fully solved, currently unavoidable uses of PFAS in medical devices are also included in this submission.

Important note 3 - The States of Maine and Minnesota adopted a broad definition for PFAS substances. The vast majority of PFAS substances, as defined by Maine and Minnesota, that are found in products are not found in the environment. The broad definition impacts PFAS use in multiple categories of products and equipment needed to make products. PFAS substances are used in these applications because they have unique properties that impart specific performance characteristics making them essential to a product's function. The accompanying spreadsheet provides a detailed comparison of fluoropolymer, fluoroelastomer, and alternative materials for each application. The reason for the use of the fluoropolymer or fluoroelastomer is generally fairly obvious when you look at the application and the alternatives.

2. Related documents

2.1. PFAS Currently Unavoidable Uses spreadsheet - Industry PFAS Submission Project

2.1.1. PFAS Currently Unavoidable Uses - Feb 2024.xls

3. Definitions

3.1. ***Currently Unavoidable Use of PFAS (CUU)*** - a use of PFAS that is essential for the health, safety, or functioning of society and for which alternatives are not reasonably available.

3.2. ***Widespread Use*** -

Exhibit C

3.2.1. For essential uses of a PFAS-containing product, uses that are very high volume with widespread use are identified.

3.2.1.1. For example - fluoroelastomers and perfluoroelastomers have very widespread use in professional/industrial products (> 10M products per year sold in the US).

3.2.2. **For consumer uses** - Over 100 Million products sold in the US each year use this Currently Unavoidable Use of PFAS, or

3.2.3. **For industrial uses (including professional uses)** - Over 10 Million products sold in the US each year use this Currently Unavoidable Use of PFAS.

3.3. ***vPvB*** - Very persistent and very bioaccumulative

3.4. ***PBT*** - Persistent, bioaccumulative, and toxic

4. Key notes

4.1. Importance of PFAS

4.1.1. > 500 million products containing PFAS are sold in the US each year

4.1.2. Banning PFAS would eliminate

4.1.2.1. Laptops

4.1.2.2. The internet (unless servers are moved offshore)

4.1.2.3. Food processing

4.1.2.4. Water processing and treatment

4.1.2.5. Oil and gas industry

4.1.2.6. Heart surgeries and biopsies

4.1.3. Banning PFAS without exception for Currently Unavoidable Uses would likely create the largest recession in the history of the United States.

4.2. PFAS in Drinking Water and Humans

4.2.1. From this project and related testing data

4.2.1.1. ~99% of PFAS found in drinking water and humans is from <0.1% of products (primarily legacy fire extinguisher fluid and legacy foundation/concealer (C9-C15 fluoroalkyl phosphate in personal care products)).

4.2.1.2. ~99.99% of PFAS found in drinking water and humans is from <1% of products (a slight additional contribution from washing of waterproof fabrics contain fluoroacrylates).

4.2.1.3. The average silicone part has 100X more forever chemicals than the worst fluoropolymer (ePTFE). 200 ppm vs 2 ppm.

4.2.1.4. Based on ISO 10993-18 medical biocompatibility testing: Silicone, ABS, polystyrene, PVC, nylon, and polyurethane leak more dangerous chemicals into humans than fluoropolymers

4.2.1.5. Fluoropolymers are used because they are safer and more effective than their alternatives.

4.3. PFAS and Drinking Water - Kentucky 2023 PFAS testing of all drinking water sites

4.3.1. Kentucky 2023 drinking water sites testing

4.3.1.1. https://eec.ky.gov/Environmental-Protection/Water/Reports/Reports/2023-PFASFinishedDrinkingWaterResults.pdf

4.3.1.2. Kentucky was chosen because

4.3.1.2.1. Modern data (2023)

4.3.1.2.2. Comprehensive PFAS testing of each drinking water site

4.3.2. Sources of PFAS in drinking water

4.3.2.1. Based on the comparison of drinking water testing results and laboratory testing results of products

4.3.2.2. Legacy fire fighting foam

4.3.2.2.1. Fire fighting foam that uses C8 fluoro surfactants

Exhibit C

Exhibit C

4.3.2.2.2. Generally phased out of products a decade ago

4.3.2.2.3. Testing characteristic

4.3.2.2.3.1. Always - PFOS

4.3.2.2.3.2. Majority of situations - PFOA

4.3.2.2.3.3. Would not have - PFNA or PFDA (higher-length PFOA substances)

4.3.2.3. Modern fire fighting foam

4.3.2.3.1. Fire fighting foam that uses C4 or C6 fluoro surfactants

4.3.2.3.2. Common in modern fire fighting foam

4.3.2.3.3. Testing characteristic

4.3.2.3.3.1. Always - at least one of 6:2 FTS, PFHxS, PFBS

4.3.2.3.3.2. Majority of situations - PFHxA, PFBA

4.3.2.3.3.3. Would not have - PFOS, PFOA, PFNA, or PFDA

4.3.2.4. Cosmetics (Foundation and Concealer)

4.3.2.4.1. Foundation and concealer using C9-C15 Fluoroalkylphospate

4.3.2.4.1.1. Degrades over time into high concentration of PFOA, PFNA, and PFDA

4.3.2.4.2. Phased out in 2021/2022

4.3.2.4.3. Testing characteristic

4.3.2.4.3.1. Always - PFNA and PFDA (PFDA not included in Kentucky testing)

4.3.2.4.3.2. Majority of situations - PFOA

4.3.2.4.3.3. Would not have - PFOS or any sulphonate, or short-length fluoro carboxylates (PFBA, PFPeA, PFHxA).

Exhibit C

4.3.2.5. Physical products

4.3.2.5.1. Primarily fluoroacrylate coatings of water-resistant fabric

4.3.2.5.1.1. Would release all lengths of perfluorocarboxylic acids during washing in detergent.

4.3.2.5.2. Common today

4.3.2.5.3. Testing characteristic

4.3.2.5.3.1. Always - All lengths of perfluorocarboxylates from PFBA to PFDA.

4.3.2.5.3.2. Would not have - PFOS or any sulphonate.

4.3.2.6. Unknown

4.3.2.6.1. Testing results from water are not consistent with any known product.

4.3.3. Chart of Projected Sources of PFAS in 2023 Kentucky drinking water site testing

4.3.3.1. 113 sites tested in Kentucky in 2023

4.3.3.2. Note - some sites could be listed under more than one source. The total should be above 100%

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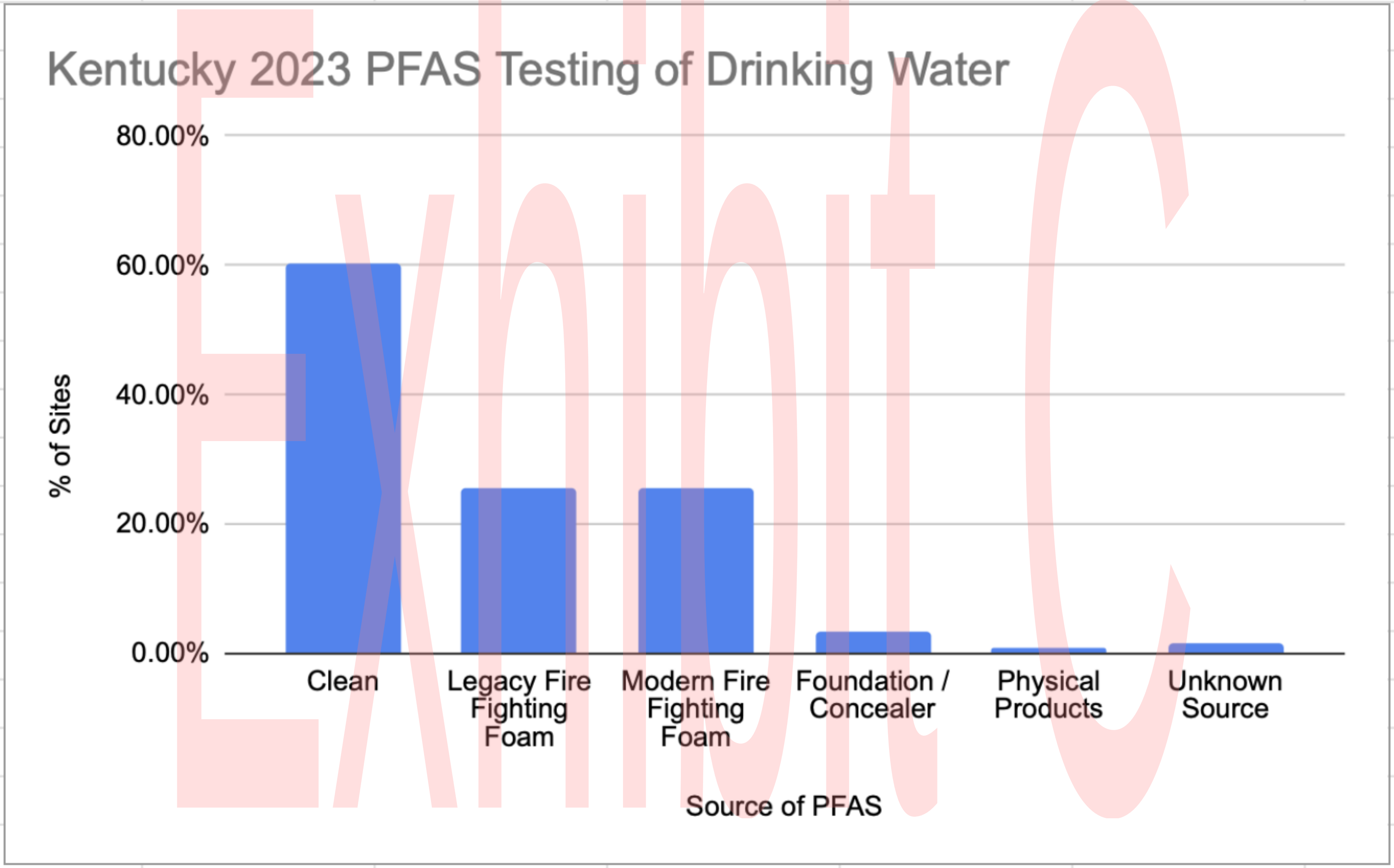

Exhibit C

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Exhibit C

5. PFAS Currently Unavoidable Uses

5.1. The full details are contained in the accompanying spreadsheet PFAS Currently Unavoidable Uses - Feb 2024.xls.

5.1.1. The comparisons are too large and detailed for a Word document and are instead summarized in an Excel file.

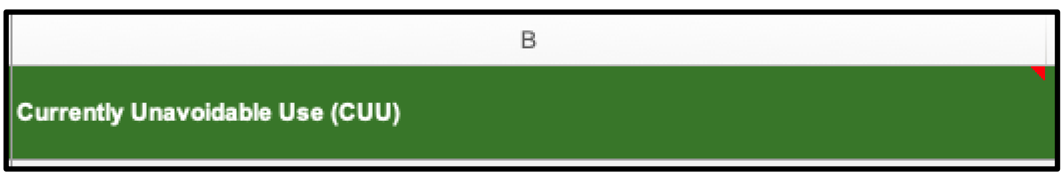
5.2. This document features several tabs with tables containing details about ***CUU's***.

5.2.1. The CUU tab provides details about the specific ***CUU's*** as well as where and why they are specifically used.

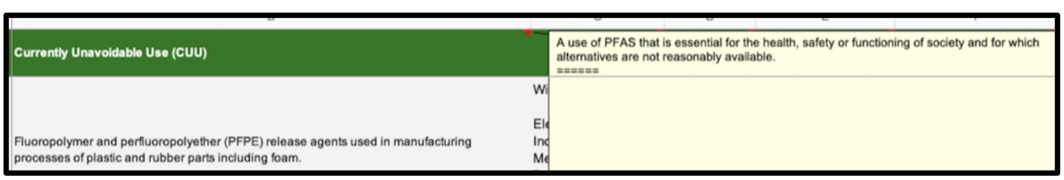
5.2.2. The remaining tabs are the Alternative tabs. They provide the evaluation of alternative materials across a range of criteria applicable to the relevant use, which is labelled on the tab at the bottom of the document.

5.3. The core data is found within the tables, while further explanatory notes are found in the applicable column and row headers.

5.4. Cells with a red triangle in the top right corner have additional information pertinent to their respective row or column. They are found in Row 1 of the CUU tab and Column A of the Alternatives tabs. For example:



5.5. Additional details are revealed by hovering the mouse cursor over the cell (without clicking it). For example:



5.6. Additionally, this same information is captured in the document below.

Exhibit C

6. CUU Tab

6.1. Columns A and B (CUU Number and Description) provide the numbering and descriptions for each ***CUU***.

6.2. Column C (Products) provides an overview of the applicable product families that require the listed Currently Unavoidable Use.

6.3. Column D (HS Codes) provides a list of HS Codes of products that require the listed ***CUU***. Some uses are so pervasive that the entire HS Code (Customs Code) chapters are listed.

6.4. Column E (Example Products) details a list of example products that require the applicable ***CUU.*** This list is representative and is not intended to be exhaustive.

6.5. Column F (Essential Use of Product) describes the intended use of the product and explains how it is essential for health, safety, or the functioning of society. It also describes if products using this CUU are ***Widespread*** or ***Industrial***.

6.6. Column G (Essential Use of PFAS) describes how the specific use of PFAS in the product is essential to the function of the product.

6.7. Column H (Comparison of Alternatives) describes reasonably available alternatives for this specific use of PFAS and compares them to the applicable ***CUU***. For further details, refer to the relevant Alternatives tab.

6.8. Column I (PFOA) identifies if this CUU contains any PFOA or Long Chain Perfluoroalkylcarboxylates (LCPFCAs). This column is based on 2023 and 2024 testing data of hundreds of representative parts for PFOA and LC-PFCAs.

6.9. Column J (Alternatives Tab) provides a direct link within the document to the identified tab comparing the performance of PFAS materials and alternative materials.

7. Alternatives Tabs

7.1. Row 1 (Comparison) identifies the alternative materials being evaluated.

7.2. Low Friction

7.2.1. Excellent - The material has a low coefficient of static friction. It is nearly frictionless.

Exhibit C

7.2.2. Decent - The material has a lower coefficient of static friction but has some friction in use.

7.2.3. Poor - The material has a high coefficient of static friction. It displays strong friction during use and is not suitable for applications requiring low friction.

7.3. ***Chemical Resistance*** - the resistance to acids or bases may not be uniform for a material. The rating reflects the general potential applications of the material

7.3.1. Excellent - The material has superior resistance to acids and bases. Acid and bases have no discernible effect on the material.

7.3.2. Decent - The material is resistant to acids and bases but does exhibit some degradation. It should not be in extended contact with, or subject to, high concentrations of acids or bases.

7.3.3. Poor - The material is not resistant to acids and/or bases.

7.4. Water Resistance

7.4.1. Excellent - The material is hydrophobic (*i.e.* it is impermeable to water even as a coating).

7.4.2. Decent - The material is resistant to water, but not completely hydrophobic or waterproof.

7.4.3. Poor - The material is permeable to water.

7.5. Oil Resistance

7.5.1. Excellent - The material is oleophobic (*i.e.* it is impermeable to oil even as a coating).

7.5.2. Decent - The material is resistant to oil, but not completely oleophobic, oil-proof, or stain-resistant.

7.5.3. Poor - The material is permeable to oil.

7.6. Temperature Resistance

7.6.1. Excellent - The material can withstand temperatures above 150°C.

7.6.2. Decent - The material can withstand temperatures above 100°C, but is impacted by temperatures above 150°C.

Exhibit C

7.6.3. Poor - The material is impacted by temperatures above 100°C.

7.7. Fire Resistance

7.7.1. Excellent - The material meets stringent fire/flame resistance standards.

7.7.2. Decent - The material has fire/flame resistance but does not meet the most stringent standards.

7.7.3. Poor - The material is not fire/flame resistant.

7.8. Flexibility

7.8.1. Excellent - The material exhibits good flexibility and is useful in most applications requiring flexibility.

7.8.2. Decent - The material has some rigidity, but still exhibits some flexibility.

7.8.3. Poor - The material is rigid and is not suitable for applications requiring flexibility.

7.9. Forever Chemicals (Initial)

7.9.1. Excellent - The material does not contain any substances with an EU harmonized classification of vPvB or PBT after manufacturing.

7.9.2. Decent - The material contains trace amounts (<1 ppm) of substances with an EU harmonized classification of vPvB or PBT after manufacturing.

7.9.3. Poor - The material contains amounts (> 1ppm) of substances with an EU harmonized classification of vPvB or PBT after manufacturing

7.10. Forever Chemicals (Over Time)

7.10.1. Excellent - The material does not degrade into substances with an EU harmonized classification of vPvB or PBT.

7.10.2. Decent - The material degrades lightly into substances (<1 ppm) with an EU harmonized classification of vPvB or PBT over time.

7.10.3. Poor - The material degrades into substances (> 1ppm) with an EU harmonized classification of vPvB or PBT over time.

7.11. Bio-compatibility

Exhibit C

7.11.1. Excellent - The material passes US FDA and EU MDR biocompatibility testing and does not normally require toxicological justification.

7.11.2. Decent - The material passes US FDA and EU MDR biocompatibility testing but often requires toxicological justification.

7.11.3. Poor - The material does not generally pass US FDA or EU MDR biocompatibility testing or it requires significant toxicological justification.

7.12. Insulation

7.12.1. Excellent - The material has a low dielectric constant and is suitable for most insulating or electronics purposes.

7.12.2. Decent - The material has a medium dielectric constant and is only suitable for some insulating or electronics purposes.

7.12.3. Poor - The material has a high dielectric constant and is not normally suitable as an insulating material in electronics.

7.13. High-Density Applications

7.13.1. Excellent - The material is usable in applications requiring thin layers or high density.

7.13.2. Decent - The material is usable in applications that do not require thin materials, but it is not suitable for very fine or dense applications.

7.13.3. Poor - The material is not feasible as a thin film or in high-density applications.

7.14. Polymer Additive

7.14.1. Excellent - The material can be added to a wide range of polymers to provide additional properties.

7.14.2. Decent - The material can be added to some polymers to provide some level of additional properties.

7.14.3. Poor - The material is not suitable as a polymer additive.

7.15. Porous

7.15.1. Excellent - The material is permeable to air.

Exhibit C

7.15.2. Decent - The material is partially permeable to air but is resistant to airflow.

7.15.3. Poor - The material is not permeable to air.

7.16. Durability

7.16.1. Excellent - The material has superior resistance to wear.

7.16.2. Decent - The material is partially resistant to wear but is not suitable for high-wear situations.

7.16.3. Poor - The material is not suitable for situations where wear resistance is required.

7.17. Optical Transparency

7.17.1. Excellent - The material is optically transparent.

7.17.2. Decent - This material has some optical transparency but is not suitable for applications requiring clarity and high transparency.

7.17.3. Poor - This material is not normally optically transparent

7.18. Structural

7.18.1. Excellent - The material is rigid with the ability to support its weight and any weight of the fluid it is transporting. It also has superior fatigue resistance.

7.18.2. Decent - The material can support its weight, but it is not as reliable for additional weight or fatigue.

7.18.3. Poor - The material cannot rigidly support its weight.

7.19. Radiation Resistance

7.19.1. Excellent - The material has superior resistance to gamma and e-beam radiation and does not exhibit degradation due to radiation.

7.19.2. Decent - The material has some resistance to gamma and e-beam radiation but exhibits degradation with repeat or high dosage exposure.

7.19.3. Poor - The material degrades in gamma or e-beam radiation.

7.20. Acceptable

Exhibit C

7.20.1. A material is deemed acceptable if it receives an excellent or decent rating in non-critical properties. The material must receive an excellent rating in critical properties to be deemed acceptable.

7.20.1.1. Critical properties are identified where ratings (excellent, decent, poor) are shown in bold.

8. Acknowledgements

Special thank you to Nials Everett, Chris Scully, Julie Van Moorsel, Dr Tim Holt, and the entire Claigan Environmental staff and students for their contributions. And thank you to all of our industry members who contributed so much in such little time.

Exhibit C

CUU	Currently Unavoidable Use (CUU)	Products	HS Codes	Example Products	Essential Use of Product	Essential Use of PFAS	Comparison of Alternatives	PFOA	Alternatives Tab
1	Fluoropolymer and perfluoropolyether (PFPE) release agents used in manufacturing processes of plastic, rubber, and pressed wooden parts including foam.	Widespread use Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory, Building Products, and Security & Defense	HS Code Chapters - 32, 39, 40, 56 83, 84, 85, 86, 87, 88, 89, and 90	Gaskets (401693), o-rings (401693), and molded rubber parts in electronics (40), pumps (841381), medical devices (9018), door locks (830140), pressed wood pallets (441520)	Widespread use. Used in the majority of manufactured products on the market.	Release agents are required to release rubber parts from their molds	Superior to other release agents. May be replaceable in the future by silicone. Wide verification and validation required. Silicone has higher friction and adhesion than fluoropolymer based release agents.	None	Release agent
2	PTFE used as an additive drip agent in plastics to meet flammability safety requirements	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 39, 40, 48, 49, 76 83, 84, 85, 86, 87, 88, 89, and 90	Electronics with plastic components (85). Examples- vacuum cleaners (850860), computers (847130), fans (841490), food processing equipment (843880), and electric cars (870380).	Widespread use. Used in the vast majority of complex electronics on the market to meet flame retardancy standards such as UL 94 and IEC 60695-11.	Provide required anti-drip flame retardancy required by fire regulation and standards. Currently no effective replacements for PTFE as an anti-drip additive. Virtually all electronics use PTFE anti-drip agents in one or more parts. Restriction of PTFE anti-drip agents would create a significant safety risk for electronics and require the redesign and re-qualification of safety of virtually every electronic product on the US market	Only additive widely approved for use to meet strict anti-drip flame retardancy requirements in plastics	None	Anti-Drip
3	PTFE, ETFE, PFA, PVDF, and FEP as a wire insulator.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 83, 84, 85, 86, 87, 88, 89, and 90	Laptops (847130), medical endoscopes (901890), mass spectrometers (902781), car ignition (8708), tablets (847160), Pumps (8414), Data Machines (8517), Printers (8544), Analytical Instruments (9026), Photometers/Instruments (9027)	Widespread use. >100M products per year Used in the majority of complex higher performance electronics on the market.	Provide temperature and chemical resistance in combination with electrical insulation	Other materials do not have sufficient temperature and corrosive resistance, feasibility in dense electronics (too thick), and electrical insulation	None except PFA. PFA can be manufactured without residual PFOA but time will be required for conversion.	Wiring
4	Fluoropolymers (PTFE, ETFE, FEP, and PFA) used for electrical insulation purposes except wiring.	Hoses, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 83, 84, 85, 86, 87, 88, 89, and 90	Coaxial cables (854420), audio ports (853669), chemical hoses (3917), antennas (852910), electrical transformers (850431), electric switches (853630)	Widespread use. >10M products per year. Common in most RF applications. Necessary for many radio frequency applications Also common to general electrical insulation, static dissipative hoses, and fire suppression.	Fluoropolymers have the best in class dielectric constants / electrical insulation while maintaining flexibility. This includes both electrical isolation but also in static dissipation and related safety activities.	Other polymers do not provide sufficient electrical insulation (poorer dielectric constants). Ceramics can provide sufficient dielectric constants for some RF applications, but do not have the flexibility required for most applications.	None except PFA. PFA can be manufactured without residual PFOA but time will be required for conversion.	Dielectric
5	Fluorosilicone, amorphous fluoro resins, and fluoroelastomers (including perfluoroelastomers) for electrical insulation purposes except wiring.	Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 83, 84, 85, 86, 87, 88, 89, and 90; and HS Code 3917.	High voltage cables (854460), electric vehicles (870380), hoses (3917), (853340) electrical resistors (including rheostats and potentiometers) and industrial machinery (843890).	High voltage applications would be difficult without fluoroelastomers	Specialized uses requiring electrical isolation in a rubber	No other material has equivalent dielectric constant / electrical insulation capability with flexibility Fluoroelastomer use is more specialized and lower volume than PTFE and ETFE for the same purpose.	None	Insulator
6	Fluoropolymers in invasive, implantable, fluid, and gas contacting applications in medical devices.	Medical	HS Code Chapter - 90	Endoscopes (901890), surgical instruments (9018), surgical tubing, and pacemakers (902150), electrical components (854370)	Widespread medical use. Necessary for most invasive procedures	Low friction, flexibility, and high biocompatibility are essential for internal procedures	Alternatives do not have equivalent low friction, flexibility, and/or biocompatibility. Some polymers, such as silicone and polyurethane, have applications in invasive medical devices but not in situations requiring low friction or thin material. Silicone also contains over 100X higher concentrations of forever chemicals (D4, D5, and D6) than PFA fluoropolymer.	Yes. However PFOA presence is strongly linked to flexibility and will take time and validation to phase out.	Medical
7	PTFE as an additive up to 25% in plastics for the purpose of reduced friction and wear	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 28, 32, 38, 39, 40, 49, 73, 74, 82, 83, 84, 85, 86, 87, 88, 89, and 90	Bearings (848210), medical devices, drills (846721), manufacturing equipment, food processing equipment (820830), industrial vehicles and instruments for analysis (9027).	Widespread use. Very common in longer life products with moving parts. Without these products, there would be no more automation or automated assistance.	PTFE additive provides greatly reduced friction and wear in plastic parts. This property greatly extends their lifetime and time before replacement.	Alternatives do not have equivalent low friction or compatibility as an additive. No other additives are as effective in safely reducing the coefficient of friction of plastics. Restriction of PTFE additives in plastics for friction reduction would reduce the lifetime of many products, resulting in products going to waste or landfall sooner and more often. In addition, PTFE added plastics extend product life/service intervals thereby reducing potential fluid and gas releases/exposures. They also reduce power consumption compared to non-PTFE added counterparts.	No	Friction
8	PTFE, ETFE, and PCTFE for professional, industrial, or high temperature applications (>150C) requiring reduced friction, or chemical inertness.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 32, 39, 40, 83, 84, 85, 86, 87, 88, 89, and 90.	Chemical reactors (841989), breathing appliances (9020), chemical processing, oil and gas (847989), laboratory equipment, engines, electrical transformers (850450), and industrial equipment.	Widespread professional and industrial use. Requirement for industrial and laboratory machinery. Working at high temperatures or harsh environments would no longer be possible.	Fluoropolymers have tremendous chemical and temperature resistance combined with low friction. All three are essential for the operation and safety in industrial environments.	No other materials have the same low friction and chemical inertness properties as PTFE, ETFE and PCTFE at regular temperatures and at high temperature (150C). PTFE and PCTFE extend product life/service intervals thereby reducing potential chemical releases/exposures. They also can reduce power consumption compared to non-PTFE/PCTFE counterparts.	No	Harsh Env.
9	Fluoroacrylic coatings necessary for chemical or fire safety for fabrics including applications requiring extreme water repellancy for professional use.	Textiles	HS Code Chapters - 39, 42, 56, 62, and 63	Chemical aprons (6210), Splash shields (392690), motorcycle racing jacket (420310), and hazardous environment clothing (621010)	Safety clothing is necessary for worker safety in hazardous environments.	Fluoroacrylics provide adhesion to the fabric and protection from acid, water, and oil.	Alternatives do not have the combination of acid, water, temperature, and oil resistance sufficient for hazardous environments while maintaining permeability to air (breathability).	Yes from the fracturing of the C-O-C bond in the fluoroacrylic coatings. But in low concentration.	Fabric Coating
10	Fluoroacrylic coatings on fabrics necessary for the protection or storage of portable medical devices or laboratory equipment.	Textiles, Medical, Laboratory	HS Code Chapter - 84 and 90	Water resistance cases for pumps (841370), dialysis equipment (901890), CPAPs and other sensitive medical or laboratory devices (901920).	Water resistance provided by the carrying case is necessary for sensitive medical and laboratory requirement.	Fluoroacrylics provide adhesion to the fabric and significant protection from acid, water, and oil. The safety of the laboratory or medical device is dependant on their proper care from the environment.	Alternatives do not have the combination of acid, water, and oil resistance sufficient for complete protection of the sensitive equipment or medical devices.	Yes from the fracturing of the C-O-C bond in the fluoroacrylic coatings. But in low concentration.	Fabric Coating

11	PTFE, PFA, FKM, and PVDF membranes for gas and aqueous filtration, or particle retention.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 38, 39, 73, 84, 85, 86, 87, 88, 89, and 90.	Medical filtration membrane (901819), laboratory filtration membranes (8414), water purification / food processing equipment filtration membranes (842121), and drinking water filtration and laboratory membranes (9020)	PTFE, PVDF, FPA, and FKM membranes are hydro- (water) and oleo- (oil) phobic while still allowing air to pass. These membranes provide the ability to extract air components from liquids and solids in specialized environments. Fluoropolymer membranes perform well under pressure and are stable over time and resistant to corrosive cleaning reagents.	PTFE, PVDF, PFA, and FKM membranes are the only material with best in class air porousness and resistance to water and oils.	No other material has the same gas permeability while being hydrophobic, oleophobic, acid resistant, and alkali resistant. Fluoropolymer membranes also have the advantage of maintaining their performance characteristics even at elevated temperatures. Although it is theoretically possible to develop a porous gas permeable polyethylene frit for some applications, this would be a long project and is risky regarding tightness and reproducibility of the gas transfer. Safety and accuracy would degrade in these specialized medical, laboratory, or industrial applications.	Yes. From the fracturing ('rubberizing') of the fluoropolymer to create the membrane fibre. Low concentration: 1 to 4 ppm	Membranes
12	PTFE as a lubricant additive under 30% concentration not in contact with drinking water.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 34, 84, 85, 86, 87, 88, 89, and 90	Widespread use. Mineral or silicone oil with PTFE powder added. Used in a wide range of consumer, professional, and industrial machinery to maintain low friction. PTFE added oil lubricants are both found inside machinery and are sold independently for use on moving parts.	The PTFE added lubricants significantly decrease the wear and increase the lifetime of machinery parts.	PTFE powder added to oils safely provides lubrication in a large range of environments necessary for proper function and lifetime of machinery.	No other material has the same impact as a low friction additive to mineral or silicone oil than PTFE.	No	Lubricant
13	PTFE as a fused coating on cookware	Cookware	HS Code Chapters 73, 76 and 84	Frying pans, electric griddles, electric waffle machines. (7323, 761510)	Cooking appliances and frying pans are essential to the continued functioning of society. Non-stick cookware is necessary to reduce cooking and cleaning time for consumers and professionals.	Fused PTFE powder to create anti-stick coating on cooking surface	No polymer provides the same low friction at high temperature. Ceramic cookware can provide sufficient non-stick (low friction) but is not as durable as PTFE coated cookware, reducing the lifetime of the fry pan or cooking appliance.	No	Cookware
14	PTFE as a coating for chemical containers	Containers	HS Code Chapters - 39, 73, 84, and 86	Chemical containers (for storage or industrial machinery) for hazardous chemicals (7309-7311) (841989, 8609)	PTFE has the necessary acid, water, oil, and temperature resistance to handle some of the most hazardous chemicals.	PTFE provides excellent resistance to chemicals, acids, water, and oils - and temperatures.	Alternatives do not provide sufficient resistance to acid, water, oils, and temperature for all harsh chemicals. Ceramics have similar performance characteristics but could only be used to coat metal vessels. Ceramic coatings are more difficult to coat completely without gaps in larger containers, creating leakage or degradation risk.	No	Harsh Env.
15	Fluoroelastomers (including perfluoroelastomers), fluorosilicone, and amorphous fluoro resins as a sealing and packing material in situations requiring chemical resistance, oil resistance, oxidation resistance, decompression resistance, elasticity, high temperature (over 150C), and/or low temperature (<-20C).	Rubbers, Building Products, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 32, 34, 39, 40, 49, 59, 68, 72, 73, 83, 84, 85, 86, 87, 88, 89, and 90.	Widespread use. Pumps, oil and gas (848790), industrial machinery (848420), chemical tanks (7309), food processing, medical devices, laboratory equipment, aerospace, chemical processing, pharmaceutical and cosmetic processing equipment, and equipment for extreme environments	Products using fluoroelastomer seals can be found in virtually every industrial or machinery application world wide. Without fluoroelastomer seals, virtually all industrial applications would no longer be viable.	Fluoroelastomers (including perfluoroelastomers and amorphous fluoro resins) are the necessary sealing material for applications requiring temperature resistance, chemical resistance, flexibility, and water/oil resistance. Without fluoroelastomers, sealing on machinery would not be viable in many applications.	No other rubbers have equivalent hydrophobic and oleophobic properties, oxidation resistance, and chemical safety over a range of low and high temperatures as fluoroelastomers. Fluoroelastomers are also very resistant to explosive decompression. Fluoroelastomer use can extend product life/service intervals thereby reducing potential chemical releases/exposures. Alternative materials would need to be replaced monthly, as they begin to leak. PTFE has similar environmental properties, but is a plastic and is not suitable for applications requiring the conformity of a 'rubber' seal. Fluoroelastomers also have a higher coefficient of friction than PTFE and create a superior 'seal' in most applications.	No	Seals
16	Fluoroelastomers (including perfluoroelastomers), fluorosilicone, and amorphous fluoro resins as a sealing and packing material for drinking water or food contact if compliant with NSF, FDA, and State food and/or drinking water regulations.	Rubbers, Industrial, Machinery	HS Code Chapters - 40, and 84.	Widespread use. Seals in water purification facilities and laboratory equipment. Very common material in drinking water contact. (842121, 842199)	Water purification is essential to the functioning of society.	Fluoroelastomers provide flexibility, biocompatibility, temperature resistance, and water resistance.	No other rubbers have equivalent hydrophobic and oleophobic properties, UV resistance, and chemical safety over a range of temperatures as fluoroelastomers. The most common alternatives are not chemically compatible for direct contact for long exposure time (years). PTFE has similar environmental properties, but is a plastic and is not suitable for applications requiring the conformity of a 'rubber' seal. Fluoroelastomers also have a higher coefficient of friction than PTFE and create a superior 'seal' in most applications. Additionally, silicone has reduced biocompatibility and high forever chemicals due to its normal high concentration of residual D4, D5, and D6 forever chemicals.	No. However, fluoroelastomers can contain 6:2 fluorotelomer from their emulsion surfactant. Any presence of 6:2 fluorotelomer (and related short chain perfluorocarboxylate degradation products) must conform to drinking water standards.	Water Seals
17	PTFE tape for moisture insulation, or joining of fluid or gas components.	Self adhesive tape, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 40, 84, 85, 86, 87, 88, 89, 90, and HS Code 3919.	Widespread use. PTFE tape for home and professional use, plumbing, machinery with fluids or gasses, drinking water equipment, food production equipment, industry water processes, medical endoscopes, analytical instruments, and any other equipment requiring piping to be sealed together. (3919)	PTFE tape is the most effective joining materials in a fluid environment. Alternative materials do not have equivalent water and oil sealing in a thin coating.	PTFE rubber tape has the best in class water and oil resistance in a thin applicable tape.	Alternative materials do not provide the same water or oil seal in a thin tape.	Yes. The fracturing of the PTFE polymer chain to produce PTFE rubber commonly produces PFOA and LC-PFCA. Manufacturing of PTFE tape without PFOA is possible and PFOA containing PTFE can be phased out.	PTFE Tape
18	PTFE tape for reduction of friction.	Self adhesive tape, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 39, 40, 84, 85, 86, 87, 88, 89, 90, and HS Code 3919.	Industrial machinery or equipment with moving parts. (3919). Printing equipment (3215)	PTFE tape provides a thin coating to reduce friction between moving parts.	PTFE rubber tape has very low friction, reducing the wear, and extends the lifetime of moving parts.	No other tape materials has as low friction as PTFE tape and the ability to conform to uneven surfaces. Replacement of PTFE tape in a low friction application will negatively affect product performance and reduce lifetime of the product - causing earlier disposal or replacement of the product using the PTFE tape.	Yes. The fracturing of the PTFE polymer chain to produce PTFE rubber commonly produces PFOA and LC-PFCA. Manufacturing of PTFE tape without PFOA is possible and PFOA containing PTFE can be phased out.	PTFE Tape
19	Fluorocoating of rubber, metal, carbon, and plastic seals in high temperature, professional, or industrial applications where chemical resistance is required.	Rubbers, Building Products, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory, Aerospace	HS Code Chapters - 40, 83, 84, 85, 86, 87, 88, 89, and 90	Plunger in a syringe (901831), rubber plunger in industrial equipment (841319), rubber component in contact with chemicals.	Most standard rubbers are high friction (nitrile rubber, styrene rubber, EPDM) and require a fluorocoating for low friction. This is necessary for plungers and other rubber parts likely to encounter friction in operation.	Fluorocoating of standard rubber such as nitrile or butadiene rubber provides low friction to a standard rubber.	Alternative materials do not sufficiently reduce the friction of rubber to allow for the necessary movement of the rubber part. No other coating material provides the same environmental protection to rubber and metal seals.	No	Rubber coating

Exhibit C

20	PTFE, ETFE, and PFA coating of metal for environmental or temperature resistance not in contact with food or drinking water.	Metal, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory, Aerospace	HS Code Chapters - 72, 84, 85, 86, 87, 88, 89, and 90	Widespread use. Outdoor machinery, construction vehicles, oil and gas platforms, industrial equipment (3208) (721070)	Metals and machinery used in harsh or outdoor environment need chemical, water, and oil resistant coatings to protect from the conditions.	Fluoropolymer coatings provide environmental resistant to metal parts. Resistance to water, acids, and oils extends the lifetime of the parts in outdoor and harsh environments.	No other coating materials provide the same environmental (water, oil, acid, and chemical) protection to metals. Replacement PTFE and PFA environmental coatings for metals will reduce the corrosion resistance (in particular over temperature) of many metals resulting in failure of these metals and/or reduced product lifetime (resulting in more products entering end of life disposal sooner).	No	Outdoor
21	PTFE, FEP, and PFA coating of metal for low friction, improved wetting, and/or wear resistance in machinery or tools	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90.	Machinery or equipment with moving parts. Wood saw blade, pumps, and other moving components in contact with other materials. (721070). Machines and mechanical appliances (847989), pumps (8413), laboratory or plant machinery (841989), spectrometers (902730). Includes paint, anodization, and other coatings on metals.	Cutting, drilling, grinding, milling, and other activities with metal in contact with other materials requires low friction, high wear resistance and high temperature resistance.	Fluoropolymers coatings are nearly frictionless, have excellent wetting properties, and can withstand high temperature and wear.	Alternative materials do not have equivalent low friction, wetting, and/or temperature resistance. PEEK provides similar durability but not equivalent low friction. PFA does not have as low friction as PTFE, but is lower friction than PEEK. Replacement PTFE, FEP, and PFA environmental coatings will greatly reduce the performance of some machinery, increase wear, and reduce lifetimes on metal components. Liquid lubricants can be used, but they are temporary in nature, and the most effective lubricants for low friction in metal parts contain PTFE powder and are covered by another derogation request.	None except PFA. PFA can be manufactured without residual PFOA but time will be required for conversion.	Machinery
22	PTFE, PFA, FEP, and TFE copolymers in hoses in chemical, pump, or valve applications.	Tubing, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90; and HS Code 3917.	Widespread use. Pump hoses, chemical plants, gasoline hose, fuel lines, and oil and gas. (4009)	Transport of chemical or petroleum fluids requires specialized materials.	Fluoropolymers have excellent chemical, acid, and oil resistance - the requirements for transportation of many petroleum and chemical fluids. Fluoropolymers also have the flexibility necessary for hose (as opposed to rigid tube) applications.	No other polymer that can be formed into hoses or braided to transport chemicals has the equivalent acid, chemical, oil, fire, and temperature resistance with the necessary flexibility required for hoses.	None except PFA. PFA can be manufactured without residual PFOA but time will be required for conversion.	Hoses
23	Fluorocoatings on labels on products (excluding textiles) necessary for environmental resistance	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory, Personal Protective Equipment (PPE), Consumer	HS Code Chapters - 65, 84, 85, 86, 87, 88, and 90	Widespread use. Safety label on product, product serial number label, battery capacity and composition label, and other labels with indelibility and lifetime requirements. (482110)	Clear labels that do not degrade over time are required for safety and regulatory reasons on most electronic, personal protective equipment, professional, and industrial products. A thin fluorocoating protects the label from the environment, maintaining the legibility of the label and meet standards such as UL 969.	Fluoropolymer coatings provide water and oil resistance to labels - reducing, if not preventing legibility issues with the label's writing.	Alternative coatings do not have the equivalent water or oil resistance. Or, in the case of nitrile or EPDM rubber, do not have the required transparency to read the label's writing. PVC has nearly equivalent water and oil resistance, but has risks of other regulated substances (such as phthalates) and does not withstand temperature ranges as well as fluoropolymers.	No	Labels
24	PTFE, PFA, FEP, PVDF, ETFE, and fluoroelastomer (including perfluoroelastomer) tubing not in contact with drinking water.	Tubing, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, 90; and HS Code 3917.	Widespread Use. (391739) Transformers, power suppliers, laboratory equipment, medical devices (901839), accelerometers (903180), and servers	Electrical transformers are reliant on PTFE tubing to protect their wiring. Medical devices and laboratory equipment use fluoropolymer tubing for transport of fluids in situations where non-reactive materials are critical. Tubing and bellows are used in articulating joints in machinery and vehicles. Without which, the joints would be inflexible and would wear.	Fluoropolymers have flexibility, biocompatibility (low chemical reactivity), optical transparency, and high temperature resistance. For electronics, the flexibility and high temperature resistance is critical for power applications such as the leads in transformers. For medical devices, the flexibility, transparency, and low chemical reactivity are critical for human or laboratory processes.	Alternative polymers do not have equivalent low chemical reactivity, optical transparency, flexibility, and temperature resistance. Polyurethane and PVC tubing can be used in some applications, but have poor resistance to acids and bases, can release chemicals (isocyanates or phthalates) into the fluid, and both have poor temperature stability.	No	Tubes
25	Heat transfer fluids for industrial applications	Heat transfer fluids, Electronics, Vehicles, Industrial, Machinery, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, and 89; and HS Code 3824.	Servers, semiconductor manufacturing equipment, radar equipment, and large power supplies.	Specialized high performance products that require fast and efficient transfer of heat from the heat generation source.	Fluorinated fluids have best in class heat transfer properties.	No other fluids have equivalent heat capacity to transfer heat sufficiently in machinery. Replacement with other fluids would create safety and performance issues in industrial applications such as semiconductor manufacturing, data centers, and military/aerospace.	Unknown	N/A
26	PVDF and PTFE as the cathode binder in lithium batteries	Lithium batteries, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90; and HS Code 8507.	Lithium batteries in electronics, vehicles, medical devices, servers, power drills (846721), analysis equipment for water, and portable electronic equipment. (850760)	Lithium batteries are fundamental to electric vehicles, servers, and portable electronics / tools.	Fluoropolymer binders have high heat resistance and excellent electrical insulation - improving performance of lithium batteries and reducing delamination of the electrodes in the battery.	Alternative polymers do not have as good of temperature resistance and/or electrical insulation, reducing the performance and lifetime of lithium batteries. Other polymers could not maintain the rigorous performance requirements of a binder in a high density lithium battery. Lead acid batteries have similar performance to lithium batteries, but can release lead at the end of life and have a weight that makes them unusable for mobile applications including electrical vehicles.	No	Batteries/Cap
27	PVDF, PTFE, TFE, and sulfonated PTFE as a binder, separator, or spacer in capacitors (including copolymers)	Capacitors, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90; and HS Code 8532.	supercapacitors and other high capacitance capacitors have a broad use in electronics, electrical distribution, and industrial equipment. (8532)	Fluorinated binders in capacitors are fundamental to high performance / capacitance capacitors. The fluoropolymers fill a similar role in a capacitor as they do in a lithium battery.	Fluoropolymer binders, separators, and spacers provide the electrical insulation and temperature resistance needed in high capacitance capacitors.	Alternative polymers do not have as good temperature resistance and/or electrical insulation, reducing or preventing the performance of the high performance capacitors	No	Batteries/Cap
28	Surfactants in emulsion based bio-assays and dry-chemistry assays	Medical, Laboratory	HS Code Chapter 90	Specialized low volume use in laboratory assays. Research and development, and medical applications.	Surfactants are commonly needed in laboratory and medical assays. These assays are necessary for measurement of biological, human, and chemical properties.	Fluorinated surfactants have the best surfactant performance. High performance and critical measurements using bio and dry chemistry assays often have to use fluorinated surfactants for measurement accuracy.	Fluoro based surfactants are commonly used as the surfactants in specialized bio-assays and dry chemistry assays. Fluoro based surfactants are useful for membrane protein stabilization in subsequent purification steps as they do not strip natural lipids and other co-factors from the proteins. In addition, the bulky fluorinated tails can not penetrate into the interior and disrupt the structure. Fluorinated surfactants often decrease non-specific aggregation and are thought to result in improved distribution. Without fluoro based surfactants, many specialized laboratory or medical measurements would not be possible or, at least, not with the same accuracy.	Yes. The very small amount present is very low volume, specialized use, and has controlled disposal. No risk of impact to humans or drinking water.	N/A
29	PTFE foil coating of rubber for biotechnology or chromatography purposes.	Medical, Laboratory	HS Code Chapter 90	Specialized very low volume use in laboratory and medical testing. Research and development, and medical applications. (902720)	PTFE foil is a specialized use in gas (and other) chromatography. This is a low volume application necessary for very specialized tests.	By enclosing the gas / fluid path with PTFE, higher precision chromatography is possible due to the reduced friction and low chemical reactivity of the tubing.	No other polymer has as low reactivity and low friction as PTFE. Specialized biotechnology or chromatography applications require the highest possible performance for measurement accuracy and consistency.	No	N/A

Exhibit C

Exhibit C

30	Fluorinated polyethylene for chemical storage and handling.	Industrial, Machinery, Laboratory	HS Code 3904	Fluorinated polyethylene containers for hazardous or laboratory chemicals.	Certain laboratory and hazardous chemicals will dissolve standard polyethylene or other polymer containers. Fluorinated polyethylene containers are needed for transport and storage of these chemicals (pesticides, optical personal care products, and industrial cleaners).	Fluorinated polyethylene provides the chemical resistance to standard polyethylene containers necessary to contain and transport certain chemicals.	Alternative non-fluorinated polymers do not have the chemical resistance to safely contain or transport pesticides and industrial cleaners. PFA fluoropolymer has similar performance as fluorinated polyethylene, but is more flexible and not suitable for most applications of fluorinated polyethylene.	Yes. Small concentration of PFOA and LC-PFCA are created by the fluorination of polyethylene.	N/A
31	Fluorosilicone and nano-fluorocoatings for antismudge and antireflective coatings for plastics and glass.	Electronics, Building Products, Vehicles, Industrial, Machinery, Medical, Laboratory, Eyewear	HS Code Chapters - 83, 84, 85, 86, 87, 88, 89, and 90.	LCD screens (852859), ski goggles (900490), sunglasses and eyewear (900410), refrigerator shelves (841899), and windows (761010).	Anti-smudge and anti-reflective coatings are necessary to maintain optical clarity in products that are touched by humans or are exposed to the environment. Without anti-smudge and anti-reflective coatings, safety and functionality could be compromised by lack of visibility.	Fluorinated coatings provide hydrophobic (water repellant) and oleophobic (oil repellant) properties to glass and plastics while maintaining optical transparency.	Alternative materials do not have equivalent water or oil resistance with the necessary optical clarity. In particular, oil (fingerprint) repellency of other materials are not equivalent. Other anti-fingerprint coatings exist, such as parylene, but they do not adhere to plastic substrates as effectively as fluoropolymer side chain polymers and have lower thermal stability.	No	Anti-smudge
32	PTFE, PCTFE, PVDF, FEP, ePTFE, PFA, and TFE (including copolymers) as a sealing or spacer material.	Seals (plastic, rubber, or metal), Building Products, Electronics, Vehicles, Industrial, Machinery, Pumps, Medical, Laboratory	HS Code Chapters - 28, 32, 38, 39, 40, 49, 59, 72, 73, 74, 82, 83, 84, 85, 86, 87, 88, 89, and 90	Widespread use. Pumps, oil and gas, industrial machinery, food processing, pharmaceutical and cosmetic processing equipment, medical devices, laboratory equipment, aerospace, chemical processing, electronic components, and equipment for extreme environments.	Products using fluoropolymer seals can be found in a wide range of industrial or machinery applications. Fluoropolymer seals are used in situations requiring a solid or vacuum seal versus the rubber seal of a fluoroelastomer, or added / impregnated into sealing material to provide the necessary performance properties.	Fluoropolymers have the acid, alkali, temperature, heat, water, and oil resistance needed for industrial sealing applications.	Alternatives do not provide sufficient resistance to acid, chemicals, water, oils, and temperature. In most of the applications listed in this entry, alternative sealing materials were tested, and no materials and closure systems showed positive results.	No Except PFA and ePTFE. They often contain PFOA and LCPFCA from the fracturing of the C-O-C bond of PFA, and the crosslinking of the polymer in ePTFE. Both can be designed without PFOA or LC-PFCA.	Seals
33	PVDF and ETFE as a component in fluid or gas systems	Plumbing, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90 - HS Code 3917	Pumps (841381), water circulation systems (842121), water purification system (842121), laboratory equipment (8419), and water heaters (8419).	Fluid and gas transportation is critical for a wide range of industries. Society cannot function without the ability to transport fluids and gases.	PVDF and ETFE provide significant performance advantages as components in a fluid or gas transportation system as either part of the tubing or as connector pieces in the system.	Alternatives do not have sufficient resistance to water, oil, and chemicals; and with the necessary durability and biocompatibility. The only other polymer with similar properties is PTFE. PTFE is higher density and has less abrasion resistance than PVDF. PVDF is preferred in industrial or heating applications for piping. ETFE has higher tensile strength than PTFE and can be used under harsher conditions that PTFE. The exception is the PEEK polymer. PEEK is technically a viable alternative to PVDF. Validation work needs to be completed to ensure replacement is viable in all circumstances.	No	Fluid/Gas Comp.
34	PTFE in coatings of labels for security or tamper evidence.	Tamper proof labels	HS Code Chapters - 84, 85, 90 HS Code 3923	Food packaging (3923), smart cards (8523.52), secure forms delivery, passports, self-adhesive plates, sheets, film, foil, tape (3919)	Abrasion and tamper proof labelling is needed for the security of personal information and product safety.	PTFE coatings provide abrasion and tamper proof protection for labels. PTFE cannot be modified by chemicals and shows physical wear if tampered, such as leaving a "Void" marking when the tamper evident label is pulled away/off.	For security - no other polymer provides the same tamper proof properties (chemical resistance) as PTFE as a coating. Use of another polymer would reduce the security of devices especially those for financial transactions or personal identification. For tamper evidence - PTFE material film (plus an adhesive) is used in the label in order to provide evidence. Other plastics do not have the combination of chemical resistance and visibility of tampering than irradiated (soft) PTFE.	No	Labels
35	Fluoroacrylic and PFA coatings (and PFPE solvents) for encapsulation of capacitors or semiconductor components.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90; and HS Code 8532 and 8542	Capacitors and integrated circuits used in computers, servers, machinery, and laboratory equipment	Electronics with advanced capacitors and integrated circuits are necessary for the continued functioning of society.	Very thin fluoroacrylic and PFA coatings provide water resistance at high temperature to sensitive electronics. There will be a very small amount of residual perfluoropolyether (PFPE) from application of the coatings	Alternative non-fluorinated materials do not have adequate chemical, water, and heat resistance in a high density / thin film application.	Below measurable levels due to small size of application	IC Coating
36	PTFE and fluorosilicone sprays for maintaining lubrication in industrial equipment.	Lubricants, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 34, 84, 85, 86, 87, 88, 89, and 90	Widespread use. Pumps (841381), oil and gas, industrial machinery, food processing, medical devices, laboratory equipment, aerospace, chemical processing, and equipment for extreme environments.	Widespread use. Very common in longer life products with moving parts. Without these products, there would be no more automation or automated assistance.	PTFE and fluorosilicone sprays provides lubrication in a large range of environments necessary for proper function and lifetime of industrial machinery, metal parts, and wire/cable.	No other spray is as effective in low concentrations and thickness in achieving reduced friction. Silicone spray is less effective than fluoro sprays and often contains D4, D5, and D6 forever chemicals (also regulated in the EU with further restriction expected). Silicone lubricants stay 'wet', apply thicker, do not have good high temperature resistance, and are less effective on moving parts.	No	Lubricant
37	Ionic fluoro fluids as electrolytes in capacitors or batteries	Lithium batteries, Capacitors, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90; and HS Code 8507 and 8532.	Lithium batteries and supercapacitors in electronics (8507), vehicles (870380, medical devices, servers, power drills (8467), and portable electronic equipment.	Lithium batteries, capacitors, and supercapacitors are fundamental to electric vehicles, servers, industrial equipment, and portable electronics / tools.	Fluoro ionic fluids provide great surfactant power, chemical/biological inertness, easy recovery and recyclability, low surface tension, extreme surface activity, no flammability, and high thermal stability. The surface activity and high thermal stability are excellent for high performance lithium batteries and supercapacitors.	Other ionic fluids can be used, but these fluids do not exhibit either/or the performance or flammability resistance of FILs.	No	N/A
38	Perfluorinated polyether (PFPE) as a lubricant for harsh (very low or high temperature) environments	Building Products, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 83, 84, 85, 86, 87, 88, 89, and 90.	Industrial machinery, components, and equipment uses at low and high temperatures.	Industrial machinery is required to work in low and high temperatures in laboratory and outdoor environments.	PFPE provides lubrication at very low temperatures which is not available for other materials. PTFE can offer high temperature lubrication equivalent to PFPE.	Silicone oil does not have the temperature range of PFPE and is not suitable for contact with some plastics. PFPE can handle a higher temperature range and is compatible with a wider range of rubbers.	No	N/A
39	PVDF polymers and PVDF terpolymers for ferroelectric films.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90.	Specialized use of ferroelectric films in micromachines and memory devices. Use of PVDF terpolymer films in actuators for medical devices (e.g. catheters or other implantable devices).	Micromachines and memory devices are specialized use, but are necessary for miniature applications and memory storage. Medical devices such as catheters and other implantable devices have an essential medical use.	PVDF and similar films are fundamental to the specialized use of ferroelectric films. Without PVDF, ferroelectric films would not be possible. PVDF terpolymer ferroelectric films enable the construction of flexible actuators that assist medical devices in their function. Without PVDF films, flexible actuators would not be possible in medical uses.	Specialized PVDF films have the highest dielectric constant of polymers, are new innovations, and are not replaceable with other materials. Given the electroactivity, strength and flexibility of PVDF terpolymer films, they enable the construction of flexible actuators for which there is currently no alternative.	No	N/A

Exhibit C

40	Fluoroethers for degreasing applications	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90.	Metal components for electronics, medical, industrial, or laboratory equipment are commonly degreased with fluoroethers.	Clean high precision metal components are needed for electronics, laboratory, medical, and high precision applications.	Fluoroethers provide degreasing cleanliness necessary for metals in high precision applications.	Chlorinated and brominated solvents can be used to degrease metal parts, they have higher greenhouse gas and environmental emissions; and reduced solvency power - resulting in most environmental hazards and would reduce part quality.	No	N/A
41	Residual hydrofluoroolefins used as blowing agents for insulating foam internal to products	Polyurethane foam, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90, and HS Code 392690	Blown foam for refrigerators, centrifuges, buildings, and shipping of fragile products.	Blow foam is necessary for thermal insulation for food safety and for transportation of valuable / fragile products.	Hydrofluorolefins used as a blowing agent for insulated foam leaves residual hydrofluorolefins.	HFOs (hydrofluorolefins) are the environmentally friendly replacements for hydrofluorocarbons (HFCs). To meet greenhouse gas emissions targets, companies need to continue to use and convert to HFOs.	No	N/A
42	PTFE as a manufacturing aid or tool for high temperature (> 150C) applications	Tools for manufacturing	HS Code Chapter 84.	Tools includes tools, jigs, and molds for high temperature manufacturing.	Industrial manufacturing processes often involve high temperatures which require tools that can withstand high temperature with strong chemical resistance.	PTFE withstands high temperatures and has very good chemical resistance.	Metals are too thermally conductive for most high temperature manufacturing processes. Other polymers either do not have the temperature resistance of PTFE (example - polyethylene) or are difficult to machine into custom tools (example - PEEK).	No	Harsh Env.
43	Fluorocoatings on laser fibers, laser fiber components, and fibers for optical purposes including light guidance.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90.	Fibre optics in communication systems (854470), medical endoscopes (901890), industrial vehicles (8708), aerospace, and laboratory equipment.	UV curable coatings based on fluorinated polymers (amorphous fluoropolymers) are used in connecting optical fibres or fiber based components to maintain light guidance along a chain of fiber and fiber based components when making a device. For optical components, light guidance needs to be maintained with high reliability and precise optical matching to avoid losses and transmitting light between beam forming components.	Fluoropolymers have optical transparency, excellent optical matching properties, and can be used in thin or dense environments.	Alternative materials are not as transparent to visible light and have poorer optical matching properties.	None expected. The amount of amorphous fluoropolymer is not sufficient for measurable perfluorocarboxylates in the final device even for a potential degradation product.	Optical Coating
44	Fluorosilicone used as a surfactant or anti-foaming agent in semiconductor materials	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90; and HS Code 8532 and 8542	Integrated circuits used in computers, resistors, servers, industrial machinery, and laboratory equipment	Precision semiconductor products are fundamental to virtually all modern electronic applications.	The fluorosilicone surfactants are used in a manufacturing step for a microscopic material internal to a semiconductor device. The resulting chemical is only used in the manufacturing of the product and will not be present above 50 ppm organic fluorine in the final product.	Other surfactants are not as effective for this high precision application or as inert. In semiconductor manufacturing this surfactant cannot react without other materials.	No	N/A
45	F2 gas and PFA fluorinated plastics in capacitors and microchips	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 34, 39, 40, 48, 49, 73, 84, 85, 86, 87, 88, 89, and 90; and HS Code 8532 and 8542	Integrated circuits used in computers, servers, industrial machinery, and laboratory equipment	Precision semiconductor products are fundamental to virtually all modern electronic applications.	A microlayer of fluorinated material is created in capacitors and semiconductor devices by F2 gas fluorination (usually plasma fluorination) of a plastic such as polyethylene or polyphenylene sulfide The thin layer has amorphous fluorinated alkane molecules. This very thin internal fluorinated layer provides specialized capacitance curves and is useful in specialized applications. Capacitors and microchips require extreme chemical resistance or flexibility advantages.	Thin fluorinated plastics provide capacitance performance advantages plus environmental resistance not available in other materials, and temperature resistance necessary for dense electronics	No	N/A
46	PTFE filled die attach material for semiconductor devices	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90; and HS Code 8532 and 8542	Integrated circuits and semiconductor devices (854110) used in computers, servers, industrial machinery, and laboratory equipment	Precision semiconductor products are fundamental to virtually all modern electronic applications.	PTFE provides a chemical inertness and temperature resistance to microchip die attach material.	No other polymer powder is as chemically inert and has as high temperature resistance as PTFE powder.	No	N/A
47	PFBS (Perfluorobutane sulfonate) and its salts - for the purposes of optical clarity in flame retarded polymers.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90.	Refrigerator, computer display, kiosk terminal	Optically clear and flame retarded displays are important for displays used by consumers.	Flame retarded clear plastic tends to be slightly cloudy, reducing the transparency of the screen. By adding <0.01% PFBS, the plastic of the displays is 'clarified', and can be used easily and safety.	No information is available on a potential replacement for PFBS. Currently is it the only material effective for its specialized application.	No	N/A
48	PVDF, PTFE, PCTFE, FKM, ETFE, PFA, PVDF in chemical and pharmaceutical packaging	Diagnostic / laboratory reagents, Pharmaceuticals	HS Code Chapters - 38, 39, and 90.	Reagents (3822), chemical analysis instruments and apparatus (9027), plastic articles and materials (3926), pharmaceutical packaging	Pharmaceutical and chemical packaging has to be very chemical resistance, high purity, and have high biocompatibility (low leaching).	Fluoropolymers including PVDF, PTFE and other fluorinated polyethylenes, provide chemical resistance for corrosive and solvent chemicals. Heat or UV resistance needed during some uses. Fluoropolymers incorporated into liners and seals in chemical packaging, and through fluorinations of inner container surfaces maintains integrity of the containers, preventing potentially hazardous leaks and protecting human health and the environment.	No alternatives to fluorinated chemical containers currently exist. Replacement with non-fluorinated materials would create a safety hazard for workers. Non-fluorinated polymers such as polyethylene lack resistance to corrosive and solvent chemicals and harsh conditions.	No Except PFA. PFA often contains PFOA and LCPFCA from the fracturing of the C-O-C bond of PFA. Both can be designed without PFOA or LC-PFCA.	Chemical packaging
49	PTFE, PFA coated tubing to prevent clogging if compliant to applicable NSF, FDA, or State requirements	Analyzer reagent tubing, wastewater tubing, printer tubing	HS Code Chapters - 39, 40, 49, 73, 84, 85, 90	Printer system tubing & spigots, pumps (841381), water circulation systems (842121), water purification system (842121), laboratory equipment (8419), and water heaters (8419).	Water quality tubing, analyzers, printers.	Parts that require either low friction or have a role in hostile chemical environments. PTFE required to reduce friction to prevent clogs within a hostile environment.	No alternative material with required resistance to hostile environments.	No Except PFA. PFA often contains PFOA and LCPFCA from the fracturing of the C-O-C bond of PFA. Both can be designed without PFOA or LC-PFCA.	Tubes
50	Conductivity agent in continuous ink jet for coding and marking	Printing ink, ink cartridges	HS Code Chapters - 32 and 84.	Printer inks (321511, 844399)	Essential marking of information, tracing and tracking of product. Sell by dates for food, pharmaceuticals, bottling and packaging.	Lithium trifluoromethanesulfonate is used as a conductivity agent in the ink formulation	No non-PFAS conductivity agents compatible with these formulations have been identified. Lithium trifluoromethanesulfonate is only used when other approaches are unsuccessful.	No	N/A
51	High temperature greases containing perfluoropolyether (PFPE)	Lubricating preparations	HS Code Chapter 34.	Fluorinated greases and oils (340399)	Assembly aid in production	Lubricant with high fluid resistance	No alternative material with required resistance to fluids	No	N/A

52	PTFE fibers and filtration disks used in corrosive gas filtration	Machinery, Electronics, Industrial	HS Code Chapter - 90 HS Code - 8421	Chemical analyzers, filtering or purifying machinery and apparatus for gases, others (8421)	These types of instruments are used to test if the water is safe for consumption or discharge in to the environment.The filtration allows successful conversion of these gases back to harmless forms that will not damage the environment or affect human health.	For filtration of corrosive or oxidizing gases the material is required to be very chemical resistant. The material must be able to separate particles from gas flow without damaging the filter.	Other polymers and filter material will react by dissolving and do not have the wide range of environmental resistance.	Yes. From the fracturing ('rubberizing') of the fluoropolymer to create the membrane fibre. Low concentration: 1 to 4 ppm	Membranes
53	PTFE Impregnated fabric for high temperature insulation	Electronics, Vehicles, Industrial, Machinery, Laboratory, Cooking Appliances	HS Code Chapters - 32, 39, 40, 83, 84, 85, 86, 87, 88, 89, and 90.	Insulation blankets in appliances, kilns, chemical reactors, conveyor belts	PTFE impregnated glass fabric is used as a heat insulating materials in high temperature professional and consumer products. The insulation fabric prevents heat from impacting other components including human contact surfaces.	PTFE provides additional insulation over glass fibre alone.	Silicone impregnated glass fibre does not have the temperature or chemical resistance of PTFE impregnated glass fibre.	No	Harsh Env.

Exhibit C

*****For additional information please see Claigan's full submission.

RECEIVED
By: OAH on 2/29/2024

Claigan
Less Journey. More Results.

Claigan Environmental Inc.
10 Brewer Hunt Way, Suite 200
Kanata, ON, Canada, K2K 2H5

Letter of Support

John Crane stands firmly behind efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. However, we express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. It's important to acknowledge that PFAS play a vital role in ensuring product functionality and meeting stringent safety standards.

In line with our commitment to finding balanced solutions, Claigan Environmental has developed a comprehensive Currently Unavoidable Uses (CUU) proposal, which is being submitted to the states of Maine and Minnesota. This proposal is founded upon rigorous laboratory testing and incorporates valuable insights gathered from diverse stakeholders. By engaging experts from various industries, Claigan Environmental has adopted a collaborative approach to address this complex issue.

John Crane actively participated in the consultation process and supports Claigan Environmental's submission. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS while mitigating adverse impacts on businesses, communities, and public health.

Sincerely,

Denise S. Lee

Denise S. Lee
Global Product Regulatory Compliance Program Manager, Innovation
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john crane

Please consider the environment before printing this e-mail

Denise Lee Attachment 3 RECEIVED
By: OAH on 2/29/2024

Claigan Environmental Inc.
10 Brewer Hunt Way, Suite 200
Kanata, ON, Canada, K2K 2B5

Industry PFAS CUU Project

PFAS Currently Unavoidable Uses Proposals (CUU)
Fifty-three (53) Proposals

Submission by Industry

This document is the guidance document to fifty-three (53) PFAS Currently Unavoidable Uses proposals being submitted by industry. Each CUU proposal is separate, but listed together in an orderly fashion for clarity and the convenience of regulators. Most of the proposals are for widespread uses of PFAS. These uses span across all industry segments and were included together. If required, they can be separated, but they would create between 300 and 400 separate proposals for regulators to review (for the 53 fundamental uses).

The Industry PFAS CUU project is made up of >50 companies that span consumer, professional, medical, industrial, and laboratory uses of PFAS. The CUUs listed here are based on very detailed work by each member of the project combined with tens of thousands of parts tested by Claigan Environmental in 2023 and 2024.

This submission should be the most comprehensive list of Currently Unavoidable Uses in physical products (articles), with detailed justifications and comparisons of alternatives.

The full CUU proposals and justifications are listed in detail in the accompanying spreadsheet PFAS Currently Unavoidable Uses Proposals - Feb 2024.xlsx.

Claigan Environmental Inc.
10 Brewer Hunt Way, Suite 200
Kanata, ON, Canada, K2K 2B5

Table of Contents

1. Summary

This report is a submission by Claigan Environmental Inc. (Claigan) on behalf of the Industry PFAS Submission Project (“PFAS Submission Project”). The PFAS submission project is made up of 50+ companies from a wide range of industries (consumer, professional, industrial, medical, oil and gas, laboratory equipment, textiles, electronic components, and retail sales.)

The PFAS Submission Project is focused primarily on the needs of complex products (articles). Claigan is both a restricted materials consultancy and a high-volume restricted materials testing laboratory. Each of the PFAS Submission Project submissions are based on contributions from all major sectors of industry, and 2023 and 2024 PFAS testing data from tens of thousands of parts.

The detailed justification of each CUU is covered in the accompanying spreadsheet PFAS Currently Unavoidable Uses Proposals - Feb 2024.xlsx.

Each CUU entry includes

- A brief description of the Currently Unavoidable Use of PFAS
- A brief description of the type of product including industries and example products with HTS codes.
- A description of the intended use of the product and explanations on how it is essential for health, safety, or the functioning of society.
- A description of how the specific use of PFAS in the product is essential to the function of the product. If this use of PFAS is required by federal or state law or regulation, citations will be provided for that requirement.
- A description of whether there are reasonably available alternatives for this specific use of PFAS.
- Plus
    - Whether the PFAS use includes PFOA or Long Chain Perfluoroalkyl Carboxylic Acids (LC-PFCA). Many of these PFAS uses do not include (nor degrade into) any PFAS found in drinking water and humans.

- PFOA / LC-PFCA presence is based on tens of thousands of parts tested in 2023 and 2024.

Important note 1 - due to the short timeline for the PFAS Currently Unavoidable Use consultation, each justification is only in brief with a detailed comparison of alternatives. Each justification can be further elaborated upon if needed.

Important note 2 - the regulation of chemical substances in medical devices is governed by the FDA. It is generally assumed that this preempts restrictions of PFAS in medical devices under state regulation, "A product for which federal law governs the presence of PFAS in the product in a manner that preempts state authority". However, for completeness and until this question is fully solved, currently unavoidable uses of PFAS in medical devices are also included in this submission.

Important note 3 - The States of Maine and Minnesota adopted a broad definition for PFAS substances. The vast majority of PFAS substances, as defined by Maine and Minnesota, that are found in products are not found in the environment. The broad definition impacts PFAS use in multiple categories of products and equipment needed to make products. PFAS substances are used in these applications because they have unique properties that impart specific performance characteristics making them essential to a product's function. The accompanying spreadsheet provides a detailed comparison of fluoropolymer, fluoroelastomer, and alternative materials for each application. The reason for the use of the fluoropolymer or fluoroelastomer is generally fairly obvious when you look at the application and the alternatives.

2. Related documents

2.1. PFAS Currently Unavoidable Uses Proposals spreadsheet - Industry PFAS Submission Project

2.1.1. PFAS Currently Unavoidable Uses Proposals - Feb 2024.xlsx

3. Definitions

3.1. ***Currently Unavoidable Use of PFAS (CUU)*** - a use of PFAS that is essential for the health, safety, or functioning of society and for which alternatives are not reasonably available.

3.2. ***Widespread Use*** -

3.2.1. For essential uses of a PFAS-containing product, uses that are very high volume with widespread use are identified.

3.2.1.1. For example - fluoroelastomers and perfluoroelastomers have very widespread use in professional/industrial products (> 10M products per year sold in the US).

3.2.2. **For consumer uses** - Over 100 Million products sold in the US each year use this Currently Unavoidable Use of PFAS, or

3.2.3. **For industrial uses (including professional uses)** - Over 10 Million products sold in the US each year use this Currently Unavoidable Use of PFAS.

3.3. ***Forever chemicals***

3.3.1. *Substances that are either*

3.3.1.1. ***vPvB*** - Very persistent and very bioaccumulative

3.3.1.2. ***PBT*** - Persistent, bioaccumulative, and toxic

3.4. ***Machinery***

3.4.1. *Machinery includes all aspects of machinery including (but not limited to) manufacturing, construction, clean energy, water treatment, and forestry*

3.5. ***Laboratory***

3.5.1. *Laboratory includes all aspects of laboratory equipment including (but not limited to) water testing, life sciences, research and development, and medical testing.*

4. Key notes

4.1. Importance of PFAS

4.1.1. > 500 million products containing PFAS are sold in the US each year

4.1.2. Banning PFAS would eliminate

4.1.2.1. Laptops

4.1.2.2. The internet (unless servers are moved offshore)

4.1.2.3. Food processing

4.1.2.4. Water processing and treatment

4.1.2.5. Forestry

4.1.2.6. Life sciences

4.1.2.7. Oil and gas industry

4.1.2.8. Heart surgeries and biopsies

4.1.3. Banning PFAS without exception for Currently Unavoidable Uses would likely create the largest recession in the history of the United States.

4.2. Sources PFOA / LC-PFCA in Products

4.2.1. Most fluoropolymers and virtually all fluoroelastomers do not contain PFOA or LC-PFCA

4.2.2. The follow sections are based on 2022 - 2024 testing of products for PFOA / LC-PFCA and include explanation of how these substances are formed in very specific situations.

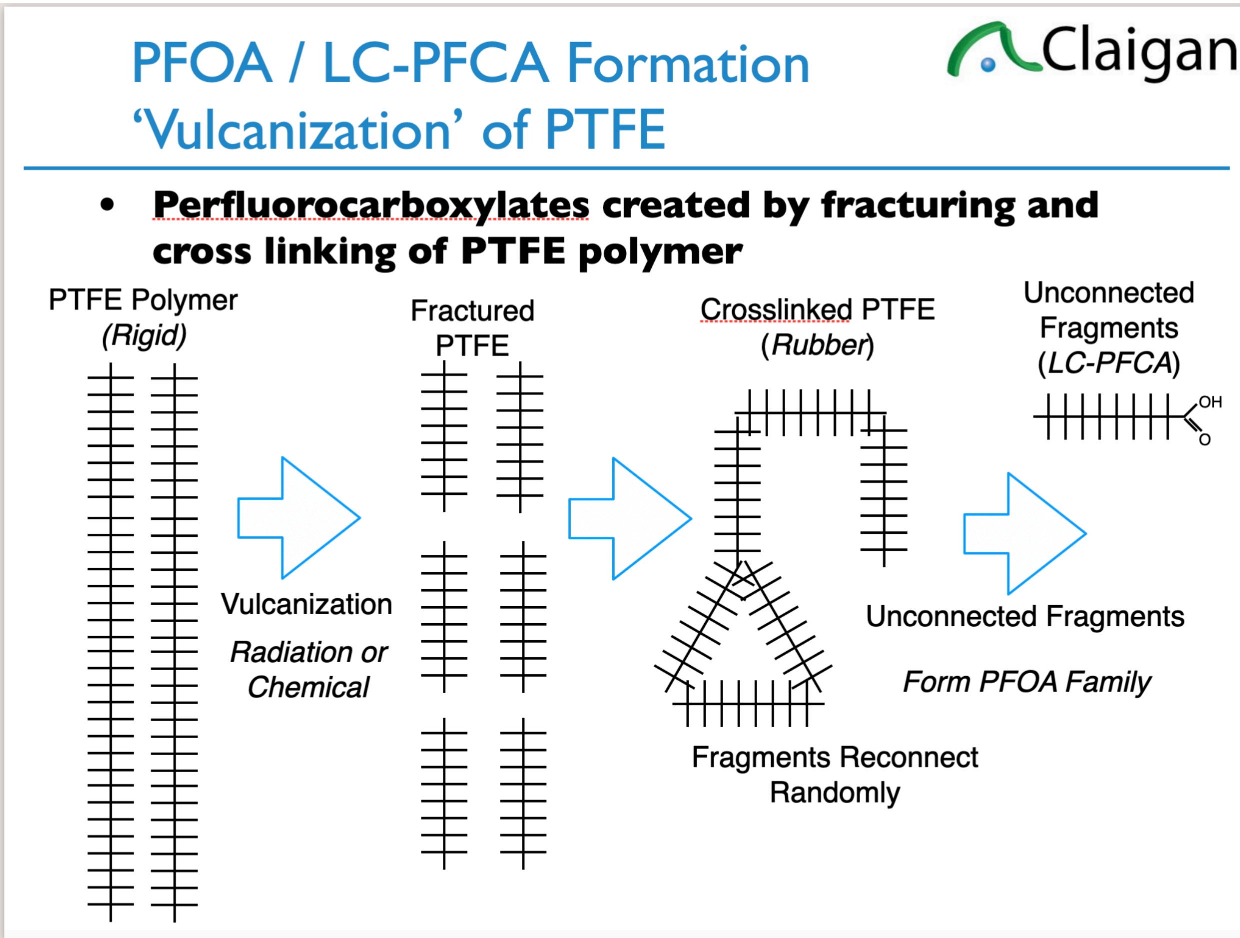
4.2.3. **Cause #1** of unintentional PFOA / LC-PFCA - Formation of LC-PFCA during vulcanization of rigid PTFE (or PVDF) into cross-linked rubber

4.2.3.1. Vulcanization / crosslinking of PTFE involves

4.2.3.1.1. Fracturing of long rigid PTFE polymer through radiation or chemical means

4.2.3.1.2. Reconnecting of fragments of PTFE in random directions (creating rubber instead of rigid polymer)

4.2.3.1.3. Some fragments react instead with air and create random sizes of perfluorocarboxylates.



4.3. **Cause #2** of unintentional PFOA / LC-PFCA - PFAS polymers (such as PFA or fluoroacrylates) that have a fluoromonomer side chain with a fragile C-O-C (carbon-oxygen-carbon) bond.

4.3.1. Formation of perflluorocarboxylates

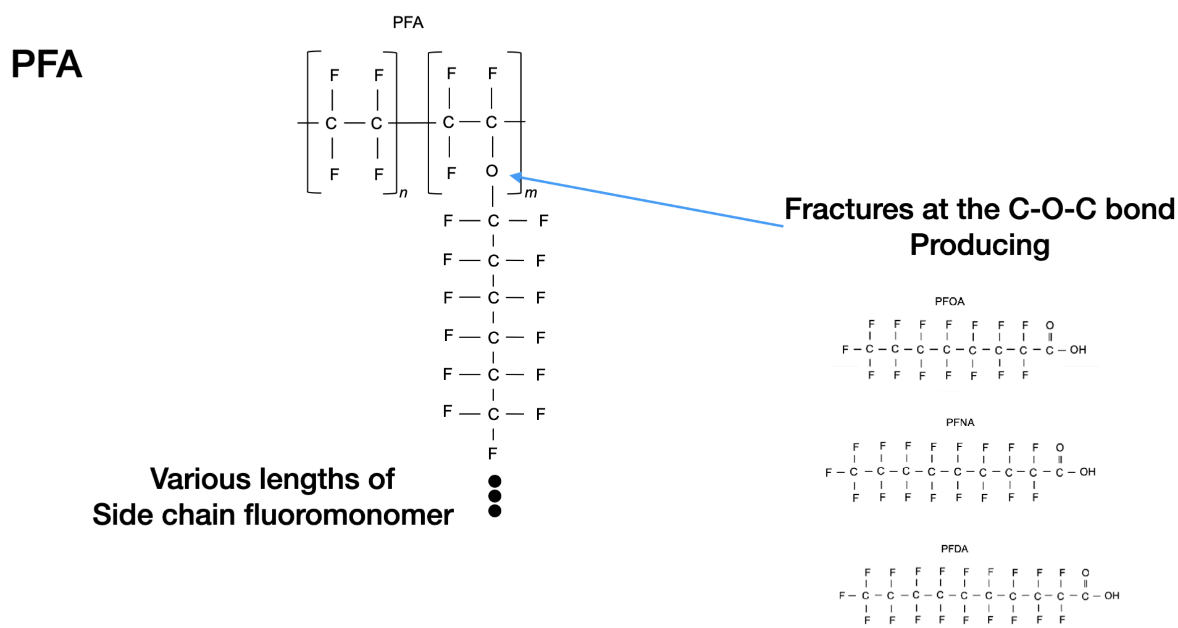
4.3.1.1. Fragile C-O-C bonds fracture during initial manufacturing and over time.

4.3.1.2. Fluoromonomer fragments are ‘fluorotelomers’, PFOA-like molecules with an extra 2 carbon hydrogens (such as 8:2 FTOH).

4.3.1.3. The fluorotelomer fragments react with air and water to slowly form perfluorocarboxylates

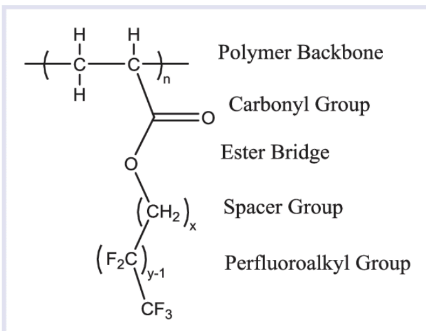
4.3.1.4. The lengths of eventual perfluorocarboxylates depend on the lengths of side chain monomers on the original PFA or fluoroacrylate polymer.

Formation of PFOA / LC-PFCA
PFA (Perfluoroalkoxy Alkane Polymer)



PFOA / LC-PFCA Formation Fluoroacrylates

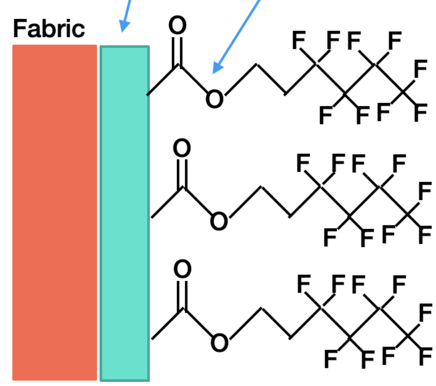
- Fluoroacrylates have a 'side chain polymer'
  - Acrylic or other polymer
    - With chains of PFAS extending from polymer
    - *PFOA may be present as an impurity from PFAS side chain*
  - Example - water repellant coatings



Side chain PFAS

Fragile C-O-C Bond

Acrylic polymer



Side Chain PFAS

4.4. Perfluorocarboxylates and Perfluorosulfonates Found in Fluoropolymers and Fluoroelastomers

4.4.1. Presence of perfluorocarboxylates and perfluorosulfonates

4.4.2. 2022 to 2024 testing data by Claigan Environmental

Comparison	PTFE	PVDF	ETFE	Crosslinked PTFE	ePTFE	PFA	Fluoroelastomers	Fluoroacrylates	Fluorophosphates
Short Chain Perfluorocarboxylates (C4-C7)	Never	Never	Never	Commonly	Commonly	Commonly	Commonly	Commonly	Commonly

Long Chain Perfluorocarboxylates (C8-C14)	Never	Never	Never	Commonly	Commonly	Commonly	Never	Commonly	Commonly
Short Chain Fluorotelomers (C4-C7)	Never	Never	Never	Never	Never	Never	Never	Commonly	Commonly
Long Chain Fluorotelomers (C8-C14)	Never	Never	Never	Never	Never	Never	Never	Commonly	Commonly
Short Chain Fluoroacrylates (C4-C7)	Never	Never	Never	Never	Never	Never	Never	Commonly	Never
Long Chain Fluoroacrylates (C8-C14)	Never	Never	Never	Never	Never	Never	Never	Commonly	Never
Short Chain Fluorosulphonates (C4-C7)	Never	Never	Never	Never	Never	Never	Never	Never	Never
Long Chain Fluorosulphonates (C8-C14)	Never	Never	Never	Never	Never	Never	Never	Never	Never
Short Chain Fluorotelomer Sulphonates	Never	Never	Never	Never	Never	Never	Commonly	Never	Never
Long Chain Fluorotelomers Sulphonates	Never	Never	Never	Never	Never	Never	Never	Never	Never

4.5. PFAS in Drinking Water and Humans

4.5.1. From this project and related testing data

4.5.1.1. ~99% of PFAS found in drinking water and humans is from <0.1% of products (primarily legacy fire extinguisher fluid and legacy foundation/concealer (C9-C15 fluoroalkyl phosphate in personal care products)).

4.5.1.2. ~99.99% of PFAS found in drinking water and humans is from <1% of products (a slight additional contribution from washing of waterproof fabrics contain fluoroacrylates).

4.5.1.3. The average silicone part has 100X more forever chemicals than the worst fluoropolymer (ePTFE). 200 ppm vs 2 ppm.

4.5.1.4. Based on ISO 10993-18 medical biocompatibility testing: Silicone, ABS, polystyrene, PVC, nylon, and polyurethane leak more dangerous chemicals into humans than fluoropolymers

4.5.1.5. Fluoropolymers are used because they are safer and more effective than their alternatives.

4.6. PFAS and Drinking Water - Kentucky 2023 PFAS testing of all drinking water sites

4.6.1. Kentucky 2023 drinking water sites testing

4.6.1.1. https://eec.ky.gov/Environmental-Protection/Water/Reports/Reports/2023-PFASFinishedDrinkingWaterResults.pdf

4.6.1.2. Kentucky was chosen because

4.6.1.2.1. Modern data (2023)

4.6.1.2.2. Comprehensive PFAS testing of each drinking water site

4.6.2. Sources of PFAS in drinking water

4.6.2.1. Based on the comparison of drinking water testing results and laboratory testing results of products

4.6.2.2. Legacy fire fighting foam

4.6.2.2.1. Fire fighting foam that uses C8 fluoro surfactants

4.6.2.2.2. Generally phased out of products a decade ago

4.6.2.2.3. Testing characteristic

4.6.2.2.3.1. Always - PFOS

4.6.2.2.3.2. Majority of situations - PFOA

4.6.2.2.3.3. Would not have - PFNA or PFDA (higher-length PFOA substances)

4.6.2.3. Modern fire fighting foam

4.6.2.3.1. Fire fighting foam that uses C4 or C6 fluoro surfactants

4.6.2.3.2. Common in modern fire fighting foam

4.6.2.3.3. Testing characteristic

4.6.2.3.3.1. Always - at least one of 6:2 FTS, PFHxS, PFBS

4.6.2.3.3.2. Majority of situations - PFHxA, PFBA

4.6.2.3.3.3. Would not have - PFOS, PFOA, PFNA, or PFDA

4.6.2.4. Cosmetics (Foundation and Concealer)

4.6.2.4.1. Foundation and concealer using C9-C15 Fluoroalkylphospate

4.6.2.4.1.1. Degrades over time into high concentration of PFOA, PFNA, and PFDA

4.6.2.4.2. Phased out in 2021/2022

4.6.2.4.3. Testing characteristic

4.6.2.4.3.1. Always - PFNA and PFDA (PFDA not included in Kentucky testing)

4.6.2.4.3.2. Majority of situations - PFOA

4.6.2.4.3.3. Would not have - PFOS or any sulphonate, or short-length fluoro carboxylates (PFBA, PFPeA, PFHxA).

4.6.2.5. Physical products

4.6.2.5.1. Primarily fluoroacrylate coatings of water-resistant fabric

4.6.2.5.1.1. Would release all lengths of perfluorocarboxylic acids during washing in detergent.

4.6.2.5.2. Common today

4.6.2.5.3. Testing characteristic

4.6.2.5.3.1. Always - All lengths of perfluorocarboxylates from PFBA to PFDA.

4.6.2.5.3.2. Would not have - PFOS or any sulphonate.

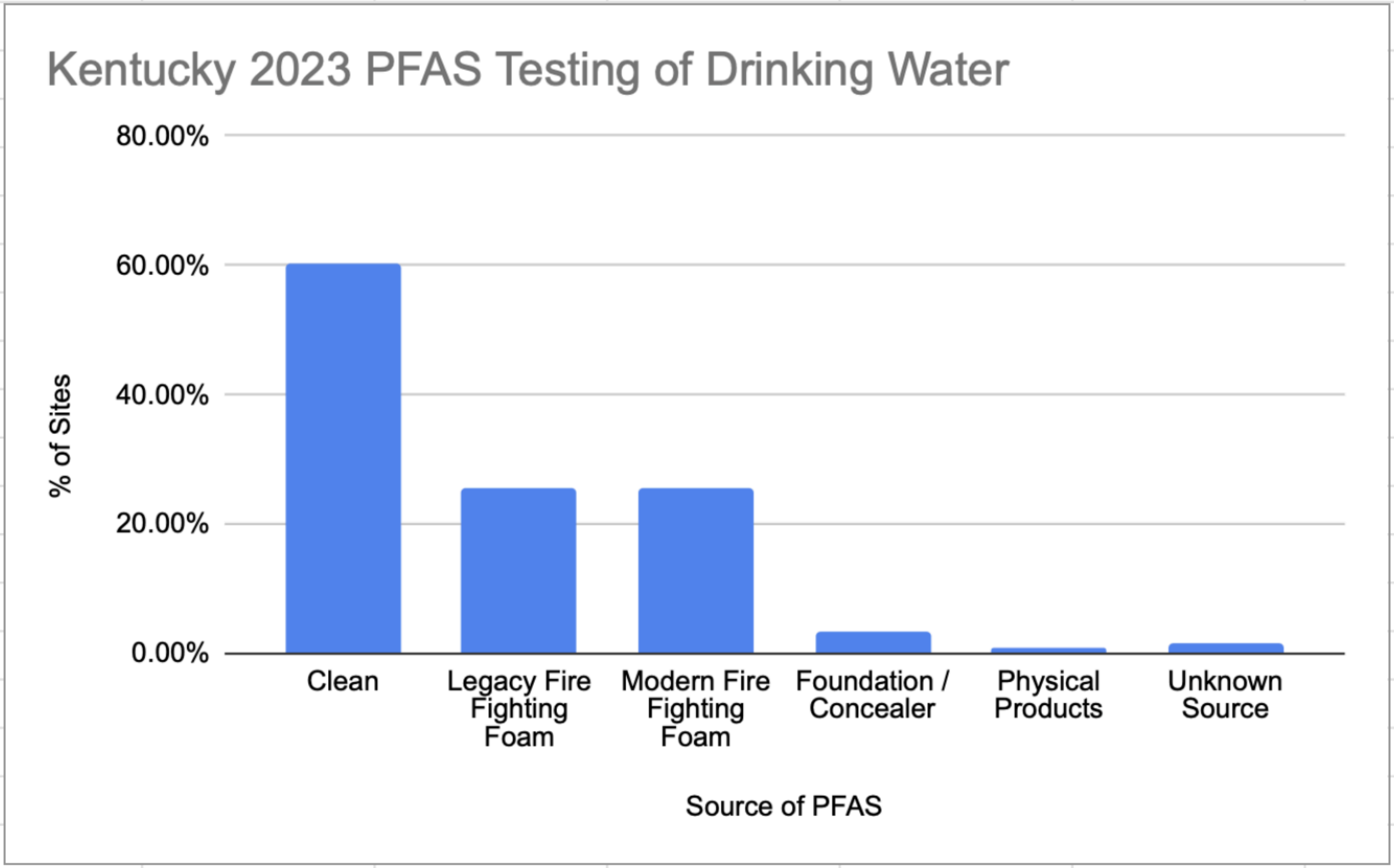
4.6.2.6. Unknown

4.6.2.6.1. Testing results from water are not consistent with any known product.

4.6.3. Chart of Projected Sources of PFAS in 2023 Kentucky drinking water site testing

4.6.3.1. 113 sites tested in Kentucky in 2023

4.6.3.2. Note - some sites could be listed under more than one source. The total should be above 100%


Kentucky 2023 PFAS Testing of Drinking Water
80.00%
60.00%
40.00%
20.00%
0.00%
% of Sites
Clean
Legacy Fire Fighting Foam
Modern Fire Fighting Foam
Foundation / Concealer
Physical Products
Unknown Source
Source of PFAS

5. PFAS Currently Unavoidable Uses

5.1. The full details are contained in the accompanying spreadsheet PFAS Currently Unavoidable Uses Proposals - Feb 2024.xlsx.

5.1.1. The comparisons are too large and detailed for a Word document and are instead summarized in an Excel file.

5.2. This document features several tabs with tables containing details about ***CUU's***.

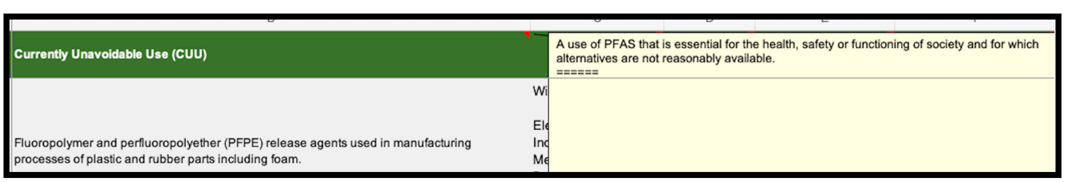
5.2.1. The CUU tab provides details about the specific ***CUU's*** as well as where and why they are specifically used.

5.2.2. The remaining tabs are the Alternative tabs. They provide the evaluation of alternative materials across a range of criteria applicable to the relevant use, which is labelled on the tab at the bottom of the document.

5.3. The core data is found within the tables, while further explanatory notes are found in the applicable column and row headers.

5.4. Cells with a red triangle in the top right corner have additional information pertinent to their respective row or column. They are found in Row 1 of the CUU tab and Column A of the Alternatives tabs. For example:

5.5. Additional details are revealed by hovering the mouse cursor over the cell (without clicking it). For example:



5.6. Additionally, this same information is captured in the document below.

6. Explanation of Currently Unavoidable Use (CUU) Proposal Tab

6.1. Columns A and B (CUU Number and Description) provide the numbering and descriptions for each ***CUU***.

6.2. Column C (Products) provides an overview of the applicable product families that require the listed Currently Unavoidable Use.

6.3. Column D (HS Codes) provides a list of HS Codes of products that require the listed ***CUU***. Some uses are so pervasive that the entire HS Code (Customs Code) chapters are listed.

6.4. Column E (Example Products) details a list of example products that require the applicable ***CUU.*** This list is representative and is not intended to be exhaustive.

6.5. Column F (Essential Use of Product) describes the intended use of the product and explains how it is essential for health, safety, or the functioning of society. It also describes if products using this CUU are ***Widespread*** or ***Industrial***.

6.6. Column G (Essential Use of PFAS) describes how the specific use of PFAS in the product is essential to the function of the product.

6.7. Column H (Comparison of Alternatives) describes reasonably available alternatives for this specific use of PFAS and compares them to the applicable ***CUU***. For further details, refer to the relevant Alternatives tab.

6.8. Column I (PFOA) identifies if this CUU contains any PFOA or Long Chain Perfluoroalkylcarboxylates (LCPFCAs). This column is based on 2023 and 2024 testing data of hundreds of representative parts for PFOA and LC-PFCAs.

6.9. Column J (Alternatives Tab) provides a direct link within the document to the identified tab comparing the performance of PFAS materials and alternative materials.

7. Alternatives Tabs

7.1. Row 1 (Comparison) identifies the alternative materials being evaluated.

7.2. Low Friction

7.2.1. Excellent - The material has a low coefficient of static friction. It is nearly frictionless.

7.2.2. Decent - The material has a lower coefficient of static friction but has some friction in use.

7.2.3. Poor - The material has a high coefficient of static friction. It displays strong friction during use and is not suitable for applications requiring low friction.

7.3. ***Chemical Resistance*** - the resistance to acids or bases may not be uniform for a material. The rating reflects the general potential applications of the material

7.3.1. Excellent - The material has superior resistance to acids and bases. Acid and bases have no discernible effect on the material.

7.3.2. Decent - The material is resistant to acids and bases but does exhibit some degradation. It should not be in extended contact with, or subject to, high concentrations of acids or bases.

7.3.3. Poor - The material is not resistant to acids and/or bases.

7.4. Water Resistance

7.4.1. Excellent - The material is hydrophobic (*i.e.* it is impermeable to water even as a coating).

7.4.2. Decent - The material is resistant to water, but not completely hydrophobic or waterproof.

7.4.3. Poor - The material is permeable to water.

7.5. Oil Resistance

7.5.1. Excellent - The material is oleophobic (*i.e.* it is impermeable to oil even as a coating).

7.5.2. Decent - The material is resistant to oil, but not completely oleophobic, oil-proof, or stain-resistant.

7.5.3. Poor - The material is permeable to oil.

7.6. Temperature Resistance

7.6.1. Excellent - The material can withstand temperatures above 150°C.

7.6.2. Decent - The material can withstand temperatures above 100°C, but is impacted by temperatures above 150°C.

7.6.3. Poor - The material is impacted by temperatures above 100°C.

7.7. Fire Resistance

7.7.1. Excellent - The material meets stringent fire/flame resistance standards.

7.7.2. Decent - The material has fire/flame resistance but does not meet the most stringent standards.

7.7.3. Poor - The material is not fire/flame resistant.

7.8. Flexibility

7.8.1. Excellent - The material exhibits good flexibility and is useful in most applications requiring flexibility.

7.8.2. Decent - The material has some rigidity, but still exhibits some flexibility.

7.8.3. Poor - The material is rigid and is not suitable for applications requiring flexibility.

7.9. Forever Chemicals (Initial)

7.9.1. Excellent - The material does not contain any substances with an EU harmonized classification of vPvB or PBT after manufacturing.

7.9.2. Decent - The material contains trace amounts (<1 ppm) of substances with an EU harmonized classification of vPvB or PBT after manufacturing.

7.9.3. Poor - The material contains amounts (> 1ppm) of substances with an EU harmonized classification of vPvB or PBT after manufacturing

7.10. Forever Chemicals (Over Time)

7.10.1. Excellent - The material does not degrade into substances with an EU harmonized classification of vPvB or PBT.

7.10.2. Decent - The material degrades lightly into substances (<1 ppm) with an EU harmonized classification of vPvB or PBT over time.

7.10.3. Poor - The material degrades into substances (> 1ppm) with an EU harmonized classification of vPvB or PBT over time.

7.11. Bio-compatibility

7.11.1. Excellent - The material passes US FDA and EU MDR biocompatibility testing and does not normally require toxicological justification.

7.11.2. Decent - The material passes US FDA and EU MDR biocompatibility testing but often requires toxicological justification.

7.11.3. Poor - The material does not generally pass US FDA or EU MDR biocompatibility testing or it requires significant toxicological justification.

7.12. Insulation

7.12.1. Excellent - The material has a low dielectric constant and is suitable for most insulating or electronics purposes.

7.12.2. Decent - The material has a medium dielectric constant and is only suitable for some insulating or electronics purposes.

7.12.3. Poor - The material has a high dielectric constant and is not normally suitable as an insulating material in electronics.

7.13. High-Density Applications

7.13.1. Excellent - The material is usable in applications requiring thin layers or high density.

7.13.2. Decent - The material is usable in applications that do not require thin materials, but it is not suitable for very fine or dense applications.

7.13.3. Poor - The material is not feasible as a thin film or in high-density applications.

7.14. Polymer Additive

7.14.1. Excellent - The material can be added to a wide range of polymers to provide additional properties.

7.14.2. Decent - The material can be added to some polymers to provide some level of additional properties.

7.14.3. Poor - The material is not suitable as a polymer additive.

7.15. Porous

7.15.1. Excellent - The material is permeable to air.

7.15.2. Decent - The material is partially permeable to air but is resistant to airflow.

7.15.3. Poor - The material is not permeable to air.

7.16. Durability

7.16.1. Excellent - The material has superior resistance to wear.

7.16.2. Decent - The material is partially resistant to wear but is not suitable for high-wear situations.

7.16.3. Poor - The material is not suitable for situations where wear resistance is required.

7.17. Optical Transparency

7.17.1. Excellent - The material is optically transparent.

7.17.2. Decent - This material has some optical transparency but is not suitable for applications requiring clarity and high transparency.

7.17.3. Poor - This material is not normally optically transparent

7.18. Structural

7.18.1. Excellent - The material is rigid with the ability to support its weight and any weight of the fluid it is transporting. It also has superior fatigue resistance.

7.18.2. Decent - The material can support its weight, but it is not as reliable for additional weight or fatigue.

7.18.3. Poor - The material cannot rigidly support its weight.

7.19. Radiation Resistance

7.19.1. Excellent - The material has superior resistance to gamma and e-beam radiation and does not exhibit degradation due to radiation.

7.19.2. Decent - The material has some resistance to gamma and e-beam radiation but exhibits degradation with repeat or high dosage exposure.

7.19.3. Poor - The material degrades in gamma or e-beam radiation.

7.20. Acceptable

7.20.1. A material is deemed acceptable if it receives an excellent or decent rating in non-critical properties. The material must receive an excellent rating in critical properties to be deemed acceptable.

7.20.1.1. Critical properties are identified where ratings (excellent, decent, poor) are shown in bold.

8. Acknowledgements

Special thank you to Nials Everett, Chris Scully, Julie Van Moorsel, Dr Tim Holt, and the entire Claigan Environmental staff and students for their contributions. And thank you to all of our industry members who contributed so much in such little time.

RECEIVED
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Fran Groesbeck Attachment 1

PFAS EDUCATION

PART 1: COOKWARE, PFAS, AND PTFE

The CBA is a not-for-profit trade association owned by its membership: manufacturers of cookware, bakeware and kitchenware with substantial operations and headquarters in the United States. The CBA began in the early 1920s as the Aluminum Wares Association, became the Metal Cookware Manufacturers Association in the 1960s, and in the 1970s changed its name to the Cookware Manufacturers Association in recognition of its representation of all types of cookware and bakeware materials. The CBA's mission is to inform and promote the industry to its members, their customers and to the general public.

The members of The Cookware & Bakeware Alliance (CBA) develop standards to promote the welfare of the cookware industry and improve its service to the public. The CBA Engineering Standards are continually updated to reflect changes in materials and technology and include test methods for nonstick finishes on cookware that when followed ensure coating performance and durability.

Nonstick cookware and bakeware manufactured according to CBA Standards use only US FDA food contact compliant materials for surfaces. CBA supports the responsible manufacturing and safe uses of PTFE and other fluoropolymers, and a science-based approach to regulations that benefit human health and the environment. CBA supports labeling provisions to alert consumers to the presence of PFAS, but based on current science, considers it unnecessary to prohibit sales and eliminate consumer choice.

Your cookware and bakeware industry resource.

Knowledge is powerful. This is a key element in why The Cookware & Bakeware Alliance was formed back in 1922, to collect and share important information and create safe consumer products.

For years we have answered questions and shared resources on important topics facing our industry. Many times, only part of the answer is shared, or one viewpoint. The Good Science site has been created to help provide resources and access to more information on important topics. We now bring all of this information to our website to share and promote Good Science. Visit the Good Science webpage to explore.

For questions, please contact Fran Groesbeck, Managing Director (fran@cookware.org).

Thank you for your interest in Good Science!

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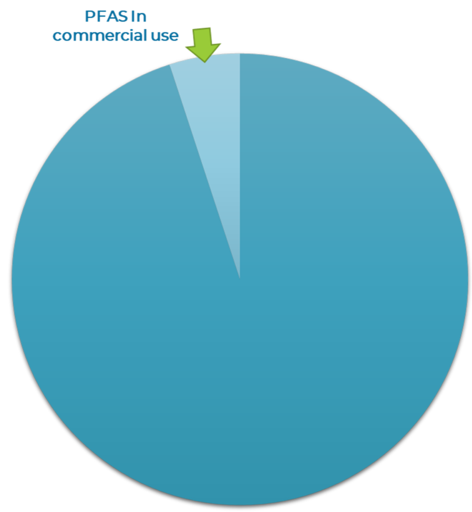
PART 1: Cookware, PFAS, and PTFE



Per- and polyfluoroalkyl substances (PFAS) are a diverse group of chemistries that contain carbon-fluorine bonds, the strongest chemical bonds in organic chemistry. Due to their unique and useful properties, PFAS are widely used and critical to enabling numerous technologies.

The term PFAS encompasses in some instances as many as 12,000+ substances. However, it is estimated that roughly 5% of all PFAS substances are in commercial use today. Further, not all PFAS are the same. The chemistries currently in commercial use have very different physical and chemical properties, health, and environmental profiles, uses, and benefits.

- Large family of substances
- Significantly varied properties
- Subgroups have unique and specific differences

They can be considered part of a universe of fluorinated organic substances with varying physical, chemical, and biological properties including polymers and non-polymers; solids, liquids, and gases.[1]

A subgroup of PFAS having specific characteristics and properties is called fluoropolymers. The discovery of the first fluoropolymer, polytetrafluoroethylene (PTFE), occurred in 1938 [2], and it led to its use in the most critical and demanding applications known. Aerospace and military applications were first to use fluoropolymers to insulate cables or create impermeable seals because it can withstand the harshest conditions and it replaces materials that have a high risk of failure due to a deterioration of properties. Uses in conditions where other materials fail due to corrosion and extreme temperature are the hallmark of fluoropolymers, often making them irreplaceable.

The first nonstick cookware appeared in the US in 1961.[3] Fluoropolymers are used in cookware, for their non-stick and barrier properties. To ensure food contact substances are safe for their intended use, the FDA conducts a rigorous scientific review before they are authorized for the market.[4]

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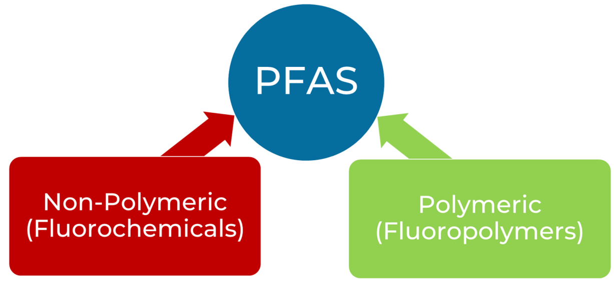
PFAS can be divided into two distinct groups: non-polymeric and polymeric PFAS. Furthermore, the non-polymeric, ie fluorochemicals, are water soluble, versus the polymeric, ie fluoropolymers, are not.



The non-polymeric PFAS (fluorochemicals) are typically used for food contact materials (FCM), such as fast-food packaging and microwave popcorn bags, as well as a number of other applications and industries. The FCM examples referenced can indirectly contribute to dietary exposure through the migration of PFAS into food, which can be a food safety concern [5]. Because they are water soluble, consumers have the potential to be exposed through foods and/or drinking water.

Whereas the polymeric PFAS (fluoropolymers), such as PTFE, which are used in nonstick cookware and bakeware coatings, are not water soluble, and have documented safety profiles. They are thermally, biologically, and chemically stable. They are also nonmobile, non bioavailable, non bioaccumulative, nontoxic, and most importantly they are not soluble in water. Although fluoropolymers fit the current PFAS structural definition, they have very different physical, chemical, environmental, and toxicological properties when compared with other PFAS.[6]

Fluorochemicals	Characteristic	Fluoropolymer *(used in cookware)*
Yes	Water Soluble	No
Yes	PFAS of Concern	No
Yes	Transported in Air	No
Yes	Toxicity	No
Yes	Persistence/ Non-Degradable	Yes

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[1] Identification and classification of commercially relevant per- and poly-fluoroalkyl substances (PFAS) Robert C. Buck,Stephen H. Korzeniowski,Evan Laganis,Frank Adamsky; First published: 14 May 2021 https://doi.org/10.1002/ieam.4450

[2] https://www.aps.org/publications/apsnews/202104/history.cfm

[3] ibid

[4] Authorized Uses of PFAS in Food Contact Applications https://www.fda.gov/food/chemical-contaminants-food/authorized-uses-pfas-food-contact-applications

[5] Schaider, L.A.; Balan, S.A.; Blum, A.; Andrews, D.Q.; Strynar, M.J.; Dickinson, M.E.; Lunderberg, D.M.; Lang, J.R.; Peaslee, G.F. Fluorinated Compounds in U.S. Fast Food Packaging. Environ. Sci. Technol. Lett. 2017. [CrossRef] [PubMed] https://www.mdpi.com/2304-8158/10/7/1443

[6] A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and Fluoroelastomers. Stephen H. Korzeniowski,Robert C. Buck,Robin M. Newkold,Ahmed El kassmi,Evan Laganis,Yasuhiko Matsuoka,Bertrand Dinelli,Severine Beauchet,Frank Adamsky

First published: 09 June 2022 https://doi.org/10.1002/ieam.4646

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Supplying the Industry with Standards, Connections & Solutions.

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PFAS EDUCATION

COOKWARE & BAKEWARE ALLIANCE
CBA
EST. 1922

PART 2: FLUOROPOLYMERS AND HUMAN HEALTH

PFAS Education Series

PART 2: Fluoropolymers and Human Health

Definition of Fluoropolymers:

Fluoropolymers are defined according to Buck et a.l[1] as a distinct subset of fluorinated polymers, based on a carbon-only polymer backbone with fluorine atoms directly attached to it, e.g., polytetrafluoroethylene (PTFE), fluorinated ethylene propylene (FEP) and perfluoroalkoxy polymer (PFA). Many fluoropolymers have been approved for food contact applications by regulators, including the US FDA (21 CFR 175.1550), the European Union through Regulation (EU) 10/2011 and also through specific national regulations such as German BfR recommendation LI.

Fluoropolymers do not present an unacceptable risk to human health.

The current OECD definition of PFAS includes thousands of substances with wide ranges of properties, including classes such as fluoropolymers which have traditionally been differentiated from legacy non-polymeric PFAS (PFOA or PFOS). In 2021, the OECD wrote, "The term "PFASs" is a broad, general, non-specific term, which does not inform whether a compound is harmful or not, but only communicates that the compounds under this term share the same trait for having a fully fluorinated methyl or methylene carbon moiety".[2]

A typical restriction on a substance or material requires the demonstration of "unacceptable risk", and fluoropolymers do not meet this standard, as demonstrated by years of research:

- The OECD is a central source of definitions for global chemical regulation (including the definition of PFAS) and classifies polymers with "insignificant environmental and human health impacts" as polymers of low concern.[3]

- PTFE is not soluble in water (or any other common solvents) and is not mobile in the environment.[4]

- Fluoropolymers have been repeatedly found to meet all of the OECD characteristics of polymers of low concern,[5] based on their stability, lack of bioavailability, lack of bioaccumulation, and general absence of observed ill effects.

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- In a scientific opinion published in 2016 relating to the risk analysis of chemical products in food, the scientific committee of the European Food Safety Authority (EFSA) specified that the risk analysis of polymers used in food additives must consider the molar mass of the polymer in question. For fluorinated polymers, EFSA proposed a threshold of 1,500 Daltons. Beyond this threshold, EFSA indicated that it is unlikely that the polymers will be absorbed through the gastrointestinal barrier and therefore considered that they do not present a health hazard.(6) By comparison, PTFE for food contact applications is characterized by sizes ranging from hundreds of thousands to several million Daltons. This recent opinion from EFSA shows that fluorinated polymers and in particular PTFE used for food contact materials like nonstick coated cookware do not pose a concern for health authorities.

Studies have consistently shown that fluoropolymers do not pose a risk to human health, largely due to their inertness, insolubility, and lack of reactive functional groups.

- A 2016 study by Naftalovich et al. shows that PTFE ingestion to increase satiety was both successful and safe. They also reviewed the biological safety of PTFE.(7)

- A 2022 study by Lee et al. shows that fluoropolymers such as PTFE are safe when ingested. For example, no toxic effects were observed from PTFE exposure in mice. No traces of PTFE were observed in the blood of mice even though they were exposed to very large amounts of PTFE.(8)

- The International Agency for Research on Cancer (IARC) has repeatedly investigated the carcinogenicity and toxicity of PTFE, finding it has no toxicological impact, and cannot be classified according to its carcinogenicity (IARC Group 3).(9)

Use of fluoropolymers in cookware and bakeware does not lead to negative health impacts.

The evidence does not indicate that use of fluoropolymer-coated cookware exposes users to non-polymeric PFAS.

- In a study on articles in the Korean market, Choi et al show that only a very limited number of articles (3 out of 139 fry pans) show migration of low molecular weight PFAS and only in the first migration experiment with no detection in later experiments. All detected quantities were significantly below the level of concern.(10)

- Studies of PTFE-coated cookware have detected no or for some products only traces of low molecular weight PFAS in the first migration experiment. The French consumer association 60 millions de consommateurs (n°579, April 2022), published a study on 9 non-stick coated articles. Despite detecting very low levels of low molecular weight PFAS, the author conceded that these substances “were probably not used in the manufacturing of the pans

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but could have been introduced in an accidental manner during manufacturing, packaging or transport".[11]

- PTFE is known to start to deteriorate at an extremely slow rate above 260 °C (500°F). Above 360 °C (680°F), the degradation of PTFE starts to be measurable. However, according to the German Federal Office for Risk Assessment (BfR), the concentration of these emissions while normally using PTFE-coated cookware is so low that there is no health risk for the user.[12]

- It should be noted that degradation temperatures for fats and oils are typically lower than 200 °C (392°F), consequently at a much lower temperature than when fluoropolymers would begin to degrade. For instance, emission of volatiles, such as aldehydes, from coconut, safflower, canola, or extra virgin olive oil are measured by Katragada et al. from 180 °C (356°F).[13] This suggests that regular usage of fluoropolymer-coated cookware would not result in sufficient temperatures for fluoropolymer degradation.

Studies and expert reports consistently evaluate PTFE coated cookware as safe for users.

- The European Food Safety Authority (EFSA) published a 2020 report assessing the safety of PFAS in food contact materials, primarily focusing on non-polymeric legacy PFAS (PFOA and PFOS).[14] The study assessed the use of PTFE in cookware, saying it may contribute to human exposure on the scale of micrograms per kilogram, a level far below background exposure from eating fish, meat, eggs, and fruit (among the most common sources of exposure to PFAS).

- The American Cancer Society considers the use of fluoropolymer-coated cookware safe, saying "there are no proven risks to humans from using these products. While PFAS can be used in making some of these coatings, it is not present (or is present in extremely small amounts) in the final products".[15]

Fluoropolymers, including PTFE, are widely used in other applications with no evidence of negative health effects.

PTFE is widely used in medical devices, including implanted devices, which are highly regulated and thoroughly studied for any negative health impacts. Evidence demonstrates the use of PTFE in these devices is safe, suggesting it does not pose a health risk for humans in other uses such as in cookware.

- The US-based independent research and innovation organization ECRI (Emergency Care Research Institute) was tasked by the US Food and Drug Administration (FDA) to carry out a review of the scientific literature and produce a report on the state of knowledge of the biocompatibility of PTFE-based (medical devices in terms of local and systemic host

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response. The analysis covered a total of 52 studies. The analysis found no local response to PTFE in implanted devices, and no exaggerated or fatal systemic responses.[16]

The general consensus of researchers is that PTFE and fluoropolymers do not present a health risk to humans.

- Their suitability for direct use in the human body is a central reason for their role in medical devices, and many researchers have argued that PTFE should be considered a polymer of low concern by meeting or exceeding all OECD criteria. This view is reinforced by regulatory agencies in the EU and the United States in multiple reviews and meta-analyses.

- The scientific literature on the health impacts of fluoropolymers, PTFE particularly as used in cookware, suggests that the use phase does not pose a risk to human health, as the fluoropolymers themselves are not absorbed by the body (not biologically available) and have no indicated harmful effects, and other non-polymeric PFAS are not present in meaningful quantities in the final products.

Beyond fluoropolymers, exposure to non-polymeric PFAS in other applications nonetheless presents a risk to health.

- According to the European Chemicals Agency (ECHA), the largest sources of PFAS contamination in the environment come from non-polymeric applications such as fluorinated refrigerants or waterproof coatings [e.g., treatments and finishes], which then raise concerns for exposure to humans through the food and water supply.[17] Regulatory solutions for PFAS exposure should be guided by the scientific consensus, while considering categories like fluoropolymers which have been consistently shown to be safe and result in minimal exposure.

Where or why does nonstick cookware come into all this?

PTFE, or polytetrafluoroethylene, is the PFAS material that makes nonstick coatings non-stick. As we discussed in Part 1 – PTFE is a fluoropolymer: it is non-water soluble, it is non-toxic, and it is not mobile or bio-accumulative. It has a certain level of persistence, but as with other fluoropolymers, it is this trait that makes it beneficial in so many applications.

Fluoropolymers do not fit any of the new classifications such as:

PBT : Persistent, Bioaccumulative, Toxic
vPvB : very Persistent, very Bioaccumulative
PMT : Persistent, Mobile, Toxic
vPvM : very Persistent, very Mobile

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Looking at PTFE from a high level, it offers many benefits to the products that use it. It is an insulator, so it reduces heat transfer. It reduces friction, which is what allows it to aid products from cookware to cars. Also, we must remember this is one of the non-water soluble PFAS types, so water contamination is not possible.

Fluoropolymers, like PTFE, are stable under normal, foreseeable use conditions. Stability is resistance to physical, chemical, or biological breakdown. Fluoropolymers, in general, have very good chemical and thermal stability due to the strength of the Carbon to Fluorine bond. (Henry et al: 2018).[5]

PTFE is the most stable fluoropolymer and has a continuous use temperature of 500°F (260°C). (Plastics Safe Handling Guide 2018).[18] This temperature is well above temperatures realized during normal cooking and baking activities when a nonstick housewares article is used per the manufacturers' use and care instructions.

Consumer Nonstick Housewares Products

Fluoropolymers, mainly PTFE, are the principal ingredients in traditional nonstick coatings for housewares. In most cases, these coatings are water-based, liquid coatings. The PTFE has to be stable in this liquid mixture in order to be applied to a product like a piece of cookware. PTFE, as helpful as it is, is extremely stubborn when it comes to mixing with water. In order to get PTFE to be stable in a water mixture, a surfactant is needed as a dispersing aid. Historically, the surfactant used to make PTFE stable in water was a fluorinated surfactant (i.e. fluorochemical).

You don't need a lot of the fluorochemical to make this work. A good analogy is if you had an Olympic size swimming pool, you would need to add a thimble-sized amount of the fluorosurfactant to make the PTFE stable. To put this small amount into another perspective, it translates to just over a minute in a century, or 0.000000025%

Aqueous film forming foams (AFFF) used to fight petroleum-based fires can often contain as much as 3.0% of fluorochemicals which are PFAS of true concern. To contrast these amounts, it would require 2 million years of cookware production to equal the environmental exposure caused by 1 year's use of AFFF.[19]

There are PTFE manufacturers that are committed to the reduction of emissions from polymerization aid/surfactant technology used in the fluoropolymer manufacturing process, the adoption of state-of-the-art emission reduction technologies, and informing downstream users of fluoropolymers about their safe handling, use, and prevention of environmental release.[20]

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Conclusion:

There is no scientific basis that PTFE-coated cookware and bakeware poses a hazard or risk to humans or the environment when used under normal conditions. Therefore, in our opinion it is safe to use and should not be restricted.

More from the PFAS Education Series

In the other parts in this series by CBA, we discussed several topics around PFAS and Cookware & Bakeware.

Part 1: Cookware, PFAS, and PTFE, the definition of PFAS involving a large family of substances with significantly varied properties and uses, was discussed. PFAS was divided into two distinct groups: non-polymeric and polymeric. The polymeric PFAS (fluoropolymers) are neither water soluble, nor mobile, nor bioavailable, nor bio accumulative.

Next in the series:

Part 3: A Closer Look at PFAS in Cookware & Bakeware: other contested issues with fluoropolymers were discussed such as, Environmental Emissions of PFAS, End of Life of Nonstick Cookware, Feasibility of Alternatives to PTFE.

Visit the Good Science webpage to explore.

The Cookware and Bakeware Alliance

The CBA is a not-for-profit trade association owned by its membership: manufacturers of cookware, bakeware and kitchenware with substantial operations and headquarters in the United States. The CBA began in the early 1920s as the Aluminum Wares Association, became the Metal Cookware Manufacturers Association in the 1960s, and in the 1970s changed its name to the Cookware Manufacturers Association in recognition of its representation of all types of cookware and bakeware materials. The CBA's mission is to inform and promote the industry to its members, their customers and to the general public.

The members of The Cookware & Bakeware Alliance (CBA) develop standards to promote the welfare of the cookware industry and improve its service to the public. The CBA Engineering Standards are continually updated to reflect changes in materials and technology and include test methods for nonstick finishes on cookware that when followed ensure coating performance and durability.

Nonstick cookware and bakeware manufactured according to CBA Standards use only US FDA food contact compliant materials for surfaces. CBA supports the responsible manufacturing and safe

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uses of PTFE and other fluoropolymers, and a science-based approach to regulations that benefit human health and the environment. CBA supports labeling provisions to alert consumers to the presence of PFAS, but based on current science, considers it unnecessary to prohibit sales and eliminate consumer choice.

Your cookware and bakeware industry resource.

Knowledge is powerful. This is a key element in why The Cookware & Bakeware Alliance was formed back in 1922, to collect and share important information and create safe consumer products.

For years we have answered questions and shared resources on important topics facing our industry. Many times, only part of the answer is shared, or one viewpoint. The Good Science site has been created to help provide resources and access to more information on important topics. We now bring all of this information to our website to share and promote Good Science. Visit the Good Science webpage to explore.

For questions, please contact Fran Groesbeck, Managing Director (fran@cookware.org)

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THE COOKWARE & BAKEWARE ALLIANCE

Building industry excellence through engineering, engagement, education and expertise.

PFAS Education Series

PART 3: A Closer Look at PFAS and Cookware & Bakeware

In previous parts of this series by CBA, we discussed several topics around PFAS and Cookware & Bakeware.

1. In Part 1 the large group of PFAS was divided into **non-polymeric fluorochemicals** and **polymeric fluoropolymers**. Fluoropolymers such as PTFE, which is used in nonstick coatings of cookware and bakeware, have very different properties compared to fluorochemicals. Existing legal restrictions of legacy fluorochemicals such as PFOA or PFOS should not be extended to fluoropolymers without scientific justification.
2. In Part 2, it was shown that fluoropolymers do not present an unacceptable risk to human health and are classified as polymers of low concern. PTFE coated cookware and bakeware are assessed by authorities in the US and Europe as safe for the user. In addition, the emissions of PFAS into the environment during the production of PTFE coated cookware is negligible.
3. In Part 3 we will have a closer look at the complete lifecycle of PTFE coated cookware and bakeware and current alternatives.

Lifecycle Assessment

Any lifecycle of consumer goods can be separated into four different sections: 1. Manufacturing of raw materials, 2. manufacturing of the product, 3. use of the product and 4. end-of-life.

It is important to point out that in the case of PTFE coated cookware phases 1, 2 and 4 are carried out by professionals with clear and elaborate OSHA safety and EPA environmental regulations.

Only phase 3 is carried out by non-professional consumers.

In Part 2 it was shown that PTFE coated cookware is of no or negligible concern during phases 2 and 3. Using existing best-available technologies emissions of these PTFE coated products are insignificant and will even be reduced in the coming years.

In phase 1 chemical manufacturers produce fluorinated monomers such as TFE (tetrafluoroethylene) and transform them into fluoropolymers using both fluorinated and non-fluorinated polymerization aids. There are technical and scientific indications that either of these production steps can be done without any non-polymeric PFAS emissions to the environment. A fluoropolymer industry-led initiative includes a platform to promote the adoption of commercially available state of the art technologies to minimize non-polymeric PFAS emissions during manufacturing.[(1)]

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It can be summarized that based on phases 1 – 3 of the full lifecycle PTFE-coated cookware should not be restricted.

End-of-Life

Landfill, incineration or recycling are viable options for PTFE-coated cookware and bakeware used by consumers or professionals at the end-of-life.

A RIVM (Dutch National Institute for Public Health and the Environment) incineration review states that PTFE is stable at 260 °C without loss of mass. A PTFE coated article in **landfill** would therefore not decompose at the temperatures found in this environment (https://rivm.openrepository.com/handle/10029/625409). In addition, fluoropolymers such as PTFE are not soluble in water, not mobile, stable to most chemicals (https://setac.onlinelibrary.wiley.com/doi/10.1002/etc.5182) and UV radiation.

Therefore, it can be expected that there are negligible emissions of non-polymeric fluorochemicals in landfill due to PTFE-coated cookware.

Incineration and recycling can be discussed together because in both cases the fluoropolymer is thermally treated. Several studies have shown that it is possible to destroy or mineralize the fluoropolymers including undesired decomposition products such as problematic fluorochemicals (Utah 2023 https://www.wastedive.com/news/clean-harbors-incinerator-pfas-forever-chemicals/640829/, Dutch RIVM https://rivm.openrepository.com/handle/10029/625409, Karlsruhe Institute of Technology 2019 and 2023 https://doi.org/10.1016/j.chemosphere.2019.03.191).

Therefore, using the best-available technology and appropriate temperatures, PTFE and other fluoropolymers are of no concern for emissions of PFAS into the environment.

Due to the significant reduction of carbon footprint using recycled aluminum and stainless steel compared to their primary materials, it is strongly recommended to use an existing collection scheme or to implement a new scheme for PTFE-coated cookware at its end-of-life. Based on a rough estimate by FEC (European Federation for Cookware, Cutlery and Houseware Industry) more than 100 Mio. pieces of coated cookware is sold in Europa annually. The recycling of PTFE-coated aluminum cookware at end-of-life would reduce the carbon footprint by more than 250’000 tons $CO_{2\ eq.}$ per year.

Conclusion

PTFE-coated cookware and bakeware has throughout its full lifecycle a negligible risk for PFAS emissions into the environment and is safe-to-use for the consumer. Therefore, **in our opinion,** there is no foundation to restrict the manufacture, usage or recycling of products made with fluoropolymers.

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Alternatives to PTFE-coated cookware

There are alternatives to PTFE-coated cookware and bakeware. The options can be split into two sub-groups: with and without nonstick coating. According to the 2023 Consumer Outlook Report, published by HomePage News, 72% of consumers indicated that they have a preference for products with nonstick coatings[(2)]. Therefore, stainless steel, cast iron or enameled cookware are not an equivalent alternative because they possess no nonstick property.

Nonstick is not only a function that simplifies the life of the user, it also reduces the risk of burning food with undesirable by-products that might be unhealthy. In turn, this also reduces the potential of food waste. It is an obvious feature of nonstick cookware that the cleaning is easier, and less cleaning agents and water is needed. Overall, nonstick cookware has a lower environmental footprint during its usage compared to alternatives without this property.

An example of nonstick alternatives are silicone-based coatings which are mainly used for bakeware. They are a low performance alternative to fluoropolymer systems, both in terms of temperature and damage resistance and nonstick performance. To avoid deterioration of silicones, temperatures of 230°C/446°F should not be exceeded during use [BfR recommendation, https://www.bfr.bund.de/cm/349/LI-Temperature-Resistant-Polymer-Coating-Systems-for-Frying--Cooking-and-Baking-Utensils.pdf].

The best-known nonstick alternative to PTFE based nonstick coatings are ceramic or sol-gel coatings. Ceramic refers to the material from which the coating is made of and sol-gel to the production technique being used. Today, there are two points in assessing this alternative:

- PTFE is a 100% defined material (polytetrafluoroethylene), but ceramic nonstick coatings can be made with a variety of materials. Thereby, the final ceramic coating and its composition varies from manufacturer to manufacturer.
- The ceramic coating itself has usually no nonstick performance and needs additional additives such as silicone oils.

To avoid any regretful substitution of PTFE-coated nonstick cookware, it is mandatory to carry out a study of the full lifecycle of ceramic coatings. To our best knowledge, no such analysis exists, and these coatings have been studied a lot less due to their limited applications compared to PTFE.

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Important points regarding PTFE-based nonstick coatings:

1. PTFE-based nonstick coatings will retain their nonstick properties for as long as the coating is present on the coated article. This is due to the inherent nonstick properties of PTFE, a fluoropolymer. Alternative nonstick coating technologies will lose the nonstick characteristics over time.
2. PTFE-based nonstick coatings are unaffected by household dishwashers.
3. PTFE-based nonstick coatings emit very low levels of volatile organic compounds (VOCs) during the coating application process.
4. The risk of PTFE-based nonstick coatings releasing low molecular weight PFAS substances of concern or any other substance that might adulterate food during normal use is very low.[3]

Conclusion

Not enough is scientifically known about the full lifecycle of ceramic or sol-gel coated cookware to declare this a valuable alternative to PTFE coated cookware and bakeware. The risk of a regretful substitution is significant.

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YAGEO Group
YAGEO KEMET Pulse

February 23, 2024

Letter of Support

YAGEO Group stands firmly behind efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. However, we express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. It's important to acknowledge that PFAS play a vital role in ensuring product functionality and meeting stringent safety standards.

In line with our commitment to finding balanced solutions, Claigan Environmental has developed a comprehensive Currently Unavoidable Uses (CUU) proposal, which is being submitted to the states of Maine and Minnesota. This proposal is founded upon rigorous laboratory testing and incorporates valuable insights gathered from diverse stakeholders. By engaging experts from various industries, Claigan Environmental has adopted a collaborative approach to address this complex issue.

YAGEO Group actively participated in the consultation process and supports Claigan Environmental's submission. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS while mitigating adverse impacts on businesses, communities, and public health.

Susan Barkal
YAGEO Group
Senior Vice President & Head of Quality and Compliance
(864) 963-6300

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By: OAH on 2/29/2024

Katie Pelch Attachment

NRDC

February 29, 2024

Via https://minnesotaoah.granicusideas.com/
Quinn Carr
Rule Coordinator
Minnesota Pollution Control Agency (MPCA)
520 Lafayette Road North
St. Paul, MN 55155-4194

Re: Request for Comments: Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

We respectfully submit our comments on the following questions posed by MPCA:

1. **Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?**

MN law states "(j) *"Currently unavoidable use" means a use of PFAS that the commissioner has determined by rule under this section to be essential for health, safety, or the functioning of society and for which alternatives are not reasonably available,"* with no further description of "essential for the health, safety, or functioning of society" or "alternatives". "Essential for the health, safety, or functioning of society" is encompassed within "currently unavoidable use," and we suggest that it is more productive to focus on the broader term and delineate what constitutes a "currently unavoidable use" instead of trying to categorize them under the two prongs of the definition.

We recommend that MPCA find that the use of PFAS in a product category is currently unavoidable only if all the following criteria are met:
(1) There are no safer alternatives to PFAS that are reasonably available.
(2) The function provided by PFAS in the product is necessary for the product to work.
(3) The use of PFAS in the product is critical for health, safety, or the functioning of society.

The second proposed criteria could easily fit under both prongs of the definition of "unavoidable use." If PFAS is not necessary for the product to work, that is a safer alternative to the use of the PFAS. It also means that the use of PFAS in the product is not necessary for the health, safety, or functioning of society. It is not important to delineate which prong the criteria falls under.

However, it is important to specifically articulate the criteria so that it is considered in every analysis and is not overlooked.

In order to implement these three criteria, additional terms are critical to define. Specifically, we recommend including the following definitions:

- "Safer alternative" means an alternative that, in comparison with another product or product manufacturing process, has reduced potential adverse impacts and/or potential exposures associated with PFAS. Alternatives include materials, processes, designs, products, or chemicals that achieve the desired result. For example, a safer alternative to stain resistant sprays for avoiding stains could be the use of detergents or the use of fibers that are inherently stain resistant.
- "Necessary of the product to work" means required for the product to perform its core function, as determined by the department. For example, the core function of a couch is for people to sit on.
- "Product" means an item manufactured, assembled, packaged, or otherwise prepared for sale in Minnesota, including but not limited to, its components, sold or distributed for personal, residential, commercial, or industrial use, including for use in making other products.

The proposed criteria above add critical detail to inform considerations of safer alternatives and necessity. Additional considerations of necessity beyond these criteria will rely on the discretion of the agency to account for information that comes before the MPCA.

2. **Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?**

Firstly, if alternatives are already being used or if PFAS in an application has already been banned in another jurisdiction and that ban is in effect, then the alternative should be determined to be reasonably available. In addition, if the findings of an available study or evaluation of alternatives by an authoritative body shows the viability of safer alternatives to PFAS in the product category under review, then those alternatives should also be considered reasonably available.

Secondly, a cost threshold is not appropriate in this context, because the cost implications can vary dramatically from product to product. Rather the focus should be on assessing what is "reasonably available." We believe that inquiry could involve considerations of adequate supply of the alternatives and potentially the cost to the public. Costs to manufacturers are variable and subject to market pressures, including MPCA action. An alternative may initially start out significantly more expensive than the PFAS it is intended to replace, but as demand increases, the cost can fall rapidly, and a mandated switch away from PFAS could be the catalyst for demand for the alternative to increase. This is why it is important for cost considerations to not be determinative (and to have determinations of "currently unavoidable use" be time bound, as the availability of alternatives can change over time).

The need for any consideration of costs to be more focused on the impact to the public rather than the manufacturer is reinforced by the nature of alternatives that should be covered. As we propose above, MPCA should adopt definitions that make clear that alternatives can include materials, processes, designs, products, or chemicals that achieve the desired result. For example, a safer alternative to stain resistant sprays for avoiding stains on upholstery could be the use of detergents or the use of fibers that are inherently stain resistant. In the example where detergents are a viable alternative to PFAS treated upholstery, there would be little to no direct costs to the public, but there might be economic impacts for the manufacturer of the PFAS treated upholstery. Thus, the cost to the manufacturer should not be the relevant cost for MPCA's analysis.

There should also be some consideration of the significance of additional cost to the public. However, minor costs should not influence the analysis. Even when considering costs to the public, a set threshold in absolute dollars should not be used as product categories may vary significantly in scale of cost. Nor is a percentage-based threshold appropriate because the significance of a certain percentage cost difference depends on the context–a high percentage could still amount to mere cents. In addition, any cost should be considered alongside societal costs of PFAS exposure and clean up.

3. **Should unique considerations be made for small businesses with regards to economic feasibility?**

For reporting requirements, it makes sense to consider economic feasibility for small businesses based on a combination of the number of employees and revenue. For example, Maine has exempted from reporting manufacturers that have 100 or fewer employees. However, there may be cases where a business has fewer than 100 employees, but makes substantial revenue to which reporting would not be a financial hardship. Furthermore in the case of franchises or businesses with contractors, the franchisor or the number of contractors (so that we are not creating perverse incentives to hire contractors instead of employees) should be considered in the analysis of economic feasibility of reporting.

However, these considerations should not be made when restricting the avoidable use of PFAS. Regardless of size, businesses should not be permitted to use PFAS unnecessarily because of the significant harms that may follow for human health and the environment.

4. **What criteria should be used to determine the safety of potential PFAS alternatives?**

As mentioned above, safer alternatives should include materials, processes, designs, products, or chemicals that achieve the desired result. For example, a safer alternative to stain resistant sprays for avoiding stains could be the use of detergents or the use of fibers that are inherently stain resistant.

A safer alternative should be an alternative that, in comparison with another product or product manufacturing process, has reduced potential adverse impacts and/or potential exposures associated with PFAS. There are tools such as Greenscreen or Chemforward to compare potential adverse impacts of alternatives, but as the proposed definition above suggests, non-chemical alternatives that achieve the desired end result should be considered.

The Washington Safer Products program has developed detailed criteria for "safer alternatives," which are available in [Phase 3 Working Draft Criteria for Safer.](#) If you have questions about these criteria or about the Safer Products for Washington program, we recommend contacting SaferProductsWA@ecy.wa.gov. The WA Department of Ecology has already shown great success in applying these criteria for identifying safer alternatives to PFAS in a number of product categories.

5. **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?**

A currently unavoidable use determination should be reevaluated at least every five years. This length of time provides a degree of certainty for businesses while taking into account often quickly changing market conditions. Furthermore, when a manufacturer applies for a renewal of a currently avoidable use determination, they should not only have to show that their use still meets the criteria outlined in question 1, but they should also provide evidence of significant efforts to develop a safer alternative to the continued use of PFAS in the product or product category, including, but not limited to, published peer-reviewed papers and funding of third-party research with no financial conflict of interest. Without such a requirement, there is little incentive for businesses to make efforts to find alternatives to PFAS.

If significant changes in available information about alternatives becomes available the MPCA should review any relevant currently unavoidable use determinations and revoke any determinations where the use no longer meets the criteria for a currently unavoidable use. Furthermore, a public petition process should be put in place to allow for petitions to review a determination based on a significant change of information.

6. **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?**

A petition process should be put in place for requests for a currently unavoidable use determination. In submitting a petition, a manufacturer should be required to provide evidence that their use of PFAS meets *all* of the following criteria:
(1) There are no safer alternatives to PFAS that are reasonably available.
(2) The function provided by PFAS in the product is necessary for the product to work.
(3) The use of PFAS in the product is critical for health, safety, or the functioning of society.

When evaluating the above suggested criteria for an unavoidable use, MPCA does not need to evaluate all the criteria if the determination can be made on fewer criteria since all criteria must be met for an exemption. In other words, if a use is found not to meet one of the three criteria, the use is avoidable.

When reviewing this evidence MPCA should also consider the relevance and significance of the information provided for the product category, other available reliable information, and bans on the sale or use of PFAS in the product or product category in another state or other countries. If the sale or use of PFAS in the product or product category has already been banned in another state or other countries, and if the ban is in effect, then that should demonstrate that the use of PFAS is not a currently unavoidable use. Finally, MPCA should provide an opportunity for public comment, where other stakeholders could provide relevant information.

In the case that a currently unavoidable use determination has already been granted for a product or product category, there should also be a petition process in which the public or other stakeholders can provide information showing that the use is now no longer currently unavoidable. (See our response to question 5.)

7. **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.**

8. **Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?**

MPCA should not *a priori* determine that any PFAS use is currently unavoidable. This would bypass a petition process where manufacturers must provide evidence to MPCA that a use is currently unavoidable. It also removes any incentives to develop or implement safer alternatives for these uses.

Rather, MPCA should make additional determinations that the following are avoidable uses before the 2032 phase out:

1) Expanded textiles category: California has passed a law that bans the sale of PFAS containing textile articles starting January 1, 2025 (with a limited set of products provided an extension until 2028) and has defined "textile articles" broadly as "textile goods of a type customarily and ordinarily used in households and businesses, and include, but are not limited to, apparel, accessories, handbags, backpacks, draperies, shower curtains, furnishings, upholstery, beddings, towels, napkins, and tablecloths." Therefore textile articles beyond upholstered furniture and textile furnishings (already listed to be avoidable uses in Minnesota law) should also be determined to be avoidable, including apparel, accessories, handbags, backpacks, footwear, and other products. MPCA should expand the restrictions on PFAS in textiles to be consistent with the scope of California's law (AB 1817).

   Similarly, Washington Department of Ecology, under the Safer Products for Washington law, has taken action on the use of PFAS in apparel and gear, including: athletic wear, rain wear, reusable diapers, menstrual underwear, school uniforms, dresses, hats, scarves, gloves, shoes, extended use products, backpacks, sleeping bags, umbrellas, camping furniture, and climbing rope. In this case, Ecology made the draft regulatory determinations that PFAS uses must be reported for: apparel intended for extended use by experts or professionals that are not marketed to the general public, shoes, and gear. Ecology further made a draft regulatory determination to restrict the use of PFAS in all other types of apparel.

2) Pesticides: Maine passed a law (H.P. 1501 - L.D. 2019) prohibiting the distribution of pesticides that are contaminated by perfluoroalkyl and polyfluoroalkyl substances; or that contain intentionally added PFAS beginning in 2030. “Pesticides” include any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pests; any substance or mixture of substances intended for use as a plant regulator, defoliant or desiccant; and any substance or mixture of substances intended to be used as a spray adjuvant. "Pesticide" includes a highly toxic pesticide.

3) Oil and gas products: Colorado passed a law (HB22-1345) that bans the sale or distribution of multiple product categories with PFAS, including oil and gas products, starting January 1, 2024. "Oil and gas products” include hydraulic fracturing fluids, drilling fluids and proppants.

4) Coatings, paints and varnishes: The Organisation for Economic Co-operation and Development (OECD), an intergovernmental organization with representatives from 38 industrialized countries, as well as the European Commission, produced a report on coatings, paints and varnishes (CPVs). They conclude that “for the most closely examined uses in CPVs, non-fluorinated alternatives account for a large majority of market share. It is more cost-effective to use the nonfluorinated alternatives and therefore FPs [fluoropolymers] and SC [short-chain] PFASs are typically used only where specific high- performance attributes are sought.” The information in this report and in the European Union’s Universal PFAS Restriction Proposal (see below) show that most if not all PFAS uses in coatings, paints and varnishes are avoidable.

The European Union has proposed an economy wide ban on PFAS, known as the Universal PFAS Restriction Proposal. In Table 9 of Annex XV many product/use categories have received no derogations to the proposed ban, meaning that alternatives have already been identified and the use of PFAS in those products is avoidable. Here we have listed a few examples that are not already included in MN law: metal plating, sterilization gases, PTFE thread sealing tape, window frames, various types of coatings, paints and sealants, and various packaging applications.

9. Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination?

In order to reduce administrative burdens and delay tactics, MPCA should use the broadest reasonable product category in making currently unavoidable use determinations and rely on the determination for the category for any product in the product category. This requires a definition of a “product category”, and we propose the following:

> "Product category" means a group of similar products that are used for a similar purpose and that could functionally replace each other for that purpose, as determined by the department, and does not mean a specific variation within a product. For example, pants, insulation, and cookware are each a product category whereas stain resistant pants, spray insulation, and nonstick cookware are specific variations of products within those product categories.

In using the broadest reasonable product category in making its determination, the department need not be overly limited by exceptions. Instead, the department could identify exclusions from a product category, if appropriate.

We would be happy to discuss any of the information provided in our comments. For further details, please contact:

Avi Kar, Senior Director, Toxics, Environmental Health (akar@nrdc.org)
Anna Reade, PhD, Director, PFAS Advocacy, Environmental Health (areade@nrdc.org)
Katie Pelch, PhD, Scientist, Environmental Health (kpelch@nrdc.org)

RECEIVED
By: OAH on 2/29/2024

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29 February 2024

Minnesota Pollution Control Agency

Sent via website to https://minnesotaoah.granicusideas.com

RE: Request for Comments: Planned new Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID number R-4837.

Dear Minnesota Pollution Control Agency:

PSG® writes to express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. PSG therefore seeks Currently Unavoidable Uses consideration from the Minnesota Pollution Control Agency. It's important to acknowledge that certain PFAS play a vital role in ensuring product functionality in critical applications in order to meet stringent safety standards.

PSG is the global pump, metering and dispensing-solution expert, enabling the safe and efficient transfer of critical and valuable fluids that require optimal performance and reliability in applications where it matters most. Additionally, PSG is a leading provider of flow meters designed to reduce waste and downtime while accurately measuring, monitoring and controlling the distribution of fluids. Headquartered in Oakbrook Terrace, IL, USA, PSG is comprised of several world-class brands, including Abaque®, All-Flo™, Almatec®, Blackmer®, Ebsray®, em-tec®, Griswold®, Hydro™, Malema™, Mouvex®, Neptune®, PSG® Biotech, Quantex™, Quattroflow®, and Wilden®. PSG products are manufactured on three continents – North America, Europe and Asia – in state-of-the-art facilities that practice lean manufacturing and are ISO-certified.

PSG manufactures and provides pumps, flows meters, and flow control devices that use certain fluoropolymer PFAS, primarily due to the fact that these materials are suitable to function in a broad temperature range (from very cold to very hot), are chemically compatible with a wide range of substances that are caustic and hazardous, provide seals to prevent hazardous or caustic materials from escaping into the environment while they are being produced, transferred, and used, are wear and gall resistant, are used for cleanliness and reduced particle generation, and are able to provide process critical lubrication. Uses are ubiquitous and are vital to the essential needs of society. Some example applications include:

1. The transfer of fuels (such as gasoline, diesel, home heating oil, etc...) at various stages of the supply chain: transfer from the refinery to the storage facility to the truck to the end customer tank. Critical to transportation of people and goods, and the heating of homes.
2. The transfer of liquid propane from tank to truck to customer's tank to provide propane for heating of homes and spaces, and for cooking.
3. The transfer, handling, and dosing of fertilizer and pesticides for agriculture to support the food supply.
4. The transfer of solvents in the chemical industry for the production of paints and coatings, as well as inks for the printing industry.
5. Handling, measuring, and transferring caustic materials used in semiconductor production. Semiconductors are critical elements that enable the miniaturization and functionality of electronic items.
    a. The original cell phones were called "bricks" due to their size and weight, and all they did was make phone calls. Now phones are smaller and more functional, and their multi-functional nature is an underpinning of modern-day society.
    b. Before integrated circuits and semiconductors, computers were the size of multistory buildings and were only found in the military, on university campuses, and at major companies. Now computers are small with exceptional processing power and applied to many daily devices we use.
    c. Electronics are in our cell phones, computers, televisions, automobiles, home appliances, etc., and at the core of home, work, communication, and travel...
6. Handling, measuring, and transferring caustic materials used in Battery manufacturing, which are used to power electric vehicles and other electronic devices.
7. Handling, measuring, dosing management of water, wastewater, and agriculture.
8. Various military applications whose requirements are so stringent that the use of PFAS is the only feasible solution to meet the specifications.

The examples above are compelling, and we are unaware of any materials that are readily available alternatives to the fluoropolymer PFAS used in these applications, among others. Exhibit A, attached, while not exhaustive, provides additional details about the broad range of product and applications.

In line with our commitment to finding balanced solutions, we have worked through our industry associations: Hydraulic Institute, Fluid Sealing Association, Valve Manufacturers Association, the Water and Wastewater Manufacturers Association (a.k.a. Flow Control Coalition) which have developed a comprehensive Currently Unavoidable Uses (CUU) proposal, that is being submitted to the states of Maine and Minnesota. Their proposal, which is separate from this one, is founded upon expert knowledge of the design of critical processes, and incorporates valuable insights gathered from diverse stakeholders including design engineers, end-users and manufacturers of critical system components.

By engaging engineers and experts from the various segments of the fluid handling industry, the Associations have applied a collaborative, systems level approach to this complex issue. Highly corrosive materials, high temperatures, harsh environments, accessibility and life-cycle considerations all are part of the design criteria of the industrial and other process systems which currently require certain PFAS as there are no viable alternatives to handle toxic substances, prevent hazardous leaks and fugitive emissions, ensure clean air and water, etc.

In closing, PSG is respectfully requesting your consideration for our products as you establish Currently Unavoidable Uses for certain PFAS. Please feel free to reach out to me for any additional information that you may require through my contact information below.

Thanks and regards,

Christopher Walsh

Christopher Walsh
Vice President, Engineering & Marketing
Mobile: 331-277-8137
Email: Christopher.walsh@psgdover.com

Exhibit A

2/29/2024

Identification of Currently Unavoidable Uses for PFAS

Product Description	GPC/HTS Code	Use of PFAS	Alternatives
Backflow Preventer Parts / Accessories	10005865	Fluoroelastomer seals	
Backflow Preventers	10005866	Fluoroelastomer seals	
Backflow Test Kits	10005863	Fluoroelastomer seals	
Vacuum Breakers	10005864	Fluoroelastomer seals	
Screw Pumps	10008345	Fluoroelastomer seals Bearing components Flame resistant plastics used in Wiring. Motors and Controllers required to meet UL safety standards.	
Peristaltic/Roller Pumps	10008346	Fluoroelastomer seals Bearing components Flame resistant plastics used in Wiring. Motors and Controllers required to meet UL safety standards.	
Vane Pumps	10008347	Fluoroelastomer seals Bearing components, wear disc, valve coating, magnetic couplings, vanes, push rods Flame resistant plastics used in wiring, Motors and Controllers required to meet UL safety standards.	
Progressive Cavity Pumps	10008348	Fluoroelastomer seals Bearings, stators, joint sealing Flame resistant plastics used in wiring. Motors and Controllers required to meet UL safety standards.	
Gear Pumps	10008349	Fluoroelastomer seals Bearing components Flame resistant plastics used in Wiring. Motors and Controllers required to meet UL safety standards.	
Lobe Pumps	10008350	Fluoroelastomer seals Bearing components Flame resistant plastics used in Wiring. Motors and Controllers required to meet UL safety standards.	
Piston Pumps	10008351	Fluoroelastomer seals Bearing components Flame resistant plastics used in Wiring. Motors and Controllers required to meet UL safety standards.	
Plunger Pumps	10008352	Fluoroelastomer seals Bearing components Flame resistant plastics used in Wiring. Motors and Controllers required to meet UL safety standards.	
Diaphragm Pumps	10008353	Fluoroelastomer seals, valve seats, check valves, diaphrams, pump head components, tubing, valving, pistons, Flame resistant plastics used in cables, wiring, Motors and Controllers required to meet UL safety standards.	
Pneumatics Pumps	10008354	Fluoroelastomer seals Bearing components Flame resistant plastics used in Wiring. Motors and Controllers required to meet UL safety standards.	
Industrial Pumps - Electric Engines	10008355	Fluoroelastomer seals Bearing components Flame resistant plastics used in Wiring. Motors and Controllers required to meet UL safety standards.	
Industrial Pumps – Replacement Parts / Accessories	10008364	Replacement parts would use various PFAS for repair of pumps (seals, components, etc)	
Industrial Pumps - Engines	11030100	Fluoroelastomer seals Bearing components Flame resistant plastics used in Wiring. Motors and Controllers required to meet UL safety standards.	
Industrial Pumps – Replacement Parts / Accessories	11050100	Replacement parts would use various PFAS for repair of pumps (seals, components, etc)	
Pumps	10004055	Fluoroelastomer seals, bearing components, moulded plastic components, Tribologic components, coatings Flame resistant plastics used in cables, wiring, Motors and Controllers required to meet UL safety standards.	
Valves/Fittings - Water and Gas	10004024	Fluoroelastomer seals, valve liners	
Valves/Fittings Accessories/Replacement Parts - Water and Gas	10008011	Includes multiple PFAS materials for replacement/repair. (e.g. bearings, gaskets, compression packings, seals, seats, linings)	
Gaskets - Polymer	3920.10.00.00	Fluoroelastomer seals	
Thread Sealant (Paste)	3403.19.00.00	Fluoropolymer friction reducer critical to NPC piping systems and system sealing	
Thread Sealant (Tape)	3403.19.00.00	Fluoropolymer friction reducer critical to piping systems and system sealing	
EPS (Plastic) Seals	3296.90.45.10	Fluoroelastomer seals	
PTFE Expansion Joints	3917.40.00.90	Temperature and chemical resistance	

PTFE lined Hoses	3917.39.00.10 3917.21.00.00 4009.42.00.50 3917.33.00.00 3917.29.00.90 3917.39.00.50	Temperature and chemical resistance	
ETFE Lined Pipes Valves and Fittings	7306.19.10.50 8481.80.90.50 7307.99.10.00	Temperature and chemical resistance	
PFA Lined Pipes Valves and Fittings	7306.19.10.10 8481.30.20.90 8481.80.30.65 8481.80.30.20 7307.19.90.80 8481.80.90.50	Temperature and chemical resistance	
PVDF lined Pipes Valves and Fittings	7306.19.10.10 8481.30.20.90 7307.19.90.80 8481.80.90.50	Temperature and chemical resistance	
PTFE lined Pipes Valves and Fittings	7306.19.10.10 8481.80.10.90 8481.80.30.30 8481.80.30.75 7307.19.90.80	Temperature and chemical resistance	
Sealants	10003204	Chemical resistance, Gas permeability, Diffusion coefficient	
Adhesives		Chemical resistance, Gas permeability, Diffusion coefficient	
Lubricating Greases	10005268	Long period operation, High temperatures, Low friction/low wear, Good gliding properties, Resistant to aggressive chemicals and reagents	
Lubricating Oils/Fluids	10005267	Long period operation, High temperatures, Low friction/low wear, Good gliding properties, Resistant to aggressive chemicals and reagents	
Lubricating Products Variety Packs	10005270	Long period operation, High temperatures, Low friction/low wear, Good gliding properties, Resistant to aggressive chemicals and reagents	
Lubricating Waxes	10005269	Long period operation, High temperatures, Low friction/low wear, Good gliding properties, Resistant to aggressive chemicals and reagents	

RECEIVED
By: OAH on 3/1/2024
Ian Choiniere Attachment

American Chemistry Council | Center for the Polyurethanes Industry

March 1, 2024

Mary H. Lynn
MPCA
520 Lafayette Road North
St. Paul, Minnesota, 55155-4194

RE: Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

Dear Ms. Lynn,

The American Chemistry Council's Center for the Polyurethanes Industry[1] (CPI) thanks the Minnesota Pollution Control Agency (MCPA) for engaging stakeholders during the rulemaking regarding Products Containing Per-and polyfluoroalkyl substances (PFAS). The Notice of the Request for Comment (Notice) specifically asks for information related to currently unavoidable uses.

Polyurethanes manufacturers and chemical producers have been investing in the transition to low-global warming potential (GWP) foam blowing agents for decades. Since the early 2010s, polyurethanes manufacturers have had access to hydrofluoroolefin (HFO) foam blowing agents. HFO blowing agents provide a significant GWP reduction as compared to earlier generations of blowing agents and have a short atmospheric lifetime. The three primary HFO foam blowing agents used in the polyurethanes sector have ultra-low GWPs using the 100-year basis[2], which is approximately 200-1400 times lower than the substances previously used in the industry. In October 2023, the U.S. Environmental Protection Agency (EPA) published a final rule outlining the federal phaseout of HFC blowing agents with a GWP of over 150.[3] For polyurethane end uses, this phaseout date is January 1, 2025. The only currently available alternative to high-GWP blowing agents like HFCs is HFOs.

1) Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Rather than defining by exact criteria, CPI recommends that the following guiding principles be used to help determine what is a currently unavoidable use:

- **Essential functionality:** Do the products provide critical or essential function in daily lives, society, infrastructure, and critical operations?
- **Lack of Alternatives:** Are there alternatives available that meet technical readiness to fill the gaps from a performance, regulatory, or demand standpoint? Are there reliability or performance concerns that may cause customers to be hesitant to switch?
- **Cost-effectiveness:** Are the benefits of transitioning to alternatives higher than the cost?

[1] The Center for the Polyurethanes Industry's (CPI) mission is to promote the growth of the North American polyurethanes industry through effective advocacy, delivery of compelling benefits messages demonstrating how polyurethanes deliver sustainable outcomes, and creation of robust safety education and product stewardship programs.
[2] Fifth Assessment Report, Intergovernmental Panel on Climate Change
[3] 88 FR 88825

- **Compatibility:** Where products are integrated into existing systems or processes, would transitioning or obsolescence require substantial capital investment, disruption, socioeconomic or other issues?
- **Regulatory Compliance:** Are these products necessary to meet legal or regulatory compliance obligations?
- **Safety and Security:** Are these products crucial for ensuring safety or security?

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Costs of PFAS alternatives should be considered in the definition of "reasonably available." As mentioned earlier, the benefits of transitioning to an alternative should outweigh the costs associated with the transition. MPCA should look at not only the performance benefits of transitioning to alternatives, but the safety benefits as well. MPCA should weigh the tradeoffs in performance and safety, in addition to the monetary costs associated with transitioning to alternatives to ensure that necessary products remain in commerce in the state of Minnesota.

3.) Should unique considerations be made for small businesses with regards to economic feasibility?

Yes, considerations should be made for small businesses with regards to economic feasibility. Changing to alternatives can increase the cost of products that can impact small businesses' ability to conduct business in an affordable manner. For example, changes in the blowing agents used in spray foam can impact the price of spray foam. Applicators of spray foam are generally small businesses, and changes in price stemming from changes to the formula could impact their ability to remain in business.

4) What criteria should be used to determine the safety of potential PFAS alternatives?

Instead of creating new criteria for PFAS alternatives, MPCA should look to federal programs that are already in place. For example, EPA's Significant New Alternatives Policy (SNAP) Program has reviewed environmental fate data on HFO foam blowing agents for acceptability as approved alternatives to previous generation materials. By deeming HFO foam blowing agents "acceptable," EPA has determined that HFO foam blowing agents "reduce overall risk to human health and the environment compared to other substitutes for the particular end-use."[4] Additionally, HFO foam blowing agents are not classified as persistent, bioaccumulative, or toxic (PBT). The HFOs used as foam blowing agents have atmospheric lifetimes measured in days and are designed to readily breakdown in the atmosphere if released, forming compounds that occur naturally in the environment.[5]

5) How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

Currently unavoidable use determinations should last indefinitely, until there is an alternative that is proven to be cost-effective, safe, and provides similar performance to the original product and, if applicable, deemed an acceptable alternative by federal regulatory programs already in place.

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[4] Final Rule, Protection of Stratospheric Ozone: Listing of Substitutes Under the Significant New Alternatives Policy Program in Refrigeration, Air Conditioning, and Fire Suppression, 88 Fed. Reg. 26382, 26414 (Apr. 28, 2023).

[5] ECHA PBT Assessment List. Available at: https://echa.europa.eu/fi/pbt

As previously mentioned, MPCA should reference EPA's SNAP Program for alternatives to blowing agents. Many of these federal programs go through years-long, thorough, and rigorous regulatory processes to determine the performance and safety of new alternatives. Another example is the Federal Trade Commission's (FTC) R-Value rule. The FTC only reopens the R-Value rule every 10 years.

6) How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

As mentioned above, products that are already governed by existing federal and state regulations should qualify as being designated currently unavoidable uses. Stakeholders whose products are already governed should not need to be considered for currently unavoidable use, as they are already considered a currently unavoidable use by existing regulations. A technical advisory committee should be established to determine currently unavoidable uses if the products are not already governed by existing regulations.

To the second question, conversely, no, stakeholders should not be able to request a PFAS use not be determined as a currently unavoidable use.

To the third question, information to be considered when submitting a request should address the guiding principles mentioned in response to question 1.

7) In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

Blowing agents like HFOs and HFC blends with a GWP under 150 should be considered currently unavoidable uses. These products have already been evaluated by EPA's SNAP Program, which has deemed HFO blowing agents as an acceptable alternative to high-GWP blowing agents.

Additionally, these blowing agents are used in spray foam insulation, which provide copious economic and environmental benefits by reducing the energy needed to heat and cool buildings. This, in turn, reduces the greenhouse gas emissions associated with heating and cooling and reduces utility costs.

Intended Use of Spray Foam

Spray polyurethane foam is used to insulate and air seal residential and commercial buildings, as well as provides a moisture barrier. The air barrier provided by spray foam prevents unwanted air flow caused by cracks and gaps. This keeps the internal temperature of the building envelope more consistent and reduces the energy needed to heat and cool. This reduces energy costs, carbon emissions, and HVAC load. These qualities make spray foam integral to helping Minnesota achieve its climate goals.[6,7,8]

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6 https://www.revisor.mn.gov/laws/2007/0/Session+Law/Chapter/136/?keyword_type=exact&keyword=The+Next+Generation+Energy+Act

7 https://climate.state.mn.us/sites/climate-action/files/Climate%20Action%20Framework.pdf

8 https://www.pca.state.mn.us/air-water-land-climate/climate-change-initiatives

As much as 40% of a building's energy is lost due to air infiltration. Gaps, holes and air leaks—which can all be prevented—can make energy bills unnecessarily high and let valuable resources go to waste. Spray foam offers a solution: it weatherizes homes acting as both insulation and an air sealant, or air barrier, closing those nooks and crannies that let air escape and increase monthly energy bills. EPA's Energy Star program estimates that by adding insulation and sealing air leaks, homeowners could save up to 20% on their monthly energy bills.[9]

Essentiality of HFOs to Spray Foam

Blowing agents are necessary for polyurethane foam to expand and develop a cellular structure. HFO blowing agents, specifically, are integral to spray polyurethane foam, as they provide thermal resistance and are affordable. Additionally, HFO foam blowing agents are not classified as PBT. The HFOs used as foam blowing agents have atmospheric lifetimes measured in days and are designed to readily breakdown in the atmosphere if released, forming compounds that occur naturally in the environment.[10]

Environmental fate data on the HFO foam blowing agents were reviewed under Section 612 of the Clean Air Act (CAA) – EPA's SNAP Program – for acceptability as approved alternatives to previous generation materials. By deeming HFO foam blowing agents "acceptable," EPA has determined that HFO foam blowing agents "reduce overall risk to human health and the environment compared to other substitutes for the particular end-use."

Additionally, in the preamble of the final rule regarding HFOs in refrigerant end uses, EPA stated:

> Regardless of what definition of PFAS is used, not all PFAS are the same in terms of toxicity or any other risk. Some PFAS have been shown to have extremely low toxicity, for example. If a chemical has been found to present lower overall risk to human health or the environment, it might be found acceptable under SNAP regardless of whether or not it falls under a particular definition of PFAS. Likewise, SNAP might not find a potential alternative acceptable if it presented greater overall risk, regardless of whether or not it falls under a particular definition of PFAS. As described in the risk screens for alternatives found in the docket for this rulemaking, potential risk to human health or the environment has been considered directly for each chemical, and the risks are not assumed to follow from a chemical falling into any particular category of substances.[11]

The American Innovation and Manufacturing (AIM) Act, which was signed into law at the end of 2020, implements the phasedown of HFC blowing agents. HFO blowing agents are a preferred alternative to HFCs and are already playing an important role in supporting EPA's climate goals under the AIM Act. By requiring the reporting and eventually banning of HFO blowing agents, per the overly broad PFAS definition in the Minnesota's PFAS in Products legislation, Minnesota PCA is restricting the use of an alternative to high-GWP blowing agents and undermining EPA's climate goals in the AIM Act.

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[9] Methodology for Estimated Energy Savings from Cost-Effective Air Sealing and Insulating, EPA Energy Star
[10] ECHA PBT Assessment List. Available at: https://echa.europa.eu/fi/pbt
[11] 88 Fed. Reg. 26382 at 26414

Alternatives to HFOs

As of now, there are currently no alternatives to HFOs on the market. HFCs would be the closest alternative; but, as mentioned above, are currently being phased out under the AIM Act's Technology Transition rule. Other potential alternatives to HFOs, like pentane, have flammability risks associated with them and are deemed unacceptable by the United Nations Foam Technical Options Committee (UN FTOC)[12] [13].

8) Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

As previously stated, MPCA should rely heavily on existing regulations to make these determinations. Ultra-low GWP blowing agents like HFOs have already been extensively studied by EPA's SNAP Program to determine the overall risk to human health and the environment and have been determined as an acceptable alternative. Taking into consideration determinations made at a federal level will greatly assist MPCA in determining actual chemicals of concern instead of overly broad approaches to regulating chemical families.

Conclusion

MPCA should develop a set of guiding principles to determine if a product is a currently unavoidable use. Additionally, MPCA should heavily consider the environmental, health and safety, performance, and monetary cost of an alternative compared to its benefits when determining whether or not a product meets the definition of a currently unavoidable use. MPCA should rely on current federal regulations and programs to assist with making these determinations.

If you have any questions or need additional information, please contact me at Ian_Choiniere@americanchemistry.com or (202) 249-6424.

Sincerely,

Ian Choiniere
Director
Center for the Polyurethanes Industry

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[12] UNEP September 2016 Report of the Technology and Economic Assessment Panel Volume 1, Pg 112 (& 2014 report Volume 4, pg 35)
[13] Rigid and Flexible Foams Technical Options Committee 2018 Assessment Report, UNEP, ISBN: 978-9966-076-57-1 page 11, 24, and 30-31

Scott Armstrong Attachment 1 RECEIVED
By: OAH on 3/1/2024

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Industry PFAS CUU Project

PFAS Currently Unavoidable Uses Proposals (CUU) Fifty-three (53) Proposals

Submission by Industry

This document is the guidance document to fifty-three (53) PFAS Currently Unavoidable Uses proposals being submitted by industry. Each CUU proposal is separate, but listed together in an orderly fashion for clarity and the convenience of regulators. Most of the proposals are for widespread uses of PFAS. These uses span across all industry segments and were included together. If required, they can be separated, but they would create between 300 and 400 separate proposals for regulators to review (for the 53 fundamental uses).

The Industry PFAS CUU project is made up of >50 companies that span consumer, professional, medical, industrial, and laboratory uses of PFAS. The CUUs listed here are based on very detailed work by each member of the project combined with tens of thousands of parts tested by Claigan Environmental in 2023 and 2024.

This submission should be the most comprehensive list of Currently Unavoidable Uses in physical products (articles), with detailed justifications and comparisons of alternatives.

The full CUU proposals and justifications are listed in detail in the accompanying spreadsheet PFAS Currently Unavoidable Uses Proposals - Feb 2024.xlsx.

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Table of Contents

1. Summary

This report is a submission by Claigan Environmental Inc. (Claigan) on behalf of the Industry PFAS Submission Project ("PFAS Submission Project"). The PFAS submission project is made up of 50+ companies from a wide range of industries (consumer, professional, industrial, medical, oil and gas, laboratory equipment, textiles, electronic components, and retail sales.)

The PFAS Submission Project is focused primarily on the needs of complex products (articles). Claigan is both a restricted materials consultancy and a high-volume restricted materials testing laboratory. Each of the PFAS Submission Project submissions are based on contributions from all major sectors of industry, and 2023 and 2024 PFAS testing data from tens of thousands of parts.

The detailed justification of each CUU is covered in the accompanying spreadsheet PFAS Currently Unavoidable Uses Proposals - Feb 2024.xlsx.

Each CUU entry includes

- A brief description of the Currently Unavoidable Use of PFAS
- A brief description of the type of product including industries and example products with HTS codes.
- A description of the intended use of the product and explanations on how it is essential for health, safety, or the functioning of society.
- A description of how the specific use of PFAS in the product is essential to the function of the product. If this use of PFAS is required by federal or state law or regulation, citations will be provided for that requirement.
- A description of whether there are reasonably available alternatives for this specific use of PFAS.
- Plus
    - Whether the PFAS use includes PFOA or Long Chain Perfluoroalkyl Carboxylic Acids (LC-PFCA). Many of these PFAS uses do not include (nor degrade into) any PFAS found in drinking water and humans.

- PFOA / LC-PFCA presence is based on tens of thousands of parts tested in 2023 and 2024.

Important note 1 - due to the short timeline for the PFAS Currently Unavoidable Use consultation, each justification is only in brief with a detailed comparison of alternatives. Each justification can be further elaborated upon if needed.

Important note 2 - the regulation of chemical substances in medical devices is governed by the FDA. It is generally assumed that this preempts restrictions of PFAS in medical devices under state regulation, "A product for which federal law governs the presence of PFAS in the product in a manner that preempts state authority". However, for completeness and until this question is fully solved, currently unavoidable uses of PFAS in medical devices are also included in this submission.

Important note 3 - The States of Maine and Minnesota adopted a broad definition for PFAS substances. The vast majority of PFAS substances, as defined by Maine and Minnesota, that are found in products are not found in the environment. The broad definition impacts PFAS use in multiple categories of products and equipment needed to make products. PFAS substances are used in these applications because they have unique properties that impart specific performance characteristics making them essential to a product's function. The accompanying spreadsheet provides a detailed comparison of fluoropolymer, fluoroelastomer, and alternative materials for each application. The reason for the use of the fluoropolymer or fluoroelastomer is generally fairly obvious when you look at the application and the alternatives.

2. Related documents

2.1. PFAS Currently Unavoidable Uses Proposals spreadsheet - Industry PFAS Submission Project

2.1.1. PFAS Currently Unavoidable Uses Proposals - Feb 2024.xlsx

3. Definitions

3.1. ***Currently Unavoidable Use of PFAS (CUU)*** - a use of PFAS that is essential for the health, safety, or functioning of society and for which alternatives are not reasonably available.

3.2. ***Widespread Use*** -

3.2.1. For essential uses of a PFAS-containing product, uses that are very high volume with widespread use are identified.

3.2.1.1. For example - fluoroelastomers and perfluoroelastomers have very widespread use in professional/industrial products (> 10M products per year sold in the US).

3.2.2. **For consumer uses** - Over 100 Million products sold in the US each year use this Currently Unavoidable Use of PFAS, or

3.2.3. **For industrial uses (including professional uses)** - Over 10 Million products sold in the US each year use this Currently Unavoidable Use of PFAS.

3.3. ***Forever chemicals***

3.3.1. *Substances that are either*

3.3.1.1. ***vPvB*** - Very persistent and very bioaccumulative

3.3.1.2. ***PBT*** - Persistent, bioaccumulative, and toxic

3.4. ***Machinery***

3.4.1. *Machinery includes all aspects of machinery including (but not limited to) manufacturing, construction, clean energy, water treatment, and forestry*

3.5. ***Laboratory***

3.5.1. *Laboratory includes all aspects of laboratory equipment including (but not limited to) water testing, life sciences, research and development, and medical testing.*

4. Key notes

4.1. Importance of PFAS

4.1.1. > 500 million products containing PFAS are sold in the US each year

4.1.2. Banning PFAS would eliminate

4.1.2.1. Laptops

4.1.2.2. The internet (unless servers are moved offshore)

4.1.2.3. Food processing

4.1.2.4. Water processing and treatment

4.1.2.5. Forestry

4.1.2.6. Life sciences

4.1.2.7. Oil and gas industry

4.1.2.8. Heart surgeries and biopsies

4.1.3. Banning PFAS without exception for Currently Unavoidable Uses would likely create the largest recession in the history of the United States.

4.2. Sources PFOA / LC-PFCA in Products

4.2.1. Most fluoropolymers and virtually all fluoroelastomers do not contain PFOA or LC-PFCA

4.2.2. The follow sections are based on 2022 - 2024 testing of products for PFOA / LC-PFCA and include explanation of how these substances are formed in very specific situations.

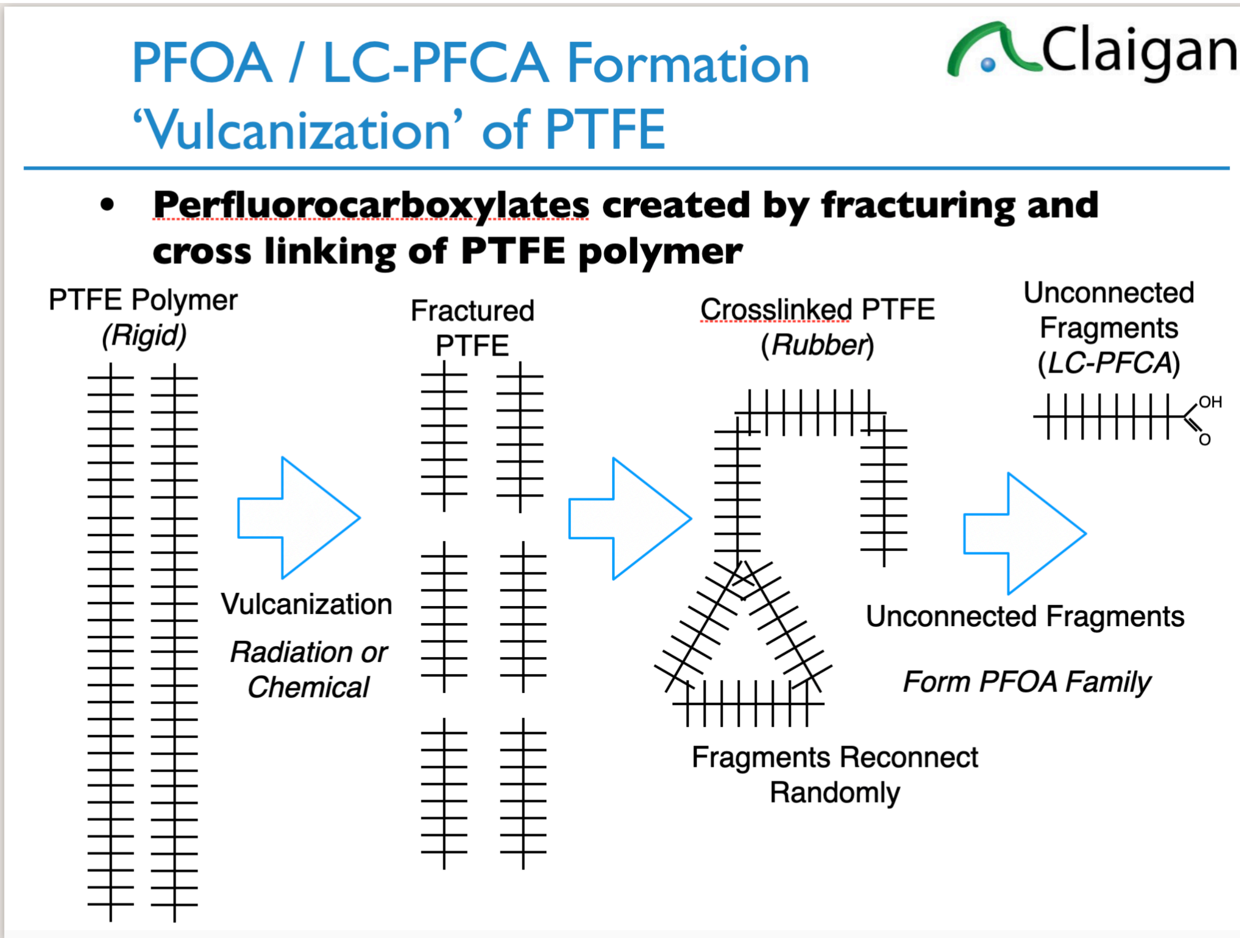
4.2.3. **Cause #1** of unintentional PFOA / LC-PFCA - Formation of LC-PFCA during vulcanization of rigid PTFE (or PVDF) into cross-linked rubber

4.2.3.1. Vulcanization / crosslinking of PTFE involves

4.2.3.1.1. Fracturing of long rigid PTFE polymer through radiation or chemical means

4.2.3.1.2. Reconnecting of fragments of PTFE in random directions (creating rubber instead of rigid polymer)

4.2.3.1.3. Some fragments react instead with air and create random sizes of perfluorocarboxylates.



4.3. **Cause #2** of unintentional PFOA / LC-PFCA - PFAS polymers (such as PFA or fluoroacrylates) that have a fluoromonomer side chain with a fragile C-O-C (carbon-oxygen-carbon) bond.

4.3.1. Formation of perflluorocarboxylates

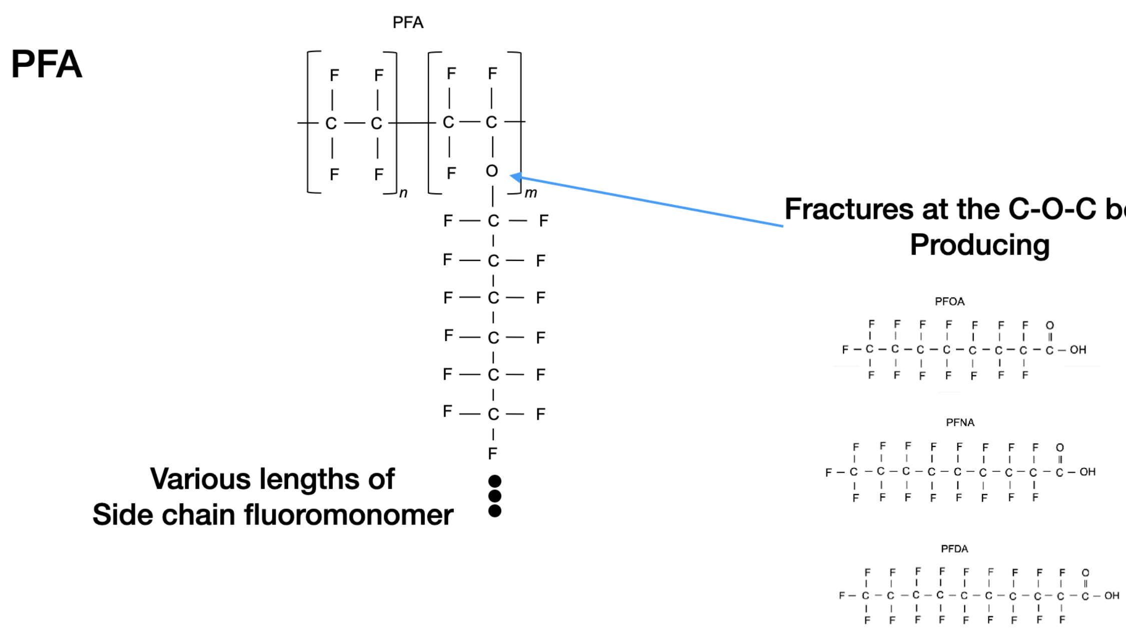
4.3.1.1. Fragile C-O-C bonds fracture during initial manufacturing and over time.

4.3.1.2. Fluoromonomer fragments are ‘fluorotelomers’, PFOA-like molecules with an extra 2 carbon hydrogens (such as 8:2 FTOH).

4.3.1.3. The fluorotelomer fragments react with air and water to slowly form perfluorocarboxylates

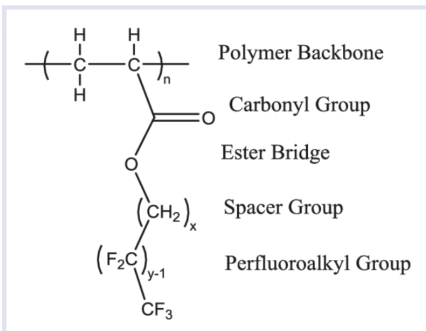
4.3.1.4. The lengths of eventual perfluorocarboxylates depend on the lengths of side chain monomers on the original PFA or fluoroacrylate polymer.

Formation of PFOA / LC-PFCA
PFA (Perfluoroalkoxy Alkane Polymer)

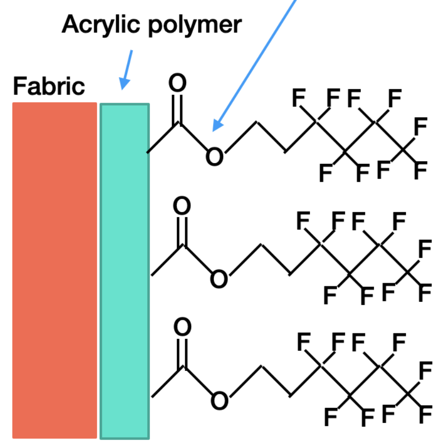


PFOA / LC-PFCA Formation Fluoroacrylates

- Fluoroacrylates have a 'side chain polymer'
  - Acrylic or other polymer
    - With chains of PFAS extending from polymer
    - *PFOA may be present as an impurity from PFAS side chain*
  - Example - water repellant coatings



Side chain PFAS



Side Chain PFAS

4.4. Perfluorocarboxylates and Perfluorosulfonates Found in Fluoropolymers and Fluoroelastomers

4.4.1. Presence of perfluorocarboxylates and perfluorosulfonates

4.4.2. 2022 to 2024 testing data by Claigan Environmental

Comparison	PTFE	PVDF	ETFE	Crosslinked PTFE	ePTFE	PFA	Fluoroelastomers	Fluoroacrylates	Fluorophosphates
Short Chain Perfluorocarboxylates (C4-C7)	Never	Never	Never	Commonly	Commonly	Commonly	Commonly	Commonly	Commonly

Long Chain Perfluorocarboxylates (C8-C14)	Never	Never	Never	Commonly	Commonly	Commonly	Never	Commonly	Commonly
Short Chain Fluorotelomers (C4-C7)	Never	Never	Never	Never	Never	Never	Never	Commonly	Commonly
Long Chain Fluorotelomers (C8-C14)	Never	Never	Never	Never	Never	Never	Never	Commonly	Commonly
Short Chain Fluoroacrylates (C4-C7)	Never	Never	Never	Never	Never	Never	Never	Commonly	Never
Long Chain Fluoroacrylates (C8-C14)	Never	Never	Never	Never	Never	Never	Never	Commonly	Never
Short Chain Fluorosulphonates (C4-C7)	Never	Never	Never	Never	Never	Never	Never	Never	Never
Long Chain Fluorosulphonates (C8-C14)	Never	Never	Never	Never	Never	Never	Never	Never	Never
Short Chain Fluorotelomer Sulphonates	Never	Never	Never	Never	Never	Never	Commonly	Never	Never
Long Chain Fluorotelomers Sulphonates	Never	Never	Never	Never	Never	Never	Never	Never	Never

4.5. PFAS in Drinking Water and Humans

4.5.1. From this project and related testing data

4.5.1.1. ~99% of PFAS found in drinking water and humans is from <0.1% of products (primarily legacy fire extinguisher fluid and legacy foundation/concealer (C9-C15 fluoroalkyl phosphate in personal care products)).

4.5.1.2. ~99.99% of PFAS found in drinking water and humans is from <1% of products (a slight additional contribution from washing of waterproof fabrics contain fluoroacrylates).

4.5.1.3. The average silicone part has 100X more forever chemicals than the worst fluoropolymer (ePTFE). 200 ppm vs 2 ppm.

4.5.1.4. Based on ISO 10993-18 medical biocompatibility testing: Silicone, ABS, polystyrene, PVC, nylon, and polyurethane leak more dangerous chemicals into humans than fluoropolymers

4.5.1.5. Fluoropolymers are used because they are safer and more effective than their alternatives.

4.6. PFAS and Drinking Water - Kentucky 2023 PFAS testing of all drinking water sites

4.6.1. Kentucky 2023 drinking water sites testing

4.6.1.1. https://eec.ky.gov/Environmental-Protection/Water/Reports/Reports/2023-PFASFinishedDrinkingWaterResults.pdf

4.6.1.2. Kentucky was chosen because

4.6.1.2.1. Modern data (2023)

4.6.1.2.2. Comprehensive PFAS testing of each drinking water site

4.6.2. Sources of PFAS in drinking water

4.6.2.1. Based on the comparison of drinking water testing results and laboratory testing results of products

4.6.2.2. Legacy fire fighting foam

4.6.2.2.1. Fire fighting foam that uses C8 fluoro surfactants

4.6.2.2.2. Generally phased out of products a decade ago

4.6.2.2.3. Testing characteristic

4.6.2.2.3.1. Always - PFOS

4.6.2.2.3.2. Majority of situations - PFOA

4.6.2.2.3.3. Would not have - PFNA or PFDA (higher-length PFOA substances)

4.6.2.3. Modern fire fighting foam

4.6.2.3.1. Fire fighting foam that uses C4 or C6 fluoro surfactants

4.6.2.3.2. Common in modern fire fighting foam

4.6.2.3.3. Testing characteristic

4.6.2.3.3.1. Always - at least one of 6:2 FTS, PFHxS, PFBS

4.6.2.3.3.2. Majority of situations - PFHxA, PFBA

4.6.2.3.3.3. Would not have - PFOS, PFOA, PFNA, or PFDA

4.6.2.4. Cosmetics (Foundation and Concealer)

4.6.2.4.1. Foundation and concealer using C9-C15 Fluoroalkylphospate

4.6.2.4.1.1. Degrades over time into high concentration of PFOA, PFNA, and PFDA

4.6.2.4.2. Phased out in 2021/2022

4.6.2.4.3. Testing characteristic

4.6.2.4.3.1. Always - PFNA and PFDA (PFDA not included in Kentucky testing)

4.6.2.4.3.2. Majority of situations - PFOA

4.6.2.4.3.3. Would not have - PFOS or any sulphonate, or short-length fluoro carboxylates (PFBA, PFPeA, PFHxA).

4.6.2.5. Physical products

4.6.2.5.1. Primarily fluoroacrylate coatings of water-resistant fabric

4.6.2.5.1.1. Would release all lengths of perfluorocarboxylic acids during washing in detergent.

4.6.2.5.2. Common today

4.6.2.5.3. Testing characteristic

4.6.2.5.3.1. Always - All lengths of perfluorocarboxylates from PFBA to PFDA.

4.6.2.5.3.2. Would not have - PFOS or any sulphonate.

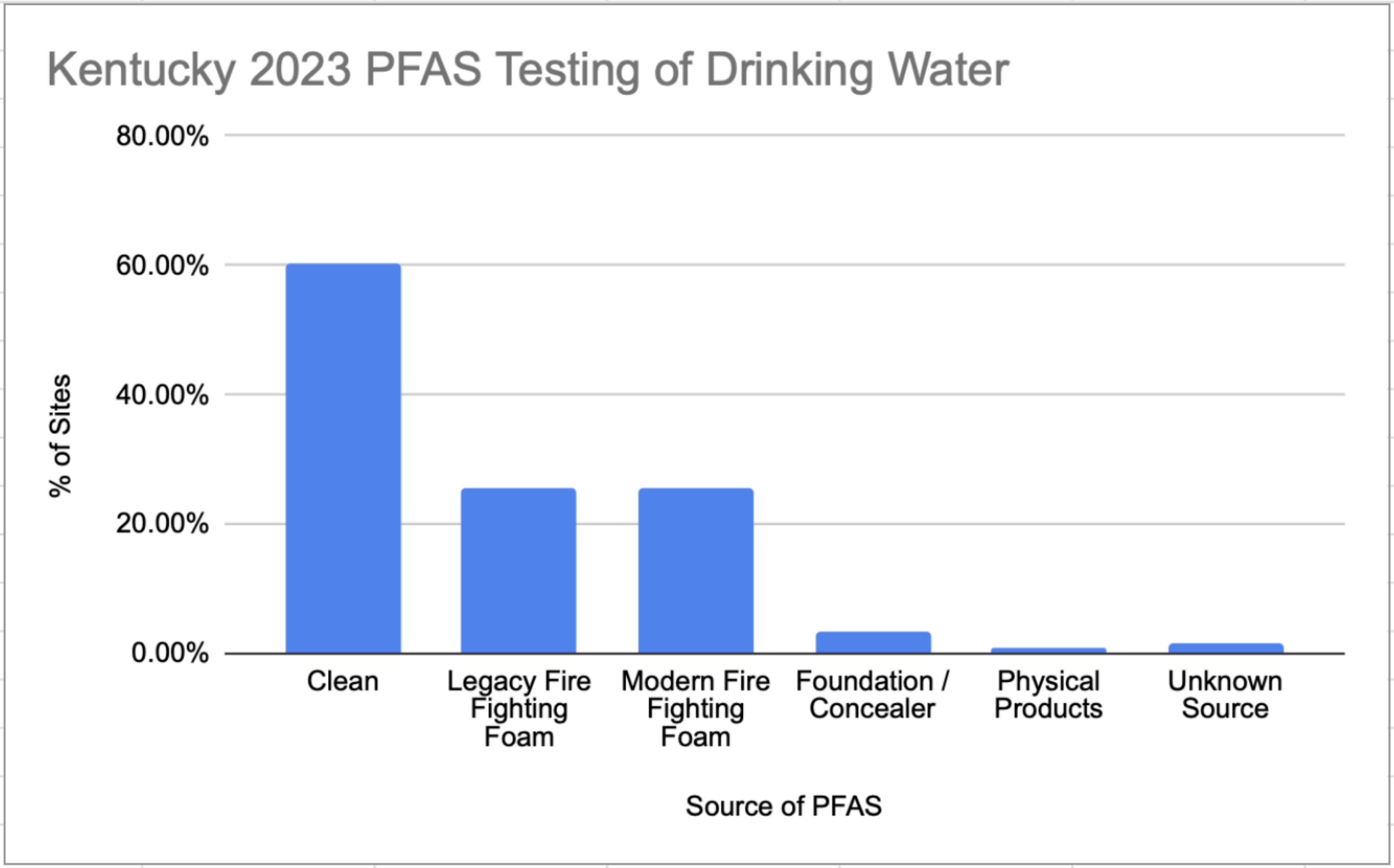
4.6.2.6. Unknown

4.6.2.6.1. Testing results from water are not consistent with any known product.

4.6.3. Chart of Projected Sources of PFAS in 2023 Kentucky drinking water site testing

4.6.3.1. 113 sites tested in Kentucky in 2023

4.6.3.2. Note - some sites could be listed under more than one source. The total should be above 100%


Kentucky 2023 PFAS Testing of Drinking Water
80.00%
60.00%
40.00%
20.00%
0.00%
% of Sites
Clean
Legacy Fire Fighting Foam
Modern Fire Fighting Foam
Foundation / Concealer
Physical Products
Unknown Source
Source of PFAS

5. PFAS Currently Unavoidable Uses

5.1. The full details are contained in the accompanying spreadsheet PFAS Currently Unavoidable Uses Proposals - Feb 2024.xlsx.

5.1.1. The comparisons are too large and detailed for a Word document and are instead summarized in an Excel file.

5.2. This document features several tabs with tables containing details about ***CUU's***.

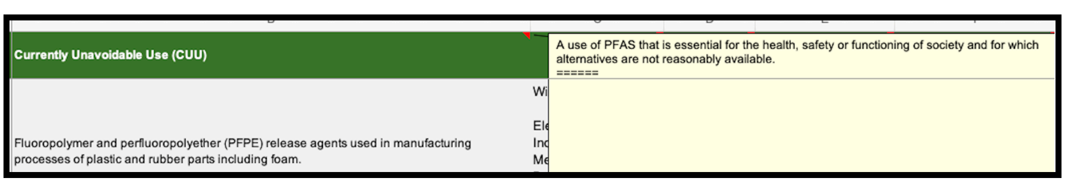
5.2.1. The CUU tab provides details about the specific ***CUU's*** as well as where and why they are specifically used.

5.2.2. The remaining tabs are the Alternative tabs. They provide the evaluation of alternative materials across a range of criteria applicable to the relevant use, which is labelled on the tab at the bottom of the document.

5.3. The core data is found within the tables, while further explanatory notes are found in the applicable column and row headers.

5.4. Cells with a red triangle in the top right corner have additional information pertinent to their respective row or column. They are found in Row 1 of the CUU tab and Column A of the Alternatives tabs. For example:

5.5. Additional details are revealed by hovering the mouse cursor over the cell (without clicking it). For example:



5.6. Additionally, this same information is captured in the document below.

6. Explanation of Currently Unavoidable Use (CUU) Proposal Tab

6.1. Columns A and B (CUU Number and Description) provide the numbering and descriptions for each ***CUU***.

6.2. Column C (Products) provides an overview of the applicable product families that require the listed Currently Unavoidable Use.

6.3. Column D (HS Codes) provides a list of HS Codes of products that require the listed ***CUU***. Some uses are so pervasive that the entire HS Code (Customs Code) chapters are listed.

6.4. Column E (Example Products) details a list of example products that require the applicable ***CUU.*** This list is representative and is not intended to be exhaustive.

6.5. Column F (Essential Use of Product) describes the intended use of the product and explains how it is essential for health, safety, or the functioning of society. It also describes if products using this CUU are ***Widespread*** or ***Industrial***.

6.6. Column G (Essential Use of PFAS) describes how the specific use of PFAS in the product is essential to the function of the product.

6.7. Column H (Comparison of Alternatives) describes reasonably available alternatives for this specific use of PFAS and compares them to the applicable ***CUU***. For further details, refer to the relevant Alternatives tab.

6.8. Column I (PFOA) identifies if this CUU contains any PFOA or Long Chain Perfluoroalkylcarboxylates (LCPFCAs). This column is based on 2023 and 2024 testing data of hundreds of representative parts for PFOA and LC-PFCAs.

6.9. Column J (Alternatives Tab) provides a direct link within the document to the identified tab comparing the performance of PFAS materials and alternative materials.

7. Alternatives Tabs

7.1. Row 1 (Comparison) identifies the alternative materials being evaluated.

7.2. Low Friction

7.2.1. Excellent - The material has a low coefficient of static friction. It is nearly frictionless.

7.2.2. Decent - The material has a lower coefficient of static friction but has some friction in use.

7.2.3. Poor - The material has a high coefficient of static friction. It displays strong friction during use and is not suitable for applications requiring low friction.

7.3. ***Chemical Resistance*** - the resistance to acids or bases may not be uniform for a material. The rating reflects the general potential applications of the material

7.3.1. Excellent - The material has superior resistance to acids and bases. Acid and bases have no discernible effect on the material.

7.3.2. Decent - The material is resistant to acids and bases but does exhibit some degradation. It should not be in extended contact with, or subject to, high concentrations of acids or bases.

7.3.3. Poor - The material is not resistant to acids and/or bases.

7.4. Water Resistance

7.4.1. Excellent - The material is hydrophobic (*i.e.* it is impermeable to water even as a coating).

7.4.2. Decent - The material is resistant to water, but not completely hydrophobic or waterproof.

7.4.3. Poor - The material is permeable to water.

7.5. Oil Resistance

7.5.1. Excellent - The material is oleophobic (*i.e.* it is impermeable to oil even as a coating).

7.5.2. Decent - The material is resistant to oil, but not completely oleophobic, oil-proof, or stain-resistant.

7.5.3. Poor - The material is permeable to oil.

7.6. Temperature Resistance

7.6.1. Excellent - The material can withstand temperatures above 150°C.

7.6.2. Decent - The material can withstand temperatures above 100°C, but is impacted by temperatures above 150°C.

7.6.3. Poor - The material is impacted by temperatures above 100°C.

7.7. Fire Resistance

7.7.1. Excellent - The material meets stringent fire/flame resistance standards.

7.7.2. Decent - The material has fire/flame resistance but does not meet the most stringent standards.

7.7.3. Poor - The material is not fire/flame resistant.

7.8. Flexibility

7.8.1. Excellent - The material exhibits good flexibility and is useful in most applications requiring flexibility.

7.8.2. Decent - The material has some rigidity, but still exhibits some flexibility.

7.8.3. Poor - The material is rigid and is not suitable for applications requiring flexibility.

7.9. Forever Chemicals (Initial)

7.9.1. Excellent - The material does not contain any substances with an EU harmonized classification of vPvB or PBT after manufacturing.

7.9.2. Decent - The material contains trace amounts (<1 ppm) of substances with an EU harmonized classification of vPvB or PBT after manufacturing.

7.9.3. Poor - The material contains amounts (> 1ppm) of substances with an EU harmonized classification of vPvB or PBT after manufacturing

7.10. Forever Chemicals (Over Time)

7.10.1. Excellent - The material does not degrade into substances with an EU harmonized classification of vPvB or PBT.

7.10.2. Decent - The material degrades lightly into substances (<1 ppm) with an EU harmonized classification of vPvB or PBT over time.

7.10.3. Poor - The material degrades into substances (> 1ppm) with an EU harmonized classification of vPvB or PBT over time.

7.11. Bio-compatibility

7.11.1. Excellent - The material passes US FDA and EU MDR biocompatibility testing and does not normally require toxicological justification.

7.11.2. Decent - The material passes US FDA and EU MDR biocompatibility testing but often requires toxicological justification.

7.11.3. Poor - The material does not generally pass US FDA or EU MDR biocompatibility testing or it requires significant toxicological justification.

7.12. Insulation

7.12.1. Excellent - The material has a low dielectric constant and is suitable for most insulating or electronics purposes.

7.12.2. Decent - The material has a medium dielectric constant and is only suitable for some insulating or electronics purposes.

7.12.3. Poor - The material has a high dielectric constant and is not normally suitable as an insulating material in electronics.

7.13. High-Density Applications

7.13.1. Excellent - The material is usable in applications requiring thin layers or high density.

7.13.2. Decent - The material is usable in applications that do not require thin materials, but it is not suitable for very fine or dense applications.

7.13.3. Poor - The material is not feasible as a thin film or in high-density applications.

7.14. Polymer Additive

7.14.1. Excellent - The material can be added to a wide range of polymers to provide additional properties.

7.14.2. Decent - The material can be added to some polymers to provide some level of additional properties.

7.14.3. Poor - The material is not suitable as a polymer additive.

7.15. Porous

7.15.1. Excellent - The material is permeable to air.

7.15.2. Decent - The material is partially permeable to air but is resistant to airflow.

7.15.3. Poor - The material is not permeable to air.

7.16. Durability

7.16.1. Excellent - The material has superior resistance to wear.

7.16.2. Decent - The material is partially resistant to wear but is not suitable for high-wear situations.

7.16.3. Poor - The material is not suitable for situations where wear resistance is required.

7.17. Optical Transparency

7.17.1. Excellent - The material is optically transparent.

7.17.2. Decent - This material has some optical transparency but is not suitable for applications requiring clarity and high transparency.

7.17.3. Poor - This material is not normally optically transparent

7.18. Structural

7.18.1. Excellent - The material is rigid with the ability to support its weight and any weight of the fluid it is transporting. It also has superior fatigue resistance.

7.18.2. Decent - The material can support its weight, but it is not as reliable for additional weight or fatigue.

7.18.3. Poor - The material cannot rigidly support its weight.

7.19. Radiation Resistance

7.19.1. Excellent - The material has superior resistance to gamma and e-beam radiation and does not exhibit degradation due to radiation.

7.19.2. Decent - The material has some resistance to gamma and e-beam radiation but exhibits degradation with repeat or high dosage exposure.

7.19.3. Poor - The material degrades in gamma or e-beam radiation.

7.20. Acceptable

7.20.1. A material is deemed acceptable if it receives an excellent or decent rating in non-critical properties. The material must receive an excellent rating in critical properties to be deemed acceptable.

7.20.1.1. Critical properties are identified where ratings (excellent, decent, poor) are shown in bold.

8. Acknowledgements

Special thank you to Nials Everett, Chris Scully, Julie Van Moorsel, Dr Tim Holt, and the entire Claigan Environmental staff and students for their contributions. And thank you to all of our industry members who contributed so much in such little time.

RECEIVED
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Yuri Ikada Attachment 1

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March 1, 2024

JFMDA Input for Request for Comments on Currently Unavoidable Uses under Minnesota Session Law – 2023, Chapter 60, H.F. No.2310

We, Japanese Federation of Medical Devices Association (JFMDA), would like to express the gratitude of having the opportunity of stating our opinion to Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837.
https://www.pca.state.mn.us/get-engaged/pfas-in-products-currently-unavoidable-use

JFMDA answers to the questions from the MPCA.

1) ***Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?***

Yes, criteria should be defined.
First, medical devices are essential to health, safety or the functioning of society.
Like pharmaceuticals, medical devices are invariably used in the treatment and diagnosis of diseases and other medical procedures, supporting our lives. Medical devices are constantly evolving, incorporating the latest technologies and combining various techniques. This evolution has made it possible to diagnose previously undetectable diseases at an early stage and to cure diseases and injuries that could not be cured in the past. It has also contributed to improving people's quality of life by reducing the burden on patients.

In addition, the following criteria could be considered.
- their elimination or substitution via design changes or materials and components which do not require any of the materials or substances listed in Annex II is scientifically or technically impracticable,
- the reliability of substitutes is not ensured,
- the total negative environmental, health and consumer safety impacts caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits thereof.

2) Should costs of PFAS alternatives be considered in the definition of “reasonably available”? What is a “reasonable” cost threshold?

Yes.

For example, fluoropolymers are the only materials that combine excellent properties such as biocompatibility, persistence (stability), chemical resistance, repellency from water and oil , low-friction, heat resistance, electric insulation, flame resistance and durability, and are known as essential materials that support social infrastructure functions such as medical devices and their progress.

Even if there are alternatives that can replace some of the functions of fluoropolymers, other costs must be considered in the cost of material substitution. For example, the use of an alternative material may shorten the life of the product and require more resources for maintenance, thus increasing the cost of substitution.

In addition, in the case of medical devices, the following socio-economic impacts are expected due to substitution, which may increase social costs.

- The use of alternative materials may reduce product functionality and increase risks to patients, such as medical accidents
- Shortage of supply of medical devices will occur because it will take considerable time to change the design of medical devices that have already been developed.
- Medical device manufacturers will be forced to concentrate their human, financial, and other resources on design changes, which will affect the technological development of medical devices. The launch of medical devices with the latest technology in Minnesota will be delayed, resulting in lost opportunities for Minnesotans to receive the latest technology in medical care.

3) Should unique considerations be made for small businesses with regards to economic feasibility?

Some consideration may be needed, but we do not have any concrete information on this issue.

4) What criteria should be used to determine the safety of potential PFAS alternatives?

With regard to safety as an alternative to PFAS, it is essential that no hazardous properties be identified.

In addition, for medical devices, it is essential to guarantee safety as a medical device by PFAS alternative. Medical devices require not only clinical efficacy but also high safety and quality. To achieve them, PFAS is widely used in medical devices because of its biocompatibility, persistence (stability), chemical resistance, repellency from water and oil, low-friction, heat resistance, electric insulation, flame resistance, durability, flexibility and other characteristics. (Details of PFAS applications in medical devices are described in Appendix 1.)

Medical devices have the following characteristics

1) Clinical efficacy and safety

- Third-party certification is required.
- Sevier requirements for safety than consumer products are required and it takes long period to evaluate biocompatibility and long-term reliability.
- It also needs to assess whether the design change will have any impact on clinical efficacy.

2) Long supply chain

Time-consuming to identify PFAS-containing parts

3) High-mix low-volume production

Evaluation by substitution is necessary for each product type, and reliability evaluation is time-consuming. In addition, the low volume of parts purchased makes it difficult for parts suppliers to recover their investment, resulting in a low priority for alternative technology development and time-consuming development of alternative technologies.

4) Long product development cycle

Many products are used for long period while undergoing repairs

Based on the characteristics of medical devices described above, we will discuss the time period required to become PFAS-free for medical devices.

<Identification of parts containing PFAS>

Due to the extremely long supply chain of medical devices and the large number of parts, it is expected to take several years to identify parts containing PFAS. Since the proposed regulation would apply not only to the medical device sector but also to products in all sectors, it is easy to imagine that a very large number of survey requests would be concentrated on component suppliers and that it would take a very long time to obtain survey responses.

<Substitution of parts>

For example, in the case of medical electrical equipment, design engineers rarely specify PFAS as a material for parts. In most cases, they present the required specifications such as repellency from water, chemical resistance, flame resistance, and low-friction, etc., to the parts manufacturer, who then selects a material that meets the required specifications. Even if there are a variety of alternative candidates at the material level, each has different physical properties, so the parts manufacturer must develop an alternative technology that satisfies the part's required specifications. Reliability evaluation at the component level is also necessary.

Since the supply of parts for medical equipment is small, parts suppliers tend to give low priority to responding, and it takes time for parts suppliers to develop their own parts.

<Evaluation of alternative components in medical devices>

PFAS-free alternatives developed by parts manufacturers shall be evaluated for adoption in medical devices.

Parts in direct contact with the human body and wetted parts (*) are required to be evaluated for biocompatibility and shall be evaluated based on the EN ISO 10993-1 series standard.

In the case of devices that invade the human body, material changes may require a clinical trial, which requires a study protocol, contract with physicians, approval by the ethics committee of the medical institution, informed consent from the person undergoing the trial, protection of personal information, implementation of the trial, analysis of data, etc., and evaluation over several years.

In the case of medical electrical equipment, if the changed component is an electrical safety critical component, the safety test must be redone.

Even for medical devices for which such evaluations are not required, it is necessary to verify that design changes to alternative components do not affect performance and safety, which requires a much longer evaluation period than for consumer products.

*Wetted parts:

Parts that (re)administered medicines, body fluids or other substances, including gases, to/from the body, or that transport or store such medicines, body fluids or other substances, including gases, to be (re)administered to the body

5) How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

We believe that no time limit should be set for the exclusion of medical devices, and that PFAS restrictions on medical devices should be considered at an appropriate time when other sectors have made some progress in PFAS alternative.

As noted in the comments to question 4), simply changing the design of an existing product to a PFAS-free component would require a considerable number of years of evaluation, and if a sufficient grace period were not set, there would be a shortage of medical devices in Minnesota.

In addition, medical device manufacturers will be forced to concentrate human, financial, and other resources on design changes, which will affect the technological development of medical devices. The launch of medical devices with the latest technology in Minnesota will be delayed, resulting in lost opportunities for Minnesota citizens to receive the latest technological medical care.

Since the amount of PFAS used in medical equipment is small and disposal is properly managed, the need to regulate PFAS content in medical equipment in the same manner as in other sectors is extremely low. Since regulating other sectors first will lead to a switch to PFAS-free in medical devices for general-purpose components even without regulating medical devices, it would be more socio-economically beneficial for medical devices to focus resources on new development and prioritize the introduction of medical devices with the latest technology. We believe that it is more beneficial from a social and economic perspective to focus resources on new development and prioritize the introduction of the latest technology in medical equipment.

6) ***How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA?***

For example, in cases where it is determined that the use of PFAS is necessary to realize products with functions required by medical institutions, which are the users of medical devices.
Cases in which the use of PFAS is determined to be necessary when parts specifications required to realize the specifications of medical devices are requested from parts manufacturers.

Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable?

There is no possibility that it will not be deemed unavoidable due to lack of alternative technology.

What information should be submitted in support of such requests?

Features and benefits of PFAS, safety of PFAS, lack of alternative materials with equivalent performance to PFAS, etc.

7) ***In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.***

Please see Appendix 1 “Uses of PFAS in Medical device” for explanation on functions of PFASs, uses of medical device, and alternative materials.

The majority of PFAS used in the medical device sector are “Fluoropolymers” and “Fluoroelastomers”.

“Fluoropolymers" and "Fluoroelastmers" meet the OECD's "Polymers of Low Concern", and are used as safe and stable materials in many medical devices such as catheters and guidewires, as well as in medical devices implanted in the body, such as artificial blood vessels. For example, PTFE is an excellent medical material with stability and biocompatibility, and has been used implanted in the human body for decades without showing adverse effects. Fluoropolymers are also stable in the environment, and there is limited information on their degradation products, therefore there is no international consensus to conclude that they are "hazardous materials posing an unacceptable risk to human health or the environment”.

Fluoropolymers in medical devices used in medical institutions can be managed at the time of their disposal, therefore they are not discharged into the ocean through sewage or rivers, as is unlike the case with fluorinated polymers used in food wrapping paper and water repellents for clothing. The fluoropolymers used in medical devices are disposed of at waste disposal sites, and are therefore not released into the ocean and are not considered to be a major source of microplastics. In addition, research reports investigating the materials of microplastics show that the chemical composition are mainly polyethylene, polypropylene, polyethylene terephthalate, and polystyrene, and that fluoropolymers are not commonly found in microplastics. (Nature Reviews Materials volume 7, p138-152, 2022: Risk assessment of microplastic particles)

'Fluoropolymers' combine biocompatibility, persistence (stability), chemical resistance, repellency from water and oil , low-friction, heat resistance, electric insulation, flame resistance, durability, etc., while 'fluoroelastomers' also combine high stability, chemical resistance and flexibility. Since these properties derive from the C-F bond, there are currently no equivalent alternative materials. These materials are therefore required as components and coating materials for a wide range of medical devices, such as endovascular treatment devices and radiological diagnostic equipment.

8) ***Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?***

Yes.
Medical device should be determined as currently unavoidable uses because they are essential to the health, safety, or functioning of society

9) ***Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.***

We have strong concerns about the legitimacy and socioeconomic impact of uniformly regulating PFAS by lumping them all together as "common hazards and risks“.   PFAS are lumped together on the basis of their "persistent" nature, however, the chemical structure and physical, chemical and biological properties of each sub-group of PFAS differ greatly, and their toxicity profiles are not identical. In addition, the risk to human health, the environment, and the socioeconomy varies greatly depending on the application. We request to establish appropriate grace measures for essential use, and also request to regulate on a priority basis PFAS subgroups with greater hazards or PFAS application posing higher environmental risks as well.

For example, fluoropolymers are lumped together with PFCAs and are included in the proposed restriction as posing a high risk to humans and the environment, even though they meet the criteria for a "polymer of low concern" as defined by the Organization for Economic Co-operation and Development (OECD). Fluoropolymers are the only materials that combine excellent properties such as biocompatibility, persistence (stability), chemical resistance, repellency from water and oil , low-friction, heat resistance, electric insulation, flame resistance and durability, and are known as essential materials that support social infrastructure functions such as medical devices and their progress.

We believe that it is beneficial to society to establish effective regulations for PFAS after appropriate assessment of health and environmental risks, socioeconomic impacts, risks of exposure to humans throughout the product life cycle, and feasibility of countermeasures for low concern fluoropolymers and fluoroelastmers. In other words, by prioritizing the regulation of PFAS subgroups, including Arrowheads substances, for which there is evidence or strong suspicion of hazards, and applications with severe environmental and health risks, it will be possible to effectively and efficiently reduce risks to human health and the environment with minimal socioeconomic impact.

As an organization supplying medical devices, we request the following in order to contribute to human health and safety and to socio-economic development in Minnesota, and to ensure that healthcare professionals and people in Minnesota do not lose an opportunity to access to the best medical care.

1. Enact effective PFAS regulations in a phased manner based on appropriate risk and socioeconomic assessments
2. Exempt fluoropolymers and fluoroelastomers from the proposed PFAS regulation
3. Medical Devices and In-Vitro Diagnostic Medical Devices shall be exempted as Essential Use

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About JFMDA:

We JFMDA (The Japanese Federation of Medical Devices Association) was founded by medical device associations consisting of manufacturers and suppliers of medical and health-care devices, equipment, instruments and materials.

The JFMDA represents 20 medical device associations, consisting of about 4300 companies that together more than 120,000 employees.

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Appendix 1

Uses of PFAS in Medical device

This document is the appendix 1 of the Input for Request for Comments on Currently Unavoidable Uses under Minnesota Session Law – 2023, Chapter 60, H.F. No.2310 from the Japanese Federation of Medical Devices Association (JFMDA)

submitted on 1. March 2024

Table of Content

General

PFAS are a very important group of substances for Medical device, which depends on these uses to maintain safety, as they are highly effective in chemical resistance, Repellency from water and oil, and electric insulation.
PFAS polymer resins are two to ten times more expensive than other commodity plastics. There is no use other than where the equipment does not work without the use of PFAS.
General electronics components are not covered in this document. However, since our equipment also uses common electronic circuit parts, we also use parts common to information equipment and general consumer EEE. For usage and non-substitutable information for such parts, please refer to Japan 4EE Input for Request for Comments on Currently Unavoidable Uses under Minnesota Session Law – 2023, Chapter 60, H.F. No.2310. Semiconductors are also used in our products. Many PFASs are used in semiconductors and semiconductor manufacturing equipment. Comments on most of the items in this section have been submitted by industry associations that specialize in the respective items. We hope that dossier submitters consider the manufacturer's opinions.

In this chapter, the use of PFAS in components and materials are explained. Then the some examples of the uses follows. These examples are not exhaustive.

1. Reserver for adding pressure / Ultrasound Probe

In ultrasonic probes, when the acoustic coupling medium expands as a result of temperature changes, the internal pressure of the medium chamber may increase excessively. It results in damage to the sealing part of the medium chamber and possible air bubble contamination.

Resin is used as the material that makes up the media chamber because of its acoustic properties. Even if the media chamber is sufficiently sealed, during long-term use, the pressure inside the media chamber gradually decreases due to elongation caused by the creep phenomenon of the resin.

As a result, the pressure inside the media chamber becomes lower than the external pressure, and air may permeate through the resin that constitutes the media chamber.

If air bubbles are introduced into the media chamber, they become reflectors of ultrasound waves, which inhibits ultrasound transmission and reception. As a result, the ultrasound image is degraded.

In this type of ultrasonic probe, it is necessary to adjust the pressure in the media chamber to suppress the generation of bubbles, and fluorine rubber, which has low permeability to gases and liquids, is used to achieve this objective.

Cross-sectional view of an ultrasonic probe

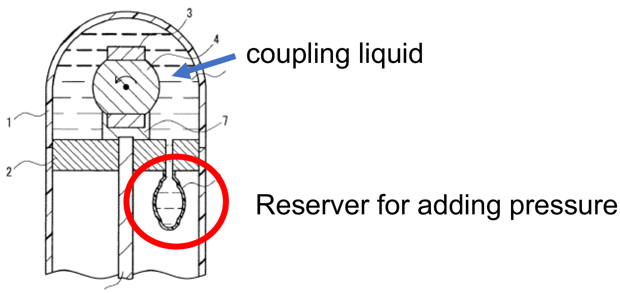
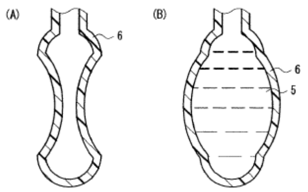


Image of Reserver for adding pressure



(A)adding pressure (B) unpressurized

Figure 1.3.1.

Period required for replacement: About 1 years, if a non-fluorine material with PFAS-equivalent performance is produced.

2. Medical devices inserted into the living body

Medical devices inserted into the body need to be covered with rubber or resin material to protect the outer surface of the drive unit, and FKM or fluororesin (PVDF, etc.) is used in areas where chemical resistance, biocompatibility, heat resistance, and non-adhesiveness are required. Chemical resistance is necessary for disinfection and cleaning after use to prevent infection. Biocompatibility is necessary for medical devices to be inserted into the body. Heat resistance is necessary for autoclave sterilization at 136 degree Celsius. Non-adhesiveness is necessary to prevent adhesion of mucous membranes and other substances that adhere to the device when it is inserted into the body.

Figure 1.4.1.

Description: Fluoropolymers for use in medical devices Endoscope Applications

PFAS substance(s) used: name and CAS number (If known):

PFAS including but not limited,

fluorocarbon elastomers (FKM)

Fluorocarbon elastomers, such as Fluorocarbon elastomers(FKM) , are the unique elastomers developed, which have been used in medical device such as endoscope with many benefits, including but not limited: i. fluorocarbon elastomers have a wide working temperature range from -26°C to 205°C, which is critical for high temperature sterilization applications, such as steam sterilization, dry heat sterilization, which are current standard sterilization practices in hospital. ii. fluorocarbon elastomers have a wide range of chemical resistance, which is critical for low temperature sterilization applications, such as hydrogen peroxide gas plasma sterilization, high level disinfection, and other liquid chemicals for cleaning. iii. fluorocarbon elastomers have excellent aging characteristics, which is very important for shelf time of medical device products.

Thermoplastic polyurethane (TPU) is an alternative material, but it cannot be substituted because it has poor chemical resistance and heat resistance, so the quality of sterilization, disinfection, and cleaning decreases, and the risk of infection increases.

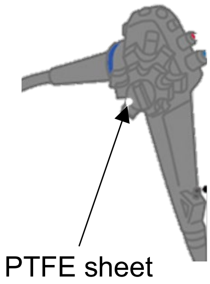


Figure 1.4.2.

Since the fluorine material has excellent low friction and non-adhesion while having chemical resistance, PTFE sheets are used between the sliding parts of the drive unit. Since there is no material other than fluorine having similar properties, change to alternative materials is not possible.

3. Solvent for cleaning and draining endoscope lens component

Figure 1.5.1.

HFE, the fluorinated composite material has good drying properties, no heat resistance, and low surface tension, so it has high particle removal ability. Non-flammable drying technologies include rotational drying and hot air drying using water as a solvent, but dry stains are likely to occur on the lens surface and are insufficient, and if they are incorporated into the product as they are, endoscopic image defects will occur and diagnosis will be hindered.

4. Insulation components for surgical instruments

- **Resectoscopes including electrodes to resect tissue (tumor or BPH)**

PTFE CAS: 9002-84-0

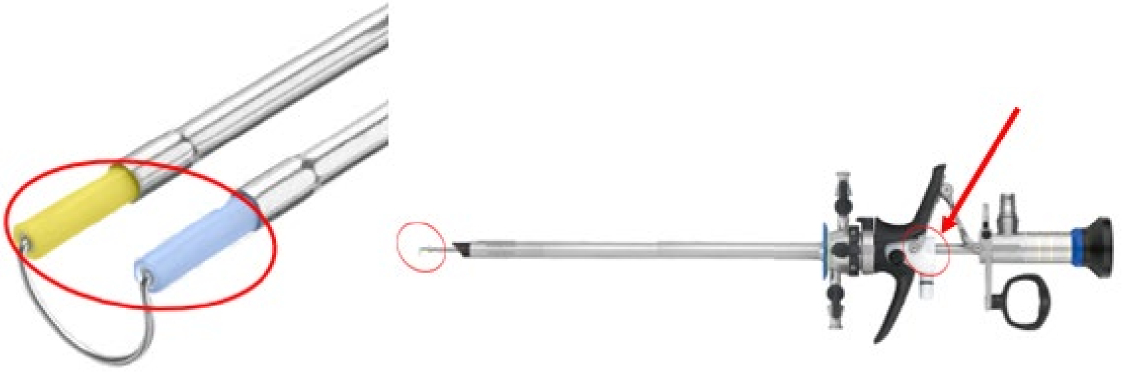


Figure 1.6.1.

Arc resistance to RF- plasma; Cleanability of surfaces; safe dielectric strength at small layer thickness; Non- Slip- Stick effect for movement; low friction for mounting in and on pipes and rods; low friction for moving parts (after cleaning cycles- grease would be removed); high temperature resistance for steam cleaning and disinfection; high chemical resistance for cleaning and disinfection (Peroxide, etc.)

There is no hazard and exposure risk. All materials in contact are controlled via ISO 10993. This product is single used

-PI is not flexible, has high slip- stick behavior

-PEEK will burn down under RF- plasma (arc)

-PET chemical resistance is to low, slip- stick behavior, non sufficient thermal stability

-All Cleaning disinfection tests have to be requalified, since low surface energy of PTFE is unmatched it can be estimated that cleaning procedures have to be harsher in the future.

◆ **Pad for Ultrasonic surgical device**

It is essential for ultrasonic surgical device to have the pad which contacts with ultrasonic probes that are vibrating at high speeds.

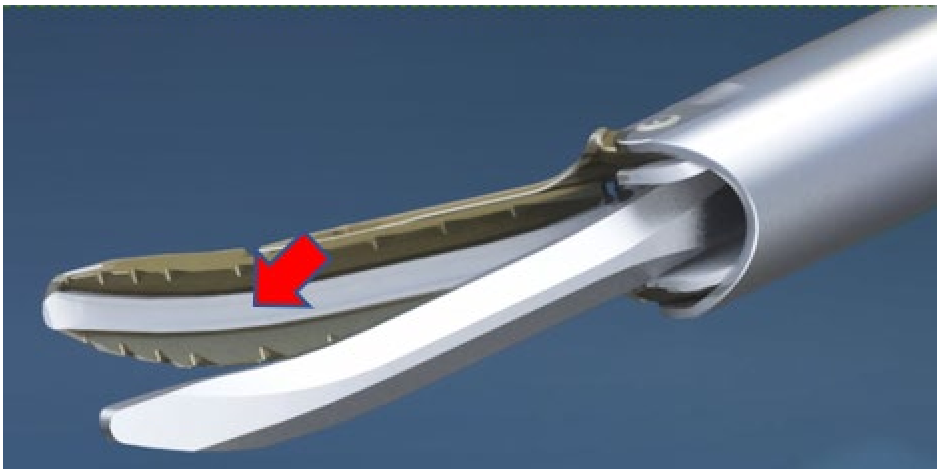


Figure 1.6.2.

During surgery, the tissue is sandwiched between the pad and the ultrasound probe, and the tissue is incised without bleeding due to the frictional heat and friction action caused by ultrasonic friction. During the incision of the tissue and after the incision is completed, the ultrasonic probe and the pad come into contact with the ultrasonic vibrating at high speed. In order to reduce the frictional heat generated at this time, it is necessary that the pad has low friction. In addition, even if the friction is low, the ultrasonic probe vibrates at high speed, so high wear resistance is required. In addition, a large amount of heat is generated due to friction. Since this is a surgical treatment tool, it is essential to have chemical resistance (acid and alkali resistance), heat resistance, and electrical insulation. The PTFE is the only material that can withstand that's friction and heat, so PTFE is indispensable. (If it is another member, it will melt easily and become unusable immediately.) ） In addition to these properties, biocompatibility is required. See "Biocompatibility" in the endoscope section of "Plumbing" for details.

◆ **Probe holder for Ultrasonic surgical device**

Probes Suppress exists to prevent pipe and ultrasonic probe that is vibrating at high speed from being destroyed and forming unintended electrical paths by coming into contact with each other.

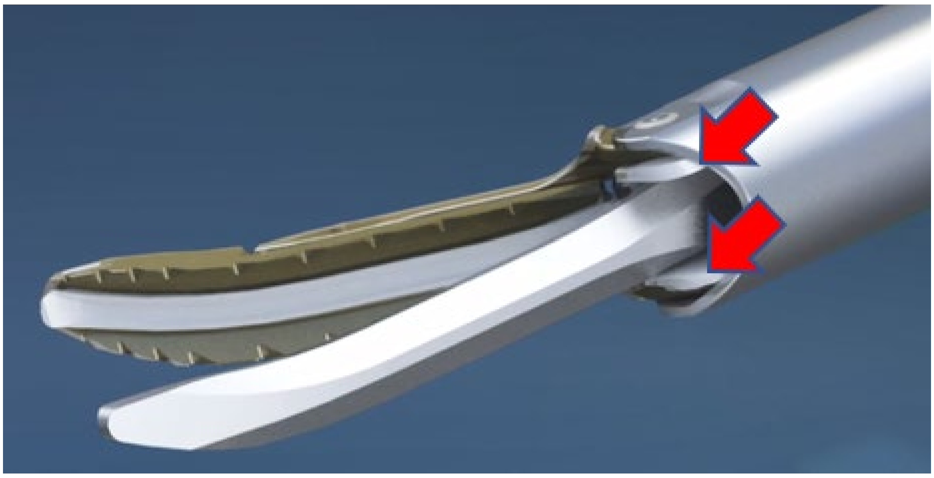
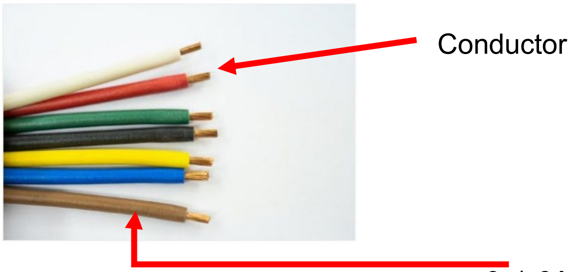


Figure 1.6.3.

By performing surgery from a small port, it is necessary to reduce the burden on the patient by reducing the wound created on the patient's outer surface during surgery, and it is necessary to make it thin as a surgical treatment tool. As a result of thinning, the rigidity is weakened, so if the equipment is accidentally twisted with the tissue in between, the probe may deflect and come into contact with the pipe. In order to prevent this, it is necessary to be able to withstand wear and heat generation due to contact with a probe that vibrates at high speed, and it is essential to be able to withstand heat resistance, slipperiness, and wear resistance. In addition, the viewpoints of biocompatibility, chemical resistance (acid and alkali resistance), mechanical physical properties, flame retardancy, and electrical insulation required for energy surgical treatment tools are also essential. In particular, moldability is important to maintain the fineness of equipment, and PFA is indispensable. In addition to these properties, biocompatibility is required. See "Biocompatibility" in the endoscope section of "Plumbing" for details.

5. Electric wires and insulation

An electric wire is a linear member for transmitting electricity. Metal, which is a good conductor, is used for the part that transmits electricity, and plastic resin that has electric insulation is used around the wire in order to block the influence on anything other than the transmission destination of electricity.



Sheath

Figure 1.7.1.

Polyvinyl chloride is generally used for covering parts where plastic resin is used, which is called as sheath, but PTFE, PFA, FTPE, etc. are selected depending on the suitability of use and electric insulation requirements. Since these are more expensive than polyvinyl chloride, they are used only when it is difficult to use other materials such as polyvinyl chloride.

PFAS functions required by PFAS wires and availability of alternatives.

Wires using PFAS for coating have high electrical insulation when the coating is thin (100 μm or less). PFAS also has a high heat resistance of 150-200°C. In addition, PFAS wires can be used even when there are chemicals around the device because PFAS has chemical resistance.

Examples of devices equipped with electric wire and insulation

◆ **Medical cables of probe cable for ultrasound diagnostic equipment**

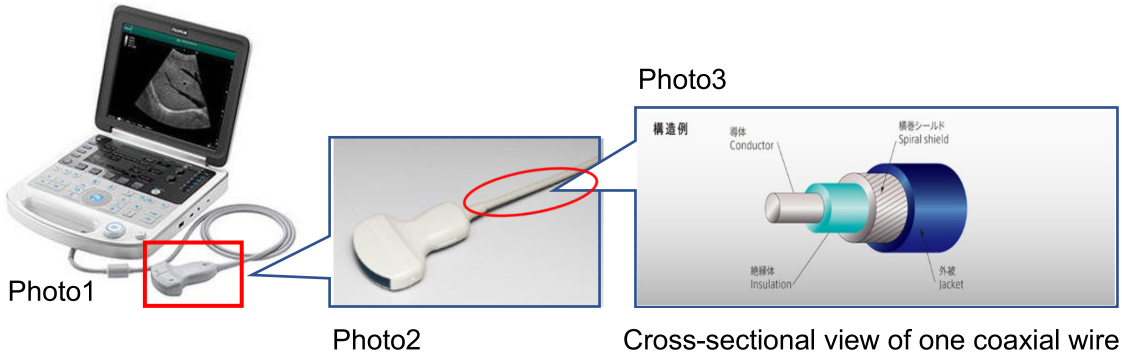


Figure 1.7.2.

The ultrasonic diagnostic device is shown in Photo 1 and consists of an image analysis unit and a cable with a transducer.

The cable with transducer shown in Photo 2 is composed of about 200 coaxial wires in order to transmit and receive about 200 signals.

The inside of the red circle cable in Photo 2 is as shown in Photo 3.

Photo 4 shows a cross-sectional view of one of Photo 3.

The performance required for these coaxial wires is (electric insulation / low dielectric constant), heat resistance, and extrusion suitability. PFA/FEP is used as a material that satisfies these three elements.

Table 15 shows the comparison results with the alternative candidate material PEEK.

In order to obtain a diagnostic image with high accuracy, the attenuation of coaxial wire must be 2 dB / m or less in terms of the size shown in Table 15 , and the required performance is not satisfied unless PFA/FEP is applied.

In order to satisfy the attenuation, it is necessary to reduce the capacitance, and for this purpose, the dielectric constant must be 2.1 or less.

The cross-sectional view of one coaxial wire is shown in Photo 4, and the red arrow part is the insulating layer and the green arrow part is the outer layer.

Both layers require thickness control of 0.05 mmt or less, and PEEK cannot be controlled, especially for the outer layer because it does not stretch.

In order to evenly cover the outer layer without destroying the shield layer, stretching is necessary.

PEEK meets only heat resistance requirements.

		PFA		PEEK		Required characteristics
electrical characteristics	dielectric constant	2.1	○	3.15	×	≦2.1
	Attenuation*1	1.75	○	≧2	×	@10MHz <2 d B/m
heat resistance	Rated temperature	≧200	○	≧200	○	200° C or higher
extrusion suitability	Coating thickness control	GOOD	○	BAD	×	≦0.05mmt
	Non-stop extrusion time	GOOD	○	BAD	×	≧2hr

*1Conductor 48AWG (7/0.012), OD 0.18mmΦ

Table 1.7.1. Comparison with alternative candidate material PEEK

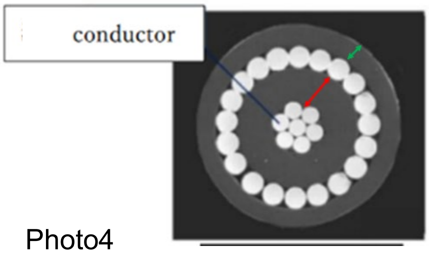


Photo4

Cross-sectional view of one coaxial wire

Figure 1.7.3.

◆ **Cables in MRI**

Magnetic resonance imaging (MRI) diagnostic equipment transmits and receives high-frequency signals in the FM frequency band in a high magnetic field space, so coaxial cables are used to efficiently transmit high-frequency signals.

A coaxial cable is a distributed constant line with a cross-sectional structure consisting of a center conductor, an insulator around it and which is further surrounded by a metal braided outer conductor.

Impedance matching is important in transmission lines for high-frequency signals to suppress reflections, and coaxial cables with a characteristic impedance Z_0 of 50 Ω are used.
The ratio of outer and inner conductor diameters that minimizes transmission loss in coaxial cables is defined as D/d=0.2785. Therefore, if polyethylene with a dielectric constant of 2.3 is used as the insulator, the characteristic impedance is 50Ω, which is used for most coaxial cables. To obtain these characteristics, PFAS (PTFE, FEP, ETFE) is now essential for MRI equipment.

Figure 1.7.4. MRI equipment

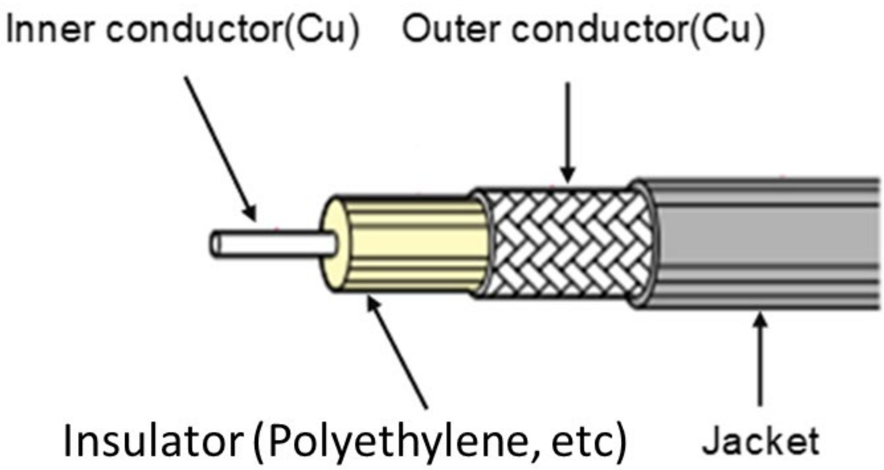
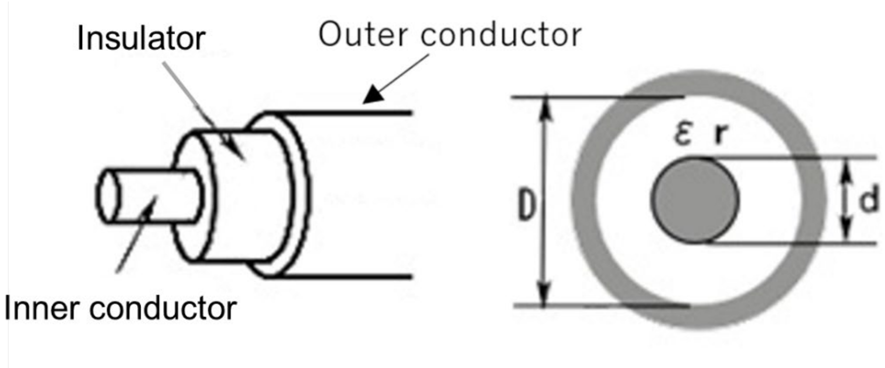


Figure 1.7.5. Structure of Coaxial cable (commercial product)



$$Z_0 = \frac{60}{\sqrt{\varepsilon}} \log_e \frac{D}{d} = \frac{138.1}{\sqrt{\varepsilon}} \log \frac{D}{d}$$

ε：Dielectric constant of dielectric

D：Inner diameter of outer conductor
(Outer diameter of insulator)

d：Outer diameter of inner conductor

Figure 1.7.6. Theory of coaxial cable

Technical Explanation of Non-Substitutability, Pictorial photographic data, information on reference websites, etc. are shown below.

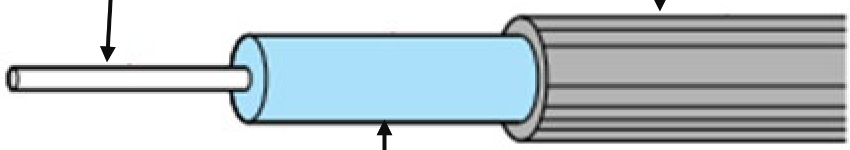


Figure 1.7.7. Semi-Rigid Cables

In contrast to general coaxial cables, shape memory types such as semi-rigid cables with a seamless metal tube as the outer conductor, or semi-flexible cables with a plated coating on the braided conductor, generally use fluoropolymer as the insulator.
The insulator of such cables maintains tight tolerances, the cable structure is highly uniform, and power loss due to reflection is minimized, resulting in superior transmission characteristics at high frequencies compared to general coaxial cables made of polyethylene.
The low loss of the cable provides a higher power capacity than general coaxial cables of the same size. Furthermore, it has excellent temperature characteristics, and stable characteristics can be obtained over a wide temperature range (about -55°C to +200°C).
Particularly in the antenna power feeding system such as MRI equipment, which uses cable assemblies tuned to a specific electrical length (phase), it is critical that the electrical length of the cable little varies due to temperature, deflection, tension or other environmental factors.
Transmitter circuit units in which semi-rigid cables are used transmit high-frequency signals in the rang from several kW to more than 10 kW with high-precision phase control. Therefore, the temperature inside the enclosure covered with noise shielding is expected to be up to 100°C.
Based on the above, the following properties are considered necessary when substituting fluoropolymer.

Dielectric constant is about 2.1 to 2.3.

Dissipation factor is about 0.0002.
Rated temperature is 100°C or higher.
Electrical length (phase) variation is -100 PPM/℃ or less.

The insulator of commercially available coaxial cables is de facto two options of polyethylene and fluoropolymer. Polyethylene has a good dielectric constant and dissipation factor, but has a temperature rating of about 75°C and an electrical length (phase) variations of about -250 PPM/°C, which do not meet the requirements. Therefore, general coaxial cables using polyethylene cannot be used. Other resin materials are also considered difficult to substitute due to the fact that the cable industry has not adopted them for insulator.

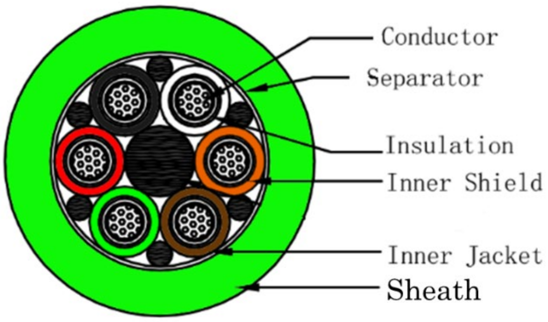


Figure 1.7.8. Composite coaxial cables

Composite coaxial cables consist of multiple small gauge coaxial cables and single core cables, which are bundled together with a common shield and jacket.
In MRI equipment, it is used for the internal wiring of the patient bed, and the cable bears a bending motion in accordance with the bed motion by every patient or every imaging part.
For coaxial cables, fluoropolymer is used for insulator and jacket, and for single core cables, used for jacket.
The following properties are considered necessary when substituting fluoropolymer.
(Coaxial cable)
Dielectric constant is about 2.1 to 2.3.
Dissipation factor is about 0.0002.
Withstands soldering temperatures (lead-free solder melting temp: 217°C).
Coefficient of kinetic friction (jacket) is about 0.1 to 0.2.
(Single core cable)
Withstands soldering temperatures (lead-free solder melting temp: 217°C).

Dynamic coefficient of friction is about 0.1 to 0.2.
Small gauge coaxial and single core cables are as small as 28 AWG to 30 AWG, and require heat resistance to withstand terminal soldering operations and low dynamic friction resistance to withstand bending fatigue up to 100,000 times.

The insulator of commercially available coaxial cables is de facto two options of polyethylene and fluoropolymer. Polyethylene has a good dielectric constant and dissipation factor, but has a temperature rating of about 75°C and does not meet the soldering temperature requirement. Therefore, general coaxial cables using polyethylene cannot be used. Other resin materials are also considered difficult to substitute due to the fact that the cable industry has not adopted them for insulator.
For coaxial and single core cable jackets, polyethylene, for example, has good sliding properties although inferior to fluoropolymer, but it cannot be used because it does not meet the soldering temperature requirements. The jacket must also be flexible when bent. PEEK, for example, satisfies the heat resistance requirement, but cannot be used because of its flexibility and sliding properties.

◆ **Cables in XR and CT**

Radiological equipment such as radiography equipment, CT tomography equipment, and bone densitometry equipment generate X-rays at up to 150 kV. Such high voltage is supplied to the X-ray tube. Electric wires are used to supply high voltages to the X-ray tube, but the wire coating materials that can withstand high voltages are Fluoropolymer is used.
To obtain these characteristics, PFAS (PFA, PTFE) is now essential.

Figure 1.7.9. Example of Radiologocal medical devices

A high voltage generator is used to generate high voltages. In addition to voltage resistance, the wires used in the insulating oil inside the high-voltage generator must have a dielectric constant close to that of the insulating oil for oil resistance and electric field mitigation. For this reason, fluoropolymer is used for the coating of the wires.

Technical Explanation of Non-Substitutability, Pictorial photographic data, information on reference websites, etc. are shown below.

Required Electrical Characteristics
- Dielectric breakdown voltage: 19kV/mm
- Dielectric constant: 2.1 (dielectric constant close to that of insulating oil is required for electric field mitigation)
- Alternative material: silicone rubber
- A dielectric constant of 3.0 or higher makes electrolytic mitigation impossible.

◆ **Surgical power cord**

Figure 1.7.10.

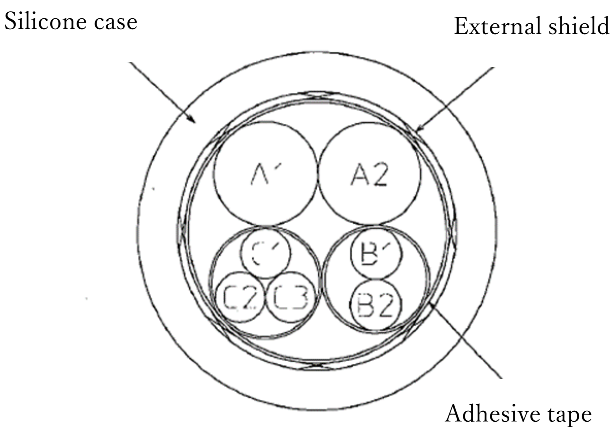


Figure 1.7.11.

The surgical treatment tool shown in the above figure11 has a structure in which the tip of the treatment part can be rotate. The power supply cord twists according to the rotation of the treatment part. Since the resistance and hardness of the rotation of the tip treatment tool due to this twist greatly hinder the operation of the surgeon, it is essential to maintain the flexibility of the cord in surgical treatment tools especially which need delicate operation. It is necessary to maintain electric insulation between each bundled cord, but the flexibility is not maintained when

it becomes thicker. So it is essential that each cord is covered with PFA.
In addition, since surgical devices conduct high-frequency currents, they are affected by the capacitance between each cord. In addition to suppressing changes in capacitance due to changes in the position of the cord internally, the suppression tape for regulating the position of each cord must have flexibility with the function of preventing the increase of capacitance between cords by autoclave, which is a sterilization process, and it is essential to be EPTFE.

- **RF- generators electrical insulation of patient treatment circuit to mains and other electrical circuits**

Figure 1.7.12.

RF- generators electrical insulation of patient treatment circuit to mains and other electrical circuits [RF = radio frequency current]
RF- generators used in the transformer for wire insulation so it is inside the generators . It is used in wire and tubes.Electric insulating and non-adhesion are required. All electrical tests according to IEC 60601-2-2 have to be repeated. It is a high risk that leakage current limits cannot be kept PI and PEEK is not flexible enough. PET chemical resistance is to low, not sufficient heat resistance.
US(Ultra Sonic)- generators also used it.

6. Sealing materials

Parts description

- Packings, gaskets, and O-rings

Packings and gaskets exist to connect and seal by placing/placing them between parts. As an example, they are used in piping and pipe connections. Gases and liquids that pass through pipes leak out through the smallest gaps, and packing gaskets exist to prevent this. Packing in the narrow sense is used for power system parts, and those used for non-moving parts are called

gaskets. Various innovations have been made in molding and realizing functions, such as spiral gaskets made of alternating layers of thin metal strips and PTFE sheets, and wrapped gaskets made of 0.4~0.8 mm hot PTFE, covering gaskets of metal or other materials.
Those with a circular/round cross section are called O-rings.
In addition to PTFE, fluoropolymer rubbers such as FKM and FFKM are also used for this application.

Figure 1.8.1. Packings, gaskets, O-rings

➢ Bearings

A bearing reduces friction between two parts to make movement smoother. Bearings are classified into radial bearings, thrust bearings, and linear bearings, depending on whether rotational or linear motion is involved. A bush is also a type of bearing.
Fluoropolymer bearings such as PTFE have a low coefficient of friction and can maintain a constant torque within various tolerances, while minimizing rattling and noise. In particular, PTFE must be used for bearings near chemical fluids such as acids, alkalis, organic solvents, and ozone, and for food contact applications, where oil is not preferred.

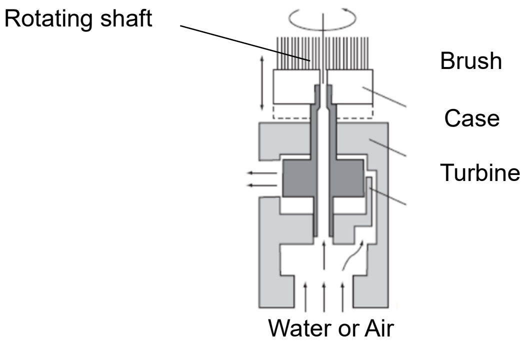


Figure 1.8.2. Bearing used for the rotating shaft sliding part of the sensor cleaning brush

➢ Sealing tape

Sealing tape, made of PTFE material, is an adhesive tape used to secure parts within equipment. It is employed to fasten parts that could pose safety risks if dislodged, as well as to seal mounting parts. Additionally, the tape serves as a filler to address gaps in the joints or connections of pipes for flowing liquids or gases, such as water pipes, air pipes, and hydraulic pipes. Notably, the tape can establish liquid- or gas-tight connections with tapered pipe threads by directly filling the voids between the threads.

Figure 1.8.3.

The functions of sealing materials of PFAS and alternatives

Functions of PFAS Required by Sealing Materials and the Feasibility of Alternatives to PFAS

- Required Functions for Sealing Materials

  Liquids and gases flowing in pipes, or near parts, often consist of strong acids, alkalis, or organic solvents. Therefore, the sealing materials used must be resistant to these chemicals. Fluoropolymer is highly resistant to such chemicals, and additionally, it is ozone-resistant, making it an ideal choice when ozone is present in the piping.

  If the liquid or gas in the piping, or the equipment itself, operates at high temperatures, PTFE or PFA are good options due to their high heat resistance of up to 260°C, a limit higher than other resins. FFKM and FKM rubbers also exhibit high heat resistance, withstanding temperatures up to 250-300°C.

  For applications where sealing materials, such as gaskets, are used on sliding surfaces, where lubricating oil is unsuitable (particularly in contact with food), or where play and noise must be avoided, sealing materials must also possess low friction and self lubrication properties.

  In the restriction report on seal tape, paste-like sealing materials are mentioned as alternative materials. However, if these sealing materials contain hydrocarbon substances, reactive functional groups may decompose. This could pose a risk of contamination in the surrounding area due to the produced decomposition products. For sealing tape used for equipment operating in clean environments, where such contamination is unacceptable, paste-like sealing materials cannot be used as alternatives.

  As a sealing material that combines outstanding chemical resistance, ozone resistance, heat resistance, water and oil repellency, low friction, self-lubrication, and cleanliness, there is no substitute for fluoropolymers. The substitution of fluoropolymers with other materials poses a significant challenge. Non fluorine elastomers might be considered as potential replacements for fluorine rubbers like FKM rubber. However, their heat resistance, low friction, and chemical resistance do not measure up to those of fluorine-rubbers like FKM rubber. Therefore, substituting fluorine -rubbers with non fluorine elastomers is unfeasible.

Examples of the products which uses sealing materials

◆ **Endoscope reprocessor**

The endoscope reprocessors use a variety of chemical solutions such as acids, alkalis, and alcohols to clean and disinfect the endoscopes after use. Some of these solutions may cause health hazards such as chemical burns if they come into direct contact with the human body, and sealing materials in the endoscope reprocessor are required to have chemical resistance to withstand these chemical solutions and prevent leakage.

Therefore, fluoropolymers such as PTFE, FKM, FFKM, and FEPM, which have high chemical resistance to various chemical solutions, are used for sealing materials such as packing, gaskets, O-ring and sealing tape.

Other substances such as EPDM and silicone are not sufficiently resistant to these solutions, especially the peracetic acid used for endoscopes disinfection, because these substances deteriorate in a short period of time. Therefore, it is impossible to substitute other substances.

Endoscope

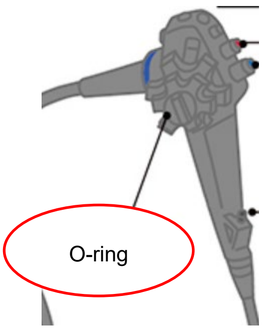


Figure 1.8.4.

A medical device that is inserted into the body through the oral cavity to observe and treat the inside of a lumen. FKM is necessary because the O-ring provided in the sliding part must have chemical resistance and low friction. Chemical resistance is a property necessary for sterilization, disinfection, and cleaning after use to prevent infection. As a sterilization method, there is a method using gas such as EOG or hydrogen peroxide, and the sterilization gas penetrates the interior of the product, so chemical resistance is a necessary characteristic even for internal parts.

The sterilization methods that can be used are limited depending on the region, and it is not enough for a product to be compatible with just one, but it is necessary to have resistance to all sterilization methods. There is no material with chemical resistance equivalent to that of FKM and low friction.

◆ **Computed Radiography (CR)**

CR generates an X-ray image by converting the X-ray information recorded on an imaging plate (IP), a type of X-ray detector used in X-ray photography, into an electrical signal by exciting it with a laser beam.
PTFE is used for the sliding bearings in IP transport unit inside CR.

The durable life of a CR is about 6 years. In order to achieve this, it must be durable enough to withstand 64 million times of IP conveyance (calculated from the assumed frequency of use of CR). In order to achieve this durability, the sliding and wear resistance of PTFE are essential, and there is no material that has the same sliding and wear resistance as PTFE.

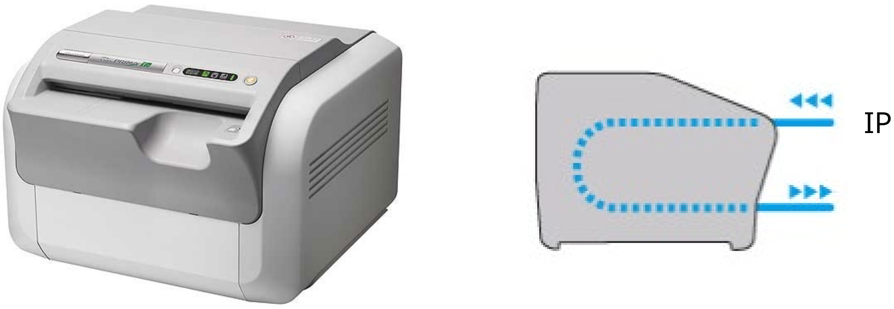


Figure 1.8.5. Computed Radiography

Figure 1.8.6. sliding bearing

7. Valves

Valves are general for equipment with a movable mechanism that can open and close flow paths in order to go through, stop, and control the flow of fluids. They are used in a wide variety of products, from relatively small devices with flow paths and valves to large-scale manufacturing processes and chemical plants. There are many types of valves. Some valves, which are often incorporated in medical device, are discussed. They are not exhaustive.

The functions and alternatives which valves require:
The chemical resistance against acids, alkalis, organic solvents oils, and ozone, which flows through valves, is essentially required. Valves, which opens and close frequently required the property of low friction, repellency from water and oils, non-adhesion. Any failure of valves can cause serious accidents. therefore, the durability of fluoropolymer resin is required for valves PTFE and other fluoropolymer resins are frequently used. Fluoropolymer resins, such as, PTFE are the only materials that can simultaneously provide and express multiple functions required for the proper functioning of valves.

- Solenoid valve

A solenoid valve is electromehanically operated. One of the operations is to open and close a valve using the principle that when an electric current is applied to an electromagnet (solenoid), an iron piece called a plunger is attracted and released when the electric current is cut off. Diaphragms divide into a valve compartment that opens and closes flow paths and a functioning compartment that drives. Fluoropolymer resins, such as, PTFE, FKM, FFKM, and FEPM, are frequently used for flow paths, diaphragms, and sealing materials in solenoid valves. Solenoid valves have wide variety of types, such as, liner action, pilot operated, the combination of liner action and pilot operated.

- Ball valves

A ball valve opens and closes a flow path by rotating a hollow ball. In automatic valves, an electric motor is used to rotate the ball. A large cross-sectional area of the flow path can be obtained, and the resistance of the path can be kept low. Fluoropolymer resins, such as, PTFE, are frequently used

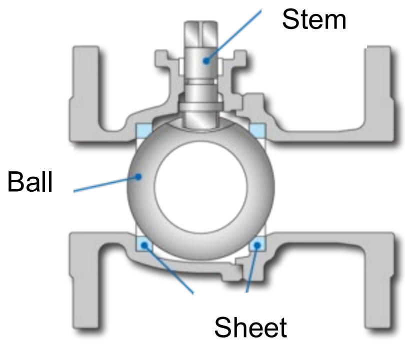


Figure 1.9.1.

- Check valve

A check valve is installed on gas or liquid piping where the fluid back pressure closes the valve plug to prevent reverse flow. A check valve is called as non-return valve, reflux valve, retention valve, foot valve, or one-way valve There are disc check valves that blocks backflow by closing the O-ring valve with a disc and duckbill check valves that uses a valve plug shaped like a duck's beak. Fluorinated materials such as PTFE, FKM, FFKM and FEPM are used for the valve plug and the sealing materials of the housing.

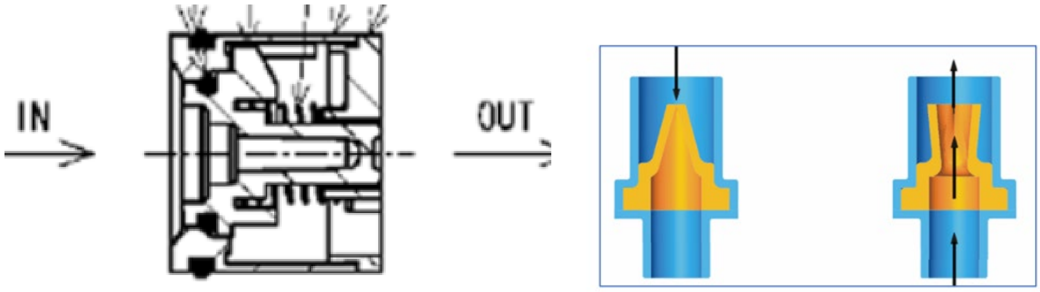


Figure 1.9.2.

- Relief valves/safety valves

A relief valve is a valve that automatically releases pressure when excessive pressure occurs in the pipes. A spring keeps the valve plug such as O-rings or diaphragms closed, and it opens (released) when a pressure exceeding the spring force occurs.

Fluorinated materials such as PTFE, FKM, FFKM and FEPM are used for the valve plug and the sealing materials of the housing.

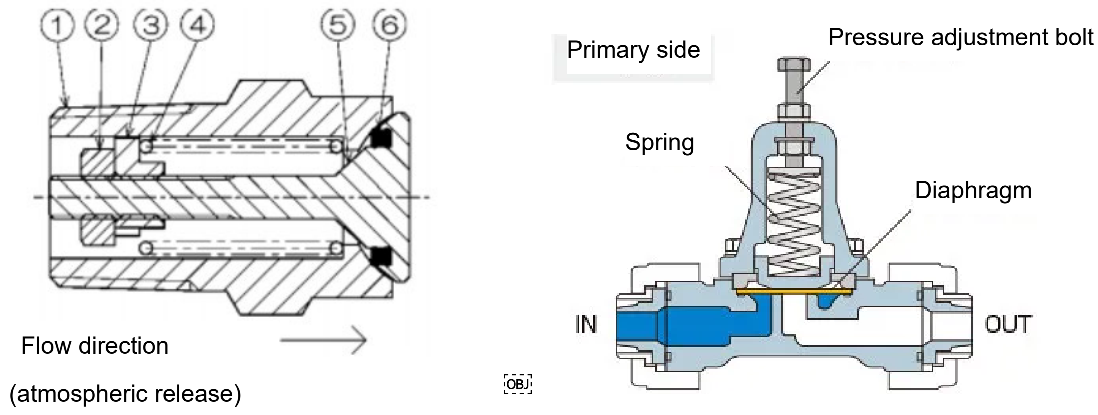


Figure 1.9.3.

Examples of the products which incorporates valves

◆ **Endoscope reprocessor**

The endoscope reprocessors use a variety of chemical solutions such as acids, alkalis, and alcohols to clean and disinfect the endoscopes after use.

Various valves such as solenoid valves, ball valves, check valves, and relief valves are used to switch the solutions and control the flow. If the performance of the valve is degraded or broken, the cleaning and disinfection of the endoscope may be inadequate, leading to cross-infection. Therefore, fluoropolymers such as PTFE, FKM, FFKM, and FEPM, which have high chemical resistance to various chemical solutions, are used for the valve discs, diaphragms, and sealing materials between housings in each valve.

Other substances such as EPDM and silicone are not sufficiently resistant to these solutions, especially the peracetic acid used for endoscopes disinfection, because these substances deteriorate in a short period of time. Therefore, it is impossible to substitute other substances.

8. Pumps

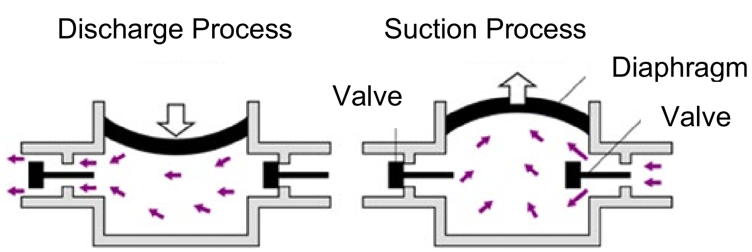


Figure 1.10.1. Explanation on Pumps [1]

[1] https://www.monotaro.com/note/cocomite/525/

A pump is a device that transfers, pumps, and stirs liquids and gases under the action of pressure. It is divided into two types according to the difference in structure: non-positive displacement pumps and positive displacement pumps. Non-positive displacement pumps are pumps that impart energy to liquids by rotating impellers, and include centrifugal pumps, propeller pumps, and viscous pumps. A positive displacement pump is a pump that pressurizes and energizes a liquid that is within a certain volume, and there are plunger pumps, diaphragm pumps, gear pumps, etc. In pumps, fluorine rubber such as FKM, FFKM, and FEPM is used for the sealing members and diaphragms of the housing. PTFE is used for the impeller bearings.

PFAS functions which pumps require and alternatives
Pumps used to transfer fluids such as acids, alkalis, organic solvents, oils, and ozone require high chemical resistance for each member in contact with the fluid. Especially in the case of diaphragms, durability that can withstand repeated bending are also required. Fluorine materials such as FKM, FFKM, and FEPM are used as materials to satisfy these requirements, and it is difficult to replace them with other materials.
In the case of bearings, low friction, self-lubrication, and wear resistance are also required. Fluorine materials such as PTFE are used as materials to satisfy these requirements, and it is difficult to replace them with other materials.

Examples of the products which incorporate pumps

- **Endoscope reprocessor**

The endoscope reprocessors use a variety of chemical solutions such as acids, alkalis, and alcohols to clean and disinfect the endoscopes after use.
And the endoscope reprocessors use internal pumps to deliver these solutions to the outer surfaces and channels of the endoscope.If the performance of the pump deteriorates or breaks down, the cleaning and disinfection of the endoscope may be insufficient, leading to cross-infection. Therefore, fluoropolymers such as PTFE, FKM, FFKM, and FEPM, which have high chemical resistance to various chemical solutions, are used for sealing materials, diaphragms, and bearings in these pumps.
Other substances such as EPDM, silicone and POM don’t have sufficient chemical resistance to these solutions, especially to the peracetic acid solution which used to disinfect endoscopes, because these substances deteriorate in a short period of time. Therefore, it is impossible to substitute other substances.

9. Heat medium

Examples of medical devices with heat medium

MR: A refrigerator is built into the system to maintain superconducting conditions
Biochemistry analyzers: Cooling is required to keep reagents in a low-temperature environment for analytical work.
Medical equipment: Localized cooling is necessary to avoid overheating and equipment malfunction or system shutdown due to prolonged operation.

Refrigerators are used for the units require temperature control, and pretreatment for measurement and analysis. Fluorinated gases are the only materials that can simultaneously provide and express multiple functions required for the proper functioning of refrigerators, such as, thermodynamic efficiency, surface tension, electrical insulation, inactivity, heat conductivity, and a wide range of operating temperature.
HFCs as F-gas will be restricted by the EU F-gas regulation and international treaties. HFCs will be replaced by organic fluorine compounds that their GWP are smaller than carbon dioxide. In that case, the substituted organic fluorine compounds (GWP>1) will be further substituted.
A succession of substitutions in a short period shortens the lifetime of specialist equipment, which is originally long-life. Refrigerators, compressors, centrifuges are used as units of specialist equipment, the derogation as spare parts should be considered. Specialist equipment cannot be repaired, it will be discarded and its lifetime will be shortened.
Refrigerants must not leak from the unit, the units that uses refrigerants such as refrigerators, compressors, and centrifuges requires the sealing materials mentioned in this document.
5(f), (g), and (h) of proposal wordings are written in Annex A of the restriction report. Specialist equipment with a long Lifetime cannot be sufficient grace periods. The grace periods should be examined.

10. Flat panel detector for digital radiography

When performing X-ray photography, the DR panel (GOS type) uses TFT to receive GOS scintillator emitted light proportional to the radiation dose and generates an X-ray diagnostic image. A GOS scintillator is used in the X-ray sensor of the DR panel. GOS scintillators are based on polyethylene terephthalate (PET) material, which has excellent flatness and flexibility, and are coated with a conductive layer and GOS phosphor (Gd_2O_2S:Tb) dispersed in a polymer.

The role of the conductive layer is to prevent image defects due to discharge. If there is a defective image due to discharge during X-ray photography, there is a risk of misdiagnosis. Uniform application of the conductive layer is essential to obtain a defect-free image. In order to improve coating performance, excellent wettability due to the low surface tension and excellent uniform coating properties (leveling properties) of the fluoropolymer due to high surface viscosity are essential.

11. Photographic imaging film for medical purpose

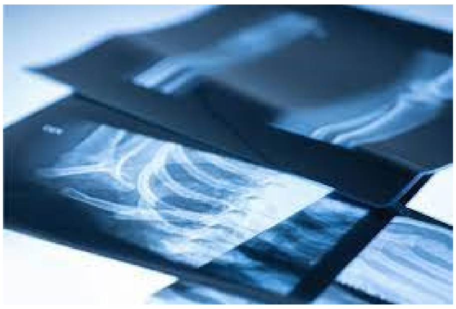


Figure 1.1.1.

The photographic films are still used for medical purposes, i.e., X-ray photography.
The photographic films for medical purposes are divided into two groups: a) for direct X-ray exposure, and b) for digitally outputting captured images.

PFAS is used as a surfactant for the photographic films and provides critical anti-electrostatic properties.

As our previous studies, it was found that fluorine-surfactants with short carbon chains do not show sufficient performance even for the molecules with fluorine atoms. Since chemical stability in the process of neutralizing and deactivating alkaline developing process was also required, designing a materials for photosensitive materials was quite difficult. There is a high possibility that general materials that have been proposed as alternatives in the world could not satisfy the required performance. Longer R&D will be required to design and find alternatives.
Since the restriction proposal on PFHxA was released in December 2019, we have conducted the feasibility study to find alternatives. However, we have not yet found alternative materials besides PFAS. We are not sure whether any non-PFAS alternative materials can be found in the future.
In our experience on the case of switching from PFOS/PFOA in the past, it took a lot of resources and approximately 10 years to find the alternative, prototyping, and develop to the commercial products. We will require extensive lead time extending beyond the 2030 deadline to redesign and revalidate the materials, equipment and production processes.

12. Coating applications for medical devices other than Metered Dose Infalers

Part Description

A surface treatment in which the surface or inner surface of a base material is covered with a fluoropolymer is called a coating or lining. A relatively thick covering is often referred to as a lining, while a thin covering is often referred to as a coating. There are various methods such as molding, bonding a sheet to the base material, bonding powder, or covering with a liquid. Fluoropolymers used include PTFE, PFA, PCTFE, FEP, and ETFE.

Metal plating and surface treatment containing fluoropolymer resins are used to adhere to metals. Coatings and linings are applied to parts in contact with fluids. The parts include the inner surface of the piping and parts in contact with the fluid. Coatings may be applied to areas where water repellency to water and oil, low friction, self lubrication, and non-adhesion are desired.

Examples of coating / lining

Piping inner surface

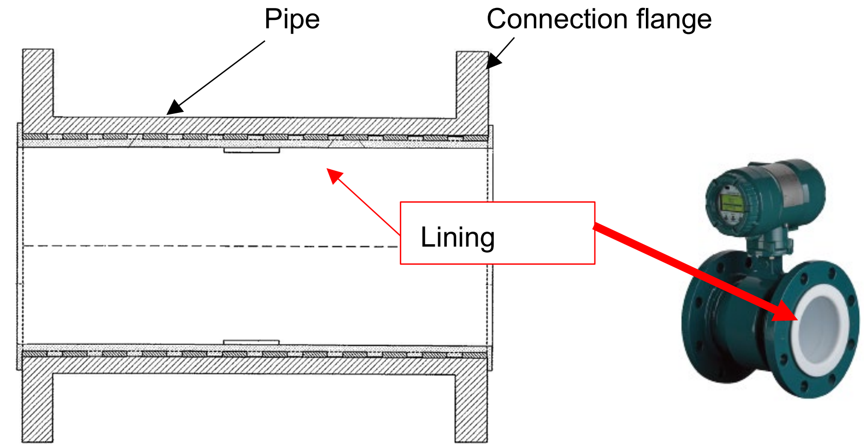


Figure 2.1.1. Coating and lining section of parts (diaphragm) in contact with fluid

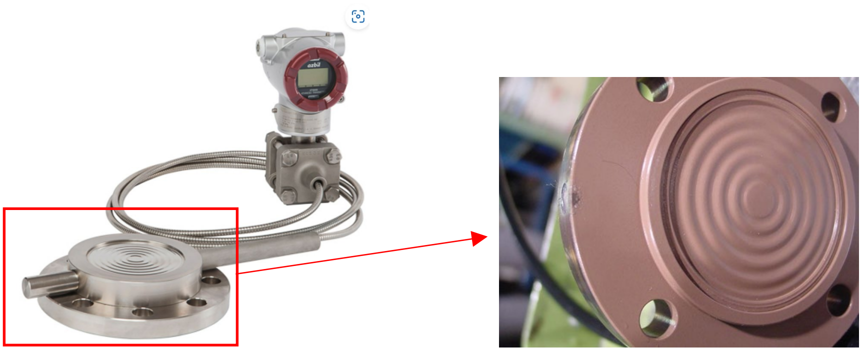


Figure 2.1.2.

PFAS functionality required by coating/lining and possible substitutions

By covering the surface with a fluoropolymer, PFAS gains chemical resistance/cleanliness and mold-releasing properties that the base material does not have. Coatings and linings in contact with fluids can withstand corrosion and operate stably without maintenance for long periods of time (10 years). For example, fluorine coatings and linings on low-hardness rubber materials provide both high flexibility and chemical resistance. When the fluid is a powder, it is difficult for the fluid to adhere to the coating/lining area due to non-adhesion of fluoropolymers.

Optical coating

A water-repellent coating layer which contains Perfluoroalkyl or perfluoropolyether compounds is formed with a thickness of less than tens of nm on the outermost surface of coating layers of the ophthalmic lens surfaces.

The water repellent coating provides superior properties such as water repellency, oil repellency, lubricity, smoothness and chemical resistance to the ophthalmic lens. These properties improve prevention of water discoloration on anti-reflection coatings, scratch resistance, ease of wiping off stains (fingerprints, sebum, etc.) on the lens surface and maintainability. As the results, these high performances enable to extend substantially the product life of lenses.

And the water-repellent coating layer is coated on anti-reflection coating layers to eliminate the ghost and flare phenomena in lens optical systems.

The one of valuable features is having both properties of low refractive index (n<=1.40) and high transparency of the coating layer which composed of perfluoroalkyl or perfluoropolyether compounds.

*1 Ghosting/flare: Reflected light generated on the lens surface is repeatedly reflected in complex ways, resulting in the appearance of light images that are not actually there. The higher the reflectivity of the lens surface, the more likely it is to appear.

*2 Anti-reflection coating: A film with a function to reduce reflected light. In ophthalmic lenses, reflection is reduced by alternately layering materials with different refractive indices to utilize light interference.

*3 Low refractive index: Since the lower the refractive index of the film of the top surface layer of an antireflection coating, the greater the effect of reducing reflections from the lens surface, a film material with a lower refractive index is required. The refractive index of general glass is 1.52, and the refractive index of base materials for eyeglass lenses is 1.50~1.90 (including plastic and glass).

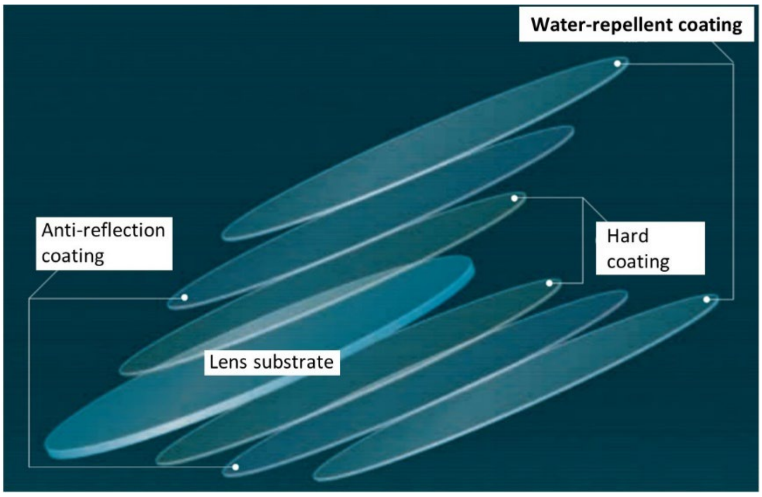


Figure 2.1.3.

Examples of Parts and Equipment Using Lining and Coating

There are a great many devices that coat base materials that come in contact with fluids.

- **Surface coating of the rubber roller (see photo below) that feeds the film in the thermal developing section of the laser imager**

A laser imager is a device that outputs various image data (general radiography, CT, MRI, etc.) taken by an X-ray machine onto DRY film, and doctors use these medical images to diagnose patients. The film with the image data output is fed by rollers. Image data is output by thermal processing (temperature 126°C), so the rollers must be heat resistant. In addition, the material generated during thermal processing adheres to the rollers, causing image defects, feeding failures, and other problems, so releasability is necessary. Therefore, fluoropolymer coated rollers with heat resistance and releasability are required. Defects in the image may result in misdiagnosis or oversight.

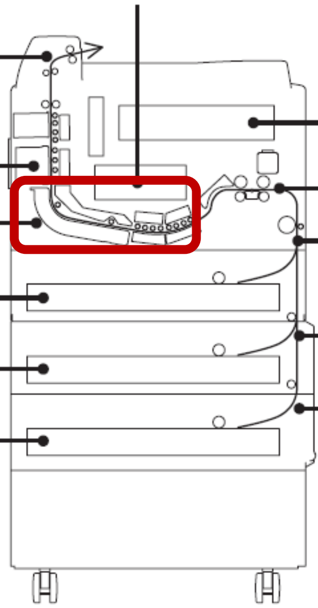


Figure 2.1.4.

◆ **Imaging Plate (IP)**

Imaging plate (IP) is an X-ray image conversion panel used in Computed Radiography (CR). When performing X-ray photography, the radiation that passes through the inspection object is temporarily recorded in the IP in the form of electronic energy distributed over the entire surface in proportion to the dose. The CR reads the X-ray information recorded in the IP and generates an X-ray image. After reading with CR, the X-ray information recorded on the IP is erased by irradiating it with white light, and the IP can be used repeatedly.

The layer structure of the imaging plate (IP) is shown in Figure 2.1.5. A phosphor is coated on a polyethylene terephthalate (PET) base approximately 350μm thick, which has excellent flatness and flexibility.

A transparent "front protective layer" is applied to the surface of the phosphor layer to prevent dirt and scratches from sticking to the phosphor layer.

Fluoropolymer is used for "front protective layer".

The role of the surface protective layer is to prevent dirt and scratches on the IP surface due to repeated transport of the IP within the CR.

Dirt and scratches on the surface of the IP will cause defects in X-ray images, making accurate diagnoses impossible. Therefore, the "front protective layer" on IP surface is required to be antifouling and low-friction.

Fluoropolymer is the only material that satisfies the following property (antifouling, low-friction) and manufacturing suitability for coating.

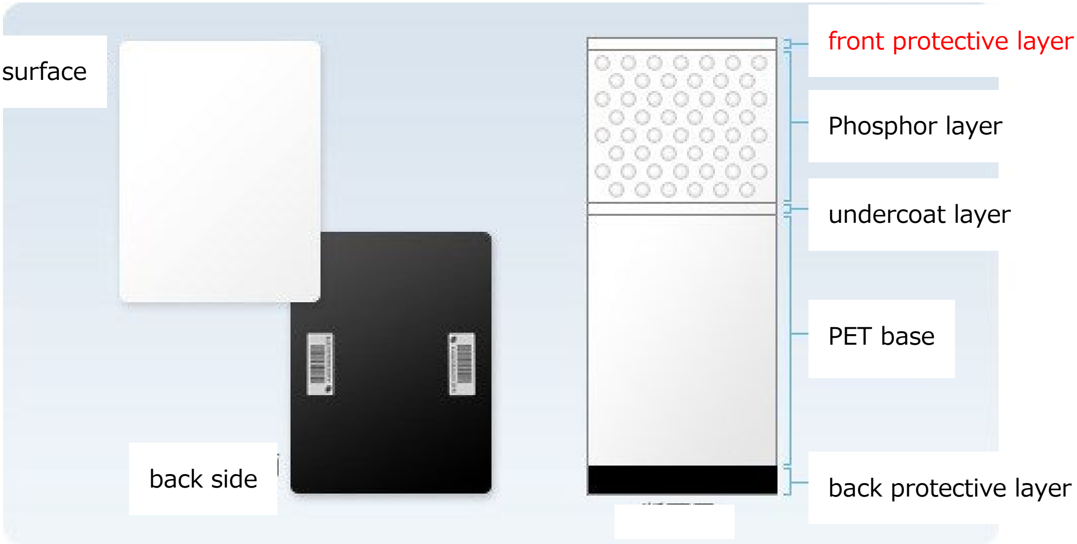


Figure 2.1.5. Imaging Plate

◆ **Computed Radiography (CR)**

PTFE is used to coat the plunger of the solenoid motor and the bobbin pipe in the mechanism that locks the IP cassette that stores IP in CR.

The durable life of CR is about 6 years. In order to achieve this, it must be durable enough to withstand 540,000 times of IP cassette loading from the assumed frequency of use of CR. PTFE's low friction property is essential, and replacing it with nickel plating reduces the durability to about 1/6, reducing the durable life of the equipment from 6 years to 1 year.

Figure 2.1.6. plunger of the solenoid motor and the bobbin pipe

◆ **Endoscope (Coating)**

- **Guidewire**

Figure 2.1.7

A guidewire used to secure the insertion route of the treatment tool when performing procedures for periods that are difficult to approach, such as the pancreatic bile duct. By coating fluoropolymer resin on the surface of a substrate such as metal, it acquires acid resistance, low friction, and non-adhesiveness that cannot be possessed by the base material alone. Biocompatibility and chemical resistance are also important characteristics for use as medical devices.

Chemical resistance is a necessary characteristic for resistance to body fluids such as stomach acid. Low friction is a characteristic necessary for smoothly guiding the treatment tool and inserting the treatment tool into the target site. Non-adhesion is a characteristic necessary for the mucous membrane and the like to not stick when inserted into a living body. There is no coating material other than fluoropolymer resin that satisfies all of these properties. Aliphatic urethane has poor low friction, and the necessary quality cannot be ensured, such as deterioration of treatment performance due to deterioration of insertability.

In addition, there is a method of using a gas such as EOG or hydrogen peroxide as a sterilization method, and since it is exposed to sterile gas, chemical resistance is a necessary characteristic. There is no material that has chemical resistance equivalent to fluoropolymer resin and has low friction.

In addition to these properties, biocompatibility is required. See "Biocompatibility" in the endoscope section of "Plumbing" for details.

- **Endoscope**

A medical device that is inserted into the body from the oral cavity to observe and treat the inside of the lumen.

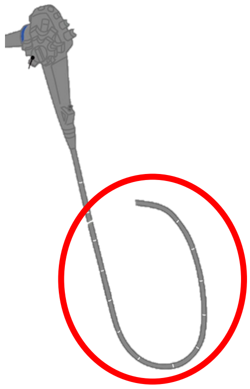


Figure 2.1.8.

By coating fluoropolymer (PTFE etc.) on the surface of base materials such as resin or rubber , chemical resistance, acid resistance, alkali resistance, heat resistance, low friction, and non-adhesiveness that cannot be possessed by the base material alone are acquired. In addition, flexibility is a necessary characteristic for insertion into complex lumens. Chemical resistance, acid and alkali resistance are necessary characteristics for disinfection and cleaning to prevent infection after use. Acid resistance is a characteristic that is also necessary for resistance to body fluids such as stomach acid. Low friction is a characteristic necessary for smooth insertion into the lumen to reduce pain. Heat resistance is a necessary characteristic to perform autoclave sterilization at 136 °C. Non-adhesiveness is a characteristic necessary for the mucous membrane and the like to not stick when inserted into a living body. There is no coating material other than fluoropolymer that satisfies all of these properties. Aliphatic urethane has poor heat resistance, chemical resistance, and low friction, and the quality of sterilization, disinfection, and cleaning decreases, increases the risk of infection, and increases patient pain. For example, in hydrogen peroxide sterilization, which is currently becoming mainstream, it has been confirmed that the coating surface easily deteriorates, and coating peeling occurs in less than half the cases compared to fluorine-based coatings.

As a sterilization method for endoscopes, there is a method of using gases such as EOG and hydrogen peroxide, and since sterile gas also penetrates the inside of the product, chemical resistance is a necessary characteristic even for internal parts. Sterilization methods are limited by the methods that can be used depending on the region, and it is not enough to be able to correspond to any one as a product, but it is necessary to be resistant to all sterilization methods. Furthermore, in metal mechanical parts such as O-rings provided on sliding parts and curved operation wires built-in, in addition to chemical resistance, low friction is required to reduce friction between members, so similarly, coatings containing fluoropolymer such as PTFE and PTFE-Ni plating are required. For example, when the coating of the operation wire is replaced with a non-PFAS member such as boron nitride, carbon, and silicone, which are general coating agents, the frictional resistance between the members increases, and the bending operation of the endoscope requires 2~5 times greater traction force than the fluorinated coating. In addition, there is molybdenum disulfide as another non-PFAS material, but although the lubrication performance is relatively excellent, it is difficult to replace it due to the risk of toxic substances generated in hydrogen peroxide sterilization. As described above, PFAS materials are indispensable because there is no material having chemical resistance equivalent to fluoropolymer and low friction.

In addition to these properties, biocompatibility is required. See "Biocompatibility" in the endoscope section of "Plumbing" for details.

1. Description: Fluoropolymers for use in medical devices Surgical Guidewire Applications

Figure 2.1.9.

2. PFAS substance(s) used: name and CAS number (If known):

PFAS substances, including but not limited,

- Poly(1,1,2,2-tetrafluoroethylene), CAS # 9002-84-0
- Perfluoro-alkoxy polymer, CAS # 26655-00-5
- Copolymer of hexafluoropropylene and tetrafluoroethylene CAS # 25067-11-2

3. It is well known that C-F bonding energy is much higher energy than C-C bonding energy, the unique crystal structure of fluoropolymers. lower surface energy, hydrophobic as well. Due to the unique microstructure structure, and hydrophobic characteristics, fluoropolymers have been used in medical device, such as endoscope with many benefits, including but not limited, i. excellent biocompatibility, biostability, and patient safety history. ii.resistant to chemical, enzyme, and microbiological attacks while eliminating biodegradation issues. iii. low co-efficient of friction allows moving parts to slide with ease, loading device effectively as well. iv. low surface energy or hydrophobic makes it nonstick material combined with its moisture barrier and chemical resistance, makes it a valuable polymer for medical device especially for physician to tackle a surgical procedure with difficulty anatomy conditions.

4. These unique chemical-physical characteristics of fluoropolymers make medical devices

safer to use for patients. However, the unique properties of fluoropolymers make them difficult to replicate with other non-fluoropolymers. For instance, to the best practices in polymer industry, the alternative materials for fluloropolymers are proposed as follows: Chlorotrifluoroethylene (E-CTFE), Ethylene Tetrafluoroethylene (ETFE), and so on and so furth. However, the proposed alternative materials are still under the umbrella of 2021 OECD definition of PFAS “Any substance that contains at least one fully fluorinated methyl (CF3-) or methylene (-CF2-) carbon atom (without any H/Cl/Br/I attached to it)”

- **Coating of surgical instruments**

The tissue gripping part consists of two parts. (Electrode member in contact with tissue and jaw holding electrode member)

Figure 2.1.10.

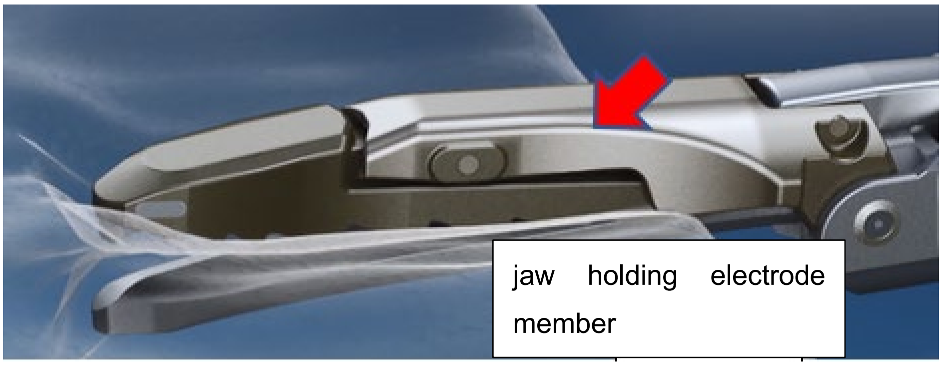


Figure 2.1.11.

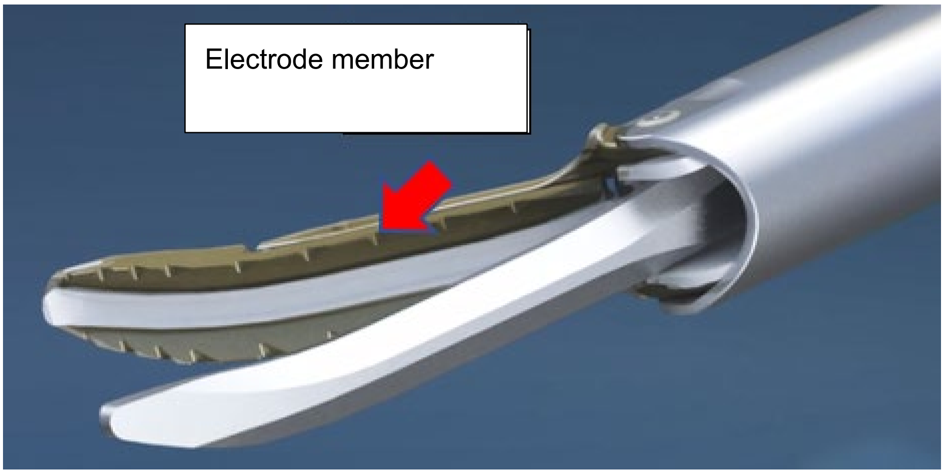


Figure 2.1.12.

Since the tissue gripping surface of the electrode part is a part where burnt tissue tends to stick very easily because of the high-frequency current being passed through it, it is especially essential for gripping surface to be non-sticking. This is because if they don't have the non-stickness, the bleeding that has been stopped will be re-bleeding due to the operation when releasing the adhesion, which is very dangerous. In addition to chemical resistance, heat resistance, electrical insulation, and low friction required for surgical treatment tools, Ni-PTFE plating is essential because mechanical properties that can withstand heat, pressure, and mechanical damage when assembling pads are required at a particularly high level and have electrical conductivity.
In order to prevent unnecessary energy from acting on the living body, the outer surface of the jaw does not conduct electricity (has insulating properties) and becomes hot due to the heat generated during treatment, so it is very important to be non-adhesion like the electrode part. PFA coating is indispensable for biocompatibility, chemical resistance, heat resistance, electrical insulation, and low friction required for surgical treatment tools.
In addition to these properties, biocompatibility is required. See "Biocompatibility" in the endoscope section of "Plumbing" for details.

◆ **Monopolar and bipolar surgical RF instruments with Halar coating**

ECTFE CAS: 25101-45-5

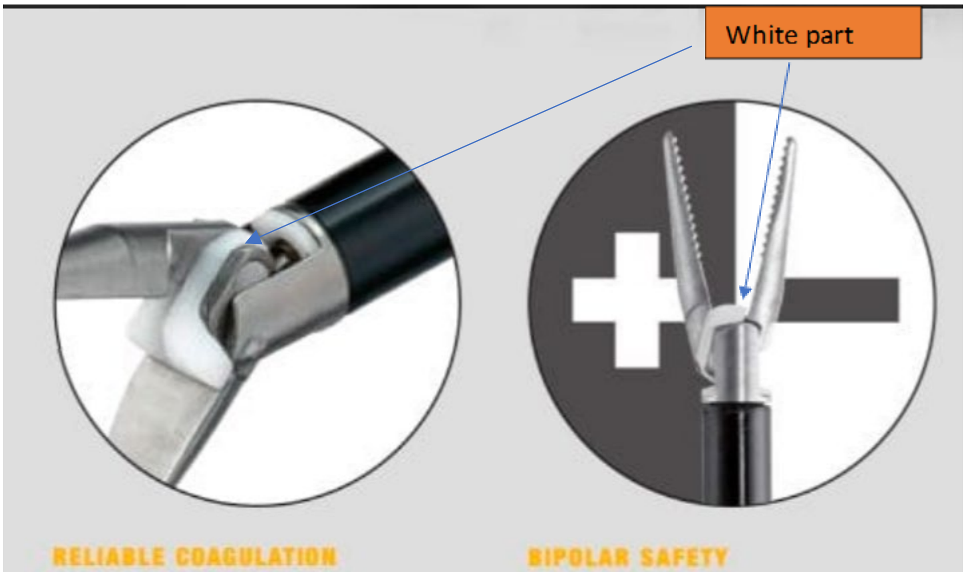


Figure 2.1.13. In below picture PFAS is used for coating for insulation

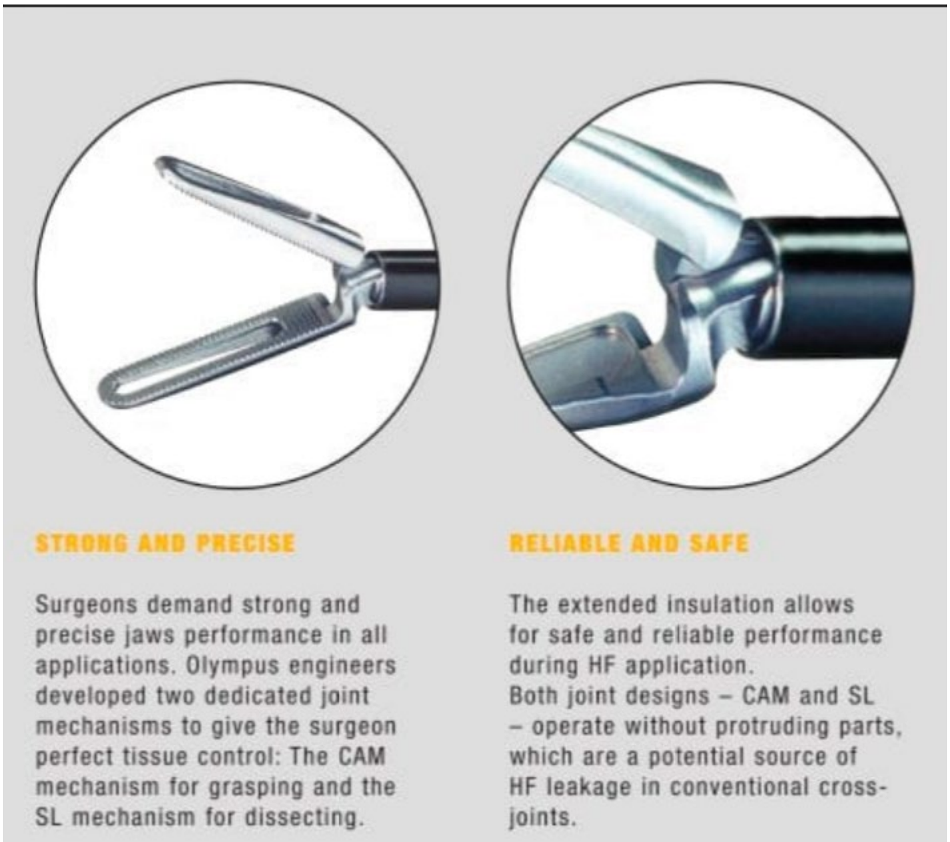


Figure 2.1.14.

Arc resistance to RF- plasma; Cleanability of surfaces; safe dielectric strength at small layer thickness; Non- Slip- Stick effect for movement; low friction for mounting in and on pipes and rods; low friction for moving parts (after cleaning cycles- grease would be removed); high temperature resistance for steam cleaning and disinfection; high chemical resistance for cleaning and disinfection (Peroxide, etc.)

PI is not flexible, has high slip- stick behavior

PEEK will burn down under RF- plasma (arc)

PET chemical resistance is to low, slip- stick behavior, non sufficient thermal stability

All Cleaning disinfection tests have to be requalified, since low surface energy of ECTFE is unmatched it can be estimated that cleaning procedures have to be harsher in the future

◆ **Anti-fog and anti-smudge coating for endoscope tip lenses**

Figure 2.1.15.

Material: Organofluorine compound

It is an organic fluorine compound and has good hydrophilicity and water repellency, so it is highly effective in preventing dirt and water droplet adhesion. Inorganic MgF_2 and SiO_2 are used as lens coatings, but they have insufficient hydrophilicity and repellency from water, and dirt and water droplets stick to the lens during diagnosis, hindering diagnosis.

◆ **Anti-reflective coating material for endoscopes**

Material: 4,5-Difluoro-2,2-bis(trifluoromethyl)-1,3-dioxole,polymer with Tetrafluoroethylene （CAS RNo：37626-13-4）

Since it is a fluorine resin and has good elasticity, it has high chemical resistance and heat resistance even when coated on the WLO resin lens part. Inorganic materials such as MgF2 and SiO2 are used as lens coatings, but their elasticity is insufficient, and in reflow resistance and reusable endoscope resistance tests, coating cracks occur on the WLO resin lens, resulting in defects.

Optical fibers are embedded inside the endoscope to transmit illumination light and images of the inside of the body. As shown in the figure below, an optical fiber consists of a core and cladding made of multi-component glass, with a coating containing PFAS (fluorinated silane coupling agent) on the outside.

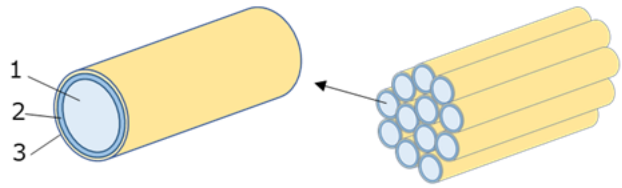


Figure. Optical fiber for endoscope
1_Core, 2_Cladding, 3_PFAS coating

Figure 2.1.16.

A PFAS coating is applied to the fiber surface to ensure chemical resistance to withstand disinfection and sterilization of the endoscope, and sliding to reduce friction between members that occurs during pulling and bending operations. As a substitute, when non-PFAS materials such as boron nitride, carbon, and silicone, which are general lubricants, are used, the frictional resistance between the fibers and other materials increases when the endoscope is repeatedly bent, and more than half of the fibers break. In the worst case, there is a risk that all the fibers break and the illumination light will not reach the body cavity during the use of the endoscope, resulting in a loss of observation, which is extremely dangerous. Molybdenum disulfide is another non-PFAS lubricant, which has relatively good lubrication performance, but it is difficult to replace molybdenum disulfide because of the risk of generating toxic substances in hydrogen peroxide sterilization, which is now becoming mainstream.

◆ **Medical Fiber Optics**

1. Fluoropolymers used in medical optical fibers for medical devices

Applications

Figure 2.1.17.

2. PFAS substance(s) used: name and CAS number (If known):
PFAS substances, including but not limited,
Poly(1,1,2,2-tetrafluoroethylene), CAS # 9002-84-0
Perfluoro-alkoxy polymer, CAS # 26655-00-5
Copolymer of hexafluoropropylene and tetrafluoroethylene CAS # 25067-11-2
Poly(ethene-co-tetrafluoroethene CAS # 25038-71-5
…

3. It is well known that C-F bonding energy is much higher energy than C-C bonding energy, the unique crystal structure of fluoropolymers, lower surface energy, hydrophobic as well. Due to the unique microstructure structure, fluoropolymers have been used in medical device, such as endoscope with many benefits, including but not limited, i. excellent biocompatibility, biostability, and patient safety history. ii.resistant to chemical, enzyme, and microbiological attacks while eliminating biodegradation issues. iii. low co-efficient of friction allows moving parts to slide with ease, loading device effectively as well. iv. low refractive index (RI), 1.3 - 1.4, makes it valuable low refractive index polymer for optical fiber application used in medical device, in which cladding materials have to be lower refractive index than core materials in order to meet total internal reflection specification through Snell's law.

4. These unique chemical-physical characteristics of fluoropolymers make medical devices safer to use for patients. However, the unique properties of fluoropolymers make them difficult to replicate with other non-fluoropolymers. For instance, to the best practices in polymer industry, the alternative materials of fluloropolymers for Polymer Optical Fiber (POF) applications are proposed as follows: Chlorotrifluoroethylene (E-CTFE), Ethylene Tetrafluoroethylene (ETFE), and so on and so furth. However, the proposed alternative materials are still under the umbrella of 2021 OECD definition of PFAS “Any substance that contains at least one fully fluorinated methyl (CF3-) or methylene (-CF2-) carbon atom (without any H/Cl/Br/I attached to it)” Silicone rubber, RI about 1.4 at 819 nm, could be proposed as an alternative substances for limited POF applications but POF need another jacket layer with lower RI materials such as fluoropolymers beyond its limitation mechanical behavior for medical optical fiber applications.

13. Ophthalmic lenses

Ophthalmic lenses are daily exposed to sunlight, rain, sweat, and washed with detergents. So, high level repellency from water and oil are required for the coating of ophthalmic lenses. PFAS-based coatings are widely used because of their excellent weatherability, low friction, and repellency from water and oil. The water-repellent coatings have been developed since the 1980s, but it is still very difficult to achieve the target performances with non-fluorine compounds. Even after more than 30 years effort, no coating without PFAS, which can pass abrasion resistance, chemical resistance, and weather resistance tests assuming everyday use, has been developed yet.

As the proposal alternatives, silicone-based water repellents are representative material, though they can achieve fluorine-based equivalents in terms of contact angle to water, they have not been able to achieve fluorine-based equivalents in terms of contact angle to oil, chemical resistance, and low refractive index.

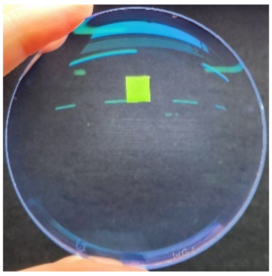
＜Test results＞
Performance comparison of fluorine-based perfluorinated polyether water-repellent coating and silicone-based polydimethylsiloxane water-repellent coating

		Perfluorinated polyether	Polydimethylsiloxane
Contact angle	To water （H_2O）	108°	104°
	To oil (Oleic acid $C_{18}H_{34}O_2$）	80°	52°
Scratch resistance	Steel wool load 500g 50 round-trip	Good	Bad
Chemical resistance	After 6hr dipping in alkali（NaOH aq. pH:11）	Good	Bad
	After 6hr dipping in acid（HNO_3 aq. pH:1）	Good	Bad

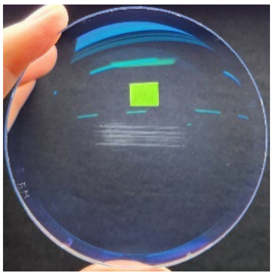
Table 2.2.1.

＜Details＞

Pictures of appearance after scratch test



perfluorinated polyether



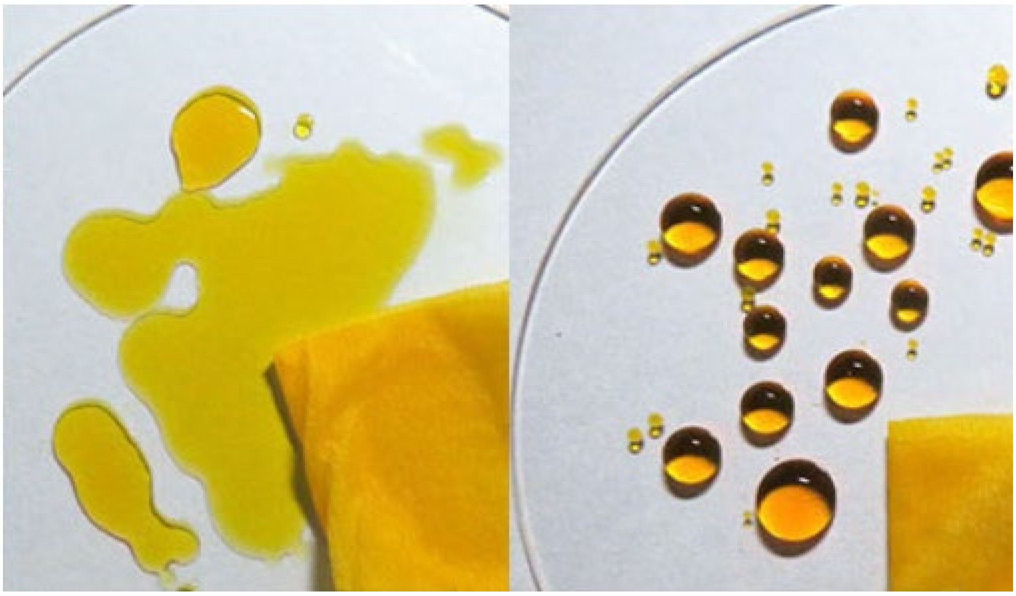
polydimethylsiloxane

Contact angle change in chemical resistance test

		Alkali		Acid	
		Water	Oleic acid	Water	Oleic acid
Perfluorinated polyether	Before	108°	80°	108°	80°
	After	105°	70°	104°	70°
Polydimethylsiloxane	Before	105°	52°	105°	52°
	After	42°	40°	48°	31°

Table 2.2.2.

Water repellent effect by coating



Without coating With Coating

Figure 2.2.1. Difference among lens with coating and without coating [2]

[2] Cannon optron https://optron.canon/ja/evaporation/pickup01.html accessed on 31 May 2023.

Period required for replacement: About 1.5 to 2 years, if a non-fluorine material with PFAS-equivalent performance is produced.
Volume of PFAS to be placed on the EU market : car camera 0.32μg/year
Amount of PFAS entering in the EU as water-repellent coating materials on ophthalmic lenses

The amount of PFAS entering the EU as water-repellent coatings on ophthalmic lenses is estimated to be 300 kg/year*1. The amount of PFAS entering the EU through water coating*2 is much smaller (1 ppm to 2 ppm) than the total amount of PFAS entering the EU through all applications (140,000 to 310,000 ton/year).

<Explanation for estimating the amount of PFAS entering the EU as water-repellent coating materials of ophthalmic lenses>.

The amount of PFAS entered in the EU as ophthalmic lenses was calculated from the product of the annual sales volume of eyeglass lenses in the EU and the amount of PFAS coated as hydrophobic coating film per lens.

1. Hypothesis

・Assume that all vision corrective spectacle lenses sold in the EU have a hydrophobic coating on both sides.

2. Estimate

1) Annual sales volume of eyeglass lenses in the EU
200,000,000 pcs/year (200 million pcs/year) *1,*2
2) Amount of PFAS per lens (both sides) **
1.5 x 10-3 g/pcs
3) Amount of PFAS entering the EU through spectacle lenses
1) × 2) = 300 kg/year
4) Total amount of PFAS entering the EU
140,000 to 310,000 tons/year *3
5) PFAS content ratio by spectacle lens
9.7E-07～2.1E-06 (1ppm～2ppm)

**The net PFAS amount a is the solid content coated as the water-repellent coatings on both sides of the lens, excluding the solvent. Assuming that the total amount a is deposited on the total number of lenses b that are put in. The amount of PFAS per lens is calculated as a/b.

Therefore, The PFASs amount entering in EU countries as water-repellent coating materials for ophthalmic lenses is much smaller than that entered in EU as other industrial application.

3. Reference

*1 WORLD LENS AND FRAME DEMAND STUDY 2022, SWV
https://www.ewintelligence.com/world-lens-and-frame-demand-study-2022/98489.article

*2 Spectacle Lenses – Europe
https://www.statista.com/outlook/cmo/eyewear/spectacle-lenses/europe

*3 ANNEX XV RESTRICTION REPORT PROPOSAL FOR A RESTRICTION, P.22/224, Socio-economic analysis, “For the EU, this resulted in an estimated amount of 140 000 to 310 000 t of PFASs introduced to the market in 2020,"
https://echa.europa.eu/documents/10162/f605d4b5-7c17-7414-8823-b49b9fd43aea

14. Membrane used for venting of medical devices

◆ **Endoscope (Electrical Contact Unit)**

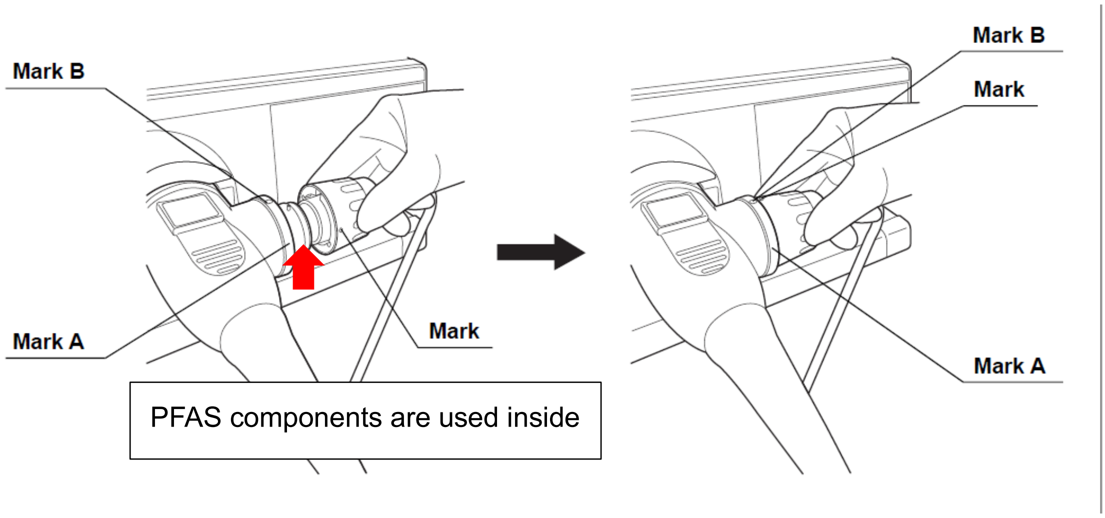


Figure 2.3.1.

In the electrical contact unit of the endoscope, ePTFE sheet is used for parts that require ventilation while waterproofing. When connecting watertight with a plug and receptacle, an air escape path is secured inside. Otherwise, high pressure will occur between the plug and the receptacle, causing poor work or damage. Since the air escape path at this time is connected to the inside of the product, waterproof performance is required as a protection of the electric parts. Therefore, by utilizing the porous structure of ePTFE, it is waterproof and moderately breathable.

There is no substitute material that is resistant to deterioration by chemicals and gases and is both waterproof and breathable.

◆ **Endoscope Reprocessor**

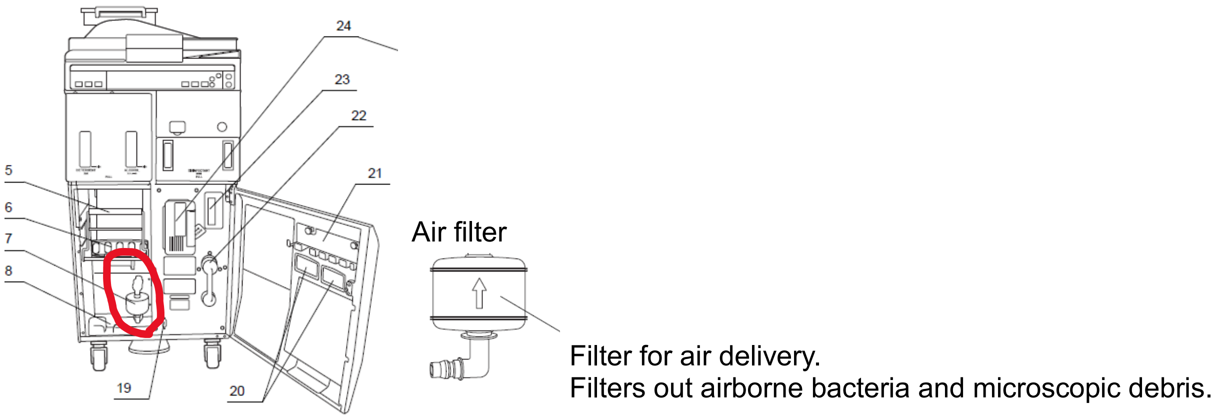


Figure 2.3.2.

After cleaning and disinfection the endoscope, a PTFE membrane filter is used as an air filter for compressed air to remove water from the endoscope channels. The filter must have filter sterilization properties (pore size of 0.2 μm) to prevent recontamination of the endoscope after cleaning and disinfection. It must have biocompatibility so that there is no risk of toxicity if debris remains the endoscope and is used in the patient.

Furthermore, for sterilization of the air filter itself, it is necessary to have heat resistance and chemical resistance that can withstand autoclaves and EtO. And it is necessary to have repellency from water so that moisture in the air that condenses during compression does not adhere to the endoscope. Fluoropolymers such as PTFE are used as materials that satisfy these characteristics. and there are no substitute materials

Figure 2.3.3.

a PTFE filter is used as a ventilation filter for disinfectant bottles such as peracetic acid solutions. Since the peracetic acid disinfectant generates peracetic acid gas over time, the gas needs to be released by the PTFE filter that is moisture-permeable and waterproof with a porous structure to prevent bursting the bottle. In addition, this filter is required to have high chemical resistance to prevent deterioration by the internal disinfectant. PTFE are used as materials that satisfy these characteristics, and there are no substitute materials.

15. Tubes and catheters in medical devices

A clarification of the scope of “tube” in the derogation would be welcomed as this should not be limited to tubes which carry liquid and gases, as the same technical requirements also apply to a broader range of uses.

- Tubes (not heat shrink tubes)
  Tubes are used for convey fluids to the places.

Figure 3.1.1.

- Joints / fittings
  Joints / fittings are components to connect tubes to units and/or tubes to tubes.

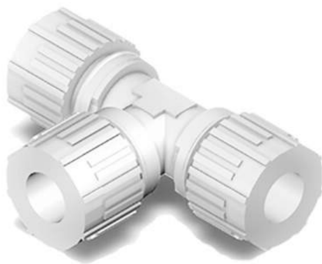


Figure 3.1.2.

- Heat shrink tubing
  By putting a thin and long object to be covered in a tube, heating it, and shrinking the tube,

the object is covered. It prevents parts from coming off or falling off, and strengthens the covered part. Fluoropolymer resin heat-shrink tubing is thin but has high electric insulation performance. PTFE and PFA are used as fluoropolymer resins.

Functions of PFAS required by heat-shrinkable tubing and availability of alternatives
Fluoropolymer resin heat-shrink tubing is thin but has high electric insulation performance. It can be used in applications where there is not enough space for electric insulation, and there is no alternative material available for applications that require tight spaces.

The functions and alternatives which tube and catheter requires:
The material of tube and catheter are determined by the types of fluids flowing through tubes. Fluoropolymers can be used as piping for fluids in the temperature range of -10°C to 200°C (PTFE) and about -40°C to 160°C (PFA), including acids, alkalis, organic solvents, ozone, and oils. Fluoropolymers (PTFE, PFA, PVDF) are the only plumbing materials that can be used when the fluids of flowing the tubes meets one or more of these characteristics.
Fluoropolymer resins are the only materials that can simultaneously provide and express multiple functions required for the proper functioning of chemical resistance/ cleanliness, repellency from water and oil, and heat resistance.

Examples of the products which incorporate "tube"

- **Endoscope**

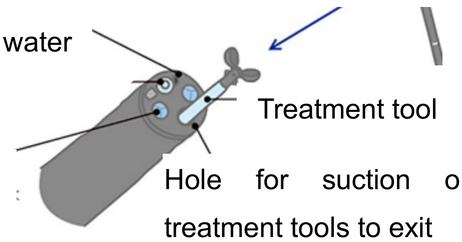


Figure 3.1.3.

A medical device that is inserted into the body from the oral cavity to observe and treat the inside of the lumen. A flow path of an air and water supply for passing water, air, or the like through a tip, a flow path of a forceps for inserting a treatment tool, and a flow path of a suction for sucking a body fluid or the like need to follow a complicated lumen shape.
Among flexible materials, chemical resistance, low friction, heat resistance, and non-adhesion are required, and PTFE and PFA are used.
Flexibility is a property necessary for insertion into complex lumens. Chemical resistance are

necessary characteristics for disinfection and cleaning to prevent infection after use.It is a necessary characteristic for resistance to body fluids such as stomach acid. Low friction is a characteristic necessary for inserting a treatment tool for collecting tissue and performing surgery in the lumen, from the operation part to the tip. Heat resistance is a necessary characteristic to perform autoclave sterilization at 136 °. Non-adhesiveness is a characteristic necessary for mucosa and the like not to stick in the flow path when inserting into a living body or sucking. PE can be mentioned as an alternative material, but it cannot be substituted because it is inferior in chemical resistance and heat resistance, so the quality of sterilization, disinfection, and cleaning is reduced, and the risk of infection increases.

In addition to these properties, biocompatibility is required. Biocompatibility means that the risk of toxicity such as allergic reactions, chronic toxicity, and genotoxicity is small.

Due to the chemical properties of fluorine compounds, the effect on living organisms is small, the purity of the material is high and the possibility of containing impurities is low, and the durability against chemical treatment is excellent and the possibility of unexpected deterioration is low.

When alternative materials other than PFAS, only bench test evaluation cannot adequately evaluate safety, and based on ISO 10993-1, biologically safe such as cytotoxicity, sensitization, irritant or intradermal reaction, systemic toxicity, subchronic toxicity, genotoxicity, implantation, hemocompatibility, etc. are evaluated again.

* Hereafter, the above idea is used for application examples for biometric contact points.

Figure 3.1.4.

In addition, the exteriors that contain these flow paths and other components inside and are inserted into the body also require chemical resistance, low friction, heat resistance, and non-adhesion in a flexible material, and PVDF (polyvinylidene fluoride) is used. The reasons for the need for each characteristic are the same as above.

◆ **Insulating tubes for surgical treatment tools**

In surgical procedures, high-frequency currents are applied to cauterize tissues and prevent bleeding. In order to cauterize only the intended portion, especially in the treatment tool called bipolar, a two-pole electrode is provided in the treatment tool. Therefore, pipes and rod-shaped members (ultrasonic drive members) serve as electrical paths, but heat shrinkable tubes by FEP are indispensable for insulating pipes and rod-shaped members and preventing short circuits in the electrical path between the two poles. In addition, in order to stabilize ultrasonic vibration, a function to attenuate unnecessary vibration is also essential.

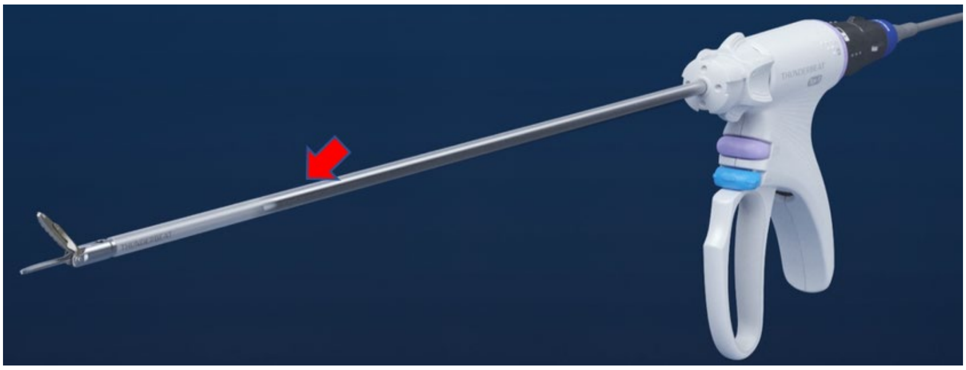


Figure 3.1.5.

This is due to the chemical resistance, heat resistance, electrical insulation, and low friction required for surgical treatment tools. In addition to these properties, biocompatibility is required. See "Biocompatibility" in the endoscope section of "Plumbing" for details.

◆ **Bipolar surgical RF instruments**

PFAS CAS: 30525-89-4

Figure 3.1.6

Arc resistance to RF- plasma; Cleanability of surfaces; safe dielectric strength at small layer thickness; Non- Slip- Stick effect for movement; low friction for moving parts (after cleaning cycles- grease would be removed); heat resistance for steam cleaning and disinfection; high chemical resistance for cleaning and disinfection (Peroxide, etc.)
PI is not flexible, has high slip- stick behavior
PEEK will burn down under RF- plasma (arc)
PET chemical resistance is to low, slip- stick behavior, non sufficient heat resistance
There is no hazard and exposure risk. All materials in contact are controlled via ISO 10993. This product is single used
All Cleaning disinfection tests have to be requalified, since low surface energy of PFA is unmatched it can be estimated that cleaning procedures have to be harsher in the future

- **Endoscopic treatment tool**

Figure 3.1.7.

A medical device for performing endoscopic procedures. In order to insert into the channel of the endoscope inserted into the body, it is necessary to follow the complex shape, and among flexible materials, PTFE and PFA are used because of their acid resistance, low friction, heat resistance, and non-adhesiveness requirements.
Flexibility is a property necessary for insertion into complex lumens. Acid resistance is a necessary characteristic for resistance to body fluids such as stomach acid. Low friction is a characteristic necessary for insertion into the endoscope channel to the distal end. Heat resistance is a necessary property in devices that use high-frequency energy to prevent damage to the device or/and endscopes during treatment. Non-adhesiveness is a characteristic necessary for mucosa and the like not to stick in the flow path when inserted into a living body or sucked.
PE can be mentioned as an alternative material, but since it is inferior at least in low friction, the treatment property is reduced due to the deterioration of insertability, so it cannot be substituted.
In addition to these properties, biocompatibility is required. See "Biocompatibility" in the endoscope section of "Plumbing" for details.

1. Description: Fluoropolymers for use in medical devices Endoscope Applications

2. PFAS substance(s) used: name and CAS number (If known):
PFAS substances including but not limited,
Poly(1,1,2,2-tetrafluoroethylene), CAS # 9002-84-0
Perfluoro-alkoxy polymer, CAS # 26655-00-5
Copolymer of hexafluoropropylene and tetrafluoroethylene CAS # 25067-11-2

3. It is well known that C-F bonding energy is much higher energy than C-C bonding energy, the unique crystal structure of fluoropolymers, lower surface energy, hydrophobic as well. Due to its unique microstructure structure, and repellency from water, fluoropolymers have been used in medical device, such as endoscope with many benefits, including but not limited, 1. excellent biocompatibility, biostability, and patient safety history. 2.resistant to chemical, enzyme, and microbiological attacks while eliminating biodegradation issues. 3. low friction allows moving parts to slide with ease, generating less heat, and undergoing less wear and tear. 4. low surface energy or hydrophobic makes it non-adhesion material combined with its moisture barrier and chemical resistance, makes it a valuable polymer for medical device industry especially for patient safety with reusable endoscope application which involves cleaning and disinfecting the devices so that they can be reused.

4. These unique chemical-physical characteristics of fluoropolymers make medical devices safer to use for patients. However, the unique properties of fluoropolymers make them difficult to replicate with other non-fluoropolymers. For instance, To the best practices in polymer industry, the alternative materials for fluloropolymers are proposed as follows: Chlorotrifluoroethylene (E-CTFE), Ethylene Tetrafluoroethylene (ETFE), and so on and so furth. However, the proposed alternative materials are still under the umbrella of 2021 OECD definition of PFAS “Any substance that contains at least one fully fluorinated methyl (CF3-) or methylene (-CF2-) carbon atom (without any H/Cl/Br/I attached to it)” Silicone rubber could be proposed as an alternative substances for certain applications but not suitable for endoscope application because of its higher on coefficient of friction, especially to tackle a surgical procedure with difficulty anatomy conditions.

◆ **Tube-shaped instruments and parts**

A grace period has been established for the use of Fluoropolymers and fluoroelastmers in catheters and tubes (6c). Catheter-based procedures require tubular components other than catheters itsself, such as Introducer Sheaths. Many of them require surface lubricity, biocompatibility, kink resistance, pushability, etc., similar to catheters, and hence tube-shaped instruments and parts should be included in 6c (Tubes and catheters in medical devices).

For example, ETFE is widely used in Introducer Sheaths, with 2-3 kg consumed annually in Europe. Although the same shape can be made from polyolefin/nylon materials, the risk of medical accidents due to kinking or rupture increases due to the difference in material properties. To avoid kinking and rupture, it is possible to increase the outer diameter (wall thickness) or use other polymers, but this not only makes operation difficult, but also has a negative impact on hemostasis and patient invasiveness, as the wound becomes larger. For the benefit of healthcare professionals and patients, ETFE are necessary.

◆ **Catheters and their manufacturing processes**

Heat shrink tubing, such as PFA, is used in the catheter manufacturing process, and no other polymers have been found to replace it. After placing a shrink tubing over the two different polymer materials coated on the core wire, and then heating them, the two polymers in the lower layer can be crimped and fused together. As a result, high-performance catheters with graded physical properties consisting of two different materials can be manufactured.
Since PFA shrink tubing has excellent heat resistance and easy peel property, it can be fused to the underlying materials each other without melting upon heating, and can be easily peeled off after the heating process.

Shrink tubing made of fluoropolymers used in the catheter manufacturing process should be registered as new application information or included in the scope of 6c tubes and catheters in medical devices.

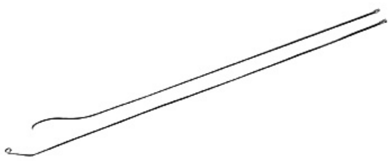


Figure 3.1.8. catheter

◆ **Tube for implantable medical devices**

Description: Fluoropolymers for use in medical devices Implants Applications
ENT –Myringotomy Ventilation Tube Application

Figure 3.1.9.

PFAS substance(s) used: name and CAS number (If known):
PFAS including but not limited,
Poly(1,1,2,2-tetrafluoroethylene), CAS # 9002-84-0
Perfluoro-alkoxy polymer, CAS # 26655-00-5
Copolymer of hexafluoropropylene and tetrafluoroethylene CAS # 25067-11-2
Poly (ethene-co-tetrafluoroethene CAS # 25038-71-5

It is well known that C-F bonding energy is much higher energy than C-C bonding energy, the unique crystal structure of fluoropolymers, low surface energy, hydrophobic as well. Due to its unique microstructure structure, and hydrophobic characteristics, fluoropolymers have been used in medical device, such as implants with many benefits, including but not limited, i. excellent biocompatibility, biostability, and patient safety history. ii.resistant to chemical, enzyme, and microbiological attacks while eliminating biodegradation issues makes it a valuable polymer for some implant applications.

These unique chemical-physical characteristics of fluoropolymers make medical devices safer to use for patients. However, the unique properties of fluoropolymers make them difficult to replicate with other non-fluoropolymers. For example, to the best practices in polymer industry, the alternative materials for fluloropolymers are proposed as follows: Chlorotrifluoroethylene (E-CTFE), Ethylene Tetrafluoroethylene (ETFE), and so on and so furth. However, the proposed alternative materials are still under the umbrella of 2021 OECD definition of PFAS "Any substance that contains at least one fully fluorinated methyl (CF3-) or methylene (-CF2-) carbon atom (without any H/Cl/Br/I attached to it)" Silicone rubber could be proposed as an alternative substances for implants applications but with certain limitation beyond its mechanical properties.

16. Lubricants where the use takes place under harsh conditions or the use is needed for safe functioning and safety of equipment

Lubricating oil is used to control friction and wear of metal contacting parts when machines are combined to rotate, reciprocate, or otherwise operate. In addition to suppressing friction and wear, this oil also suppresses corrosion and frictional heat, and its sealing and cleaning properties allow the machine to operate smoothly.

Lubricating oil formulated with PFAS have the following characteristics

・Low friction: Reduces the adverse effects of friction on the lifetime and performance of components.

・Heat resistance: Resistance to chemical changes even when used in high-temperature environments. Resistance to ignition.

・Weatherability: Excellent oxidation stability and resistance to adverse effects of oxygen. Not decomposed by moisture.

・Chemical resistance: Resistant to chemicals such as acids and alkalis.

・Chemical resistance/cleanliness: Almost no deterioration of rubber and plastic materials.

There is no other lubricant besides fluorinated synthetic lubricants that can satisfy all of the above characteristics.

Lubricants in the products.

◆ **lubricant for endoscope**

In the inside of the driving part, grease mixed with PTFE and graphite fluoride are used to ensure low friction while having chemical resistance and heat resistance. As a sterilization method, there is a method using gases such as EOG and hydrogen peroxide, and since sterile gas also penetrates the inside of the product, chemical resistance is a necessary characteristic even for internal parts. Sterilization methods are limited by the methods that can be used depending on the region, and it is not enough to be able to correspond to any one as a product, but it is necessary to be resistant to all sterilization methods. In grease which does not contain PTFE as a thickener, it cannot be sterilized because of insufficient chemical resistance. In addition, molybdenum disulfide can be mentioned as an alternative to graphite fluoride, but this is also inferior in chemical resistance, so it cannot be sterilized and cannot be substituted.

17. Diagnostic laboratory testing

Piping materials, rubber materials, and sealing materials containing PFAS for high-precision dispensing in automatic clinical immunoassay analyzers and chemistry analyzers

Automatic clinical immunoassay analyzers and automatic clinical chemistry analyzers (hereinafter collectively called, "Automatic Analyzers") are a type of In-vitro Diagnostics (IVD) and Class A in-vitro diagnostic medical device under in-vitro diagnostic device regulation (IVDR). They are devices used to measure components in samples, primarily serum, plasma, and urine collected from human bodies, by producing luminescence or color reaction by mixing these samples with in-vitro diagnostic reagents. The result data are used by physicians to understand the health conditions of patients and may be provided to the patients as the results of medical checkups.

In recent years, Automatic Analyzers are required to operate at a faster speed to quickly produce results, maintain stable operation without stopping to respond to sudden orders, and ensure high accuracy in obtaining correct results. The performance of each function in the Automatic Analyzers, such as dispensing of samples and reagents and cleaning of on-board units to keep the cleanliness of the device, must be steadily maintained. Therefore, the materials including piping materials used for such functions require high chemical stability and mechanical strength.

Example 1: Piping materials for sample and reagent dispensing units

Currently, many Automatic Analyzers adopt pipetting-based dispensing methods, by which samples and in vitro diagnostic reagents are transferred respectively from blood collection tubes and reagent bottles to the cuvettes on the Automatic Analyzer for measurement. For those applications that come in direct contact with the fluids, disposable resin tips are often used for samples, which require contamination avoidance, while metal nozzles, such as those made of SUS (stainless steel), are adopted as reagent probes, which require durability to sustain repeated washing. While these locations are exposed to open air and are typically designed for periodical replacement, the piping that connects the tips and nozzles to the dispensing and aspiration pumps is usually located deep inside the device. Such piping is not easily replaceable, so it must be resistant to aging and external thermal and chemical disturbances. Furthermore, they are expected to possess pressure and bending resistance to accommodate high-speed operations pursued in recent years. The performance of such piping is expected to be maintained, at least, as long as the life of the device. In order to achieve these requirements, PTFE, PFA, and PVDF, which are types of perfluorinated polymers, are commonly adopted.

Consideration of non-PFAS alternative materials for Example 1)

One of the alternatives to PTFE, PFA, and PVDF as piping materials is Poly Ether Ether Ketone (PEEK). PEEK is believed to demonstrate excellent performance in terms of thermal and chemical stability along with pressure resistance. However, it does not have enough bending resistance, making it unsuitable for use with a driving part. PEEK also lacks flexibility, which makes it difficult for use in the joints between the piping and tips as well as the piping and pumps, which require high sealing integrity. To address these limitations, a different type of resin piping must be explored. While it may not be impossible, it would take a long time from the initial elemental study to the realization of the devices.

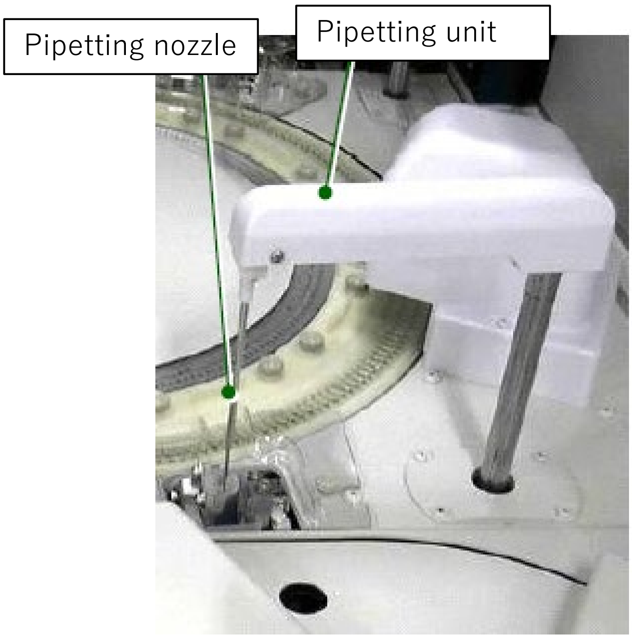


Figure 3.3.1. Example of the pipetting unit on the Automatic Analyzer

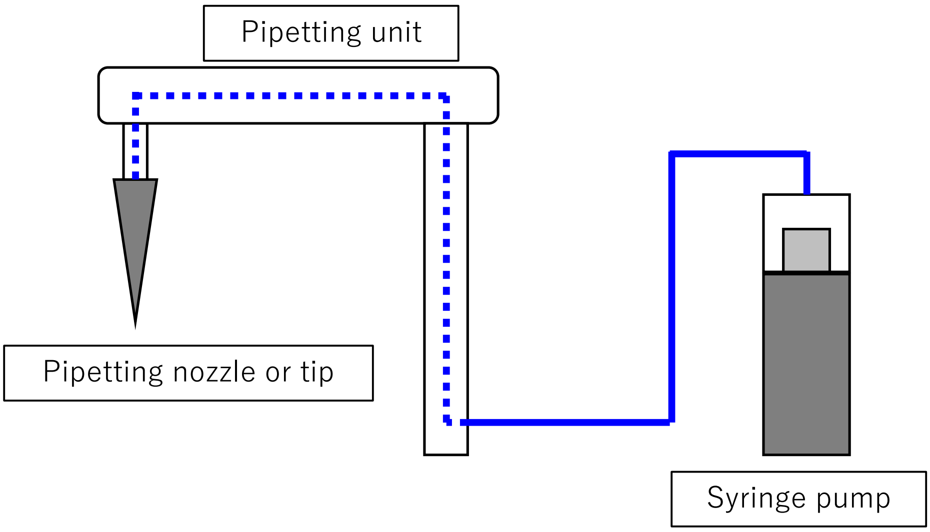


Figure 3.3.2. Schematic diagram of the piping example between the pipetting unit and the pump (The blue lines represent the piping)

The piping must possess high-pressure resistance so that it would not expand or contract under high-speed aspiration and dispensing by syringe pumps while accurately transmitting pressure without rupturing. In addition to flexibility as the piping inside the fast-moving pipetting unit, it must have elasticity as a resin to maintain high sealing integrity at joints with syringe pumps during pressurization and depressurization. Moreover, the material used for piping must be chemically resistant to fluids flowing through the pipe, such as pure water, samples, reagents, and cleaning agents. To fulfill all these requirements, PFAS tubes such as PTFE are currently adopted.

Example 2) Rubber material for solenoid valves and pumps for device cleaning

Currently, many Automatic Analyzers include some kind of components that are repeatedly used by being washed with water and cleaning agents. One of the examples is reaction cuvettes on a clinical chemistry analyzer. The reaction cuvettes are small temporary containers installed on the device. Each sample is dispensed into one of the cuvettes and mixed with reagents before being measured by the spectrophotometer. The cuvette is washed with cleaning agents after each measurement and repeatedly used. Pumps and solenoid valves must be equipped to drain wash water and cleaning agents. In many cases, a type of fluoroelastomer called FKM is used for their valves, diaphragm, and O-rings for sealing. The cleaning agents used for Automatic Analyzers are often strong-alkaline and contain surfactants to effectively clean mainly proteins and lipids present in samples such as serum. It is essential for the material to have excellent chemical resistance to withstand the conditions, making FKM an optimal selection for such applications.

Consideration of non-PFAS alternative materials for Example 2)

One of the materials that can be considered as an alternative to FKM as rubber material for pumps and solenoid valves is EPDM. FKM and EPDM demonstrate similar properties in terms of mechanical strength and chemical resistance under the presence of strong-alkaline fluids. However, EPDM is less resistant to acid fluids and has a risk of being broken when, for example, an acid cleaning agent is used to remove calcium scale deposited inside the Automatic Analyzers. Furthermore, FKM and EPDM have different compatibilities with various surfactants, making it challenging to select rubber material that stays stable with any alkaline, acid fluids and surfactant. The selection of materials must be based on the specific application and the type of fluids that come into contact with them. It is difficult to completely exclude FKM from the use in terms of a wide range of resistance to alkaline and acid fluids as well as many surfactants normally contained in cleaning agents.

Example 3) Thread sealing tape for various piping seals inside the device

Currently, many Automatic Analyzers include some kind of components that are repeatedly used by being washed with water and cleaning agents. One of the examples is reaction cuvettes on the clinical chemistry analyzer. Reaction cuvettes are small temporary containers installed on the device. Each sample is dispensed into one of the cuvettes and mixed with reagents before being measured by the spectrophotometer. The cuvette is washed with cleaning agents after each measurement and repeatedly used. A fluid control system, including pumps and solenoid valves, must be equipped to drain wash water and cleaning agents. PTFT thread sealing tape is used to seal the pipe fitting joints in the fluid control system. The cleaning agents used for Automatic Analyzer are often strong-alkaline and contain surfactants to effectively clean mainly proteins and lipids present in samples such as serum. Therefore, the sealing tape must have high chemical resistance and excellent performance in sealing off highly permeable cleaning agents. Consequently, PTFE thread sealing tape is often adopted for this purpose.

Consideration of a non-PFAS alternative material for Example 3)
Considering the use purpose of PTFE thread sealing tape as a sealing for pipe fitting joints, a possible option would be adhesive, or a method like welding.

However, they share a common drawback, which is the fact that their sealing is semi-permanent fixing. The fact makes them unsuitable for parts that require periodical replacement. Since the pipes in Automatic Analyzers, especially those that use PTFE thread sealing tape and have the cleaning agents running inside, have a chemical mixture of gas and fluid constantly flowing inside, they are always exposed to the risk of damage by fluid friction and need to be replaced when worn. Therefore, semi-permanent fixing is not practical.

When attempting to use an adhesive (including “liquid/paste pipe thread sealants without PFAS are available” mentioned in ”PTFE thread sealing tape” under E.2.13.2.7. Alternatives to fluoropolymers and PFPEs in building/construction mixtures and articles” of “ANNEX XV RESTRICTION REPORT”), the chemical resistance of the adhesive itself needs to be examined. Epoxy-based and silicone-based adhesives, for example, have comparatively good chemical resistance, but most of them are not resistant to strong-alkaline solutions containing surfactants. Therefore, they do not serve the purpose.

Currently, there are few sealing tapes available in the market that are not PTFE and not of semi-permanent fixing. There is a product such as a “high-temperature carbon-based sealing tape”, for example. However, it is not suitable as an alternative because the product is not widely available on the market and contains adhesive, making it inferior in chemical resistance. There are no other viable options at the moment.

Moreover, the “silicone-based thread-seal tapes” mentioned in ”PTFE thread sealing tape” under E.2.13.2.7. Alternatives to fluoropolymers and PFPEs in building/construction mixtures and articles” of “ANNEX XV RESTRICTION REPORT” seem to be referring to a product intended for covering basically the outside of pipe joints or repairing damaged pipes from the outside, such as Self-Fusing Silicone tape HDT2 from 3M Company. They do not share the same use purpose with PTFE thread sealing tape for sealing joints (mostly threaded portions) between a fluid control system and pipe fitting, and therefore they are not suitable as alternatives.

Based on the discussions above, if the restriction is imposed on the use of fluoropolymers and fluoroelastomer, there is a possibility that Automatic Analyzers may disappear from the European market, potentially affecting the provisions of medical service to European citizens.

RECEIVED
By: OAH on 3/1/2024
Matthias Peters Attachment

TRELLEBORG

1 March 2024

Trelleborg Sealing Solutions feedback to the planned New Rules Governing Currently Unavoidable Use Determinations about Products containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837 of the Minnesota Pollution Control Agency (MCPA)

Submission in general:

To begin we would like to thank the Minnesota Pollution Control Agency for the opportunity to contribute comments to the Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837! Trelleborg Sealing Solutions as a downstream user, produces seals and polymer bearings for machines and equipment for an unimaginable segment of the entire society. These segments are both industrial as well as professional.

Fluoropolymers and fluoroelastomers are critical and essential contribution to all of society include:

- **Human and environmental health and safety** e.g.
  - Defense
  - Avoidance of major accidents
  - Chemical industry
  - Nuclear powerplants
  - Avoid catastrophes
- **Supply of** for instance
  - Energy
  - Food,
  - Drinking water
  - Raw materials
- **Healthcare** e.g.
  - Pharmaceuticals
  - Medical devices
- **Minimized energy consumption and prolonged maintenance cycles of a vast range of equipment and installations**

In general, customer requirements determine the nature of the materials used for the seals and bearings we manufacture. In cases of demanding conditions, ranging from very to extremely, of use by our customers fluoropolymers and fluoroelastomers represent the only choice. Fluoroelastomers and fluoropolymers possess unique properties. Properties such as: low coefficient of friction, chemical compatibility, wide temperature range for use (low to high), mechanical properties allowing high surface speeds, practically non-ageing, and compatibility regarding electron and gamma radiation. It is these unique properties that represent absolute prerequisites for many specific segment requirements. It is only when these unique properties are extremely essential, that fluoroelastomers and fluoropolymers are utilized. The high price of fluoroelastomers and fluoropolymers alone ensures that use of these materials is minimized. This fact drastically reduces the use of fluoroelastomers and fluoropolymers as well as human exposure and emissions to the environment. Additionally, the fluoroelastomers and fluoropolymers used in our products, meet OECD-criteria of “polymers of low concern.” They are neither bioavailable, water-soluble, or toxic. In essence, fluoropolymers and fluoroelastomers are safe for their intended uses.

Along with the previously mentioned, fluoropolymers and fluoroelastomers are in general, critical for innovation and for sustainability! Aims of many strategic initiatives of the United States of America like the Carbon Reduction Program, the Chips and Science Act and the Digital Government Strategy are simply impossible without the use of fluoropolymers and fluoroelastomers. For these reasons we seek for a formal time unlimited determination of Currently Unavoidable Uses (CUU) for all fluoropolymers and fluoroelastomers according to Minnesota Session Laws - 2023, Regular Session Sec. 21. [116.943] Products containing PFAS. This time unlimited determination must include all monomers and processing aids needed for manufacturing of all fluoroelastomers and fluoropolymers. The actions as mentioned above would contribute in a more than reasonable manner to limit the proposed restriction of PFAS and assure the standard and quality of living and future opportunities of the entire society.

Alternatives for fluoroelastomers and fluoropolymers do not exist! Consequences of a total ban of fluoroelastomers and fluoropolymers for uses of manufacturing of seals, bearings and many other products would be dramatic! This ban will greatly affect the standard and quality of living. Future opportunities of the entire society will be lost! A restriction or even ban of fluoroelastomers and fluoropolymers as irreplaceable materials would catapult us all back into the Middle Ages!

Submission in detail

1) Should criteria be defined for “essential for health, safety, or the functioning of society”? If so, what should those criteria be?

We fully agree with the position that has been expressed many times by leading global (business) associations that the idea to define uses essential for health, safety, or the functioning of society represents a departure from the current risk-based regulatory approach and poses a number of challenges and potential risks such as unclear definitions, substitution by less sustainable alternatives or delay in regulatory decisions. In case Minnesota Pollution Control Agency (MCPA) insists on implementing the idea to define uses essential for health, safety, or the functioning of society into state legislation it is therefore paramount to ensure the possible integration of this idea in a way that can enhance the system’s ability to regulate harmful substances without putting breaks on much needed innovation and competitiveness of industry.

We would like to clearly mention that the mere presence of a hazardous substance in a process or product is not a sufficient reason to apply the “essentiality” assessment. The idea to define uses essential for health, safety, or the functioning of society could therefore be a valid solution only if applied in a targeted manner, i.e., in case of proven risks to the health and environment, difficulties in managing these risks and if no acceptable alternatives or substitutes exist.

It is widely understood that chemical, physical and (eco-)toxicological properties of PFAS can vary greatly between the more than 10,000 PFAS. OECD recognizes the diversity of PFAS as a chemical class with diverse molecular structures and physical, chemical and biological properties. They state that their proposed PFAS definition “is based only on chemical structure, and the decision to broaden this definition is not connected to decisions on how PFAS should be grouped and managed in regulatory and voluntary actions”.

We are a downstream user producing seals and polymer bearings for machines and equipment for an unimaginable segment of the entire society. The fluoroelastomers and fluoropolymers used in our products, meet OECD-criteria of “polymers of low concern.” They are neither bioavailable, water-soluble, or toxic. In essence, fluoropolymers and fluoroelastomers are safe for their intended uses so that there is no risk as well as no reason to restrict or even ban fluoroelastomers and fluoropolymers at all!

Alternatives for fluoroelastomers and fluoropolymers do not exist! Consequences of a total ban of fluoroelastomers and fluoropolymers for uses of manufacturing of seals, bearings and many other products would be dramatic! This ban will greatly affect the standard and quality of living. Future opportunities of the entire society will be lost! A restriction or even ban of fluoroelastomers and fluoropolymers as irreplaceable materials would catapult us all back into the Middle Ages!

2) Should costs of PFAS alternatives be considered in the definition of “reasonably available”? What is a “reasonable” cost threshold?

To our best knowledge and understanding this is not applicable to our activities as we as a downstream user, producing seals and polymer bearings for machines and equipment for an unimaginable segment of the entire society. The fluoroelastomers and fluoropolymers used in our products, meet OECD-criteria of “polymers of low concern.” They are neither bioavailable, water-soluble, or toxic. In essence, fluoropolymers and fluoroelastomers are safe for their intended uses so that there is no risk as well as no reason to restrict or even ban fluoroelastomers and fluoropolymers at all!

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3) **Should unique considerations be made for small businesses with regards to economic feasibility?**

To our best knowledge and understanding this is not applicable to our activities as we as a downstream user, producing seals and polymer bearings for machines and equipment for an unimaginable segment of the entire society. The fluoroelastomers and fluoropolymers used in our products, meet OECD-criteria of "polymers of low concern." They are neither bioavailable, water-soluble, or toxic. In essence, fluoropolymers and fluoroelastomers are safe for their intended uses so that there is no risk as well as no reason to restrict or even ban fluoroelastomers and fluoropolymers at all!

Alternatives for fluoroelastomers and fluoropolymers do not exist! Consequences of a total ban of fluoroelastomers and fluoropolymers for uses of manufacturing of seals, bearings and many other products would be dramatic! This ban will greatly affect the standard and quality of living. Future opportunities of the entire society will be lost! A restriction or even ban of fluoroelastomers and fluoropolymers as irreplaceable materials would catapult us all back into the Middle Ages!

4) **What criteria should be used to determine the safety of potential PFAS alternatives?**

To our best knowledge and understanding this is not applicable to our activities as we as a downstream user, producing seals and polymer bearings for machines and equipment for an unimaginable segment of the entire society. The fluoroelastomers and fluoropolymers used in our products, meet OECD-criteria of "polymers of low concern." They are neither bioavailable, water-soluble, or toxic. In essence, fluoropolymers and fluoroelastomers are safe for their intended uses so that there is no risk as well as no reason to restrict or even ban fluoroelastomers and fluoropolymers at all!

Alternatives for fluoroelastomers and fluoropolymers do not exist! Consequences of a total ban of fluoroelastomers and fluoropolymers for uses of manufacturing of seals, bearings and many other products would be dramatic! This ban will greatly affect the standard and quality of living. Future opportunities of the entire society will be lost! A restriction or even ban of fluoroelastomers and fluoropolymers as irreplaceable materials would catapult us all back into the Middle Ages!

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Schockenriedstraße 1, 70565 Stuttgart, Tel: +49 (0)711 7864 0
Geschäftsführer: Carsten Stehle (Vors.), Jennifer Ruffler, Dr. Thomas Uhlig
Sitz und Registergericht Stuttgart HRB 21275, Tax ID: DE 119553041, www.trelleborg.com/seals/de

5) How long should PFAS currently unavoidable use determinations be good for?

In general, customer requirements determine the nature of the materials used for the seals and bearings we manufacture. In cases of demanding conditions, ranging from very to extremely, of use by our customers fluoropolymers and fluoroelastomers represent the only choice.

Fluoroelastomers and fluoropolymers possess unique properties such as:

- **low coefficient of friction**
- **chemical compatibility**
- **wide temperature range for use (low to high)**
- **mechanical properties allowing high surface speeds**
- **practically non-ageing**
- **compatibility regarding electron and gamma radiation.**

It is these unique properties that represent absolute prerequisites for many specific segment requirements. It is only when these unique properties are extremely essential, that fluoroelastomers and fluoropolymers are utilized. The high price of fluoroelastomers and fluoropolymers alone ensures that use of these materials is minimized. This fact drastically reduces the use of fluoroelastomers and fluoropolymers as well as human exposure and emissions to the environment. Additionally, the fluoroelastomers and fluoropolymers used in our products, meet OECD-criteria of “polymers of low concern.” They are neither bioavailable, water-soluble, or toxic. In essence, fluoropolymers and fluoroelastomers are safe for their intended uses.

Along with the previously mentioned, fluoropolymers and fluoroelastomers are in general, critical for innovation and for sustainability! Aims of many strategic initiatives of the United States of America like the Carbon Reduction Program, the Chips and Science Act and the Digital Government Strategy are simply impossible without the use of fluoropolymers and fluoroelastomers. For these reasons we seek for a formal time unlimited determination of Currently Unavoidable Uses (CUU) for all fluoropolymers and fluoroelastomers according to Minnesota Session Laws - 2023, Regular Session Sec. 21. [116.943] Products containing PFAS. This time unlimited determination must include all monomers and processing aids needed for manufacturing of all fluoroelastomers and fluoropolymers. The actions as mentioned above would contribute in a more than reasonable manner to limit the proposed restriction of PFAS and assure the standard and quality of living and future opportunities of the entire society.

6) How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

To our best knowledge and understanding this is not applicable to our activities as we as a downstream user, produce seals and polymer bearings for machines and equipment for an unimaginable segment of the entire society. The fluoroelastomers and fluoropolymers used in our products, meet OECD-criteria of “polymers of low concern.” They are neither bioavailable, water-soluble, or toxic. In essence, fluoropolymers and fluoroelastomers are safe for their intended uses so that there is no risk as well as no reason to restrict or even ban fluoroelastomers and fluoropolymers at all!

For these reasons we seek for a formal time unlimited determination of Currently Unavoidable Uses (CUU) for all fluoropolymers and fluoroelastomers according to Minnesota Session Laws - 2023, Regular Session Sec. 21. [116.943] Products containing PFAS. This time unlimited determination must include all monomers and processing aids needed for manufacturing of all fluoroelastomers and fluoropolymers. The actions as mentioned above would contribute in a more than reasonable manner to limit the proposed restriction of PFAS and assure the standard and quality of living and future opportunities of the entire society.

Alternatives for fluoroelastomers and fluoropolymers do not exist! Consequences of a total ban of fluoroelastomers and fluoropolymers for uses of manufacturing of seals, bearings and many other products would be dramatic! This ban will greatly affect the standard and quality of living. Future opportunities of the entire society will be lost! A restriction or even ban of fluoroelastomers and fluoropolymers as irreplaceable materials would catapult us all back into the Middle Ages!

7) **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?**

We as a downstream user of fluoropolymers and fluoroelastomers for manufacturing of seals and polymer bearings seek for a formal time unlimited determination of Currently Unavoidable Uses (CUU) for all fluoropolymers and fluoroelastomers according to Minnesota Session Laws - 2023, Regular Session Sec. 21. [116.943] Products containing PFAS. This time unlimited determination must include all monomers and processing aids needed for manufacturing of all fluoroelastomers and fluoropolymers. The actions as mentioned above would contribute in a more than reasonable manner to limit the proposed restriction of PFAS and assure the standard and quality of living and future opportunities of the entire society. The fluoroelastomers and fluoropolymers used in our products, meet OECD-criteria of “polymers of low concern.” They are neither bioavailable, water-soluble, or toxic. In essence, fluoropolymers and fluoroelastomers are safe for their intended uses so that there is no risk as well as no reason to restrict or even ban fluoroelastomers and fluoropolymers at all!

Alternatives for fluoroelastomers and fluoropolymers do not exist! Consequences of a total ban of fluoroelastomers and fluoropolymers for uses of manufacturing of seals, bearings and many other products would be dramatic! This ban will greatly affect the standard and quality of living. Future opportunities of the entire society will be lost! A restriction or even ban of fluoroelastomers and fluoropolymers as irreplaceable materials would catapult us all back into the Middle Ages!

8) In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

Trelleborg Sealing Solutions as a downstream user, produces seals and polymer bearings for machines and equipment for an unimaginable segment of the entire society. The fluoropolymers and fluoroelastomers we use are listed in the table below:

Chemical name	CAS No.
Ethylene-tetrafluoroethylene copolymer (ETFE)	25038-71-5
Tetrafluoroethylene-perfluoropropylene copolymer (FEP)	25067-11-2
Tetrafluoroethylene-propylene copolymer (FEPM)	–
Perfluoroelastomer (FFKM)	–
Fluoroelastomer (FKM)	9011-17-0 64706-30-5
Fluorosilicone Rubber (FVMQ)	–
Polychlorotrifluoroethylene (PCTFE)	9002-83-9
Perfluoroalkoxy polymer (PFA)	26655-00-5
Ethene, 1,1,2,2-tetrafluoro-, homopolymer (PTFE)	9002-84-0
Polyvinylidene difluoride (PVDF)	24937-79-9
Tetrafluoroethylene-propylene copolymer (TFE/P)	–
Modified Ethene, 1,1,2,2-tetrafluoro-, homopolymer (TFM)	9002-84-0

To provide an exhaustive list of all sectors and uses of relevance of all our activities is not possible. To allow all sectors and companies a legally secure assessment of their affectedness, the scope of the restriction must be communicated in a clear and transparent manner. A list of relevant substances containing IUPAC names and CAS numbers is required for the analysis of affectedness along global supply chains. The establishment of a comprehensive information obligation for "intentionally added" PFAS for at least five years prior to a comprehensive PFAS restriction represents, from our view, a suitable approach to control PFAS emissions and to prepare a more targeted regulation. This would also enable companies and authorities to define reasonable targeted risk minimization measures.

In general, customer requirements determine the nature of the materials used for the seals and bearings we manufacture. In cases of demanding conditions, ranging from very to extremely, of use by our customers fluoropolymers and fluoroelastomers represent the only choice.

Fluoroelastomers and fluoropolymers possess unique properties such as:

- **low coefficient of friction**
- **chemical compatibility**
- **wide temperature range for use (low to high)**
- **mechanical properties allowing high surface speeds**
- **practically non-ageing**
- **compatibility regarding electron and gamma radiation.**

It is these unique properties that represent absolute prerequisites for many specific segment requirements. It is only when these unique properties are extremely essential, that fluoroelastomers and fluoropolymers are utilized. The high price of fluoroelastomers and fluoropolymers alone ensures that use of these materials is minimized. This fact drastically reduces the use of fluoroelastomers and fluoropolymers as well as human exposure and emissions to the environment. Additionally, the fluoroelastomers and fluoropolymers used in our products, meet OECD-criteria of “polymers of low concern.” They are neither bioavailable, water-soluble, or toxic. In essence, fluoropolymers and fluoroelastomers are safe for their intended uses. Seals and polymer bearings made of or containing fluoroelastomers and fluoropolymers we produce are used for manufacturing, installation, operation, and maintenance of equipment of for instance:

- Aerospace
- Defense
- Energy sector
- Chemical Industry
- Manufacturing and processing of substances, mixtures and articles
- Pharmaceutical Industry
- Pharma manufacturing
- Medicinal products
- Medical devices
- Agriculture equipment
- Food manufacturing and processing Industry
- Drinking water & potable water supply
- Oil & Gas industry
- Refrigeration
- Air conditioning and heat pumps
- Automobiles
- Trucks
- Trains
- Ships
- Transportation

- Semiconductors
- Electronics Industry including electronic products
- Drives and motion control
- Material processing
- Machine manufacturing
- Equipment manufacturing
- Processing equipment
- Recycling Industry
- Fluid Power
- Machine tools
- Marine
- Presses
- Robotics
- Sanitation
- Insulating gas in electrical equipment
- Construction products
- Petroleum and mining
- Textile & leather Industry

The seals and polymer bearings made of or containing fluoropolymers and fluoroelastomers are critical and essential contribution to all of society include:

- **Human and environmental health and safety** e.g.
    - Defense
    - Avoidance of major accidents
    - Chemical industry
    - Nuclear powerplants
    - Avoid catastrophes
- **Supply of** for instance
    - Energy
    - Food,
    - Drinking water
    - Raw materials
- **Healthcare** e.g.
    - Pharmaceuticals
    - Medical devices
- **Minimized energy consumption and prolonged maintenance cycles of a vast range of equipment and installations**

Trelleborg Sealing Solutions as a downstream user, produces seals and polymer bearings made of or containing fluoroelastomers and fluoropolymers. In general we intend to seek for a formal time unlimited determination of Currently Unavoidable Uses (CUU) for all fluoropolymers and fluoroelastomers according to Minnesota Session Laws - 2023, Regular Session Sec. 21. [116.943] Products containing PFAS for the Harmonized Tariff System (HTS) codes as mentioned below:

- 3916 "Monofilament of which any cross-sectional dimension exceeds 1 mm, rods, sticks and profile shapes, whether or not surface-worked but not otherwise worked, of plastics"
- 3917 "Tubes, pipes and hoses, and fittings therefor (for example, joints, elbows, flanges), of plastics"
- 3920 "Other plates, sheets, film, foil and strip, of plastics, non-cellular and not reinforced, laminated, supported or similarly combined with other materials"
- 3921 "Other plates, sheets, film, foil and strip, of plastics"
- 3926 "Other articles of plastics and articles of other materials of headings 3901 to 3914
- 4016 "Other articles of vulcanized rubber other than hard rubber"
- 7326 "Other articles of iron or steel"
- 8481 "Taps, cocks, valves and similar appliances for pipes, boiler shells, tanks, vats or the like, including pressure-reducing valves and thermostatically controlled valves"
- 8482 "Transmission shafts (including cam shafts and crank shafts) and cranks; bearing housings and plain shaft bearings; gears and gearing; ball or roller screws; gear boxes and other speed changers, including torque converters; flywheels and pulleys, including pulley blocks; clutches and shaft couplings (including universal joints)"
- 8484 "Gaskets and similar joints of metal sheeting combined with other material or of two or more layers of metal; sets or assortments of gaskets and similar joints, dissimilar in composition, put up in pouches, envelopes or similar packings; mechanical seals"

9) Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

From our view it would be more than meaningful if the Minnesota Pollution Control Agency (MCPA) would implement initial currently unavoidable use determinations for all flouropolymers and fluoroelastomers as part of this rulemaking including all raw materials for instance monomers and processing aids needed for manufacturing of these!

Trelleborg Sealing Solutions Germany GmbH
Schockenriedstraße 1, 70565 Stuttgart, Tel: +49 (0)711 7864 0
Geschäftsführer: Carsten Stehle (Vors.), Jennifer Ruffler, Dr. Thomas Uhlig
Sitz und Registergericht Stuttgart HRB 21275, Tax ID: DE 119553041, www.trelleborg.com/seals/de

Reasons are as follows:
Fluoropolymers and fluoroelastomers used in our products, meet OECD-criteria of "polymers of low concern"

- have documented safety profiles
- are thermally, biologically, and chemically stable
- are negligibly soluble in water
- are nonmobile, nonbioavailable, nonbioaccumulative, and nontoxic

In essence, fluoropolymers and fluoroelastomers are safe for their intended uses so that there is no risk as well as no reason to restrict or even ban fluoroelastomers and fluoropolymers at all!

10) Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

We would like to thank the Minnesota Pollution Control Agency for the opportunity to contribute comments to the Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837!

Contact information:

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Director Global Materials & Compliance

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With kind regards

Trelleborg Sealing Solutions — Stuttgart, 1 March 2024

RECEIVED
By: OAH on 3/1/2024
Best Technology Attachment

BestTechnology

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Minneapolis, MN 5547
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To: Minnesota Pollution Control Agency (MPCA)

Subject: Re: MPCA Request for Comments regarding Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

Best Technology offers the following comments on the PFAS regulations being developed by the Minnesota Pollution Control Agency (MPCA) as authorized in Chapter 60 of H.F. 2310. The MPCA has requested comments on Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

Best Technology is a distributor of metal finishing equipment and chemicals to many vital industries in the U.S. As a small business, Best Technology has concerns for industrial users having unavoidable uses of some chemical used during manufacturing (not in a finished consumer product). Since starting in the early 1990s, Best Technology has always strived to offer technologically advanced products for use in surface finish manufacturing processes. Our products are used by our customers as in-process manufacturing not as a final consumer product.

For certain manufacturing process applications, regulated industries such as medical device, aerospace, semiconductor, etc. do not have viable technological PFAS-free alternatives. Best Technology looks forward to helping customers transition as soon as alternatives are developed and proven safe and effective.

Please consider the following comments and responses to the questions raised in the request for comments document.

1) Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Yes, criteria should be defined for "essential for health, safety, or the functioning of society". Health and safety should be easier to define but "functioning of society" is a bit more vague. The economic impacts of unavoidable use should be considered if the impacts are large enough to disrupt critical infrastructure of our essential economic industries (semiconductor, medical device, aerospace/defense, etc to name a few). The above-mentioned industries rely on many essential applications for which there are no substitutes. The current legislation poses a serious threat of completely shutting down these critical industries. A law so broadly defined really places a lot of responsibility on the commissioner/MPCA to allow applications which there are literally no alternatives yet are critical to maintaining health, safety and functioning of society.

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Continued regulatory pressure has put extreme cost constraints on companies of various sizes. The "reasonably available" PFAS alternatives costs should really be based on the "essential for health, safety, or the functioning of society" classification.

3) Should unique considerations be made for small businesses with regards to economic feasibility?

According to the Small Business Administration, small businesses contribute 64% of new jobs and 44% of U.S. economic activity. Going back to question #1 (functioning of society), if costs to change to "reasonably available" alternatives make it cost prohibitive to operate a small business many jobs of Minnesotans are at risk. This is not to say that small businesses should be completely exempt from PFAS regulations, they should have to exhibit the large cost impact and perhaps the government could offer grants to implement changes.

4) What criteria should be used to determine the safety of potential PFAS alternatives?

Potential PFAS alternatives should be held to similar standards of scientific based safety standards as PFAS.

5) How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided? Should significant changes in available information about alternatives trigger a re-evaluation?

Hopefully PFAS alternatives come along with advancements in technology. Considering this, reassessment every 5 years seems to be a logical timeframe.

6) How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

Yes, the MPCA should have stakeholders request a PFAS use be considered for currently unavoidable use. Similar documentation of "essential for health, safety, or the functioning of society" should be evaluated.

7) In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

Our company distributes some chemicals which contain PFAS (as defined by Minnesota law but not EPA proposed definition) however the chemicals are not part of a physical finished good/product. The chemical is used during manufacturing only. When the chemical is used correctly in industrial, medical device, aerospace and general manufacturing cleaning, the chemical completely evaporates well before the manufacturing process is completed, leaving nothing behind. So in all cases, products "do not become part of or contained in the finished goods or article", regardless of when it is used during the manufacturing process. The intention of the MN law aims to protect the environment (ground water, etc) and human safety. Based on the intended use of our products, there is no environmental or human safety impact.

8) Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

Yes, some guidance from the MPCA would be very helpful for businesses trying to do what is right with a law that is broad-ranging and vague.

9) Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

Best Technology appreciates the opportunity to provide these comments and looks forward to collaborating with MPCA and other stakeholders to ensure that the residents of Minnesota continue to have access to products that enhance their daily lives safely.

RECEIVED
By: OAH on 3/1/2024
Catherine Palin Attachment

ALLIANCE FOR AUTOMOTIVE INNOVATION

March 1, 2024

Submitted through https://minnesotaoah.granicusideas.com/

Mr. Quinn Carr, Rule Coordinator
Ms. Maya Gilchrist, Data Analyst and Technical Lead
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

RE: Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-483

Dear Mr. Carr and Ms. Gilchrist:

The Alliance for Automotive Innovation[1] (Auto Innovators) appreciates the opportunity to provide input on the Minnesota Pollution Control Agency's (MPCA's) request for comment on planned new rules governing determinations of Currently Unavoidable Uses (CUUs) of PFAS in products. We understand that the main purpose of this rulemaking is to establish criteria and processes through which MPCA will make decisions on the uses of intentionally added PFAS that will qualify as CUUs in products sold, offered for sale, or distributed in Minnesota.

Auto Innovators represents the auto manufacturing sector, including automakers that produce and sell approximately 95% of the new light-duty vehicles in the United States, equipment suppliers, battery producers and semiconductor makers. Our mission is to work with policymakers to realize a future of cleaner, safer, and smarter personal transportation and to work together on policies that further these goals, increase U.S. competitiveness, and ensure sustainable, well-paying jobs for citizens throughout the country.

Auto Innovators has been actively involved in federal and state activities related to PFAS, including responding to all requests for comment from MPCA. Our comments and recommendations presented here are informed by the regulatory experiences in not only Minnesota but also, and not limited to, Maine, California, Washington, and other states with pending PFAS legislation.

MPCA is currently requesting comment on workable criteria for the CUU rule and definitions contained in subdivision 1 of Minn. Stat. § 116.943. MPCA states that "[t]he definitions in subdivision 1 listed above are a starting point of related terms possibly requiring clarification."[2] We read this

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[1] From the manufacturers producing most vehicles sold in the U.S. to autonomous vehicle innovators to equipment suppliers, battery producers and semiconductor makers – Alliance for Automotive Innovation represents the full auto industry, a sector supporting 10 million American jobs and five percent of the economy. Active in Washington, D.C. and all 50 states, the association is committed to a cleaner, safer, and smarter personal transportation future. www.autosinnovate.org.

[2] Minnesota Pollution Control Agency Request for Comments: Planned New Rules Governing Currently Unavoidable Use Determinations About Products Containing Per- and Polyfluoroalkyl Substances (PFAS), Revisor's ID Number R-4837, *available at* https://www.pca.state.mn.us/sites/default/files/c-pfas-rule3-01.pdf.

request to suggest that MPCA can expand on the definitions provided in the statute and has the authority to do so.

Our comments and recommendations will focus on:

- Clarification of Definitions
- Response to Specific Questions Raised by MPCA

A. Clarification of Definitions

1. Currently Unavoidable Use (CUU)

The definition of "currently unavoidable use" in statute is "a use of PFAS that the commissioner has determined by rule under this section to be essential for health, safety, or the functioning of society and for which alternatives are not reasonably available."[3]

We recommend expanding on this definition to state the following:

> ***"Currently unavoidable use"*** *means a use of PFAS that the commissioner has determined by rule under this section to be essential for health, safety, or the functioning of society and for which alternatives are not reasonably available. This includes products or product components that if unavailable would result in a significant increase in negative healthcare outcomes, an inability to mitigate significant risks to human health or the environment, or significantly interrupt the daily functions on which society relies. Products or product components that are Essential for Health, Safety or the Functioning of Society include those that are required by Federal or State Laws and Regulations.*

Additionally, we propose a new definition to further clarify "essential for the functioning of society."

> ***"Essential for the functioning of society"*** *includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, law enforcement, lifesaving equipment, essential transportation vehicles including passenger vehicles, and construction.*

We propose this additional definition to make clear that transportation vehicles, including passenger vehicles, are essential for the functioning of society. Personal vehicles are key for transportation and getting around, and thus the functioning of society—particularly, we expect, outside of major cities like Minneapolis, St. Paul, and Rochester. If this definition remains unchanged, our industry's ability to apply for an unavoidable use designation may be harmed. By further defining what is meant by "essential for health, safety, or the functioning of society," MPCA would provide a more substantive set of criteria and circumstances warranting a CUU exemption. This additional clarity would facilitate the development of more focused CUU exemption requests and aid MPCA in its reviews of such requests.

[3] Minn. Stat. § 116.943 subd. 1(j).

It is also imperative to acknowledge that the phrase "for which alternatives are not reasonably available" involves a multi-pronged decision review and must include factors such as: whether any potential substitutes are commercially available, either domestically or from a foreign supplier; whether an alternative that has been developed has passed through EPA's new chemicals review program without any restrictions that would make it unavailable; whether the alternative has been validated for use in the product for which a CUU is being requested (in our case a motor vehicle); whether the alternative has been approved by federal agencies and whether the part manufactured using that alternative has been tested and found to conform to all applicable Federal Motor Vehicle Safety Standards (FMVSS), as well as greenhouse gas emissions and fuel economy standards as appropriate.

By way of example, we refer MPCA to the definitions in California's Safer Consumer Products Act that recognize the importance of further defining alternatives[4]:

> "Economically feasible" means that an alternative product or replacement chemical does not significantly reduce the manufacturer's operating margin.
>
> "Functionally acceptable" means that an alternative product meets both of the following requirements:
> (A) The product complies with all applicable legal requirements; and
> (B) The product performs the functions of the original product sufficiently well that consumers can be reasonably anticipated to accept the product in the marketplace.
>
> "Technically feasible" means that the technical knowledge, equipment, materials, and other resources available in the marketplace are expected to be sufficient to develop and implement an alternative product or replacement chemical.

Therefore, we recommend adding a new definition that would further define the term "alternative" as used in the definition of "currently unavoidable use" and would clarify MPCA's expectations in terms of alternatives availability.

> ***"Reasonably available alternative"*** *refers to a substance or chemical that, when used in place of PFAS, results in a functionally equivalent product and that, when compared to a PFAS that it could replace, would reduce the potential for harm to human health or the environment, or has not been shown to pose the same or greater potential for harm to human health or the environment as that PFAS. To be reasonably available means a PFAS alternative which is readily available in sufficient quantity and at a comparable cost to the PFAS it is intended to replace and functions as well as or better than PFAS in a specific application of PFAS in a product or product component. Alternatives include reformulated versions of products, including versions reformulated by removal or addition of one or more chemicals or substances, that result in the reduction or removal of intentionally added PFAS from the product. Alternatives also include changes to the manufacturing process that result in the reduction or removal of PFAS from a product.*

[4] 22 Cal. Code Regs. § 69501.1.

2. Intentionally Added

As currently defined, “intentionally added” means “PFAS deliberately added during the manufacture of a product where the continued presence of PFAS is desired in the final product or one of the product's components to perform a specific function.”[5]

We recommend clarifying and expanding this definition as follows:

> ***“Intentionally added”*** *means PFAS deliberately added during the manufacture of a product where the continued presence of PFAS is desired in the final product or one of the product's components to perform a specific function. Intentionally added PFAS also includes any degradation byproducts of PFAS serving a functional purpose or technical effect within the product or its components. Products containing intentionally added PFAS include products that consist solely of PFAS. Intentionally added PFAS does not include PFAS that is present in the final product as a contaminant.*

.

We propose this modification to address the issue of contaminants. Contaminants are not intentionally added PFAS and consequently do not serve any specific function or technical effect in the final product. The presence of a contaminant is likely to be at a de minimis or undetectable level and therefore will pose little to no exposure pathway.

3. Manufacturer

We have no suggested changes for this definition but recommend that MPCA develop guidance regarding due diligence for the importer who is responsible for identifying the presence of PFAS in an imported product. MPCA should adopt some version of the guidance that EPA has prepared for its TSCA Section 8(a)(7) PFAS reporting rule[6]:

> Submitters are required to exercise certain levels of due diligence in gathering the information required by the section 8(a)(7) rule. You must report your information to the extent that the information is known to or reasonably ascertainable by you and your company. The term “known to or reasonably ascertainable by” is defined in 40 CFR 705.3, meaning all information in a person’s possession or control, plus all information that a reasonable person similarly situated might be expected to possess, control, or know.

4. Perfluoroalkyl and Polyfluoroalkyl Substances or PFAS

As currently defined “perfluoroalkyl and polyfluoroalkyl substances” or “PFAS” means “a class of fluorinated organic chemicals containing at least one fully fluorinated carbon atom.”[7]

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[5] Minn. Stat. § 116.943 subd. 1(l).

[6] U.S. Environmental Protection Agency, Instructions for Reporting PFAS under TSCA Section 8(a)(7) (Oct. 2023), at 4-2, *available at* https://www.epa.gov/system/files/documents/2023-11/tsca-8a7-reporting-instructions-10-11-23.pdf.

[7] Minn. Stat. § 116.943 subd. 1(p).

We recommend clarifying and expanding this definition to state the following:

> ***"Perfluoroalkyl and polyfluoroalkyl substances" or "PFAS"*** *means* *non-polymeric perfluoroalkyl and polyfluoroalkyl substances that are a group of man-made chemicals that contain at least 2 fully fluorinated carbon atoms, excluding gases and volatile liquids, and that have a Chemical Abstracts Service (CAS) number. "PFAS" includes PFOA and PFOS and excludes refrigerants and fluoropolymers.*

By defining PFAS as "a group of man-made chemicals that contain at least 2 fully fluorinated carbon atoms" MPCA will provide consistency with EPA's definition of PFAS as well as those of other states with PFAS laws. By adding the precision of "2 fully fluorinated carbon atoms," the PFAS definition will allow focus on a narrower but more relevant group of PFAS that may pose a concern. We recognize that this is not the definition in the enabling legislation and that MPCA may be constrained by that definition. We have provided this recommendation in the event that MPCA determines that it may have some flexibility in further defining PFAS of concern.

We also encourage MPCA to exclude chemicals that do not have Chemical Abstracts Service (CAS) numbers. CAS numbers are the universal identifier used to identify a chemical substance or molecular structure in an unambiguous manner and to discern between many possible systematic, generic, or proprietary chemicals. In the absence of CAS numbers, the automotive sector will be unable to search its Material Safety Data Sheets (MSDS) or use its International Material Data System (IMDS).

Because of the importance of this clarification, we request that it be added to the definition itself, as suggested above. MPCA should also define regulated PFAS with a list of chemical names and CAS numbers. That would clearly define the universe of chemicals that require notification and further clarify reporting requirements.

Auto Innovators also requests that MPCA provide further guidance on how they expect the regulated community to report on PFAS chemicals that have a CAS number but "are withheld by other persons or are otherwise unavailable." What due diligence is required to seek out PFAS chemicals that may be present in a product but are claimed as confidential business information (CBI) by the supplier or other entity or covered by non-disclosure agreements?

MPCA should also exempt fluoropolymers and refrigerants from the definition of PFAS, as suggested above. The current definition of PFAS being used by MPCA includes the refrigerants that are used in motor vehicle air conditioning (MVAC) applications. Those refrigerants are already the subject of regulations covering hydrofluorocarbons (HFCs) at both the state and federal levels; in fact, those regulations have resulted in the industry undertaking over the past several years the behemoth task of transitioning from one type of refrigerant to another that has a lower global warming potential. Banning use of the refrigerant now currently used in our vehicles would require original equipment manufacturers (OEMs) to have an available alternative that is also approved by all of those HFC regulations and would result in OEMs having to significantly redesign and reengineer our recently revamped MVAC systems and vehicles, possibly even with a need to retrofit older vehicles. Similarly, fluoropolymers satisfy widely accepted criteria to be considered polymers of low concern, indicating that they do not present a significant risk to human health or the environment. For this reason, fluoropolymers should be regulated differently from PFOA and PFOS. The definition of PFAS needs to be revised to exempt these substances.

5. Product

As currently defined, "product" means "an item manufactured, assembled, packaged, or otherwise prepared for sale to consumers, including but not limited to its product components, sold or distributed for personal, residential, commercial, or industrial use, including for use in making other products."[8]

We would recommend expanding this definition to state the following:

> ***"Product"*** *means an item manufactured, assembled, packaged, or otherwise prepared for sale to consumers, including but not limited to its product components, sold or distributed for personal, residential, commercial, or industrial use, including for use in making other products. For complex durable goods, "product" would encompass the complete product such as a complete vehicle, including replacement and service parts. This definition does not include the packaging for any product.*

This expanded definition accounts for the fact that complex durable goods such as vehicles may contain multiple components that contain PFAS. It would be unworkable both for MPCA and the regulated community to apply for CUU exemptions for each individual component given that all CUU exemptions would need to be approved in order to continue to sell and service the complete product, in this case, a vehicle, in the state of Minnesota. This recommended approach is consistent with the approach adopted by the state of Maine and recognizes the practicality of complete product reporting, which we discuss further below in our response to Question #6.

We recommend adopting the definition proposed by Maine DEP that would exclude packaging used in marketing, handling, or protecting a product. Maine sensibly proposed to exclude packaging that serves an essential purpose in protecting the product as it moves through the channels of trade.

For further clarification, we recommend adding a new definition that would further define the term "complex durable good." Our proposed definition is consistent with the TSCA definition[9]:

> ***"Complex durable goods"*** *means manufactured goods composed of 100 or more manufactured components, with an intended useful life of 5 or more years, where the product is typically not consumed, destroyed, or discarded after a single use.*

6. Product Component

We have no recommended changes for the definition of product component. We ask that MPCA recognize that in some circumstances, like for motor vehicles, product components can be sold separately in order to keep a product functional and in service; regardless, they should not be treated as independent products.

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[8] Minn. Stat. § 116.943 subd. 1(q).

[9] 15 U.S.C. § 2605(c)(2)(D)(ii)(II).

B. Response to Specific Questions Raised by MPCA

1. Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Yes, criteria to further define the elements that MPCA will consider as it makes CUU decisions is critical to providing clarity and transparency into this key process. We suggest that "criteria" include specific clarification of the definition of CUU itself as well as the addition of definitions for key terms in that definition. By specifying key criteria, MPCA will provide a more precise set of requirements for requesting and granting a CUU exemption. For MPCA staff reviewing CUU requests, additional criteria will provide for greater consistency in MPCA decision-making; for the regulated community, criteria will assist in understanding eligibility and in developing a CUU request (and determining whether to make a request) and for the general public, criteria will allow oversight of how CUU exemptions are being granted or denied.

Additional criteria that MPCA should consider in its decision-making process and should be captured in either the regulatory preamble or regulatory text include:

- Are any potential substitutes commercially available, either domestically or from a foreign supplier?
- Does the alternative provide the same safety and functionality required to meet federally regulated performance standards such as fire safety, efficiency, weight requirements, etc.?
- If an alternative has been developed, has it passed through EPA's new chemicals review program without any restrictions that would make it unavailable?
- Has the alternative been tested for use in the product for which a CUU is being requested?
- Has the alternative been regulated or cued up for regulation by either the federal government or a U.S. state government?

As presented in more detail in the previous section A.1. on definitions, we would recommend expanding the definition of "currently unavoidable use" and adding a definition for "reasonably available alternative."

2. Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Yes, the combined costs of identifying, developing, validating, and implementing an alternative should be considered by MPCA when making decisions about CUU exemptions. These costs include but are not limited to costs associated with redesigning product components to be PFAS free; costs associated with testing for performance and safety standards and compliance with federal and other state requirements; and the time and cost of development, testing, and application for use within the United States. The cost of using a PFAS alternative should not be substantially higher than that of use of the PFAS, as the difference is likely to be passed on to consumers and increase the price of many consumer goods.

In a CUU exemption decision, these costs should be weighed against the costs to Minnesota's residents if motor vehicles are not available for sale in Minnesota, as well as costs associated with regrettable substitution should a chosen alternative become the subject of future regulation.

For example, PFAS alternatives in the semiconductor industry's microelectronics applications must have requalification if a manufacturer substantively alters the fabrication process, which can easily exceed $10 million.[10] Similar costs can be expected for any major modifications to automotive components. If drop-in replacements (i.e., functionally equivalent and safer, cleaner, or greener alternatives) were readily available, substitutions would already have been made given the focus on PFAS. PFAS applications in passenger vehicles support advanced emissions, battery, safety, electronics, and other cutting-edge technologies.

3. <u>Should unique considerations be made for small businesses with regards to economic feasibility?</u>

Yes, A large portion of the automotive industry supply chain is comprised of small businesses. It is important to support these businesses to provide stability to the overall automotive supply chain.

4. <u>What criteria should be used to determine the safety of potential PFAS alternatives?</u>

Approved and commercially available test methods for PFAS and alternatives are still under development and their availability is limited. In their absence, comparing risk profiles of PFAS with those of alternative chemistries is challenging and could easily lead to regrettable substitution. In fact, experience with chemical substitution based on rigorous risk assessments has still resulted in regrettable substitutions. For example, while not a PFAS application, consider the move to methyl tertiary-butyl ether (MTBE) as a replacement when tetra-ethyl lead was banned for use in gasoline. MTBE proved to be of equal, if not greater, environmental concern and was ultimately the subject of a national phase-out.[11]

For this reason, it is all the more critical that as alternatives are developed, they go through rigorous testing and evaluation before they are deemed an appropriate substitute. After such a determination is made, it will still take a number of years to ensure durability and functional equivalency to be able to phase in to product development cycles. A CUU exemption for vehicles and their replacement parts is warranted at this time, while the sector and its supply chain explore substitution options.

At a minimum, we would recommend that MPCA not identify any chemical as a PFAS alternative that is included on any of the following lists: EPA's TSCA 2014 Workplan Chemicals,[12] California's

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[10] U.S. Department of Defense, Report on Critical Per- and Polyfluoroalkyl Substance Uses (Aug. 2023) at 12, *available at* https://www.acq.osd.mil/eie/eer/ecc/pfas/docs/reports/Report-on-Critical-PFAS-Substance-Uses.pdf.

[11] Thomas O. McGarity, *MTBE: A Precautionary Tale,* 28 Havard L. Rev. 282 (2004), *available at* https://tri-s.com/wp-content/uploads/2018/07/MTBE_A_precautionary_tale-enhanced.pdf.

[12] U.S. Environmental Protection Agency, TSCA Work Plan for Chemical Assessments: 2014 Update (Oct. 2014), *available at* https://www.epa.gov/sites/default/files/2015-01/documents/tsca_work_plan_chemicals_2014_update-final.pdf.

Safer Consumer Products Priority List,[13] or Washington State's Safer Products for Washington program.[14] These chemicals are all being considered for regulation under the appropriate statutes and may be unavailable for use in the future.

5. How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

We recommend any CUU exemption for the automotive sector cover a minimum of 15 years. The minimum design cycle for a vehicle is typically five years, with additional time necessary for testing and determination of compliance with state and federal regulations. Replacement parts CUU exemptions should have no expiration dates and should remain valid for the full life of the vehicle that the replacements parts were designed to maintain.

6. How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

We recommend that MPCA adopt the same approach to product identification for a CUU exemption that Maine is taking pursuant to 38 M.R.S. § 1614. Also, it is appropriate and important that MPCA and Maine consider providing reciprocity for CUU findings, since deviations from each other's CUUs would be disruptive for the flow of interstate commerce. Their proposed rule on reporting stated:

> Reporting multiple products or product components together under a single GPC [global product classification] code or HTS [harmonized tariff schedule] number under subsection A above is allowed, so long as;
> (1) All products to be so reported fall within the same GPC brick code or HTS number,
> (2) The same PFAS are present in every product, and
> (3) Each PFAS is present in every product, either:
> (a) In a substantially similar amount as determined by a commercially available analytical method, or
> (b) If reporting by range of concentration is available, within the same concentration range.[15]

For a CUU exemption for the automotive sector, we would propose that requests be permitted at the whole vehicle level (see proposed revised definition for "product" and discussion above) and be

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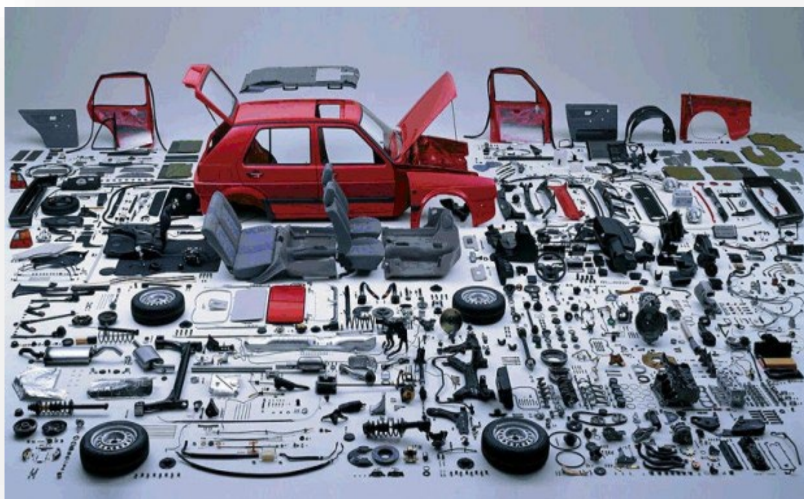
[13] *Priority Products*, California Department of Toxic Substances Control, https://dtsc.ca.gov/scp/priority-products/.

[14] Washington Department of Ecology, Priority Consumer Products Report to the Legislature (July 2020), https://apps.ecology.wa.gov/publications/documents/2004019.pdf.

[15] Maine Department of Environmental Protection, Posting Draft: Chapter 90: Products Containing Perfluoroalkyl and Polyfluoroalkyl Substances, *available at* https://www.maine.gov/dep/bep/2023/01-19-23/Chapter%2090%20Draft.pdf. Maine appears to also be basing their CUU application and decision-making on GPC/HTS groups as well. See *PFAS in Products: Currently Unavoidable Uses*, Maine Department of Environmental Protection, https://www.maine.gov/dep/spills/topics/pfas/PFAS-products/cuu.html.

permitted to be submitted by an individual manufacturer, a consortium, or automotive trade organizations, as Maine is allowing. This request would cover current production vehicles, and replacement / accessory parts and operating materials, defined as parts and materials that are intended to enhance, maintain, or repair current production vehicles.

The automotive industry sells around 15 million vehicles each year across the nation, and the same vehicles sold in Minnesota are sold in the other 49 states as well. A single vehicle has tens of thousands of individual parts as single parts, subassemblies, and assemblies, as depicted in the graphic below. Requesting a CUU exemption for individual parts that may contain PFAS will not only overwhelm MPCA staff reviewing these requests but will also place an unreasonable burden on automobile manufacturers, with no added value for MPCA or the public.



Given the lack of viable alternatives at this time, as well as the lead time necessary to test, verify, and incorporate a change in a chemistry once an alternative is available, it is appropriate and necessary to consider the vehicle as a whole at this time for a CUU exemption. In the future, it may be appropriate to consider certain subassemblies or parts separate from the vehicle as a whole.

If there are stakeholders that have concerns about the granting of any specific CUU, any request to deny or rescind that CUU should be accompanied with specific responses to the criteria presented earlier when considering the availability of alternatives.

7. <u>In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.</u>

We anticipate submitting a CUU determination request for motor vehicles and motor vehicle equipment (parts and operating materials) (the product) used for transportation (the use). Please also see our response to Question #6 above for additional details.

8. <u>Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?</u>

Yes. In keeping with our recommended revised definition of CUU, making some initial determinations as examples of what uses meet the criteria adopted by MPCA (see recommended criteria above) would be appropriate and would provide some certainty for manufacturers that sell products that are "essential for health, safety, or the functioning of society and for which alternatives are not reasonably available." Further clarification and/or a definition surrounding "essential" will similarly assist in providing certainty and clarity.

We recommend that MPCA identify motor vehicles, motor vehicle equipment, and replacement parts and operating materials necessary to maintain those vehicles as a CUU in the anticipated rulemaking. This determination would be wholly consistent with the proposed definition, the proposed criteria and, as a benchmark, with the U.S. Department of Homeland Security Cybersecurity & Infrastructure Security Agency's assignment of critical infrastructure uses during and following the COVID-19 pandemic,[16] which include:

- Workers supporting or enabling transportation and logistics functions, including truck drivers, bus drivers, dispatchers, maintenance and repair technicians, warehouse workers, third party logisticians, truck stop and rest area workers, driver training and education centers, Department of Motor Vehicle (DMV) workers, enrollment agents for federal transportation worker vetting programs, towing and recovery services, roadside assistance workers, intermodal transportation personnel, and workers that construct, maintain, rehabilitate, and inspect infrastructure, including those that require cross-jurisdiction travel.
- Workers supporting personal and commercial transportation services including taxis, delivery services, vehicle rental services, bicycle maintenance and car-sharing services, and transportation network providers.
- Vehicle repair, maintenance, and transportation equipment manufacturing and distribution facilities.
- Workers who support the construction and maintenance of electric vehicle charging stations.
- Workers who repair and maintain vehicles, aircraft, rail equipment, marine vessels, bicycles, and the equipment and infrastructure that enables operations that encompass movement of cargo and passengers.
- Workers critical to the manufacturing, distribution, sales, rental, leasing, repair, and maintenance of vehicles and other equipment (including electric vehicle charging stations) and the supply chains that enable these operations to facilitate continuity of travel-related operations for essential workers.

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[16] U.S. Department of Homeland Security, Advisory Memorandum On Ensuring Essential Critical Infrastructure Workers' Ability To Work During The Covid-19 Response (Aug. 10, 2021), *available at* https://www.cisa.gov/sites/default/files/publications/essential_critical_infrastructure_workforce-guidance_v4.1_508.pdf.

Motor vehicles and the replacement parts and operating materials to repair them are essential for health, safety, and the functioning of society. If Minnesota residents did not have access to functional vehicles to get to medical appointments, places of employment, and food and grocery stores, there would be far-reaching repercussions for quality of life and functioning of society for Minnesota residents. One estimate has Minnesota with the fifth-highest average miles driven per year by drivers, at 17,887,[17] and with residents outside of major metropolitan areas driving significantly greater distances to reach essential medical and other services. Clearly, vehicles are key for transportation in Minnesota and a lack of availability of personal transportation could jeopardize health and safety and disrupt the standard functioning of society.

Finally, Minnesota is implementing an aggressive plan to mandate that automakers bolster availability of all electric and hybrid vehicles across the state.[18] PFAS are critical to the technologies underlying electrification and enable achievement of the state's emissions standards.

Conclusion

Our recommendations provide a framework that emphasizes the key questions that must be asked and answered when assessing whether to grant a CUU exemption for PFAS use. The availability of alternatives, as we have defined them, is key to making these CUU decisions.

Thank you for considering our comments. We would be happy to discuss them with you in further detail, as well as to discuss PFAS in products issues more generally. We can also provide information on PFAS uses in our industry and the nature of our supply and production chain. I can be reached at cpalin@autosinnovate.org or at 202-326-5511.

Catherine Palin
Senior Attorney & Director of Environmental Policy
Alliance for Automotive Innovation

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[17] Elizabeth Rivelli, *What is Average Mileage Per Year?*, Car and Driver (Feb. 24, 2023), https://www.caranddriver.com/auto-loans/a32880477/average-mileage-per-year/.

[18] *Reducing Transportation Emissions*, Minnesota Pollution Control Agency, https://www.pca.state.mn.us/air-water-land-climate/reducing-transportation-emissions.

RECEIVED
By: OAH on 3/1/2024

Philip Berdos Attachment

Iwaki America
5 Boynton Road
Holliston, MA 01746

March 1, 2024

To: Minnesota Pollution Control Agency

RE: Request for Comments: Planned new Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID number R-4837.

Iwaki America stands firmly behind efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. However, we express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. It's important to acknowledge that PFAS play a vital role in ensuring product functionality in critical applications in order to meet stringent safety standards.

We manufacture chemical process metering (dosing) pumps and magnetic drive centrifugal pumps, which require PFAS components depending on the application. These critical applications require the handling of corrosive or hazardous fluids where leakage prevention is crucial. Examples include water treatment, power generation, chemical manufacturing, mining, battery manufacturing, desalination and many others.

In line with our commitment to finding balanced solutions, we have worked through our industry associations: Hydraulic Institute, Fluid Sealing Association, Valve Manufacturers Association, the Water and Wastewater Manufacturers Association (a.k.a. the Flow Control Coalition) which have developed a comprehensive Currently Unavoidable Uses (CUU) proposal, that is being submitted to the states of Maine and Minnesota. This proposal is founded upon expert knowledge of the design of critical processes, and incorporates valuable insights gathered from diverse stakeholders including design engineers, end-users and manufacturers of critical system components.

By engaging engineers and experts from the various segments of the fluid handling industry, the Associations have applied a collaborative, systems level approach to this complex issue. Highly corrosive materials, high temperatures, harsh environments, accessibility and life-cycle considerations all are part of the design criteria of the industrial and other process systems which currently require PFAS as there are no viable alternatives to handle toxic substances, prevent hazardous leaks and fugitive emissions, ensure clean air and water, etc.

Iwaki America actively participated in the consultation process and supports the Flow Control Coalition's submission. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS and ensuring that critical functions of industry and society continue while at the same time, mitigating adverse impacts on businesses, communities, and public health.

Sincerely,

Philip Berdos
Manufacturing Engineer

O: 508.474.2056
pberdos@iwakiamerica.com

IWAKI AMERICA

RECEIVED
By: OAH on 3/1/2024
Robert Denney Attachment

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March 1, 2024

Submitted via the Minnesota Office of Administrative Hearings eComments Website

Katrina Kessler
Commissioner, Minnesota Pollution Control Agency
520 Lafayette Road N
St. Paul, MN 55155-4194

Re: **<u>Comments to MPCA's Planned PFAS in Products Currently Unavoidable Use Rule</u>**

Dear Commissioner Kessler:

The PFAS Pharmaceutical Working Group ("PPWG")[1] is a group of manufacturers and distributors of drugs, biologics, animal drugs, and medical devices. PPWG appreciates the opportunity to provide comments on the Minnesota Pollution Control Agency ("MPCA") planned new rule concerning determinations for currently unavoidable uses ("CUUs") of PFAS in products (the "CUU Rule"). Minn. St. § 116.943 ("Section 116.943"), subdivision 5(c) restricts the sale, offer for sale, and distribution for sale of products containing intentionally added PFAS beginning January 1, 2032 unless the MPCA has determined by rule that the use of PFAS is a CUU. "Currently unavoidable use" is defined in subdivision 1 as "a use of PFAS that the commissioner has determined by rule under this section to be essential for health, safety, or the functioning of society and for which alternatives are not reasonably available." The CUU Rule would implement this statutory language.

PPWG previously submitted comments on a separate MPCA rulemaking (the "Reporting Rule") to implement Section 116.943, subdivision 2, which requires reporting on intentionally added PFAS in products by January 1, 2026. We reiterate our request in those comments that the MPCA state expressly that U.S. Food and Drug Administration ("FDA")-regulated products and their packaging are out of scope of the Reporting Rule. We also acknowledge that Section 116.943, subdivision 8(b), expressly exempts FDA-regulated products from the statute's testing provisions in subdivision 4 and the material restrictions in subdivision 5. Notwithstanding this exemption, PPWG still has serious concerns with how the material restrictions may impact products in medical and pharmaceutical product supply chains to the extent these products are not covered by the exemption. For example, if the restriction applied to certain products used by upstream suppliers or to non-FDA regulated products used by medical and pharmaceutical product manufacturers for research and development ("R&D"), manufacturing, or distribution of their medical and pharmaceutical products, that may negatively affect the production of our

[1] PPWG's member companies, which include their subsidiaries and affiliates, are Amgen Inc.; Bristol Myers Squibb Company; GSK; Merck & Co., Inc.; Pfizer, Inc.; and Roche.

members' FDA-regulated products or the ability to continue manufacturing these products within the specifications or marketing authorizations granted by FDA. This would contribute to uncertainty over whether certain critical medical and pharmaceutical products can remain on the market in Minnesota, thereby directly contravening the legislature's intent to ensure Minnesotans' continued access to lifesaving drugs and devices.

For instance, certain logistics equipment may be essential to pharmaceutical research, or certain materials or equipment may be critical in manufacturing pharmaceuticals to meet FDA's quality standards. These products may be irreplaceable components in the R&D or manufacturing of end products that are subject to CUU determinations. In other words, narrow application of the CUU standard could harm the suppliers of materials that source items necessary for the continued marketing of products covered to CUU determinations, causing unintended ripple effects that would undermine the Minnesota Legislature's and the MPCA's attempt to preserve access to products that represent CUUs of intentionally added PFAS.

We request that the MPCA craft a CUU Rule that avoids this result. Specifically, the agency should:

- Develop criteria and definitions that account for how a restriction on a particular PFAS use may impact not only the direct use of an end product, but how that restriction may impact other products and processes up and down supply chains (e.g., material sourcing and procurement, R&D, manufacturing, and distribution). Therefore, the criteria for assessing what is "essential for health, safety, or the functioning of society" should consider societal impacts that may be broader than direct use of the end product itself. In addition, direct and indirect supply chain costs and risks should be considered in determining whether alternatives are "reasonably available."

- Specify that CUU determinations are indefinite, and provide a transparent process involving opportunity for regulated industry comment prior to the proposed withdrawal or modification of a previously issued determination. Section 116.943 does not authorize a time-limited determination, and an indefinite determination is necessary to ensure regulatory predictability for not only the specific product covered by the determination, but also for other products and processes that rely on that specific product. For similar reasons, the MPCA should be required to timely respond to requests for determinations so that companies have proper notice about what PFAS uses may continue.

- Where appropriate, make CUU determinations for broad categories of products intended for certain health and safety uses, rather than make CUU determinations on an individual product-by-product basis. For many types of products, making CUU determinations for individual products would almost certainly omit some products that are critical to health and safety. Applying CUU determinations to groups of products or categories of products intended for specified uses would be more efficient, would promote consistent treatment across related products, and would accomplish statutory objectives.

- Prioritize any requests for CUU determinations that are for products used in medical and pharmaceutical product R&D, manufacturing, and distribution supply chains. Given that the MPCA should expect a very large number of requests for CUU determinations, this will aid in making sure requests relevant to medical and pharmaceutical products do not get lost in the queue.

I. WHILE THE FDA-REGULATED PRODUCT EXEMPTION SHOULD APPLY BROADLY, CONCERNS FOR DRUGS AND DEVICES REMAIN

The statutory exemption in Section 116.943, subdivision 8(b) applies to "a prosthetic or orthotic device or to any product that is a medical device or drug or that is otherwise used in a medical setting or in medical applications regulated by the [FDA]" (emphasis added). This is a clear legislative direction that the exemption should be interpreted broadly. Nonetheless, we still have concerns for uses of intentionally added PFAS that may not be directly covered by the broad FDA-regulated product exemption but, if subject to Section 116.943's material restriction, may cascade to affect the availability, efficacy, quality, reliability, price, or safety of exempted, FDA-regulated products.

One example is an upstream supplier whose product is directly affected by the material restriction, and this supplied item therefore becomes more expensive or unavailable to customers (e.g., medical and pharmaceutical product manufacturers) or to other actors further up the supply chain. This could have negative downstream effects on the production of FDA-regulated products including on production costs, product availability, and product safety and effectiveness, as medical and pharmaceutical product manufacturers would need to scramble to find alternatives to the supplied item or at least incur increased costs in their manufacturing processes. These manufacturers also may need to obtain FDA approval for the related change to their manufacturing process. For instance, if the PFAS content of certain gaskets, pipes, and other equipment were restricted more generally at the supplier level, this could impact the availability and price of what is supplied to medical and pharmaceutical product manufacturers, regardless of whether the manufacturer's activity is covered by Section 116.943's FDA-regulated product exemption. Depending on the resulting modification in the supplier or material used, the manufacturer may need to notify and possibly seek approval from FDA for the change.

Another example is a medical and pharmaceutical product manufacturer who cannot use a product containing intentionally added PFAS in activities to the extent those activities are not directly covered by Section 116.943's FDA-regulated product exemption, though those activities nonetheless impact the manufacturer's systems that make production of the FDA-regulated product possible. For example, a manufacturer may use certain PFAS-containing logistics equipment in drug or medical device manufacturing. It was clearly not the legislature's intent in passing Section 116.943 for such products critical to the safe and effective manufacture and use of FDA-regulated products to be banned, as it would directly undercut the statute's FDA-regulated product exemption. The CUU Rule should avoid this consequence as we recommend below.

II. CRITERIA AND DEFINITIONS IN THE RULE SHOULD RELFECT R&D, MANUFACTURING, DISTRIBUTION, AND SUPPLY CHAIN IMPACTS

The MPCA's request for comments specifically asks for comments on defining CUU criteria, including the terms "essential for health, safety, or the functioning of society" and "reasonably available." For the former, we recommend adopting the following provision:

> *The commissioner shall grant a currently unavoidable use determination for PFAS applications or end products, and for the supply chain research, development, and production activities required to produce such PFAS applications or end products, when the commissioner has evidence, or when a manufacturer, organization, or other entity has submitted evidence, that an application, product, or category of products provides benefits related to health, safety, or the functioning of society and that there are no reasonably available alternatives for that use.*
>
> *A product shall be deemed to provide benefits to health, safety, or the functioning of society where the commissioner has evidence, or the manufacturer, organization, or other entity has submitted evidence, that the product contributes to:*
>
> *(a) For health – physical or emotional health or wellness, including but not limited to evidence that the product supports the manufacture, distribution, or research and development of any product subject to the exemption in Minn. St. § 116.943, subdivision 8(b);*
>
> *(b) For safety – the safety or security of the public from danger, injury, or property damage; or*
>
> *(c) For the functioning of society – identified consumer, commercial, or industrial demands for the product.*

This provision accomplishes a number of necessary objectives. First, it helps avoid arbitrary and subjective determinations by stating that the MPCA "shall" grant the requested determination if the manufacturer has submitted qualifying evidence. It also clarifies that the MPCA should grant a CUU determination *sua sponte* when the agency has sufficient evidence to do so, since Section 116.943 does not require that CUU determinations be made only upon manufacturer request. Second, this provision clarifies that the determination should apply not only to the end product itself, but to the products and processes in the supply chain that are necessary to produce that product. Without this, a CUU determination could be substantially undermined, or even rendered meaningless, given that it is not possible to produce end products without upstream activities.

Third, this provision appropriately explains what information should be submitted to demonstrate health benefits. Health benefits should be described expansively to not only capture acute physical health attributes, but also emotional health and wellness values. Furthermore, this description of qualifying health benefits makes clear that a prominent example is that the product to be subject to the CUU determination is essential because of the product's role in drug and device manufacturing, distribution, or R&D. Fourth, and like with health benefits, benefits to safety and the functioning of society should be described broadly to capture the naturally broad scope of these terms.

We also recommend the following definition of "reasonably available alternative":

> *"Reasonably available alternative" means a substance, material, technology, process, or otherwise that is currently available at commercial scale and that, when used in place of intentionally added PFAS, does not result in:*

(a) A decrease in availability, performance, life expectancy, quality, or durability of the product or of any upstream or downstream manufacturing, distribution, or research and development activities associated with that product;

(b) A significant increase in manufacturing, design, testing, capital investment, or other costs for the product or for any upstream or downstream manufacturing, distribution, or research and development activities associated with that product; or

(c) Risks to human health or the environment that would not be present, or present in lesser degrees, with use of the intentionally added PFAS, including but not limited to risks from toxicity, energy consumption, product safety, product unavailability, and disposal.

Like with our recommended provision on essentiality, this definition recognizes that the evaluation of any potential alternative must involve an assessment of how the alternative may affect other parts of the supply chain, particularly to avoid unintended impacts on other products such as those covered by Section 116.943's FDA-regulated product exemption. Likewise, this definition accounts for how the evaluation of an alternative must consider the real, commercial availability of the alternative. The evaluation must also consider the costs of the whole process for designing and implementing the alternative, including the costs that may be borne by other companies in the product's supply chain. Lastly, the risks associated with an alternative can have substantial impacts on the alternative's availability. Our recommended definition reflects how these risks could stem not only from toxicity of the alternative itself, but also from risks across the product's lifecycle. These risks could include, but are not limited to, sustainability considerations (energy consumption, climate impacts, etc.), manufacturing product safety, end product safety and efficacy (e.g., shelf life, stability), end product unavailability (e.g., health risks of skipping doses or delaying treatment because of unavailability), and disposal.

III. CUU DETERMINATIONS SHOULD BE INDEFINITE AND TIMELY ISSUED, AND MODIFIED OR REVOKED ONLY WITH NOTICE AND COMMENT

The MPCA also specifically requested comment on whether CUU determinations should be time-limited and whether significant changes should trigger a reevaluation of a determination. CUU determinations should be indefinite because Section 116.943 does not authorize a time-limited process, and it would waste both public and private resources to reevaluate determinations on a predetermined schedule. The MPCA and manufacturers would bear significant ongoing expenses to constantly reevaluate CUU determinations, each of which may involve a technical assessment akin to the European Commission's assessment of exemptions under the Restriction on Hazardous Substances Directive ("RoHS"). Pursuant to RoHS, the European Commission contracted with the Oeko-Institut to provide technical support and assistance in evaluating such exemptions.[2] The reevaluation of CUU determinations would be even more complex than what is performed by the European Commission given the larger scope of products and chemicals affected by Section 116.943.

[2] *See* Oeko-Institut, RoHS Evaluations, https://rohs.exemptions.oeko.info/project-overview/background.

Likewise, CUU determinations should be indefinite because this gives both directly affected manufacturers and other stakeholders in impacted supply chains the necessary repose to rely on a determination without fear that it could be unexpectedly revoked or modified. As an example, changes to FDA-regulated products take many years to implement, in part because of modifications that require FDA approval. The European Chemicals Agency ("ECHA") recognized this extensive timeline by including 13.5-year derogations for medical devices in its PFAS restriction proposal.[3] At the very least, this indicates that any periodic review of previously issued CUU determinations should be conducted based on long time horizons, especially for determinations that may affect FDA-regulated products. Moreover, any such review should not require that the full CUU criteria be re-explained or re-justified, since this would in effect operate as an entirely new CUU determination process that Section 116.943 does not authorize. Instead, the review should be limited to a brief statement from the manufacturer, organization, or other entity on whether reasonably available alternatives continue to not exist.

For similar reasons, the MPCA should be required to timely respond to requests for CUU determinations; if the agency fails to respond by the required deadline, that should function as an automatic determination for as long as the MPCA is late. This is in line with exemption procedures under other chemical regulatory programs, such as RoHS Article 5 through which an existing exemption to the directive's restrictions remains valid until the European Commission has decided on a renewal application.

Likewise, a CUU determination should only be revoked or modified after proper public notice and comment; if a determination is revoked or modified, the MPCA should be obligated to explain its reasons for the decision and then give manufacturers a clear opportunity to appeal the decision. These procedures will act as safeguards to ensure that impacted stakeholders from across supply chains are able to properly plan for and then rely on CUU determinations. It will also give stakeholders beyond the direct manufacturers of the impacted product, such as medical and pharmaceutical product supply chain partners, opportunities to explain to the MPCA the importance of the determination and provide relevant information.

IV. WHERE APPROPRIATE, CUU DETERMINATIONS SHOULD BE MADE FOR BROAD PRODUCT CATEGORIES RATHER THAN PRODUCT-BY-PRODUCT

The MPCA should make CUU determinations for broad categories of products, rather than on a product-by-product basis. Section 116.943 does not require that CUU determinations be made only for individualized products. Like with time-limited determinations as mentioned above, this would waste both public and private resources as manufacturers will likely end up preparing and submitting several requests for like products, and the MPCA will need to carefully compare requests to assess potential duplication. Moreover, this process would almost certainly omit some products that should be covered by a CUU determination but are not because of arbitrary line drawing in the scope of the determination.

CUU determinations made for broad product categories would also be in line with the U.S. Environmental Protection Agency's ("EPA's") Toxic Substances Control Act ("TSCA") PFAS Reporting Rule, 40 C.F.R. Part 705. Under that rule, manufacturers are to report PFAS in

[3] ECHA, PFAS Restriction Proposal, Annex XV Report (Mar. 22, 2023), https://echa.europa.eu/documents/10162/1c480180-ece9-1bdd-1eb8-0f3f8e7c0c49.

their products through use of broad consumer and commercial product category codes found in table 5 to 40 C.F.R. § 705.15(c)(4). These codes were taken from EPA's TSCA Chemical Data Reporting program, which were in turn based on Organisation for Economic Co-operation and Development harmonized codes.[4]

V. PRIOROTIZE DETERMINATIONS FOR PRODUCTS USED IN DRUG AND DEVICE R&D, MANUFACTURING, DISTRIBUTION, AND SUPPLY CHAINS

The legislature recognized the importance of protecting Minnesotans' access to lifesaving medical and pharmaceutical products through the FDA-regulated product exemption in Section 116.943. In addition, and as discussed in our comments on the Reporting Rule, states are largely preempted from regulating medical and pharmaceutical products because these items are already heavily regulated by the FDA. Therefore, the FDA-regulated product exemption in Section 116.943 also avoids disputes about the scope of federal preemption as applied to Section 116.943's material restriction.

To avoid undermining the exemption and its critical functions, the MPCA should prioritize requests for CUU determinations concerning products used in medical and pharmaceutical product R&D, manufacturing, distribution, and supply chains. This prioritization could include, for example, flagging such requests for expedited review outside of a normal first-come, first-served queue. This can help protect the integrity of medical and pharmaceutical product manufacturing, distribution, R&D, and supply chains in the event of a backlog of CUU determination requests.

VI. CONCLUSION

PPWG thanks the MPCA for considering its comments to inform future drafting of the CUU Rule. If you have any questions, please feel free to contact me.

Sincerely,

Ryan J. Carra

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[4] EPA, Instructions for Reporting PFAS Under TSCA Section 8(a)(7), Appendix D, Table D-3 (October 2023), https://www.epa.gov/system/files/documents/2023-11/tsca-8a7-reporting-instructions-10-11-23.pdf.

RECEIVED
By: OAH on 3/1/2024

Warren Lehrenbaum Attachment

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Your Dreams, Our Challenge

March 1, 2024

Office of Administrative Hearings
600 North Robert Street, PO Box 64620
St. Paul, Minnesota 55164-0620

Submitted via: https://minnesotaoah.granicusideas.com/

Re: PFAS in Products Currently Unavoidable Use Rule; Revisor's ID Number R-4837

Dear Commissioner Kessler:

AGC Chemicals Americas ("AGCCA") and its parent company, AGC America, Inc., appreciate this opportunity to provide comments on the Minnesota Pollution Control Agency's (MPCA's) planned new rules for determining Currently Unavoidable Uses ("CUU") of PFAS chemicals in products, pursuant to Minnesota Statutes 116.943, subdivision 5(c) (the "Law").

AGCCA manufactures and supplies a range of specialized industrial chemicals and materials, including resins, coatings, films and membranes, that are incorporated into a wide range of products essential to the daily lives of Minnesota residents and businesses. Many of these materials are comprised of fluoropolymers. Although fluoropolymers fall within the extremely broad definition of "PFAS" used in the Law, they are very much *unlike* the PFAS chemicals that have been found in drinking water, groundwater and blood samples, such as PFOA and PFOS. For example, unlike those PFAS chemicals of concern, fluoropolymers are not soluble in water, so they cannot enter drinking water or groundwater. Furthermore, fluoropolymers do not degrade into smaller, water-soluble molecules. Also, fluoropolymers are not bioavailable nor do they degrade to smaller, bioavailable molecules, so they do not present toxicity concerns associated with PFAS chemicals of concern. Indeed, peer-reviewed studies demonstrate that, because of these and other characteristics, fluoropolymers satisfy internationally-recognized criteria for being "Polymers of Low Concern" (PLC) -- i.e., polymers deemed to have insignificant environmental and human health impacts.[1]

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[1] *See "A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers," Korzeniowski, Stephen H., et al., Integrated Environmental Assessment and Management 19, 2 (2023): 326–354. DOI: 10.1002/ieam; "A Critical Review of the Application of Polymer of Low*

Fluoropolymers also possess a unique combination of properties that make them critical to the performance of a wide range of products and technologies, such as semiconductors, fuel cells, wind turbines, printed circuit boards, coated wires, batteries, solar photovoltaics, avionics, aircraft components, motor vehicle engines, manufacturing equipment, scientific instruments, and laboratory and diagnostic equipment, among others. This unique, and irreplaceable, combination of properties includes the following:

- **Heat resistance**: fluoropolymers are able to maintain their physical properties at very high temperatures. This makes them particularly suitable for use in aerospace and electronic components.

- **Chemical resistance**: fluoropolymers are highly resistant to chemicals, acids, fuels, and solvents. This makes them a material of choice for use in chemical processing equipment, aerospace, automotive and pharmaceuticals.

- **Mechanical resilience**: mechanical properties include high tensile strength, flexibility, and impact resistance. This is particularly important in applications such as seals and gaskets as well as architectural films and coatings.

- **Electrical properties**: fluoropolymers have low dielectric constant, high insulation durability, and are used as sheathing materials for wire and cable due to their excellent electrical properties.

- **Inertness**: fluoropolymers are inert, non-reactive and stable (they do not degrade or decompose over time). These properties make them critical to a wide range of industrial and commercial applications in situations where equipment is likely to be exposed to chemicals.

- **Cryogenic properties**: fluoropolymers present excellent cryogenic properties, which makes them particularly suitable for use in high-tech applications such as aerospace, electronics or chemical industries.

- **Separation / barrier properties**: fluoropolymers have excellent moisture barrier and superior gas separation properties. Fluoropolymer membranes are essential to the production of clean hydrogen.

- **Dielectric properties**: dielectric properties cover low dielectric constant (Dk) and dissipation factor (Df) and are unaffected by fluctuations in temperature and humidity. This makes fluoropolymers a critical material for use in electronics and telecommunication applications.

- **Weather resistance**: fluoropolymers are able to maintain their physical properties even when exposed to harsh weather conditions, e.g., environmental degradation, including

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Concern and Regulatory Criteria to Fluoropolymers," Integrated Environmental Assessment and Management, Henry, Barbara.J., et al.,14, 3 (2018): 316-334. DOI: 10.1002/ieam.4035.

exposure to ozone, ultraviolet radiation and extreme temperatures. This makes them an essential material for architectural coating and films.

- **Durability**: fluoropolymers can withstand harsh conditions while maintaining their physical properties. This makes them particularly important for use in seals, gaskets, and wires and cables insulation.

- **Non-stick properties**: fluoropolymers prevent sticking, making them a material of choice for applications for which sticking is a concern.

This unique *combination* of properties underlies the irreplaceability of fluoropolymers in a wide range of applications, including those noted above. Alternative materials may be able to achieve comparable performance to fluoropolymers for one or a few specific parameters or properties, but overall, due to deficiencies in other properties, they have lower performance and other disadvantages as compared to fluoropolymers. Thus, while alternatives might be considered to be comparable in one or two areas of performance, they often fail to offer the combination of properties that fluoropolymers deliver. It is also important to highlight that, because fluoropolymers are generally more expensive than potential alternatives, for applications where the superior performance of fluoropolymers is **not** necessary, the market has already switched to non-fluoropolymer alternatives.

The unmatched performance of fluoropolymers across multiple areas of performance means that, for most applications in which fluoropolymers are used, attempting to substitute other materials for fluoropolymers will result in a loss of reliability and durability that in many instances will have negative effects on health, safety and the environment as well as negative economic impacts. For example, if a seal or gasket fails in a piece of heavy equipment or a heavy-duty vehicle due to temperature, chemical and mechanical stresses, the failure of that seal could threaten worker safety and result in releases of chemicals into the environment, in addition to causing economic losses due to repair costs and equipment down time. These adverse impacts are averted by the use of fluoropolymers.

Similarly, if a household or commercial appliance fails because a printed circuit board in the appliance was not protected by a fluoropolymer coating and suffered an electrical short as a result, the repair costs and, perhaps collateral costs (e.g., from spoilage) will cause economic loss to the consumer, which will disproportionately impact members of disadvantaged communities. Alternatively, in such a circumstance, the affected appliance might be disposed of prematurely, creating unnecessary waste, unnecessarily occupying landfill space, and unnecessarily consuming virgin resources to manufacture a replacement machine.

Because of the favorable health and environmental safety profile of fluoropolymers, as well as their irreplaceability in a wide range of products and applications that are essential to the daily lives of Minnesota residents and the daily operations of Minnesota businesses, fluoropolymers should be designated as CUU. Moreover, because fluoropolymers are critical components in such a wide range of essential products and applications, as illustrated by the examples described above, we believe it is impossible to compile a comprehensive list of essential products for which fluoropolymers are CUU – which is why fluoropolymers themselves should be designated as CUU. In this regard, we urge MPCA to heed the admonitions of the US Department of Defense in their recent report surveying uses of PFAS compounds that are critical to the national security of the United States.[2] In that report, the Department concluded that:

> PFAS are critical to DoD mission success and readiness and to many national sectors of critical infrastructure, including information technology, critical manufacturing, health care, renewable energy, and transportation. . . . Most of the structurally defined PFAS are *critical to the national security of the United States*, not because they are used exclusively in military applications (although a few are) but because of the civil-military commonality and the potentially broad civilian impact. (emphasis in original)[3]

Importantly, many of the critical PFAS applications identified by DoD are fluoropolymer applications. These include:

- subcomponents in modern Li-ion batteries: electrolyte solutions, cathode binders, separator coatings, casing materials, and gaskets;
- semiconductor fabrication;
- microelectronics applications, including base laminate materials used in Radio Frequency (RF) and microwave circuits;
- printed circuit boards;
- mold release agents and films typically used in composite manufacturing processes;
- hoses, tubing, hydraulic system lines, O-rings, seals and gaskets, tapes, and cables and connectors widely used in civil and military aircraft, space systems, vehicles, weapon systems, utility systems, and other applications;
- resins for specialty high-temperature or weather-/UVresistant composites; and
- specialty filters and membranes (e.g., aviation filters).[4]

Finally, it is noteworthy that the Department of Defense spent nearly $100,000 and took more than one year to complete its report. Nevertheless, the Department highlighted that the information on critical uses contained in the report "represents a fraction of the mission critical PFAS uses" due to a lack of knowledge about the composition of products and components.

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[2] US Department of Defense, Report on Critical Per- and Polyfluoroalkyl Substance Uses (August 2023), available at: https://www.acq.osd.mil/eie/eer/ecc/pfas/docs/reports/Report-on-Critical-PFAS-Substance-Uses.pdf ("DoD report").

[3] Id. at 15.

[4] Id. at A1-A7.

Therefore, DoD noted, "a more complete understanding of PFAS essential uses would require an extensive and complex evaluation of the market, a gap analysis of current requirements for manufacturer-provided product information, and illumination of the value chain of products." In other words, identifying all currently unavoidable uses of PFAS is a herculean task, and the DoD's year-long effort to catalogue such uses touched only the tip of the iceberg. For this reason and others articulated above, we urge MPCA to designate fluoropolymers (and articles manufactured from fluoropolymers) as CUU, since it is impossible to identify all individual products and components in which the use of fluoropolymers is currently unavoidable.

Below we address the specific questions for which MPCA has sought comment in the Agency's Request for Comments.

1. Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

MPCA should define criteria for determining "essential for health, safety or functioning of society." Moreover, products in commerce that do not present a risk, or present only an insignificant risk, to human health or the environment should be presumed to be "essential for health, safety or functioning of society" since, if they do not present a risk, there is no basis to remove them from commerce. Because fluoropolymers have been demonstrated to satisfy internationally accepted criteria for being polymers of low concern, MPCA and stakeholder time and resources should not be wasted on an essentiality analysis. Neither should Minnesota residents and businesses be denied access to a wide range of products important to their daily lives simply because those products contain a polymer of low concern.

If a potential significant risk to human health or the environment is identified with respect to the use of PFAS in a product, MPCA should conclude that the product is "essential for health, safety or functioning of society" if any of the following criteria are satisfied:

- If the product or one or more of its components were not available:
  - There would likely be an increase in negative health outcomes or safety threats;
  - It would likely be more difficult to mitigate risks to human health or the environment;
  - Threats to critical infrastructure[5] or supply chains will likely increase or become more difficult to mitigate;
  - Systems, products, functions or services that are relied upon for the ordinary daily functioning of society will likely become less available or less reliable

[5] For purposes of defining critical infrastructure we urge MPCA to consider the sixteen critical infrastructure categories identified by the Cybersecurity and Infrastructure Security Agency (CISA), which can be found at the following URL: https://www.cisa.gov/topics/critical-infrastructure-security-and-resilience/critical-infrastructure-sectors.

- The product, or one or more components, is required by federal or state law or regulation (e.g., to satisfy emissions standards or safety requirements)
- The product or component is integral to one or more of the following:
  - climate mitigation
  - critical infrastructure
  - delivery of medicine
  - lifesaving equipment
  - transportation
  - manufacturing or construction
  - critical and emerging technologies[6]

More generally, the concept of "essential" must be interpreted broadly in order to be workable. Under a narrow interpretation of it might be argued that products such as cell phones, laptop computers, or automobiles are not "essential to the functioning of society" since society can continue to function without these conveniences. But a constrained interpretation such as this fails to properly account for the fact that these types of products are both beneficial and an essential feature of our society. Similarly, under a narrow interpretation of "essential" it could be argued that products such as refrigeration units are not "essential to health" since people can live healthy lives without refrigeration. However, this narrow interpretation ignores the critical role that refrigeration plays in supporting good health by preventing food spoilage and preserving pharmaceuticals. These are merely a few examples of the types of products that, if they became unavailable, would cause massive social and economic dislocation. To avoid this type of disruption we strongly urge MPCA to adopt a broader interpretation of "essential".

Finally, we urge MPCA to heed DoD's warning against overly-broad restrictions on PFAS chemistries. As the Department noted:

> Emerging environmental regulations focused on PFAS are broad, unpredictable, lack the specificity of individual PFAS risk relative to their use, and in certain cases will have unintended impacts on market dynamics and the supply chain, resulting in the loss of access to mission critical uses of PFAS. These market responses will impact many sectors of U.S. critical infrastructure, including but not limited to the defense industrial base.[7]

In developing regulations interpreting the concept of "essential" MPCA should ensure that the term is interpreted broadly enough to encompass uses of PFAS that are important to the ordinary daily functioning of society.

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[6] *See* White House Critical and Emerging Technologies List Update February 2024, available at https://www.whitehouse.gov/wp-content/uploads/2024/02/Critical-and-Emerging-Technologies-List-2024-Update.pdf

[7] DoD Report at 15.

2. **Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?**

Cost is just one factor that must be considered in assessing whether an alternative is "reasonably available" to replace an incumbent chemical in a product. Specifically, an alternative should be found to be "reasonably available" only if the following criteria are satisfied:

1. The proposed alternative is demonstrated to perform the functions of the incumbent substance in a particular end use application at least as well as the incumbent substance, based on objective, quantifiable data.

2. The proposed alternative is demonstrated to satisfy any applicable standards, specifications or qualifying criteria necessary for deployment of the alternative in a particular end use application.

3. Existing supply chains for the proposed alternative can support, without interruption, the increased demand that would result from substitution of the incumbent substance.

4. Substitution of the potential alternative for the incumbent substance in a particular product will not substantially increase the cost of the product. For purposes of this criterion, a cost increase should be considered "substantial" if it exceeds the current rate of inflation at the time of the assessment. In addition, the cost should be evaluated based on the entire life cycle cost, which includes not only manufacturing, but also the maintenance and disposal costs.

In other words, an alternative cannot be considered "reasonably available" if: (i) it does not perform a required function at least as well as the incumbent substance; (ii) it does not satisfy any applicable standards, specifications or qualifying criteria necessary for deployment of the alternative; (iii) is not available at scale; or (iii) implementation of the alternative will appreciably increase the cost of the product.

With respect to costs in particular, MPCA should not assume that the adoption of an alternative will be cost neutral in terms of the manufacturing process. There are critical cost considerations around potentially needing to retool production facilities, changes in production yield, worker training, and disposal costs. In addition, MPCA should consider what effect the adoption of an alternative might have on the price of the final good and whether such a price increase would affect the ability of disadvantaged communities in Minnesotan to access or maintain important products like mobile phones, computers, automobiles, household appliances, and others.

3. **Should unique considerations be made for small businesses with regards to economic feasibility?**

It is reasonable to expect that small businesses will be disproportionately affected by the Law, since it will likely be more difficult for small businesses to identify, test and procure alternative(s) and to implement any process and/or equipment changes and/or employee training necessary to adopt the alternative(s). We encourage MPCA to consider opportunities to alleviate these burdens on small businesses, for example, through exemptions or delayed compliance deadlines.

4. **What criteria should be used to determine the safety of potential PFAS alternatives?**

An alternative should not be considered “reasonably available” unless it is demonstrated, through scientific data, to present less risk under intended conditions of use than the incumbent substance. In other words, a “safety” assessment should examine the comparative ***risks*** (i.e., hazards and exposures) presented by the incumbent and the proposed alternative. As a threshold matter, this would require MPCA to determine that the product containing the incumbent substance presents an appreciable risk to human health or the environment. If the incumbent substance does ***not*** present an appreciable risk, the substance should be designated as being CUU. Furthermore, any comparison of potential risks must include an assessment of the risks resulting from an increased likelihood of product or product component failure or decrement in product performance from the deployment of an alternative to the incumbent substance.

MPCA should articulate data quality criteria that will be applied in assessing relative risk and should adopt a weight of evidence approach to the assessment. Thus, for example, scientific studies should be accorded more weight than anecdotal evidence; surrogate data should be accorded less weight than data on the substance under consideration, and so forth.

MPCA should also consider sustainability impacts such as water use, consumption of raw materials, emissions reduction, energy efficiency, reliability during use, and avoiding the use of landfill capacity.

5. **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?**

Products in commerce that do not present a risk to human health or the environment should be presumed to be “essential for health, safety or functioning of society” without any time limit or reevaluation, since, if they do not present a risk, there is no basis to remove them from commerce. For other products, CUU determinations should last until demonstrably safer alternatives are identified that (i) are demonstrated to perform at least as well as the incumbent substance; (ii) satisfy any applicable standards, specifications or qualifying criteria necessary for deployment of the alternative; and (iii) can be implemented at scale and with no significant increase in costs.

Significant changes in available information that formed the basis of the original CUU determination should trigger a re-evaluation. Re-evaluation should apply to ***both*** affirmative CUU determinations, as well as CUU denials.

In no case should re-evaluations take place more frequently than 10 years. MPCA should consult with potentially affected industries to determine if a longer re-evaluation period may be necessary to evaluate alternatives or otherwise provide information for the re-evaluation process. In addition, for any CUU that is declined (including CUUs that were granted and then subsequently declined on reevaluation), manufacturers must be provided adequate time to transition to the alternative.

6. How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

MPCA must establish an accessible and efficient process by which manufacturers and users (or their representatives) can request a CUU determination from MPCA. The process should be flexible enough to accommodate multiple uses of a substance to be addressed in a single request, rather than requiring separate requests for each individual application – which create a huge and unnecessary burden on both MPCA and stakeholders.

A manufacturer or user that makes a timely submission of a request for a CUU determination should not be penalized if MPCA is unable to process the request by the statutory deadline of January 1, 2032, for identifying CUUs. In such cases, the manufacturer should be exempt from the ban until MPCA makes a final determination on the CUU request. In addition, if MPCA rejects a CUU request, the Agency should be required to provide the requestor with a concise explanation of the specific factors and sources of information MPCA relied upon in rejecting the CUU request.

It is reasonable to establish a process to request a reevaluation of a CUU determination. However, there is no need to establish a process for making a “not a CUU” request for products that have not received a CUU determination. Furthermore, any process around the granting or re-evaluation of a CUU must protect trade secrets. In particular, the Agency must provide clear instructions regarding the specific steps that must be taken to officially assert and/or substantiate a trade secrets claim for information submitted that qualifies as a trade secret under Minnesota law, including the timeline by which such claims must be made. In addition, the Agency should define a process whereby a manufacturer or user is notified if its trade secret is subject to a public records request or is inadvertently disclosed by the Agency.

7. **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.**

A representative list of products that should be designated as CUU is provided in Attachment A to this letter. This list is illustrative, not comprehensive.

8. **Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?**

Yes, MPCA should propose some initial CUU determinations as part of the rulemaking process, to provide manufacturers, supply chains and downstream users in Minnesota with greater certainty about the regulatory status of products that are integral to their operations and daily lives.

Please let us know if you have any questions regarding the information presented in these comments. We would welcome the opportunity to discuss this crucially important with you, and we would be happy to provide you with additional relevant information regarding the products and applications identified in this submission. Should you have any questions or concerns, please reach out to Ahmed El Kassmi at 610-423-4312 or by email at ahmed.elkassmi@agc.com.

Sincerely,

Christopher F. Correnti
President and CEO
AGC America, Inc.

Ahmed El Kassmi, Ph.D
Director, Product Stewardhip & Regulatory Affairs
AGC Chemicals Americas, Inc.

Attachment A

Representative list of CUU applications

Sector	Representative application(s)
Transportation	· Cable and wire coatings and sheathing for civil and military aircraft, aerospace, motor vehicles, watercraft, and other transportation modes, including high temperature sensor cables (e.g., sensor cables for emissions reduction and improvement of engine efficiency) · Mold release film for composites used for aircraft and helicopter fuselage, wings, etc. · Coatings for aircraft exteriors and interiors and motor vehicle exteriors · Fuel cell components including: polymer electrolyte, catalyst ink binder for Proton Exchange Membrane Fuel Cell (PEMFC), as well as humidifier/drier in balance of system for fuel cell vehicle to control moisture of incoming hydrogen required for reliable and efficient operation of the fuel cell. · Hoses and tubes, including brakes hoses, hydraulic hoses and fuel hoses to reduce evaporative fuel emissions in combustion engine vehicles · Oil seal components, piston rings, shock absorbers, bearings and gasket · Lubricants where other lubricants are not suitable, such as bushings for car door hinges, and trunk lids · In ABS and braking systems because of safety needs · Coatings for engine parts, protection film
Electronics	***Semiconductors*** · Molding assist film for power semiconductors packaging in Fuel Cell Vehicles and Battery Electric Vehicles · Coating for electronic semiconductor wires · Air and liquid filtration filters used in the semiconductor industry · Molded products for semiconductor equipment, tubes/release sheets used during semiconductor processing · Advanced Semiconductor Packaging · Pellicles for Semiconductor chip manufacturing

Sector	Representative application(s)
	· Seals, gaskets, O-rings, packings, linings and coatings for pipes and joints for semiconductor manufacture · Encapsulating material for UVC LED chip · Surface coatings of fixing films ***Batteries*** · Solid-state lithium batteries for electric vehicles ***Printed Circuit Boards*** · Mold release film in compression lamination of printed circuit boards, in semiconductors, optoelectronics components, standard packaging to protect memory chips and sensor devices used for mobile devices, data centers, and LED lens production · Substrate for print circuit board · Sound transmission membranes in circuit boards, antennas for mobile phones, technical / industrial linings, electromagnetic flowmeters · Heat-resistant sheath wire in electronic equipment operating at high frequencies and high temperature · Heat-exchanger flue gas de-sulfurization, SF6-circuit breakers, venting and insulation ***Cables & Wire, Other*** · Coating material for wires, coaxial cables and various other cables for chemical resistance conforming with international factory mutual standards (fire risk reduction) · Heat-resistant sheath wire in electronic equipment operating at high frequencies and high temperature · Optical fibers · Antifouling and mold-release coating agent for touch panel glasses, lenses and mirrors; functional anti-smudge coatings applied to various substrates (e.g. glass, metal, plastic), removing sebum and fingerprints on exterior parts (e.g. cover glass, housing, camera module in portable devices) especially smart phones and other touchscreen applications; coatings for automotive use (e.g. instrument panels with touchscreen interface); adhesion prevention for glass and parts for multifunctional printers
Communications	· Plastic optical fiber (POF) in telecommunication · Coating of special optical cables called “buffer tubes” · Coating of signal cables

Sector	Representative application(s)
	· Tubes and machine or injection molded parts, printed circuit boards material for use in high-speed communication technology
Medical devices and life sciences	***Tubes, catheters, etc*** · Catheters for intravenous and inside body interventions; small "non-kink" tubes; endoscopy; pancreatic and biliary stents; foreign body retrieval devices; balloon dilators; needles, brushes and specialty items; single use snares in colonoscopies; endoprostheses · Gaskets; diaphragms in medical ventilators/respirators and sterile syringe filters; membrane filters for sterile venting of gases, aggressive fluids, acids & non-aqueous solvents, gas filtration and aerosol sampling; humidifier/drier membranes used in CPAP (Continuous Positive Airway Pressure) machines; breath gas analyzers. · Artificial blood vessels · Dialysis-related devices · Surface coating for medical devices · Packaging of terminally sterilized medical devices · Coatings for biochip devices ***Equipment & Manufacture*** · Laminate rubber stoppers · Wire sheath material for medical equipment · Humidification or conditioning of various medical gasses · Tubes, seals, gaskets, O-rings, lining of vessels, pipes, valves, hoses, process control devices, pumps, gas scrubbers, dryers, evaporators, heat exchangers and connectors for pharmaceutical manufacturing equipment · Coating for image plate of medical printing film
Construction and Infrastructure	· Roofing and façade material for membrane structures such as train stations, sport stadia, shopping malls, airports, exhibition centers, bridges, greenhouses for commercial-scale growth of fruits, vegetables, flowers, etc. · Sports facilities and sewage disposal facilities · Light weight and composite constructions (development / future application) · Heat-resistant flexible wire · Architectural coatings and paints · Sliding bearings

Sector	Representative application(s)
	· Anti-graffiti overlay for traffic signage / safety · Laminate films to provide antifouling and touch-proofing of metals, fire and heat resistance and oil resistance to kitchen hoods
Food Contact and Processing	***Food industry*** · Seals, O-rings, gaskets, tubing and pipes, valves and fitments, tank linings, sensor covers, and non-adhesive coating for food equipment · Lining of food cans · Ion exchange membranes · Industrial-scale food and feed processing equipment, in seals, tubes, pipes, hoses, o-rings, gaskets, valves and fitments, conveyor belting, tank lining, filter membranes, sensor covers, lubricants and equipment specific to food and feed transport.
Energy	***Oil & Gas and Mining*** · Cables and cable outer "jackets", including sub-sea heating cables and self-regulating heating cables. · Structural or fluid handling components · Coating resin material for electrical wires for crude oil drilling · Wire insulation for downhole sensor cables, extract duct coating, trace heating for cold production areas, and self-regulating heating cables for cold areas · Dehumidification of sample gas for analysis · Packers, blow out preventers, seals, gaskets and O-rings ***Nuclear*** · Cables and wires, including cables of control rooms, sensor cables, and general cables for the industry. ***Photovoltaics and Wind*** · Building integrated photovoltaic (BIPV) modules, solar panels, molding wind turbine composites · Next-generation solar cells for BIPV and megasolar projects · Coatings for PV modules · Coatings for wind turbine blades and towers ***Hydrogen***

Sector	Representative application(s)
	· Proton Exchange Membrane Electrolyzer (PEMEL): water electrolysis, electromechanical hydrogen compressors and purification and electrolysis plant for renewable hydrogen production ***Other*** · Separator for REDOX flow batteries · Exchange Membrane Electrolyzer for anion exchange membrane water electrolysis (AEM) · Binders for electrode materials in batteries · Release films used for photovoltaic cells, proton exchange membrane of fuel cells, Li-ion batteries · Key polymer electrolyte, also used as a key ingredient of catalyst ink's binder for Proton Exchange Membrane Fuel Cell (PEMFC)) · Coating of tidal power cables · Humidification or conditioning of various gases
Manufacture/ Processing	***Chemical Industry*** · Coating material for industrial wires, coaxial cables and various other cables · Hoses, tubes, gaskets and other seals · Distillation column packings · Rotolining or electrostatic coating, e.g., vessels, tanks, pipes, tubes, elbows, complex manifolds, pump casings and filter housings · Electrodialysis processes for wastewater treatment (desalination and salt concentration) and separation of organic components and inorganic salts (cosmetics, medicals, food, medicine, and purification of intermediates in inorganic synthesis) · Expansion joints, compensators and bellows · Bearings, ball joints, hinges, calipers, valves · Ion exchange membranes for production of caustic soda, potash, chlorine for use in end products such as: paper, aluminum, wind turbines, hydrazine used in fuel cells, rocket fuels, pharmaceuticals, antiseptics, nylon, EDTA, soaps, cleaning agents, household bleaches and germicides, and many organic and inorganic chemicals

Sector	Representative application(s)
	Metal Plating · Acid recovery (acid and metal salt separation process by electrodialysis/diffusion dialysis) ***Water treatment*** · Industrial water treatment; electrodialysis ***Lubricants*** · Solid lubricants where other lubricants are not suitable; thread seal pastes · Coatings for improved rub and scuff resistance, reduction of friction, chemical inertness and temperature resistance and to impart release characteristics (e.g., mold release agents) ***Misc. Equipment*** · Manufacturing equipment such as belts, rollers, heat-sealers in dying, laminating, drying processes · Dryers used to remove moisture from gas samples prior to analysis to improve signal resolution · Dehumidification or humidification pretreatment in pneumatics or compressed gas · Manufacturing equipment, including seals, hoses, gaskets, o-rings, valves, linings in vessels, pipes, reactors, process control devices, pumps, gas scrubbers, 3D printers

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By: OAH on 3/1/2024

Andrew Bemus Attachment

SPAN™ SUSTAINABLE PFAS ACTION NETWORK

Office of Administrative Hearings (OAH)
c/o Rulemaking *eComments* website
https://minnesotaoah.granicusideas.com/
Minnesota Pollution Control Agency
Attention: Resource Management and Assistance Division

Regarding: Planned New Rules -- Currently Unavoidable Uses of PFAS

The Sustainable PFAS Action Network (SPAN) is submitting the following comments on the planned new rules that will govern how applicants may seek, and the Pollution Control Agency (MPCA) will consider and make, determinations that the presence of PFAS in a product represents a currently unavoidable use (CUU). Such determinations are of critical interest to SPAN Members because such determinations will establish which products will otherwise be banned from distribution in Minnesota commencing January 1, 2032.[1]

Background on SPAN

SPAN is a coalition of PFAS users and producers that are committed to sustainable, risk-based PFAS management. Our members advocate for responsible policies grounded in science that provide assurance of long-term human health and environmental protection while recognizing the critical need for certain PFAS materials as directly contributing to essential functions in our modern economy. In a recent study by INFORUM, a Washington-based economic consulting firm, critical PFAS-using industries, such as the automotive, aerospace, air conditioning and refrigeration, medical devices and pharmaceuticals, battery supplies, and semiconductor industries together account for more than six million jobs, annual wages over $600 billion, and more than $1 trillion to the nation's gross domestic product. SPAN was formed with these various and critical uses in mind, to ensure the health of the environment and consumers while maintaining America's global economic edge.

SPAN supports MPCA's efforts to establish a formal process that will ensure the approach taken by MPCA for considering and granting unavoidable use determination is timely, transparent, and has clearly established criteria which are applied fairly. In addition to responding to the specific questions upon which MPCA has requested comment, as set forth below in the numerical order as presented in MPCA's request for comment, SPAN is providing additional comments in its remarks to reiterate many of the topics addressed in its prior submittals to state government officials.

Specific Comments in Response to MPCA's Request

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[1] As a coalition comprised of various member companies and entities, SPAN expects its member companies, when appropriate to do so, will submit proposals for CUU determinations that are pertinent to their individual products, chemistries, and needs. Nevertheless, SPAN encourages MPCA to take these comments into consideration and to eventually propose categorical CUU determinations which could encompass the uses identified in SPAN's comments below. Doing so will promote efficiencies and resource savings which could benefit MPCA and the regulated community by eliminating the need to issue product-by-product determinations.

1) Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Response: SPAN recommends MPCA provide criteria, definitions, examples, as well as narrative guidance to the regulated community that will further clarify how the Agency will interpret the statutory definition of "currently unavoidable use" (i.e., a use of PFAS determined to be "essential for health, safety, or the functioning of society and for which alternatives are not reasonably available").

- SPAN recommends key terms in the Minnesota statute be further defined by MPCA. The rulemaking proposal should explain how MPCA interprets key terms in the CUU definition; specifically, "essential for health," "essential for safety," and "essential for the functioning of society." SPAN suggests such definitions clarify that "essentiality" involves the concept that if the PFAS-containing product (or use of PFAS) were unavailable, there could be a significant increase in negative healthcare outcomes, or an inability to mitigate significant risks to human health or the environment, or significant interruptions to the daily functions on which US society relies.

- Further, SPAN recommends that PFAS-containing products and uses of PFAS that are considered to be essential for the functioning of society should be defined to include (but not be limited to) PFAS that are critical to climate mitigation efforts, components in critical infrastructures, the delivery of medications, personal protective and lifesaving equipment, public transport, agriculture, scientific research and construction.

- Another key term for which it would be helpful for MPCA to interpret publicly is "alternatives are not reasonably available." Furthermore, it is unclear from the statute what MPCA will consider to be an "alternative" to a specific PFAS or its use in a particular product. For example, does MPCA interpret the term "alternative" to apply specifically and only to chemical alternatives that might be considered a "drop-in replacement" (e.g., a functional equivalent chemically for achieving the specific attribute provided by PFAS when present in a particular end use product), or to also include alternative manufacturing processes (e.g., that reduce or completely remove the use of PFAS in formulating a product), and/or to include *alternative end products* themselves which would negate the need to use a particular PFAS-containing product (e.g., these might include the substitution of the use of an umbrella made of sail cloth in lieu of the use of *outer wear/rain gear* with a PFAS-based water repellent coating).

    - To avoid inadvertently encouraging regrettable substitutions, SPAN recommends MPCA clarify it will consider a variety of important factors affecting whether an alternative is reasonably available. These should include (but not be limited to): (i) the performance capabilities of the alternative when compared to the PFAS-containing products (including the alternative's ability to meet technical specifications such as those required to meet government-issued requirements); (ii) the comparative health and environmental effects of the alternative versus the PFAS material under consideration (based on known effects supported by scientific studies); and (iii) the comparative length of service life and end-of-life disposition of the material in question compared to the alternative under consideration.

- In addition to definitions to be provided by MPCA, SPAN recommends the agency also provide examples of "currently unavoidable uses," and that these include (among others discussed below) all uses that have previously undergone reviews and received federal authorizations for specific uses pursuant to programs such as (but not limited to) the significant new alternatives program (SNAP) under the Clean Air Act; the EPA's new chemicals and significant new uses program under Section 5 of the Toxic Substances Control Act; drugs, medical devices, biologics, and diagnostics and equipment authorized under the Food and Drug Act (FFDCA); pesticides and devices subject to regulation under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); and other federal programs whereby either the PFAS, or products containing them, have been deemed acceptable for their intended use by federal government agencies. This should include products which are subject to, or PFAS (or a PFAS-containing component) is necessary for meeting, federal specifications (e.g., Department of Defense requirements and military specifications, Federal Aviation Administration standards, NASA requirements).

- Rules to be established by MPCA also should recognize that while many of the product categories identified above may not fully satisfy the statutory provision in Section 8(a) of the law that refers to "a product for which federal law governs the presence of PFAS in a manner that preempts state authority," there are many additional categories of uses that, likewise, should be eligible for CUU determinations because there are, in fact, uses of PFAS which are critical to public health, safety, and/or the functioning of society and may not have reasonably available alternatives at this time. Such a more flexible approach that is not limited simply to a "federal preemption" criterion, will help MPCA concentrate its efforts on identifying non-essential consumer products for which the 2032 prohibition (or one to occur later) might be appropriate. SPAN recommends the following additional categories of products (and their raw materials, components, and replacement parts) be included in a categorical CUU determination to be identified in its eventual regulations:

    - Packaging for drugs, medical devices, biologics, diagnostics, and food contact articles and components subject to the oversight by the Federal Food and Drug Administration or the Department of Agriculture.
    - Items and products and substances required by state laws and regulations.
    - Used product offered for sale or resale, and products that are already owned but may be leased for use but for which ownership is retained by the lessor (e.g., office machinery, rental cars).
    - Transportation equipment including: automobiles, train engines and rail cars and components, packing containers and forklifts, ships and container vessels and services equipment, agricultural vehicles and equipment, motorcycles, construction equipment, wheel chairs and other forms of mobility assisting appliances.
    - Waste disposal equipment and equipment used in storage of waste and hazardous materials and products to ensure the safety and integrity of the containment and disposal systems.
    - Air conditioning, heating, ventilation, and refrigeration equipment and their components and parts including replacement parts and materials.
    - Heat transfer fluids for cooling of electronic components (e.g., data centers);
    - Appliances and equipment used in harnessing energy (e.g., windmills, solar panels).
    - Batteries and other components in electric vehicles.
    - Personal Protective Equipment and outwear for first responders and used in rescue, law

enforcement and defense application.

- Semiconductors, transistors, wiring, insulation, connections, housings and other electronics, and circuit boards which are not exposed (other than during repair or disassembly for disposal) as well as the final packaged semiconductor devices and articles containing them.

Examples of CUUs to be provided by MPCA, and the process established for seeking to add additional ones to the state's initial lists, should allow for latitude and flexibility to permit CUU determinations to be made for items not currently contemplated by MPCA during its impending rulemakings and to encourage, rather than discourage, innovation and economic development. The process established by MPCA should permit product manufacturers and PFAS-containing product users to request CUU determinations to be made even after the notification cycle is completed and continuing even after the 2032 product prohibitions take effect. This is needed to address as yet unknown innovations that might involve uses of PFAS in technologies and applications that could enhance energy efficiency or data processing or climate change mitigating methods, but which lawfully could not be brought to bear in Minnesota after the 2032 prohibitions take effect. MPCA should establish a CUU determination process that will encourage advances in the health care, engineering, transportation, energy storage and recovery, and other technologies that are yet unknowable.

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Response: Yes. The standards for reasonably available alternatives should consider both the technical and economic feasibility of alternatives. MPCA should consider specifying that an alternative which is reasonably available must include technical and economic feasibility. This would require that an alternative be both readily available in sufficient quantities and will be available at comparable costs to the PFAS it is intended to replace, and that the alternative perform as well as or better than PFAS in a specific application of PFAS in a product or product component under pertinent specifications and use conditions. Businesses seeking CUU determination should be requested to provide information concerning the availability of alternatives as well as the technical and economic feasibility of the alternative. Furthermore, the health and environmental impacts of the use of alternatives also should be considered. For example, it might be possible to replace PFAS-containing heat resistant PPE for use by fire fighters with asbestos-containing alternatives, however, that particular substitution (or alternative) may not provide net health and environmental benefits which would outweigh the potential concerns related to the use of PFAS.

3) Should unique considerations be made for small businesses with regards to economic feasibility?

Response: Yes. Economic feasibility should be a consideration in addition to technical feasibility (such as meeting performance characteristics). Special consideration for small businesses might include longer periods for prohibitions to take effect.

4) What criteria should be used to determine the safety of potential PFAS alternatives?

Response: The safety of PFAS alternatives should be determined on a comparative basis by taking into consideration the entire lifecycle of the current (PFAS-containing) product in contrast to the "alternative" under consideration. For example, consideration should be given to the methods or manufacture of the alternative, the energy and environmental benefits of the continued use of an existing PFAS-containing product to a potential alternative, the service life of the existing product when compared to the alterative, and the likely environmental and health impacts of end-of-life treatment of and recyclability or disposal of the current and alternative material under consideration. Furthermore, the "safety" determination might need to involve a "comparative-risk" determination including whether an alternative may be available and should be considered for use which may contain PFAS, but a variety of PFAS for which there are fewer health or environmental concerns; in which case, it's use as a phased-in alternative should be considered and encouraged over time. Importantly, a "safety" determination also should consider the potential consequences of a potential failure of an alternative chemistry or PFAS-containing product, for example, if the alternative cannot meet technical standards that can affect safety. Such considerations are critical for PFAS-containing materials that must perform under challenging physical and chemical conditions and under repeated stresses, such as in aerospace and defense applications where failures can have devastating consequences.

5) How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided? Should significant changes in available information about alternatives trigger a re-evaluation?

Response: SPAN recommends MPCA have the authority to issue CUU determinations with appropriate conditions. For example, exemptions from a prohibition might be granted subject to an appropriate time limitation (e.g., a ten-year period with the ability to seek extensions if alternatives remain unavailable), and/or to be contingent on commitments from the product producer to minimize human exposures and environmental releases of PFAS to retain a currently unavoidable use designation. However, such an approach should take into consideration the availability of alternatives and the time required to obtain needed authorizations (e.g., government-issued approvals and customer qualification) before substitutions can occur. Extensions should be considered and granted if needed. Consideration also should be given to international requirements and treaties. Periodic reporting by the exemption recipient also could be a condition of the currently unavoidable use designation.

As noted above, SPAN reiterates that replacement parts for existing materials (including large and complex equipment and machinery) may need to continue to contain PFAS to meet technical and contract specifications and thus should not be prohibited even after the 2032 product prohibitions.

6) How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

Response: The process MPCA establishes by which businesses may seek CUU determinations should, at a minimum, enable members of the regulated community to request a "currently unavoidable use" classification for one or more products and to provide information sufficient to support a finding by MPCA that there was a basis for MPCA to conclude the product met the criteria to be established for a CUU. If such determinations are to be made through a public rulemaking process, SPAN advocates that the process be open to the proponents and opponents of an unavoidable use determination.

7) In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

Response: SPAN Member companies, rather than SPAN itself, will be submitting such product and company-specific requests.

8) Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

Response: Yes. As previously discussed, SPAN advocates that there are certain basic categories of use that should be considered to be unavoidable, and for which exemptions need not be sought by individual company-specific applicants. This will streamline the process for entities to seek such determinations for unique products and allow MPCA to focus on PFAS of high concern in non-essential uses which we believe is MPCA's ultimate intent with this rulemaking.

Other Comments from SPAN

- Span encourages MPCA to establish an entire framework for implementing its CUU determination program**.** SPAN recommends the state's process should enable potentially affected entities to not only apply for, but also provide guidelines, online resources, and an application portal providing administrative support for essential use determinations. The systems established should provide:
  - Deadlines for when applications must be submitted (including potentially variable timelines for different categories of products);
  - The required contents of such applications;
  - Definitive points in the application consideration processes inclusive of an interactive process whereby reviewers at MPCA may contact applicants to pose questions or seek additional information as required to assist MPCA in reaching a determination; and
  - Timelines for the consideration of and response to the applications (e.g., no later than 90 days following receipt of the application).

Reporting Requirements Under Subdivision 2: Although not responsive to the CUU comment solicitation, SPAN continues to encourage MPCA to prepare (in addition to the proposed regulations for its CUU process) and establish clear and practical reporting obligations for PFAS-containing consumer products under Subdivisions 2 and 3 of the law, which will provide information of value to MPCA's stakeholders, while ensuring any product prohibitions that are eventually codified and the CUU processes that is implemented pursuant to Subdivision 5 and 8 of the law are reasonable and risk-based, and accommodate essential PFAS uses and products that provide important societal benefits. The information gathered under the reporting requirements should be considered, evaluated, and inform any risk-based product restrictions issued by MPCA under Subdivision 5 of the law.

- SPAN advises that MCPA permit entities filing PFAS containing product reports to assert claims of confidentiality for information that is a trade secret or protected for national security reasons. SPAN also emphasizes that confidential information should be kept secure and protected from public disclosure or unintended disclosure, including through hacking efforts and commercial espionage.

- SPAN recommends that MCPA avoid duplicating EPA’s PFAS information collection efforts and place greater emphasis on gathering information on PFAS-containing substances, formulations, and other chemical mixtures that are produced in the state and will undergo further processing and use in the state in a manner that will provide an opportunity for releases and exposures to occur within Minnesota.

- SPAN suggests that MCPA adopt a “reasonably ascertainable” due diligence standard for manufacturers who are attempting to fulfill their reporting obligations and that MPCA make clear that manufacturers may reasonably rely on information provided by the suppliers, if the reporting party can document that proper inquiries were made to suppliers and the efforts they made to obtain information regarding the use of PFAS.

- SPAN requests MPCA clarify certain definitions, including the definition of “Intentionally added” PFAS. Specifically, MPCA should clarify that the definition does <u>not</u> include the following: manufacturing byproducts and impurities that might be unintentionally present in a product in commerce, and PFAS degradants that might be formed during product manufacturing but also be considered unintended components or contaminants.

- SPAN asks MPCA to clarify that the definition in the statute of “product” is, as was intended by the legislature, limited to those products made available to <u>consumers</u> for their personal use. The inclusion in the definition of products that are also made available to consumers for “commercial, or industrial use” or “for use in making other products” unintentionally expands the scope of the products on which the focus should remain. MPCA should include language in the proposal to make clear that PFAS-containing products that are used in commercial settings (e.g., office equipment) and in industrial and manufacturing applications (e.g., industrial and commercial devices, such as mechanized systems and robotics) are *excluded* from the reporting and prohibitions requirements under the law.

- SPAN requests MPCA to align its regulatory definition of PFAS (which currently is the overly-inclusive “single fully-fluorinated carbon atom” definition) with the EPA’s more targeted definition[2] in the TSCA 8(a)(7) reporting rule (a structural definition approach that relies on the presence of at least two fluorinated carbons) which covers significantly fewer substances than the “one fully fluorinated carbon” definition.

<u>Fees</u>: SPAN also recommends that reporting fees be modest and that reporting should be done using an online platform that has been tested and is efficient and “user friendly”. SPAN recommends that fees be

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[2] EPA’s reporting rules at 40 CFR 705.3 define *Per- and polyfluoroalkyl substances* or *PFAS as* any chemical substance or mixture containing a chemical substance that structurally contains at least one of the following three sub-structures: (1) R-(CF2)-CF(R’)R”, where both the CF2 and CF moieties are saturated carbons; (2) R-CF2OCF2-R’, where R and R ’ can either be F, O, or saturated carbons; (3) CF3C(CF3)R’R”, where R ’ and R” can either be F or saturated carbons.

established on a "per report" basis, or on a per-company basis (as opposed to a "per product" basis) and in a manner that enables a single company filing reports for multiple products to avoid paying reporting fees on a per-product basis.

Prioritization

Although not the focus of the recent request from MCPA for input, SPAN has in its prior submissions supported MPCA using rulemakings as a means to ensure the regulated community and MCPA have a common understanding of the processes and criteria that MPCA will be using for purposes of prioritizing for potential prohibitions under Subdivision 5 of the statute. SPAN has advocated that MCPA should concentrate its resources on products and product categories that, as directed in Section 5(b) of the statute, "in the commissioner's judgment, are most likely to contaminate or harm the state's environment and natural resources if they contain intentionally added PFAS." SPAN continues to recommend that a risk-based evaluation process be structured and applied when identifying products for potential prohibitions. Such a process should take into consideration the factors affecting risk; specifically, hazard (e.g., toxicity, bioaccumulation, persistence) and exposures (e.g., production volumes, conditions of manufacture and use, methods of disposal).

Conclusion

SPAN appreciates the opportunity to provide constructive comments to MPCA and remains available to meet and confer with appropriate MPCA personnel to discuss these comments and other matters pertaining to PFAS and PFAS-containing products.

Ben Kallen Attachment RECEIVED
By: OAH on 3/1/2024

SEMI Global Advocacy Office
1200 G Street, NW Suite 325
Washington, DC 20005

www.semi.org

March 1, 2024

Submitted via the Minnesota Office of Administrative Hearings eComments Website

Katrina Kessler
Commissioner
Minnesota Pollution Control Agency
520 Lafayette Road N
St. Paul, MN 55155-4194

Re: **<u>SEMI's Comments on the MPCA's Planned Rulemaking for Currently Unavoidable Uses of Intentionally Added PFAS in Products</u>**

Dear Commissioner Kessler:

On behalf of SEMI, the industry association serving the global semiconductor design and manufacturing supply chain, we write to offer comments on the regulations on per- and polyfluoroalkyl substances (PFAS) being developed by the Minnesota Pollution Control Agency (MPCA), as authorized in Minn. St. § 116.943 (Section 116.943). These comments discuss the MPCA's planned rulemaking governing currently unavoidable use (CUU) determinations for products containing intentionally added PFAS (the CUU Rule).

SEMI represents more than 530 member companies in the United States reflecting the full range of the country's semiconductor industry, including design automation and semiconductor intellectual property (IP) suppliers, device manufacturers, equipment makers, materials producers, and subcomponent suppliers. SEMI member companies are the foundation of the $2 trillion global electronics industry, and this vital supply chain supports 350,000 high-skill and high-wage jobs across the United States.

While SEMI fully supports the goal of limiting the release of PFAS into the environment, SEMI has serious concerns about the potential scope of these regulations as well as the risk of their incompatibility with Minnesota's own ambition to expand its semiconductor industry. With the indispensable role semiconductors play in the Minnesotan and American economy and in national security, it is critical that regulatory efforts avoid restricting semiconductor manufacturing, its corresponding supply chain, and future innovation. As such, SEMI has provided specific recommendations in these comments to inform future rule drafting in a way that would avoid irreparable harm to the semiconductor manufacturing industry in Minnesota.

Below we start by underscoring points made in our previous comments submitted on a separate MPCA rulemaking to implement the reporting requirements of Section 116.943. Namely, we discuss how all the MPCA's rulemakings to implement the statute must account for the essential need for PFAS in the semiconductor industry, which in turn underpins both the Minnesotan and national economies. We then organize our comments based around the nine questions in the MPCA's request for comments on the CUU Rule. Our responses to the MPCA's questions make the following points:

- The MPCA should adopt an interpretation of the statutory phrase "essential for health, safety, and the functioning of society" that is flexible enough to accommodate how broad CUU determinations are necessary to avoid adverse societal impacts. Since the statutory phrase contains terms that are naturally broad, it follows that the MPCA's interpretation should be in line with this legislative directive and also be broad.

- Costs must be considered in determining whether an alternative is reasonably available, and this evaluation should reflect not just the cost of the alternative in isolation, but the cost of executing the alternative throughout supply chains and at commercial scale.

- A safety evaluation for PFAS alternatives must consider the totality of risks of the alternative under a lifecycle approach, including but not limited to assessments of the alternative's intrinsic hazard, toxicity, and health risk profile, as well as risks concerning product safety, energy consumption, and disposal.

- CUU determinations should be indefinite since this will give manufacturers necessary repose and Section 116.943 does not authorize time-limited determinations. The MPCA should also encourage that determination requests be submitted by trade associations or other groups of manufacturers. The MPCA must provide sufficient protection of confidential business information (CBI) submitted as part of these requests, and the agency should be required to promptly respond to requests for determinations.

- The MPCA should encourage that CUU determinations be made for broad categories of products, rather than on a product-by-product basis. The latter process would waste both public and private resources, likely result in duplicate requests, and risk missing products that are clearly CUUs but are not covered by a determination because of arbitrary line drawing.

- As part of this rulemaking, the MPCA should grant a CUU determination that covers all uses of intentionally added PFAS in all materials and processes in the semiconductor value chain, including the final semiconductor devices on their own and when present in other end products (i.e., semiconductor devices present in industrial, commercial, and consumer products). This is because semiconductors make modern life possible, and they are therefore essential to health, safety, and the functioning of society. PFAS alternatives are also not reasonably available for use in the semiconductor industry.

I. WITHOUT CAREFUL DRAFTING, THE MPCA'S RULES TO IMPLEMENT SECTION 116.943 WILL SEVERELY DAMAGE CRITICAL INDUSTRIES AND THE HIGH-TECH ECONOMY

1. PFAS are Essential to the Semiconductor Industry

PFAS are essential to the semiconductor industry because of their low surface tension, high heat and chemical resistance, high thermal stability, radiation stability, electrical characteristics, compatibility with other chemicals, and other unique properties. These properties enable PFAS to fulfill the purity criteria required for semiconductor manufacturing. PFAS are used by the industry to meet many needs within the manufacturing process and can be found in various equipment, materials, and other critical components, including in the following:

- Control and distribution systems (pipes, pumps, valves, etc.);
- Various components in a wide range of processing tools;
- Ancillary articles (such as tubing, gaskets, containers, and filters);
- Lubrication (such as oils and greases);
- Heat transfer fluids and refrigerants for high-precision temperature control units and process chillers;
- Facility systems in semiconductor manufacturing factories such as water and chemical distribution, waste removal systems, and exhaust systems; and
- Process chemicals in photolithography, dry etching, cleaning, deposition, and other processes to reduce the potential for defects and to enable high-resolution microstructures and deliver required yield.

In short, the semiconductor manufacturing process is enormously dependent on PFAS, the majority of which currently have no viable alternatives.

2. **The Semiconductor Industry is a Crucial Part of Minnesota's Economy That Could Be Severely Damaged by the Rules**

Subdivision 2(d) of Section 116.943 makes it unlawful for companies to sell, offer for sale, or distribute for sale in the state a product containing intentionally added PFAS unless the manufacturer has reported the required information, and that manufacturer has received notification of MPCA-ordered testing under subdivision 4. In addition, subdivision 5 makes it unlawful for companies to sell, offer for sale, or distribute for sale in the state a product containing intentionally added PFAS starting January 1, 2032, unless the MPCA has determined by rule that the use of PFAS in the product is currently unavoidable.

Without the requested waiver from reporting for semiconductor manufacturers (as mentioned in our previous comments to the MPCA) and CUU determination for the semiconductors (as discussed in more detail below), Minnesota's robust semiconductor industry would suffer enormous damage. The state is home to one of the strongest semiconductor value chains in the United States, including a well-developed and robust design and fabrication network.[1] Minnesota-based companies annually export over $1.2 billion in semiconductor-related components and import nearly $575 million in semiconductor-related components.[2] According to the Minnesota Department of Employment and Economic Development, the state's semiconductor and other electronic manufacturing sector includes 153 firms supporting 9,588 jobs with an average annual wage of $68,692.[3]

PFAS are critical to the development and manufacturing of semiconductors, meaning that an overly broad and restrictive regulatory approach will cost Minnesota-based businesses and workers a major

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[1] Minnesota CHIPS Coalition, *Commentary: Minnesota Can Be a Leader in the U.S. Chip Renaissance* (Mar. 28, 2023), https://finance-commerce.com/2023/03/commentary-minnesota-can-be-a-leader-in-the-u-s-chip-renaissance/#:~:text=Minnesota%27s%20companies%20annually%20export%20over,Engineering%20Research%20Associates%20in%20St.

[2] *Ibid*.

[3] Minnesota DEED, Industry Snapshots: Computer and Electronic Product Manufacturing (June 2019), https://mn.gov/deed/newscenter/publications/review/june-2019/industry-snapshots.jsp.

opportunity to benefit from the robust federal industrial policy authorized in the *CHIPS and Science Act* (P.L. 117–167). Implementation of the MPCA's planned rules without incorporating the requests discussed in our comments will not only hinder Minnesota's high-tech economy and the many other sectors that rely upon it, but will also jeopardize the state's ability to capitalize on the billions of dollars that the federal government is planning to invest in the semiconductor industry via the CHIPS Program. In particular, the $500 million Minnesota Forward Fund, which was established in part as a resource for matching federal CHIPS funds, will be rendered unusable for one of its original purposes.

3. **The Rules Could Run Counter to National Efforts to Support the Domestic Semiconductor Industry**

Chip shortages resulting from manufacturing disruptions caused by the COVID-19 pandemic continue to impact global supply chains for several key industries and have highlighted the country's dependence on overseas suppliers of semiconductors and chips. Addressing these shortages has been one of the most bipartisan issues at the federal level with the Biden Administration and Congress working together to incentivize the reshoring of semiconductor and chip manufacturing to the United States.

In August 2022 Congress passed and the President signed the bipartisan *CHIPS and Science Act*. The goals of this law, which is focused on supporting domestic semiconductor manufacturing, are multifaceted. First, the law aims to reduce the dependence of the United States on foreign countries for critical semiconductor components, thereby ensuring a stable and secure supply chain. Second, the law aims to boost domestic innovation and competitiveness in the semiconductor industry by providing funding opportunities for research, development, and manufacturing capabilities. Finally, the law seeks to create high-quality job opportunities and strengthen the overall economy by revitalizing the domestic semiconductor manufacturing sector.

As part of the implementation of this law, Representative Betty McCollum (D-MN) and U.S. Senate Majority Whip Dick Durbin (D-IL) made the following remarks in a letter[4] to Secretary of Commerce Gina Raimondo:

> *Over decades of use, PFAS have been widely integrated into our modern society and in many cases, there are not currently any viable replacements for their function. These 'essential uses' are vital to our economic and national security, particularly in regard to their use in semiconductor manufacturing . . .*
>
> *. . . The CHIPS and Science Act provides a unique opportunity for the Commerce Department to engage and invest in tackling the issue of PFAS essential uses. This monumental legislation has set the U.S. on a course to onshore semiconductor manufacturing and continue to lead the world in advanced technology development and production . . . it is vitally important that [the National Semiconductor Technology Center] priorities include research into PFAS alternatives, as well as recycling, removal, and destruction of these harmful materials.*

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[4] Letter from Rep. Betty McCollum and Senator Dick Durbin to Secretary Raimondo (May 22, 2023), https://mccollum.house.gov/sites/evo-subsites/mccollum.house.gov/files/evo-media-document/23.05.22-commerce-letter-support-pfas-alternatives-research-in-chips-act-implementation-mccollum-durbin.pdf.

More recently, the U.S. Department of Defense weighed in on the issue of PFAS in its Report on Critical Per- and Polyfluoroalkyl Substance Uses.[5] The findings highlight the singular and currently irreplaceable role that PFAS play in the semiconductor manufacturing process:

> *Currently, no alternatives to PFAS have been identified that can provide the functional properties required for photolithography or some applications in semiconductor manufacturing equipment. Even if alternative chemicals and technologies were discovered today, due to the extremely complex qualification process throughout the value chain, it would take another 15 years to deploy them in high-volume manufacturing. Therefore, continued access to PFAS is a prerequisite for high-volume and advanced semiconductors. Lack of continued access to PFAS could lead to an inability to produce and supply semiconductor manufacturing technology.*
>
> *Replacing most PFAS uses in semiconductor fabrication would require industry-wide retooling and other process innovations, at a minimum. Some might be achievable within 10 years, but many would not. As stated above, there are some PFAS uses for which no alternatives are known. For these uses, it may be necessary to invent novel chemistries and processes. Replacing PFAS in semiconductor fabrication could be a 25-year effort and may not succeed in all respects if alternatives cannot be identified or qualified at the microchip level.*

This federal effort recognizes that semiconductors enable critical technologies and industries that form the foundation of the U.S. economy, including the automotive industry, defense, electronics, communications, data storage and analysis, legal and regulatory infrastructure, scientific (including materials) research, medicine and medical devices, the green energy transition, transportation (including aviation), and much more. PFAS are used in all of these sectors, and any regulatory effort that too hastily and broadly restricts, and requires burdensome reporting tied to a restriction, on PFAS risks irreparable harm given these uses. Moreover, broad PFAS restrictions and reporting schemes can have the unintended consequence of hampering efforts to develop PFAS alternatives and develop capture, concentration, and destruction technology to prevent environmental release rather than funding and supporting such efforts, since there is no commercially available test method for determining the exact amount of all PFAS in products and research and development for PFAS alternatives will take many years to complete.

Unfortunately, unless carefully planned in light of our comments, the MPCA rules will run counter to the bipartisan effort to improve U.S. competitiveness in semiconductor and microchip development by adding costly and largely impracticable reporting requirements and material restrictions for PFAS in the semiconductor manufacturing process and in components of nearly all commercial and consumer electronic goods. The CUU Rule specifically should be designed to avoid these consequences, as explained further below.

[5] U.S. Department of Defense, Report on Critical Per- and Polyfluoroalkyl Substance Uses (Aug, 2022), https://www.acq.osd.mil/eie/eer/ecc/pfas/docs/reports/Report-on-Critical-PFAS-Substance-Uses.pdf.

II. RESPONSES TO THE MPCA'S SPECIFIC QUESTIONS ON DEVELOPMENT OF THE CUU RULE

1. Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

It is critical that the MPCA promulgate objective decision-making standards that address precisely how the agency will determine whether the use of PFAS in a given product is a CUU, and that these terms be interpreted flexibly and broadly. As the MPCA may be aware, the European Commission has for many years been working on a potential amendment to the Registration, Evaluation, Authorisation, and Restriction of Chemicals (REACH) chemical regulatory framework to incorporate an "essential use" standard for justifying exemptions from restrictions on highly hazardous substances. The complexity of that concept, and the risks of inadvertent omissions or adverse socio-economic impacts, have resulted in numerous delays and drafting challenges. The MPCA should likewise avoid this regulatory morass, and instead adopt practical and flexible definitions that correspond with the likewise practical and flexible terms used by the legislature in Section 116.943.

Section 116.943(j) defines "Currently unavoidable use" as "a use of PFAS that the department has determined by rule under this section to be essential for health, safety or the functioning of society and for which alternatives are not reasonably available." SEMI recommends that the MPCA adopt a *broad* concept of "essential" that is both consistent with the requirements of the statute and flexible enough to accommodate the possibility that broad exemptions may be required to avoid adverse impacts on the health, safety, and functioning of society. SEMI suggests that the MPCA consider a provision in the CUU Rule to this effect:

> *The commissioner shall grant a currently unavoidable use determination for PFAS applications or end products, and for the supply chain production activities required to produce such PFAS applications or end products, when the commissioner has evidence, or when a manufacturer, organization, or other entity has submitted evidence, that an application, product or category of products provides benefits relating to health, safety, or the functioning of society and that there are no reasonably available alternative substances or technologies for that use. A product shall be deemed to provide benefits to the functioning of society where the manufacturer has submitted evidence that the product fulfills identified consumer, commercial, or industrial demands for the product in Minnesota.*

This approach would strike an appropriate balance between that reflects the text of the statute, and therefore the legislative intent behind the statute. This is because it would require manufacturers to substantiate assertions that PFAS substitutes are not available, but would presume that ongoing uses where substitutes are not available would be permitted to continue. Further, this burden shifting will promote an objective, factual-based standard where the MPCA can prohibit or restrict products for which adequate evidence of harm to health or the environment exists. Our recommended provision also provides that the MPCA "shall" grant the CUU determination when sufficient evidence is in hand, thereby requiring the MPCA to act when warranted.

Moreover, as indicated in the suggested language above, the MPCA should clarify that uses of PFAS-containing products in manufacturing operations that take place in Minnesota would be covered by CUU determinations for end products that are the result of those operations. In other words, the CUU Rule should make it clear that the CUU determination should apply not only to the end product itself, but to each of the products and processes in the supply chain that are necessary to produce that exempted product. For example, given that articles used in semiconductor manufacturing require several PFAS, including PFA, PTFE, FKM, and PVDF fluoropolymer components, the supply chain that produces fluoropolymers must be covered by a CUU determination for semiconductors to render the determination meaningful.

2. **Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?**

Costs must be considered in determining whether an alternative is reasonably available, and this evaluation should reflect not just the cost of the alternative in isolation, but the cost of executing the alternative throughout supply chains and at commercial scale. It is also critical that alternatives be considered available only where they provide equivalent or better performance. There are several applications in the semiconductor sector where there are no currently available alternatives that meet those requirements. With this in mind, we recommend that the MPCA include the following definition in the CUU Rule:

> *"Reasonably available alternative" means a substance, material, technology, process, or otherwise that is currently available at commercial scale and that, when used in place of intentionally added PFAS, does not result in:*
> *(a) A decrease in availability, performance, life expectancy, or durability of the product or of the supply chain production activities associated with that product;*
> *(b) An increase in manufacturing, design, testing, capital investment, or other costs for the product or for the supply chain production activities associated with that product; or*
> *(c) Risks to human health or the environment that would not be present, or present in lesser degrees, with use of the intentionally added PFAS, including but not limited to risks from toxicity, energy consumption, product safety, and disposal.*

In addition to recognizing the supply chain and commerciality concerns of the alternatives assessment, this definition reflects how the assessment must employ a lifecycle approach that considers all appropriate types of risk from several angles – including but not limited to not risks from toxicity, energy consumption, product safety (e.g., fire risk), and disposal. Only with these considerations will an alternative be viable, and the CUU Rule must reflect this reality.

3. **Should unique considerations be made for small businesses with regards to economic feasibility?**

The flexible consideration of costs and other factors in our above definition of "reasonably available alternative" reflects the fact that the alternatives process can affect businesses in different ways. This is true not just for large companies that could have numerous products subject to Section 116.943 and may therefore struggle with the total costs of implementing PFAS alternatives, but also for small businesses that may not be able to absorb these costs for just one or a few in-scope products.

4. **What criteria should be used to determine the safety of potential PFAS alternatives?**

Subsection (c) of our recommended "reasonably available alternative" definition mentioned above accounts for how an assessment of the safety of PFAS alternatives must consider the totality of risks of the alternative under a lifecycle approach, including but not limited to assessments of the alternative's intrinsic hazard, toxicity, and health risk profile, as well as risks concerning product safety, energy consumption, and disposal.

The safety of a PFAS alternative must be scoped out flexibly in the CUU Rule for several reasons. First, PFAS – especially when defined structurally, as is the case in Section 116.943 – is a diverse class of thousands of chemicals. While several individual PFAS have documented environmental and human health profiles, many do not as of yet.[6] It would likely be impossible, and at the least very difficult, for manufacturers to demonstrate to the MPCA that an alternative is safer than PFAS that currently have unknown toxicity profiles. Second, even if a chemical substance in isolation is labeled "safe" in terms of its hazard, exposure, and toxicity, it does not necessarily follow that a product is safer with this alternative than it is with PFAS. This is because the alternative may negatively impact other safety properties of the product, such as those relating to durability, flammability, energy consumption, and disposal. Therefore, the safety of PFAS alternatives as reflected in the CUU Rule must be defined expansively to account for the myriad of safety considerations that exist.

5. **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?**

CUU determinations should be indefinite, because this is needed to give manufacturers the necessary repose to rely on the originally issued determination, and Section 116.943 does not authorize a time-limited scheme. Indefinite determinations reflect how, especially for the semiconductor industry, the identification of PFAS, search for potential alternatives, testing of potential alternatives, and implementation of appropriate alternatives takes many years. Therefore, members of our industry need to be able to rely on a CUU determination for long enough for these steps to occur, and this time cannot be reliably estimated at the onset of the determination.

It would also waste both public and private resources for manufacturers to continually update, and for the MPCA to monitor and assess, CUU determinations on predetermined schedules. This reevaluation process would be akin to the European Commission's assessment of exemptions under the Restriction on Hazardous Substances Directive (RoHS), through which the Commission has contracted with the Oeko-Institut to provide support and technical assistance on such exemptions.[7] The process the MPCA would need to undergo to reevaluate CUU determinations would be even more complex than what is required under RoHS since Section 116.943 pertains to a much larger range of products and chemicals.

When circumstances change after a CUU determination is granted and which warrant a modification or removal of the determination, the manufacturer can notify the MPCA of this change. Only then should the agency be able to remove or modify the determination, since this will promote regulatory certainty and avoid arbitrary modifications or cancellations without the appropriate notice and input of the affected manufacturer. Likewise, if the MPCA initially rejects a CUU determination request, the agency

[6] *See, e.g.*, Agency for Toxic Substances and Disease Registry, *What are the health effects of PFAS?* (last reviewed Jan. 18, 2024), https://www.atsdr.cdc.gov/pfas/health-effects/index.html#:~:text=At%20this%20time%2C%20scientists%20are,do%20studies%20on%20lab%20animals ("At this time, scientists are still learning about the health effects of exposures to mixtures of different PFAS. Additional research may change our understanding of the relationship between exposure to PFAS and human health effects").
[7] *See* Oeko-Institut, RoHS Evaluations, https://rohs.exemptions.oeko.info/project-overview/background.

should be required to explain its reasoning for the rejection and the manufacturer should be given a clear opportunity to appeal the decision.

6. **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?**

The MPCA should encourage that CUU determination requests be submitted by groups of manufacturers or trade groups, since this will help avoid duplicate requests, will allow manufacturers to pool resources, and will ultimately reduce the MPCA's reviewing burden. This is approach is also consistent with a recent request for proposals on CUU determinations announced by the Maine Department of Environmental Protection (DEP) to implement that state's PFAS in products law.[8]

Stakeholders should not be permitted to request that use of a specific PFAS be classified as "not currently unavoidable. Section 116.943 does not authorize this process. Such requests would not be grounded in the CBI and trade secret information to which only regulated parties have access. Such requests would also be unnecessary since all stakeholders would have an opportunity to comment on the MPCA's rulemaking processes to execute CUU determinations.

Finally, the information to be submitted in support of CUU determination requests must be limited to what Section 116.943 authorizes. Specifically, this information should be cabined to:

- Identifying product information, including a brief description of product families or product categories when applicable (where the PFAS use and alternatives analysis are similar);
- Description of the intended use of the product and an explanation of why the product is essential for health, safety, or the functioning of society;
- Description of the function of intentionally added PFAS in the product;
- Description of why there are no reasonably available alternatives for the intentionally added PFAS in the product; and
- Any other information that the manufacturer wishes to include.

As part of any information required to be submitted in support of a CUU determination request, the MPCA must employ a well-defined CBI framework to protect manufacturers' valuable intellectual property. As expressed in our previous comments to the MPCA on the reporting rule under Section 116.943, semiconductor production – as well as the advanced manufacturing and technology sectors in general – treat the chemical composition of materials as proprietary information that is carefully protected and of significant commercial value.

Therefore, all of the MPCA's planned rules to implement Section 116.943 and which require submission of information from manufacturers need to include detailed provisions about how such information can be submitted (1) while respecting its status as CBI and trade secret; (2) in an aggregated manner to protect confidentiality while still providing for public release of nonconfidential portions; (3) through a

[8] Maine DEP, *PFAS in Products: Currently Unavoidable Uses* (updated Jan. 10, 2024), https://www.maine.gov/dep/spills/topics/pfas/PFAS-products/cuu.html (noting that "[p]roposals may be submitted by manufacturers individually or collectively" which Maine DEP confirmed in informal communications means that trade associations may submit proposals).

system with clear standards on what information will be kept confidential; and (4) with assurances on how such confidential information in the MPCA's possession will be protected from disclosure. Information that requires careful protection would include, for example, the identity of any PFAS in the product, the volume and concentration of such a substance, and any information related to sales volumes or production volumes.

7. **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.**

As part of this rulemaking, the MPCA should grant a CUU determination that covers all uses of intentionally added PFAS in all materials and processes in the semiconductor value chain, including in upstream semiconductor supply chain industries, the semiconductor manufacturing process itself, and for final packaged semiconductor devices. Some examples of CUU PFAS applications in each of these three subcategories include:

- Uses in upstream semiconductor supply chain industries, including but not limited to uses of fluoropolymers and other PFAS in high-purity chemical production and packaging, and fluoropolymers and other PFAS integrated into semiconductor manufacturing equipment;
- Uses within the semiconductor manufacturing process, including but not limited to PFAS ingredients within specialty chemicals and fluids, fluoropolymers and other PFAS used in production of high-purity water and chemicals, and uses of fluoropolymers and other PFAS in facility systems; and
- Uses within final packaged semiconductor devices, including but not limited to PFAS contained in finished semiconductor devices and component parts such as encapsulants, thermal interface materials, adhesives, coatings, substrates, wiring, connections, and circuit boards.

The semiconductor industry has invested significantly in (1) identifying PFAS uses in the value chain for semiconductor manufacturing and in semiconductor devices, (2) phasing out PFAS use where possible (such as the use of perfluorooctane sulfonates, or PFOS, in photolithography), and (3) regularly evaluating the availability and efficacy of non-PFAS alternative chemicals or alternative processes or materials. Indeed, the industry has been a global leader in these efforts for many years, including decades of work on the phase-out of PFOS and PFOA.

These efforts increased substantially over the past three years in anticipation of the EU universal PFAS restriction proposal under REACH. In preparation for the public consultation that took place last year on that proposal, the semiconductor industry through the Semiconductor PFAS Consortium established a substantial industry-wide collaboration platform that made deep investments across the sector. That process documented PFAS uses in the semiconductor value chain, identified the unique functionality and performance attributes that various PFAS (including fluorinated polymers) conferred that made them essential to semiconductor production, and evaluated the availability of alternative substances, materials or processes.[9] This work culminated in over 600 pages of technical reports and substantiation,

[9] Additional detail on evaluation of potential alternatives for currently unavoidable uses of PFAS materials in semiconductor manufacturing can be found in Appendix A. The information contained therein is excerpted from SEMI's submission to European Chemicals Agency in response to the proposed PFAS restriction under REACH. That

broken down by broad sub-categories of uses and applications within our sector.[10] These materials, when considered in their totality, constitute more than ample substantiation for SEMI's request that the MPCA make a determination that all current PFAS uses within the semiconductor sector are CUUs.

In brief, these papers demonstrate that many different PFAS are used in chemical formulations, components of manufacturing process tools, facilities infrastructure, and packaging used to make the semiconductor devices that are integral to the modern world. The current semiconductor state of the art is critically reliant on the use of PFAS chemistry due to the inimitable characteristics of the element fluorine and substances containing fluorine. Given the unique properties of PFAS, it will be extremely difficult, and impossible in some instances, to find viable alternatives in the short and medium terms without substantially impeding or reversing the technologies that the modern economy relies on. The use of PFAS-free alternatives in our sector could also result in environmental impacts, such as from the potential for decrease in yield and therefore an increase in chemical concentrations, water usage, energy consumption, and waste generation.

To support our requested CUU determination, the Semiconductor PFAS Consortium papers linked to in footnote 11 address the following individual topics:

1. Background on Semiconductor Manufacturing and PFAS
2. PFAS-Containing Surfactants Used in Semiconductor Manufacturing
3. PFOS and PFOA Conversion to Short-Chain PFAS-Containing Materials Used in Semiconductor Manufacturing
4. PFAS-Containing Photo-Acid Generators Used in Semiconductor Manufacturing
5. PFAS-Containing Fluorochemicals Used in Semiconductor Manufacturing Plasma-Enabled Etch and Deposition
6. PFAS-Containing Heat Transfer Fluids Used in Semiconductor Manufacturing
7. PFAS-Containing Materials Used in Semiconductor Manufacturing Assembly Test Packaging and Substrate Processes
8. PFAS-Containing Wet Chemistries Used in Semiconductor Manufacturing
9. PFAS-Containing Lubricants Used in Semiconductor Manufacturing
10. PFAS-Containing Articles Used in Semiconductor Manufacturing

As a result of this industry-wide collaboration, SEMI has identified at least 60 distinct categories of critical PFAS uses throughout the semiconductor value chain (with many different sub-applications and specific PFAS chemistries used within each of these general use categories). A brief description of some of those uses with a description of unsuitable substitutions that have been considered, as excerpted from SEMI's input to the EChA request for public consultation to the proposed REACH PFAS restrictions, is included in Appendix A of these comments. It is important to note that any timelines provided for alternatives presume that there are no known alternatives at present and that such timelines start when a feasible replacement has been identified.

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submission can be viewed at https://echa.europa.eu/documents/10162/17233/rest_pfas_rcom_part13_en.docx/5e750ee1-0541-fe43-8272-851fcbf75c4e?t=1686824437443&download=true (comments embedded on page 51).

[10] All of this information has been made publicly available at the following website for the Semiconductor PFAS Consortium, subject only to a short, free registration requirement: https://www.semiconductors.org/pfas/#:~:text=AND%20SEMICONDUCTOR%20PROCESSING%20%3E-,Technical%20Papers,-The%20Semiconductor%20PFAS.

As the detailed papers at the Semiconductor PFAS Consortium website explain, each of these general use categories, and each of the various sub-applications within these uses, relies on one or more PFAS for critical performance functions. In addition, alternative chemicals or processes are not available for these uses because they do not exist, or where they may exist they require substantial lead time (with timelines that extend beyond, and sometimes well beyond, 2032) to redesign and requalify equipment and production processes.

The Semiconductor PFAS Consortium website also includes two additional resource documents which have been incorporated by reference in our comments here:

- An overview paper that summarizes the key major PFAS use categories and identifies the impacts of premature restrictions on PFAS uses in our sector; and
- A socioeconomic impact assessment that is specifically focused on the foreseeable direct and indirect costs of a broad PFAS restriction in Europe, prepared as part of the industry's response to the proposed universal PFAS restriction under REACH. Although this paper is focused on the EU, the types and magnitudes of identified impacts are broadly representative of the effect of analogous restrictions as being implemented in Minnesota.

We believe even a review of this evidence will demonstrate to the MPCA that we have amply satisfied the burden to demonstrate the essentiality of PFAS for these uses as well as the substantial timelines that would be required to research and develop alternatives for all required uses, test them, qualify them, and integrate them into our value chain all before the 2032 prohibition takes effect.

8. **Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?**

The MPCA should start making CUU determinations now, as part of this rulemaking, to give manufacturers sufficient time to plan for Section 116.943's 2032 material restriction compliance date. As mentioned above, one of these initial determinations should be granted for PFAS used in the semiconductor industry.

9. **Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.**

The MPCA must promulgate a binding schedule for reviewing and approving CUU determinations. While the MPCA will need sufficient time to undertake appropriate, reasoned, and objectively supported analyses of CUU determination requests, this must be judged against the arguably longer amount of time manufacturers will need to pursue data collection to fully understand the potential presence, functionality, and alternatives to PFAS applications in their products. All of this must occur well in advance of the 2032 compliance date to give manufacturers an opportunity to make necessary changes or, in drastic situations, change entire product lines. If CUU determinations are not timely reviewed and granted, companies may need to cease business operations altogether in Minnesota.

It is therefore essential that the CUU Rule include a binding schedule for the consideration and adoption of CUU determinations. In addition to the initial CUU determinations that will be integrated into the CUU Rule at the onset, SEMI recommends that the CUU Rule explicitly allow manufacturers to request CUU determinations at any time and at the very least through an annual submission process. The MPCA should then be afforded a maximum of 6 months to adopt a final decision on the request. If the agency fails to timely respond to a request, that should function as an automatic CUU determination for as long as the MPCA is late. This is crucial to avoid a situation where a manufacturer is forced to make a product unavailable in Minnesota because of a delay that is out of the manufacturer's control. Such a requirement is also in line with exemption processes in other chemical regulatory programs, such as RoHS Article 5 where a current exemption to the directive's restrictions remains valid until the European Commission decides on the renewal application. Without this binding schedule, manufacturers will be left in the dark for how long the MPCA will take to decide on a CUU determination request and therefore they cannot plan ahead for the 2032 compliance date.

III. COMMENTS ON FACILITATING PRODUCTIVE ENGAGEMENT WITH INDUSTRY

SEMI appreciates the MPCA's proactive outreach to the regulated community in advance of issuing draft rules and encourages the agency to maintain this approach going forward. Engaging interested stakeholders from the outset through listening sessions, webinars, and other venues will afford these parties the opportunity to inform the MPCA's rulemaking activities in a way that empowers the agency to meet its regulatory mandates while effectively ensuring the long-term viability and competitiveness of the affected industries.

Building on this, we understand that the MPCA plans to create two working groups in the coming months to inform the agency's Section 116.943 rulemaking efforts. One of these working groups will include technical experts from industry, and SEMI welcomes the opportunity to put someone forth from our organization to serve in this capacity to advocate for meaningful rules that reflect the concerns of the semiconductor industry.

IV. CONCLUSION

SEMI is committed to balancing the need for environmental protection and the sustainability of semiconductor manufacturing operations, which is a complex challenge. As such, SEMI is grateful for the opportunity to engage on the MPCA's planned CUU Rule and is available to meet at your convenience to further elaborate on the issues discussed in these comments. If you have any questions or would like to discuss our positions, please do not hesitate to contact Ben Kallen (bkallen@semi.org).

Sincerely,

Ben Kallen
Senior Manager, Public Policy & Advocacy
SEMI

Appendix A: Evaluation of Alternatives for Currently Unavoidable Uses (CUUs) of PFAS Materials Used in Semiconductor Manufacturing

The following information is excerpted from SEMI's PFAS use case examples in comments submitted to the European Chemicals Agency on the REACH PFAS restriction proposal.

Introduction: The unique properties simultaneously afforded by PFAS materials in terms of chemical resistance, temperature resistance, flexibility, low coefficient of friction, purity, non-flammability, etc., have led to thousands of applications in semiconductor manufacturing, where precision and purity of a wide range of highly complex equipment and a broad array of chemicals are required to deliver the exacting specifications demanded of advanced circuitry. The semiconductor industry has a long history of working toward more environmentally benign solutions including compliance with regulations on restricted materials. However, the ubiquitous nature of the applications space of PFAS in this industry, coupled with the lack of suitable alternative materials, makes substitution of PFAS an exceedingly difficult challenge, one whose magnitude cannot be overstated.

This appendix illustrates the numerous use cases of PFAS in semiconductors and the challenges posed when seeking alternatives by citing several examples where substitutions were evaluated but found to be insufficient. This is by no means intended by an exhaustive review of either all the applications of PFAS in semiconductor manufacturing, nor on the evaluations of alternatives. Rather it is meant to illustrate the expansive dependency that this industry has on this unique class of materials and how, despite wide-ranging efforts, alternatives do not meet the criteria required for safe and capable replacement. The examples below are arranged based upon the application space in which the PFAS material is used. For a more exhaustive description of the use of PFAS in the semiconductor industry, please see "The Impact of a Potential PFAS Restriction on the Semiconductor Sector", an SIA PFAS Consortium-commissioned summary prepared by RINA, available on the SIA website.[1]

Ultrapure Water Systems: Ultrapure water (UPW) is one the many materials essential to semiconductor manufacturing and UPW systems are fundamental components of any chip fabricator, or fab, infrastructure. Metal or organic contaminants must be avoided to prevent defectivity that can compromise performance, yield, and reliability. Pipes, valves, fittings, and seals composing UPW systems are required to bridge performance in terms of purity[2], mechanical properties[3], flame retardancy[4], chemical resistance, safety, and reliability. This requires the use of fluoropolymers, like poly(vinylidene fluoride) (PVDF), poly(terafluoroethylene) (PTFE), perfluoroalkoxy copolymer (PFA), and fluoroelastomers such as FKM and FFKM. Poly(propylene) (PP) and poly(vinyl chloride) (PVC), among other organic polymers, have been evaluated as replacements, but do not meet the purity, chemical resistance, and lifetime required.[5,6] Feasible substitutes have yet to be identified and there is no publicly available information on the status of research and development (R&D) processes and the required time for substitution.

Heat Transfer Fluids: Fluorinated heat transfer fluids (HTF), along with fluorinated refrigerants, are used in semiconductor manufacturing to provide precise temperature control in numerous processing and testing steps. HTFs are commonly use in plasma processing such as dry etch and thin-film deposition, where, to be compatible with the materials of construction of the equipment chambers, the materials must be electrically non-conductive, as well as being appropriately non-toxic, non-flammable and not subject to inducing contamination issues[1] across a wide range of operating temperatures that require precise control.[7] Currently, non-PFAS alternatives, such as synthetic hydrocarbon oils, silicone oils, or ethylene glycol/de-ionized water mixtures cannot simultaneously meet these performance attributes.[8,9,10,11,12] Similarly, non-PFAS alternative refrigerants, such as carbon dioxide or ammonia, cannot support the low-temperature operating points, have low energy efficiency, and are toxic or flammable.[13] For more detailed discussion of the use PFAS as HTFs for use in the semiconductor industry, see the SIA PFAS Consortium White Paper on the SIA website.[14]

Lubricants: PFAS lubricants are used to reduce friction and wear between surfaces and as sealants to prevent the ingress of foreign materials into the lubrication clearance zone. Semiconductor manufacturing requires high-performance PFAS lubricants to prevent the creation of particles within cleanrooms and the extreme physical environments present in the manufacturing environments, as well as remaining inert, non-off gassing, and UV stable. Currently no alternatives are known to exist, as alternatives such as silicon-based lubricants do not offer the necessary technical performance. It is important to keep in mind that PFPEs were introduced in semiconductor applications mainly because of safety reasons due to their stability and non-flammability.[15] Any alternative would need to offer these same technical attributes, so as not to decrease the overall safety of these systems potentially causing safety incidents, explosions, injuries, and damage to manufacturing facilities. Specifically, non-PFAS lubricants generate more heat as the lubricant breaks down, which results in lost productivity via indirect routes of increased wear and loss of precision leading to increased defect rates. This has direct implications including reduced productivity and costs through machine downtime for maintenance, cleaning and relubrication activities and replacement of parts. The best potential PFAS-free alternatives are believed to be silicone-based oils and lubricants; however, these have a limited temperature range when compared to PFAS alternatives, they are prone to off gassing, and have compatibility issues with some elastomers. As such, the applications in which they can be used are limited. Silicone-based oils and lubricants are also very contaminating[16] and could lead to productivity loss.[17] For more detailed discussion of the use PFAS as Lubricants for use in the semiconductor industry, see the SIA PFAS Consortium White Paper on the SIA website.[14]

Photolithography Applications: There are multiple applications if photolithography that require the use of PFAS materials due to the unique attributes these materials provide that cannot be replicated with other chemistries by nature of the unparalleled strength of the carbon-fluorine bond and the strong electronegativity of fluorine atoms. For example, photoacid generators (PAGs) are essential components of chemically amplified resists, which are materials used to define the fine circuitry of all advanced semiconductor chips. Several non-PFAS photoacids are have been proposed as alternatives, which upon detailed investigation, prove not to be suitable for high resolution imaging as the results are significantly inferior to the performance shown by PFAS containing PAGs, by showing higher photospeed, poorer feature quality, and excessive top-loss,[18] or acute toxicity.[19] For in depth description of the use PFAS as in PAGs for use in photolithography, see the SIA PFAS Consortium PAG White Paper and PFOS/PFOA Case Study on the SIA website.[14]

Another lithographic application requiring PFAS involves their use in top-antireflective coatings (TARCs). TARCs represent the largest product group by volume, accounting for more than 50% of PFAS use in lithography. TARCs are used to suppress reflectivity, which can compromise image integrity. PFAS materials are used as they provide the appropriate optical properties, specifically very low refractive index at the imaging wavelength. A non-PFAS alternative considered was the use of silica nanoparticles[20], but this failed for practical reasons at customer sites.

Other lithographic applications using PFAS include their use as surfactants in photoresists and bottom-antireflective coatings (BARCs); high contact angle barrier layers in immersion lithography, both as immersion topcoats or in topcoat-free photoresists[21]; and as photo-imageable poly(benzoxazoles) and poly(imides), used in packaging. For an exhaustive review of these applications, included attempts at identifying alternatives, see the SIA White Paper on Surfactants[14], as well as the aforementioned RINA white paper.[1]

Seals and Gaskets: Fluoroelastomers, such as FKM and FFKM, are well known industry standard choices for vacuum seals in semiconductor processing equipment, due to their broad resistance to plasma, aggressive chemistries, and high temperature requirement that are inherent in efficient semiconductor manufacturing processes. Lifetime of seals made from proposed substitute materials such as EPDM or silicone for 'in-chamber' sealing applications will be dramatically reduced due to the increased etch rates, particle formation, permeation, outgassing and general incompatibility with common semiconductor processing conditions. In the best case, implementing the proposed alternatives will result in equipment that is in a constant, infeasible state of repair, with negative impacts on manufacturing yields, both driving significant cost increases and reducing competitiveness. At worst, proposed alternatives are completely incompatible with application conditions, and pose serious safety concerns for fab operation. Performance of fluorinated elastomers compared to such alternatives is well documented in literature for over 40 years.[22,23,24] We know of no non-fluorinated elastomeric sealing materials in production, early development, or even ideation that could come close to matching the overall performance of fluorinated elastomers as seals in wafer processing equipment.

Gases for Plasma Deposition and Etch: Perfluorocarbons (PFCs) and hydrofluorocarbon (HFCs) are used in thin film deposition, plasma etch/wafer clean, and chamber cleaning steps in the semiconductor manufacturing process. Silicon and its compounds are the basis of the manufacturing of semiconductors. PFCs and HFCs are unique in their ability to react with silica compounds in predictable, controllable, and selectable ways. It must be noted when discussing alternatives, that the uses described above are broad terms to describe a process, but in actuality, each use in the semiconductor manufacturing process is unique (e.g., 100+ different instances alone of plasma etching for one device) and can require different material(s) or compositions to meet the performance requirements.[1] Currently non-PFAS alternatives simply do not exist. The proposed alternatives, nitrogen trifluoride (NF_3) or sulfur hexafluoride (SF_6) often used in conjunction with various hydrocarbons (C_xH_y) or fluorine (F_2) gas, create significant environmental or safety concerns. First, using the alternatives in these processes creates PFAS byproducts which is antithetical to the intent of this regulation. Additionally, mixing an oxidizer (NF_3) with a flammable (hydrocarbons) creates an additional fire safety risk. Moreover, NF_3 and F_2 are toxic and present worker safety concerns.[25,26] Finally, NF_3 and SF_6 possess high global warming potentials (GWP) and are subject to regulation under the EU F-Gas regulation (517/2014).[27]

Articles: Articles is a broad term used to describe various components or 'parts' of more complex systems or equipment used in semiconductor manufacturing. This far-reaching definition includes simple components such as tubing, containers, gaskets, valves, and filters, to more complex, integrated parts such as capacitors, robots, sensors, or power supplies. These are just a few of the hundreds of articles that are used in semiconductor manufacturing equipment, in the infrastructure of the fab itself, or in the supply chain of the various materials used in fabs. PFAS materials play an indispensable role in many articles, as they provide the unique combination of properties required to deliver the precise control essential to chip manufacturing. Particularly critical to many articles is that these attributes are retained for the duration of a fab existence or, in the case of consumable parts, that they last as long as possible to avoid frequent replacement, which is costly, time-consuming, and waste generating. A detailed overview of the wide-ranging use of PFAS in articles used in semiconductor manufacturing can be found in SIA PFAS Consortium Articles White Paper on the SIA website.[14]

A prime example illustrating the necessity of PFAS use for articles is in the handling of specialty chemicals. Hundreds of chemicals are used in today's semiconductor manufacturing processes.[28,29] Impurities such as particles, metal ions, and organic contaminants can lead to yield and reliability problems.[30] Contamination control is critical in proactive and predictive yield management, especially in high volume manufacturing (HVM) in the semiconductor industry to drive down cost.[31] The strict requirements for clean chemicals, as well as compatibility issues, necessitated the selection and use of the robust and clean filters available. Specifically, electronic grade, concentrated 96% sulfuric acid is a high purity chemical used for cleaning and etching applications in semiconductor manufacturing. The acid is typically heated from 90 to 150 °C and filtered continuously. Because of the high temperature, strongly acidic and oxidizing environment, only fluorocarbon PTFE membrane can withstand the aggressive acid, and as such, PTFE has been the workhorse in the industry for this application.[32,33,34,35] Currently, there is no known commercially available membrane filter that can replace PTFE membrane for this type of application.

Finished Semiconductor Devices: Several different PFASs are used in various materials and manufacturing steps during device packaging. There is a great deal of diversity in the types of packages used and necessary to connect the integrated circuit chip to the outside world, such as a printed circuit board (PCB). For substrates and the package, the mechanical, electrical, and thermal properties drive various material properties necessary to meet demands for miniaturization and increased device density. With these demands the resistance-capacitance (RC) delay now exceeds the transistor gate delay and becomes and device performance liming factor.[36] The PFAS used provide thermal and chemical stability to enable a variety of critical performance capabilities to ensure environmental and mechanical protection to the die during processing and use. Across this breadth, there are properties that stand out as essential such as thermal and chemical resistance, low dielectric constant, low residue transfer, improvement of wetting/spread, and the ability to reduce surface energy and photo-imageable functionality. Also, in a wide array of specialty MEMS packages processing and function of the device has been proven nearly impossible replace or to achieve without PFAS. A detailed overview of the wide-ranging use of PFAS in packaging and substrates used in semiconductor manufacturing can be found in SIA PFAS Consortium PFAS-Containing Materials Used in Semiconductor Manufacturing Assembly Test Packaging and Substrate Processes on the SIA website.[14]

Cables: Materials used in cables for semiconductor manufacturing processes need to ensure sufficient functional performance like signal integrity without introducing contaminants into the process. There are currently no known alternative materials that would meet the necessary combination of demanding performance requirements of semiconductor manufacturing process. The current and only known viable solution are fluoropolymers, such as FEP, PFA, PTFE and expanded PTFE, all of which provide a dielectric constant in the desirable range of 1.0 to 2.2. A low dielectric constant drives the ability to carry electrical signals with low loss and high signal velocity.[37] Alternative materials with somewhat comparable dielectric constants exist but they have maximum continuous service temperatures in the 80 to 150°C range,[38] falling below the requirements in semiconductor manufacturing (up to 260°C under vacuum). Hydrocarbon based polymers such as polyethylene (PE), polypropylene (PP), foamed PE, hydrocarbon elastomers, and ethylene propylene diene monomer elastomers (EPDM) have maximum continuous service temperatures in the 80 to 150°C range, falling below the requirements in semiconductor manufacturing of up to 260°C under vacuum.[38] Silicone rubber has a reasonably good maximum continuous service temperature and dielectric constant, albeit not a good as fluoropolymer-based material, but is a highly outgassing material that is not suitable for semiconductor manufacturing process applications.[39, 40, 41] Polyether ether ketone (PEEK) can be attacked, for example, by strong acids even at room temperature.[42] At elevated temperatures it is more readily attacked even by weak acids and cannot function as a seal above 170°C. Any alternative material capable of meeting the functional performance requirements would have to be invented. Such a material development is inherently unpredictable, likely to be a lengthy and demanding process and may not be successful.

Summary: The examples provided here are only a tiny fraction of the myriad use of PFAS in semiconductor manufacturing. Not mentioned explicitly, but also critical to this industry are applications as surfactants and in liquid chemistries for cleaning, wet-etching, or metal plating; other uses in packaging technology, such as adhesives, release layers and encapsulants; as well as uses in chemical transport and delivery, mask making, etc. More extensive discussion on these applications and more can be found in the series of White Papers produced by the SIA PFAS Consortium.[14] Each application has their own unique requirements, for which PFAS materials have been chosen because of the unique attributes of these materials. While replacements have been evaluated, more often than not, materials cannot be found that have the combination of attributes to be suitable substitutions. The references provide evidence to this effect and are complemented by significant amounts of confidential or unpublished information from representative companies that is sensitive to their individual business objectives.

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By: OAH on 3/1/2024

National Electrical Manufacturers Association

The association of electrical equipment
and medical imaging manufacturers
www.nema.org

March 1, 2024

Submitted via:
https://minnesotaoah.granicusideas.com/

Attention: Minnesota Pollution Control Agency
Revisor's ID number R-4837

Subject: Request for comments – Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing PFAS

Dear Minnesota Pollution Control Agency:

The National Electrical Manufacturers Association (NEMA) represents nearly 325 electrical equipment and medical imaging manufacturers that make safe, reliable, and efficient products and systems serving the building systems, building infrastructure, lighting systems, industrial products and systems, utility products and systems, transportation systems, and medical imaging markets. Our combined industries account for 370,000 American jobs in more than 6,100 facilities covering every state. These industries produce $124 billion in shipments and $42 billion in exports of electrical equipment and medical imaging technologies per year.

NEMA appreciates the opportunity to provide comments on the Planned New Rules Governing Currently Unavoidable Use (CUU) determinations about products containing PFAS that will be promulgated by the Minnesota Pollution Control Agency (the "MPCA" or the "Agency") pursuant to Minnesota Statutes 116.943, subdivision 5(c)("Amara's Law").

NEMA recognizes the legal requirements that a currently unavoidable use be one determined by rule to be "essential for health, safety or the functioning of society and for which alternatives are not reasonably available." With this in mind, the following are uses NEMA recommends be included on a forthcoming draft list of CUUs:

- All uses of PFAS and PFAS-containing products that have undergone reviews and received authorizations in the context of federal programs such as (but not limited to) the US Environmental Protection Agency's (EPA's) new chemicals and significant new uses program under Section 5 of the Toxic Substances Control Act; EPA's significant new alternatives program (SNAP) under the Clean Air Act; programs overseen by the US Food and Drug Administration (FDA) concerning drugs, medical devices, biologics, and diagnostics and equipment under the Food and Drug Act (FFDCA); pesticides and devices subject to EPA regulation under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); and other federal programs whereby either the PFAS, or products containing PFAS, are determined to be acceptable for their intended use by these (and other) federal government agencies. This classification also should include products and materials having uses in programs overseen by other federal agencies such as the Department of Defense (e.g., products and materials meeting DoD requirements and military specifications), the

Federal Aviation Administration (e.g., performance rules and regulatory controls governing the design, manufacture, installation, and maintenance of aircraft parts and replacement parts), and similar NASA-issued requirements.

- All uses of PFAS and PFAS-containing products and related items (including chemical substances and mixtures) required by state laws and implementing regulations administered by state agencies responsible for maintaining public health, community safety, and the environment.

- All uses of PFAS in electrical equipment that are critical contributors to meeting our nation's goals relating to electrification, energy security, safety, reliability, durability, and sustainability. These products include electronic components found in pacemakers, electronic sensors, industrial automation relays and soft starters, circuit boards, gas-insulated power grid equipment, wiring, lighting equipment, solar panels and semiconductors. Additionally, PFAS applications that increase reliability and safety of the electrical equipment.

- PFAS used in the manufacture of zinc air hearing aid batteries, lithium-ion batteries, Nickel Metal Hydride (Ni-MH) & Nickel Cadmium Batteries, lithium primary batteries, alkaline button batteries, and coin shaped lithium rechargeable batteries.

- PFAS containing materials and articles used as components of transportation equipment including automobiles, train engines and rail cars and components, packing containers and forklifts, ships and container vessels and their services equipment, agricultural vehicles and equipment, motorcycles, construction equipment, wheelchairs and other forms of mobility assisting appliances.

- Air conditioning, heating, ventilation, and refrigeration equipment and their components and parts including replacement parts and materials.

- Appliances and equipment and component parts used in harnessing energy (e.g., windmills, solar panels) and conserving energy. These should include building materials intended to insulate and to sustain temperate conditions within.

- PFAS used in the manufacture and within products intended to store energy such as batteries and other components critical to electric vehicles.

- PFAS used in the manufacture of semiconductors and electronic equipment and devices including component parts such as transistors, wiring, insulation, connections, housings, circuit boards and component parts that are not exposed to the user (other than during repair, disassembly, or disposal).

The above is not to be considered an exhaustive list and in the future, there could be other proposals for CUU determinations. NEMA recommends that MPCA codify a process by which product manufacturers and PFAS-containing product users may continue to submit requests for CUU determinations on a going-forward basis (even after final CUU listings are established) to permit flexibility in the event items, products, and PFAS uses (including those not currently contemplated) are identified for which reasonable CUU determinations should be granted.

Additionally, NEMA would like to make MPCA cognizant of the fact that electrical manufacturers may face some challenges collecting information about PFAS present in products. Upstream suppliers may be reluctant to provide manufacturers with specific information about the type of PFAS used. Upstream suppliers may claim that the use of PFAS is essential but may not provide details due to confidentiality concerns. MPCA should allow the use of supplier statements to substantiate a manufacturer's request for CUU. To facilitate this, MPCA should set up a system that would allow upstream suppliers to provide information directly to MPCA.

NEMA also suggests that MPCA should consider coordination with other jurisdictions, such as Maine, to create an approach that allows manufacturers to submit currently unavoidable use requests that can apply to multiple jurisdictions.

NEMA appreciates this opportunity to provide comments to MPCA on CUU determinations.

Regards,

Karin Moore
SVP, Legal & Regulatory, General Counsel

Ms. Katrina Kessler, Commissioner
Mr. Quinn Carr, Rule Coordinator

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Middletown, DE, USA - 01 March 2024
VIA ELECTRONIC SUBMISSION
Minnesota Office of Administrative Hearings (OAH) Rulemaking eComments Website: https://minnesotaoah.granicusideas.com/
OAH Docket No. 71-9003-39667

Response to Request for Comments
PFAS in Products Currently Unavoidable Use Rule

To Whom It May Concern:

Datwyler Pharma Packaging USA, Inc. ("Datwyler") would like to express its appreciation for the opportunity to provide comment to the Minnesota Pollution Control Agency (MPCA) with regard to its planned new rules governing Currently Unavoidable Use (CUU) Determinations about Products Containing Per- and Polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837.

Datwyler, as a leading provider of high-quality, system-critical elastomer components, is a strategic engineering partner for innovative systems in global markets such as Healthcare, Mobility, Connectivity, General Industry and Food & Beverage. Among other things, Datwyler components in billions of syringes and in every second car around the world make an important contribution to patient and driver safety under demanding conditions. Specifically for Healthcare, our sites in the Belgium, China, Germany, India, Italy, and the United States take great responsibility to help improve patients' lives and see ourselves as a vital link between our customers and their patient. As a preferred solution partner to global pharmaceutical companies, Datwyler's Healthcare components for vials, prefilled syringes, and cartridges in the pharma packaging industry provide customers with drug and packaging stability, compatibility, and container closure integrity in the pharmaceutical and biotech markets.

Beginning January 2032, products containing intentionally-added PFSA which are sold, offered for sale, or distributed in Minnesota are banned unless determined as CUU by the MPCA, by rule, under the authority of Minnesota Statutes 116.943, subdivision 5(c); and Minnesota Statutes 116.943, subdivision 9. In its rulemaking process to establish criteria and processes through which future decisions on what, if any, uses of intentionally-added PFAS will qualify as CUUs, the MPCA has posed a few questions to inform rulemakers of relevant issues that must be considered. Datwyler hereby respectfully submits the responses contained within this submission for consideration.

1) Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Yes – Datwyler requests the MPCA to further define the criteria by which PFAS-containing products can be classified as *essential for health, safety, or the functioning of society* so that manufacturers who are delegated with the responsibility to submit proposals for CUU determinations can be best guided when reviewing and preparing documentation about PFAS-containing products. In light of PFAS in medical devices and components, including but not limited to the elastomer closures and seals, Datwyler advises that the MPCA must keep in mind preservation of patient access to healthcare and protection of the medical supply chain.

Other rulemakers have provided a definition that *essential for health, safety, or the functioning of society* "means products or product components that if unavailable would result in a significant increase in negative healthcare outcomes, an inability to mitigate significant risks to human health or the environment, or significantly interrupt the daily functions on which society relies."[1] In this definition, there is a clear definition of how the essential nature of products can be assessed and which areas and industries necessitate a fundamental review as an all-out ban would be detrimental to a critical function the state impacts on behalf of the citizens of the state.

The definition also goes on to state that "[p]roducts or product components that are Essential for Health, Safety or the Functioning of Society include those that are required by federal or state laws and regulations." [2] With this additional criteria, there is less concern for an overlap in the potential for conflicting rules to make the essential determination too complex.

Lastly, the definition continues that "Essential for the Functioning of Society includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, and construction." [3] These examples help drive understanding of some of the critical areas that lawmakers are considering and taking careful consideration to understand what and how a ban would affect these activities and industries.

As a manufacturer of fluoropolymer-coated elastomer closures for pharma packaging, Datwyler assents that such a definition strikes a good balance between environmental protection with patient access to healthcare and the protection of the medical supply chain, thus avoiding critical drug shortages on the market.

1,2,3 https://www.maine.gov/dep/spills/topics/pfas/PFAS-products/cuu.html

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Yes – Datwyler urges the MPCA to consider the costs of the alternative itself as well as the costs of implementing such alternatives. In some cases, even if there a PFAS-free alternative available, lost business in the industry may not be able to be regained due to the nature and process of qualifying the alternative by submission to the relevant health authorities (e.g. US Food and Drug Administration) requiring too much investment of time, resources, and finances, with uncertainty of approval.

Further, the *reasonably available* criteria should not be viewed purely as economic feasibility – it should also encompass the technologic feasibility as well. In some cases, there is no functionally equivalent alternative to the current use of PFAS, even with extensive investments in current research and innovation.

3) Should unique considerations be made for small businesses with regards to economic feasibility?

Uncertain – Further definition and guidance is needed of what constitutes as a "small business" as well as for how long the unique considerations would be kept in place. These considerations may need to be determined with case-by-case rulings by the MPCA.

4) What criteria should be used to determine the safety of potential PFAS alternatives?

There exists an element of concern in the proposal to consider all -CF_2 containing materials, without differentiating between the macromolecular Fluoropolymers with other smaller PFAS. Posing a definition of "all -CF_2 containing materials" to be inclusive of polymeric PFAS (like PTFE, PVDF, and FKM), shows that there is a limit to the understanding of the safety potential for these materials.

Polymeric PFAS have been analytically tested and have been deemed non-toxic, not bioavailable, non-water soluble, and non-mobile molecules that do not exhibit environmental or human health implications like other PFAS may. Because of this, we believe that criteria such as these should be used in evaluating these materials. Many assessments have shown that, in the limited chance a suitable alternative can be identified, the critical performance characteristics frequently cannot be met by the alternative compared to fluoropolymer based materials.

Safety should be evaluated with to also include function of the alternatives. Any replacements should result in functionally equivalent products that either maintain or reduce the potential of causing harm to human health or the environment. Critical performance characteristics should be defined and demonstrated by the stakeholder within the CUU determination proposal.

5) How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

Datwyler stipulates that especially for critical infrastructure CUU determinations, such as those impacting Human Medicinal Products, should have a TIME-UNLIMITED determination. In other cases, the length of the determination should be decided keeping in mind the application and life-cycle impact to society. It must be kept in mind that if a change in determination status may create a dramatic shortage and unavailability of a critical need such as medicines, or else a re-evaluation would be detrimental to balancing environmental protection with the continuation of essential services provided to the citizens of Minnesota.

In the case of new developments, re-evaluation may be sought, but in certain cases like that of healthcare, such re-evaluations may prove unhelpful. For example, within healthcare, an estimated 1 of every 5 injectable drugs for human medicinal products around the world are manufactured with packaging systems utilizing a fluoropolymer barrier coated rubber closure due to the nature of the medicine being protected for delivery. As future medicines become even more difficult to stabilize and have more sensitivities, an increased usage of fluoropolymer coated rubber closures is expected. If these medicinal products were to be banned due to the closures used in their packaging systems not maintaining CUU determination, there would be a dramatic shortage and unavailability of life-saving injections (e.g., chemotherapies, mRNA vaccines, biological drug developments, future cell-and-gene therapies), especially with new developments and drugs that are targeting commercial use within the first years after PFAS restrictions are put in place. Restarting such stability and approval exercises is virtually impossible for all drug products currently using fluoropolymer-coated closures and will induce shortage of medicinal products available to patients needing these treatments in the field.

6) How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

Stakeholders, such as manufacturers of the products, should respond to a request for proposal by the MPCA and submit a proposal for a CUU determination for a PFAS-containing product to the MPCA's review and conclusion. Stakeholders should not be able to submit a proposal for a CUU determination to be obsoleted, but rather should be permitted to request for a re-evaluation on the subject CUU determination that the MPCA can then resolve whether or not to fulfil such request at its decision.

The proposals for CUU determination should provide information similar to that requested for PFAS reporting in Minnesota Statutes 116.943, subdivision 2(a). Due to the sensitivity of trade secrecy, Datwyler requests that the MPCA balance public availability of data and trade secrecy as part of the reporting requirements. In particular, in the requirements listed in Minnesota Statutes 116.943, subdivision 2(a), subsection 3, there is a request for identification of PFAS by its chemical abstracts service (CAS) registry number “in the exact quantity determined”. Such a requirement may be excessive in this case as the focus should be on the clear demonstration of CUU requirements that the PFAS-containing product is *essential for health, safety, or the functioning of society* as well as how *alternatives are not reasonably available*. Datwyler recommends that proposals not focus on the listing of CAS numbers and instead focus on demonstrating how alternatives are not reasonably available.

7) In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

Looking at the unique and essential use of fluoropolymer coatings on elastomeric closures used for primary packaging to ensure compatibility with parenteral drugs, Datwyler welcomes the opportunity to submit a proposal for CUU determination for the product class of fluoropolymer-coated closures for primary packaging systems of medicinal products. Datwyler’s elastomer closures are essential packaging components for pharmaceutical and biotech drug products.

Parenteral/Injectable primary packaging systems of sensitive drug medicine intended to be injected (e.g., oncology chemotherapy, individualized cell/gene therapy, novel biological-based drugs, and other medicines sensitive to migrating substances from the rubber) depend on closures that have limited to no interactions with the drug medicines while maintaining barrier properties. Fluoropolymer coatings (applied with either the spray or film technology) create such an inert barrier between the rubber of the closure and the medicine within the packaging. Any changes by replacing parts with non-fluoropolymer alternatives would require development, qualification, validation, registration and approval, and are thus not economically feasible. There would also be a need by pharmaceutical and biotech companies to reallocate investment that would have gone to the development and manufacture of life-saving drug products as these companies would need to reallocate significant resource and refocus on substituting, revalidating and reregistering many parts of their process and products. The whole industry would also need to partake in a huge regulatory undertaking, further diverting attention and investment away from developing novel therapies for life-threatening diseases.

Not designating fluoropolymer-coated closures a CUU determination would severely limit the delivery and availability of medicines and life-saving treatments to the patients seeking treatment from healthcare professionals in Minnesota.

8) Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

Yes – Datwyler would humbly request that the MPCA consider the proposal in response to question 7 to make an initial CUU determination in order to assist in the understanding and demonstrated application of the process by which the MPCA shall evaluate further proposals.

9) Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

At this time, Datwyler seeks to reiterate to the MPCA that there exists an element of concern in the proposal to consider all -CF_2 containing materials, without differentiating between the macromolecular Fluoropolymers with other smaller PFAS. Posing a definition of "all -CF_2 containing materials" to be inclusive of polymeric PFAS (like PTFE, PVDF, and FKM), shows that there is a limit to the understanding of the safety potential for these materials. Datwyler highly advises that the MPCA consider clarifying the CUU criteria to allow for a streamlined review of such fluoropolymer uses that have been analytically demonstrated to be non-toxic, not bioavailable, non-water soluble, and non-mobile molecules that do not exhibit environmental or human health implications.

Datwyler keeps sustainability at the forefront of its vision and remains committed to balancing the need for environmental protection with the need for pharma packaging components designed to protect the efficacy and functionality of medicines, which is a complex challenge. Thank you for allowing us to provide these comments and for taking the time to consider these views during the rulemaking process. Datwyler admires the significant task being undertaken by the MPCA to balance environmental impacts of PFAS with maintaining essential functions of health, safety and a functioning society for all Minnesotans. Datwyler welcomes the opportunity to further engage with the MPCA and other stakeholders in this rulemaking process and offers to answer questions and provide technical perspectives in further discussions during the rulemaking process. If further information is needed about the materials included in this submission, please contact Roman Ventura by email at roman.ventura@datwyler.com.

Respectfully submitted,
Datwyler

Roman Ventura
Manager Material Applications Healthcare

Review Log

Function	Name	Title	Date
M&ST	Bram Jongen	Vice President Materials & Surface Technologies	29 Feb 2024
Reg Affairs	Giorgio Morlotti	Chemical Compliance Manager	01 Mar 2024

Version History

Edition	Comment	Approval Date
1.0	First Edition	01 Mar 2024

RECEIVED
By: OAH on 3/1/2024

Emily Sobel Attachment

mema.
The Vehicle Suppliers Association

March 1, 2024
Katrina Kessler
Commissioner
Minnesota Pollution Control Agency
520 Lafayette Road N
St. Paul, MN 55155

RE: Request for Comments: Planned New Rules Governing Currently Unavoidable Use Determinations About Products Containing Per-and polyfluoroalkyl Substances (PFAS)

Dear Commissioner Kessler,

MEMA, The Vehicle Suppliers Association, submits these comments to the Minnesota Pollution Control Agency (MPCA) on its request for comments on planned new rules governing currently unavoidable use (CUU) determinations for products containing PFAS.

MEMA is the leading trade association in North America for vehicle suppliers, parts manufacturers, and remanufacturers. It has been the voice of the vehicle supplier industry since 1904.

Automotive and commercial vehicle suppliers are the largest employer of manufacturing jobs in the United States employing over 900,000 people throughout the country. Direct, indirect, and induced vehicle supplier employment accounts for over 4.8 million U.S. jobs and contributes 2.5 percent to U.S. GDP.

Suppliers lead the way in new vehicle innovations. Member companies conceive, design, and manufacture the OE systems and technologies that make up two-thirds of the value of every new vehicle and supply the automotive aftermarket with the parts that keep millions of vehicles on the road, fueling international commerce and meeting society's transportation needs. MEMA members are committed to safety and sustainability.

Vehicle suppliers play a crucial role as the innovators and manufacturers of a multitude of technologies and wide range of components, systems, and materials that improve vehicle safety, emissions, and efficiency. PFAS play a crucial role in allowing vehicle suppliers to meet these safety and sustainability goals. The industry seeks to minimize the use of PFAS where possible, but for many components there are no currently available substitutes.

INTRODUCTION

Motor vehicles are composed of about 30,000 parts, each critical to the safe and efficient function of the vehicle[1].These parts and components are manufactured by suppliers for use in all vehicles on the road. This includes new motor vehicles as well as the aftermarket components necessary for the repair and maintenance of the existing fleet. The sheer number of parts illustrates the need for critical use determinations for the industry to allow the necessary research, development, and safety certifications to take place.

PFAS are critical to the production of motor vehicle parts and components and are therefore essential for the functioning of society. PFAS are extremely durable and can withstand extreme use and high temperature applications- all qualities that are necessary for automotive uses.

MEMA urges MPCA to exclude commercial medium and heavy-duty vehicles and their components from this regulation and provide an initial CUU determination as a part of this rulemaking. Doing so would give the industry the necessary time to identify which products contain PFAS and continue research and development of alternatives.

THE STATUTORY LANGUAGE LIMITS APPLICATION TO PRODUCTS SOLD TO A CONSUMER

MPCA must remain faithful to the language of the statute in developing its CUU determination criteria, as well as making initial CUU determinations. Minnesota Session Law-2023, Chapter 60, H.F. No. 2310 defines a product as: "an item manufactured, assembled, packaged, or otherwise prepared for sale to consumers, including but not limited to its product components, sold, or distributed for person, residential, commercial, or industrial use, including for use in making other products[2]." MPCA must interpret this definition to exclude commercial medium and heavy-duty vehicles, and their parts and components. Commercial vehicles and their parts are sold to fleet owners, not individual consumers, for business purposes, and therefore fail the first test of being an item manufactured, assembled, packaged, or otherwise prepared for sale to consumers.

MINNESOTA MUST PROVIDE CUU DETERMINATIONS FOR ALL MOTOR VEHICLE PARTS AND COMPONENTS

MPCA must provide CUU determinations for all motor vehicle parts and components for the following reasons:

First, PFAS are critical to the production of motor vehicle parts due to their durability. Notably, PFAS play a crucial role in the transition to clean transportation, which is made possible through the work of the vehicle supplier industry. For example, the ability of battery manufacturers to meet the demand for electric vehicles would be greatly impacted by restrictions on the use of PFAS. A recently released report from the U.S. Department of

[1] Sabhadiya, Jingesh *"40 Basic Parts of a Car."* February 2021
[2] Minnesota Session Laws. *"Chapter 60—H.F. No. 2310."* 2023

Defense states that it would take over 10 years to find a replacement for PFAS in batteries[3]. Once discovered, prominent lithium battery manufacturers estimate it would take 30 years to fully identify and incorporate a PFAS alternative. Given the length of time needed, MPCA should consider a lengthy CUU determination period for the motor vehicle industry, where additional safety compliance concerns must be addressed while identifying alternatives. It is crucial that MPCA consider both cost and feasibility as it develops its definition for "reasonably available" alternatives.

PFAS are also instrumental in the development of the hydrogen sector. Deployment of hydrogen fuel cell technology is crucial to meeting emissions standards. PFAS are used along the hydrogen value chain, particularly in the form of fluoropolymers, which underpin the electrolyzer and fuel cell systems. One use of fluoropolymers in hydrogen deployment is membrane electrode assemblies (MEA), which constitute the core of PEM electrolyzers or fuel stacks. Membranes provide essential functions in fuel cell and electrolyzer application, such as preventing short circuits. Industry has worked for decades to increase the efficiency of the fuel cells, notably decreasing the thickness of membranes. However, the industry still lacks reasonable alternatives to the use of PFAS in these parts. For example, while fluorine-free membranes are available, the durability is markedly poor, lasting only a few dozen hours compared to over 25,000 hours[4]. This example shows that MPCA must also consider performance in its definition of "reasonably available" alternatives.

Third, vehicle parts and components are essential for health, safety, and the functioning of society. Minnesota law states that beginning January 1, 2032, products containing intentionally added PFAS will be ineligible for sale unless MPCA has granted a CUU determination for the product. Without broad exemptions for the motor vehicle industry, it is likely that the sale of all classes of motor vehicles and their parts will be effectively banned within the state. This would create major disruptions to everyday life, as both passenger and commercial vehicles would be affected, creating an impact that will be felt far beyond the motor vehicle sector.

For example, interruptions to heavy-duty vehicle applications can impact the provision of critical services, such as the delivery of groceries, medical supplies, fuel, and other utility applications like ambulances. As a result, MEMA foresees the need for CUU determinations for all vehicle components sold and manufactured today.

Not only are PFAS critical to clean transportation, but PFAS are used in a wide array of crucial safety components in vehicles. To preserve vehicle safety, substitutions cannot be made without careful research and development, followed by certification to safety standards. This creates lengthy timelines that are in direct conflict with a 2032 total ban of PFAS. MPCA must consider safety in considering PFAS alternatives and should defer to the safety standards that are provided by the Department of Transportation and other

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[3] Department of Defense. *"Report on Critical Per- and Polyfluoroalkyl Substance Uses."* August 2023
[4] Hydrogen Europe. "*Hydrogen Europe Position Paper on PFAS.*" January 2023

standards-developing organizations.

Motor vehicle uses of PFAS are essential to health, safety, and the functioning of society. MEMA urges MPCA to grant the motor vehicle industry an initial CUU determination as it develops these criteria. Anything less will effectively ban the sale of all classes of automobiles and their parts in the state of Minnesota. Given the large number of vehicle parts, a CUU determination is necessary to allow suppliers the time to identify PFAS in products and conduct research and development for replacements. MEMA appreciates MPCA's consideration of our comments as it prepares its criteria for CUU determinations. For more information or questions, please contact Emily Sobel, MEMA senior manager of regulatory policy at esobel@mema.org.

Sincerely,

Alex Boesenberg

MEMA Vice President of Regulatory Affairs

SYENSQO
ADVANCING HUMANITY

RECEIVED
By: OAH on 3/1/2024
Michael Blume Attachment

Minnesota Pollution Control Agency
Syensqo Response to Proposed Rulemaking on Essential Uses of PFAS
March 1, 2024

On behalf of Solvay Specialty Polymers USA, LLC, member of the Syensqo group ("Syensqo"), we appreciate the opportunity to submit comments to the Minnesota Pollution Control Agency concerning the treatment of PFAS chemistries in commerce.

Syensqo is a global leader in advanced materials and specialty chemicals. Our tailor-made range of products and constantly evolving research offers everyday sustainable market-based solutions for next-generation transportation, resource efficiency, consumer goods, healthcare, and industrial production to accommodate U.S. consumers' needs. Syensqo, through its predecessors, has been connecting people and scientific minds for 160 years. Innovation is at our core and part of our DNA. In the United States, Syensqo employs over 5,000 people working in 50 sites across 25 states. Our U.S. footprint includes our composite materials manufacturing site in Winona, Minnesota where we have 265 employees. This site is critical to the American aerospace and defense industrial base and provides irreplaceable materials for military and civilian applications.

We are a science company with a remarkable past, aiming to reinvent the future with our technologies, particularly in the emerging clean energy markets. In that vein, in October 2022, Solvay Specialty Polymers, LLC (a subsidiary of Syensqo) was awarded a $178M grant from the Department of Energy (DOE) as part of an Infrastructure Investment and Jobs Act battery material funding program to produce a PVDF fluoropolymer production facility in Augusta, GA.[1] This facility has the potential to provide enough PVDF fluoropolymer to supply more than 5 million EV batteries per year at full capacity, and the project is expected to create more than 500 local construction jobs and 100 highly-skilled jobs. Once fully operational, our project is an American investment that will fill a significant domestic supply gap with all major feedstocks, including fluorspar (a designated critical mineral), coming from North America.

We strongly oppose an "currently unavoidable use" construct being applied to the entire class of PFAS chemistry for the reasons outlined below. Further, Syensqo respectfully requests a full exemption for fluoropolymers manufactured without fluorosurfactant process aids.

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[1] *See https://www.energy.gov/sites/default/files/2022-10/DOE%20BIL%20Battery%20FOA-2678%20Selectee%20Fact%20Sheets%20-%201_2.pdf*

SYENSQO
ADVANCING HUMANITY

I. *<u>This type of restriction is incompatible with complex critical supply chains and economies of scale.</u>*

Manufacturers of fluoropolymers (and other polymeric PFAS substances) need sufficient sales and volume to justify the immense capital and operation costs of an advanced chemical facility, and remain cost competitive in a truly global market (that exists for advanced polymer chemistries). For example, if only fluoropolymer coatings for architectural applications are deemed "currently unavoidable," but these coatings that are used in a vast array of other industrial applications are not approved, the loss of overall demand would be significant to manufacturers. Syensqo's facilities service a multitude of different industries for different applications. In many cases, we are multiple tiers removed from our products' end use as a material supplier. This dynamic extends across our entire portfolio of fluorinated products. Allowing only "currently unavoidable uses" in specific downstream sectors – rather than analyzing specific PFAS chemistries' risk profiles – would severely endanger the supply of materials for the approved uses by the state. The demand of PFAS products from these small subsectors cannot support the weight of the entire industry.

The US Department of Defense specifically highlights this problem as a key national defense vulnerability in their recent, "Report on Critical Per- and Polyfluoroalkyl Substance Uses."

> "PFAS are critical to DoD mission success and readiness and to many national sectors of critical infrastructure, including information technology, critical manufacturing, health care, renewable energy, and transportation…
>
> Emerging environmental regulations focused on PFAS are broad, unpredictable, lack the specificity of individual PFAS risk relative to their use, and in certain cases will have unintended impacts on market dynamics and the supply chain, resulting in the loss of access to mission critical uses of PFAS. These market responses will impact many sectors of U.S. critical infrastructure, including but not limited to the defense industrial base. Collectively, international and U.S. regulatory actions to manage PFAS' environmental impacts and identify and eliminate PFAS from the market, and the resulting market changes, pose risks to DoD operations and the defense industrial base supply chain. In addition, impacts to the global PFAS supply chain will present risks to the DoD Foreign Military Sales program and to North Atlantic Treaty Organization interoperability."[2]

Ultimately, the market will adapt and the supply of these critical materials will be available from foreign manufacturers who do not have the same environmental, labor, climate, and safety controls as U.S. suppliers. Moreover, it is highly likely that these critical supply chains will relocate to geopolitical adversaries and further disrupt domestic security for key manufacturing inputs. A downstream-agnostic approach that focuses on deeming specific

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[2] *See https://www.acq.osd.mil/eie/eer/ecc/pfas/docs/reports/Report-on-Critical-PFAS-Substance-Uses.pdf*

chemistries as "currently unavoidable" would rectify this problem and preserve critical supply/demand dynamics.

II. *The regulation does not follow the science and fails to recognize key differences in PFAS chemistries.*

Syensqo actively promotes the continued responsible and safe manufacture, use and placement of products which are essential to U.S. industry and to the decarbonization of the global economy. We take the subject of PFAS very seriously, and health and safety are our top priorities.

The regulation currently does not recognize the distinct differences in PFAS chemistries, particularly with respect to fluoropolymers which present low hazards to human health and the environment. These chemistries are vital to the critical industries that are the foundation of our sustainable future, including hydrogen-based energy, semiconductor manufacturing, EV batteries, and aerospace and defense applications.

Specifically, fluoropolymers are molecules that are inert, relatively large and have "documented safety profiles; are thermally, biologically, and chemically stable, negligibly soluble in water, nonmobile, nonbioavailable, nonbioaccumulative, and nontoxic."[3] Moreover, some of these fluorinated substances are even completely insoluble, including FKM (a fluoroelastomer) and PFPE lubricants.

III. *Alternative assessments should recognize the responsible manufacturing of certain PFAS chemistries.*

Major concerns about fluorochemistry have focused on the use of fluorosurfactant process aids used in the production of polymers.

> "The objective of this analysis is to evaluate the evidence regarding the environmental and human health impacts of fluoropolymers throughout their life cycle(s). Production of some fluoropolymers is intimately linked to the use and emissions of legacy and novel PFAS as polymer processing aids. There are serious concerns regarding the toxicity and adverse effects of fluorinated processing aids on humans and the environment." [4]

Over the last several years, we have invested millions of dollars to advance our technology where we now produce all of our fluoropolymers in the U.S. without the use of fluorosurfactants. Fluorosurfactants are non-polymeric process aids that help ingredients work together in manufacturing some fluoropolymers and historically included PFOA and PFOS, that are among the PFAS substances under the most intense spotlight. We were able to develop a next generation, more sustainable range of specialized fluoropolymers without the

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[3] *See Korzeniowski, S.H.; Buck, R.C.; Newkold, R.M.; El Kassmi, A.; Laganis, E.; Matsuoka, Y.; Dinelli, B.; Beauchet, S.; Adamsky, F.; Weilandt, K.; et al. A Critical Review of the Application of Polymer of Low Concern Regulatory Criteria to Fluoropolymers II: Fluoroplastics and Fluoroelastomers. Integr. Environ. Assess. Manag. 2023, 19, 326–354.*

[4] *See Lohmann, Rainer, Ian T. Cousins, Jamie C. DeWitt, Juliane Glüge, Gretta Goldenman, Dorte Herzke, Andrew B. Lindstrom, et al. 2020. "Are Fluoropolymers Really of Low Concern for Human and Environmental Health and Separate from Other PFAS?" Environmental Science & Technology 54 (20): 12820–28. https://doi.org/10.1021/acs.est.0c03244*.

use of fluorosurfactants while keeping the unique properties of these products, as required for special applications.[5]

A recent November 2023 scientific review specifically analyzed how the industry has responded to these claims amid new regulatory actions globally on "essential use"/"currently unavoidable use"/etc.,

> "Because they are concerned about the negative aspects of the fluorinated polymerization aids (FPAs or surfactants) currently used to replace PFOA, FP [fluoropolymer] manufacturers have been overcoming the great challenge to produce FPs free from FPAs…***FPs produced without any FPAs should be exempt for all uses across all industries including consumer applications as they raise no risk to the environment or to mammal and human health, in addition to the fact that FPs also match the PLC [polymer of low concern] criteria.***"[6] (Emphasis added.)

The supply of fluoropolymers for critical product supply chains is currently a delicate balance between market demand and regulation. A full exemption for fluoropolymers that are responsibly manufactured for industrial uses represents a path forward to address environmental, national security and economic competitiveness priorities. Thank you for your consideration. We encourage the state to take all measures to implement this statute with the widest possible interpretation for critical supply chains while recognizing the individual upstream chemistries that enable them. It's vital that these chemistries are not only allowed in commerce, but have sufficient demand to sustain production.

Very truly yours,

David A. Cetola
Vice President, Global Government Affairs

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[5] *See https://www.syensqo.com/en/innovation/science-solutions/pfas*

[6] *See Améduri B. Fluoropolymers as Unique and Irreplaceable Materials: Challenges and Future Trends in These Specific Per or Poly-Fluoroalkyl Substances. Molecules. 2023 Nov 13;28(22):7564. doi: 10.3390/molecules28227564. PMID: 38005292; PMCID: PMC10675016.*

RECEIVED
By: OAH on 3/1/2024

Joseph Dawley Attachment 1

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575 N. Dairy Ashford Rd.
Houston, Texas 77079, USA

Baker Hughes

February 29, 2024

Submitted to eComments website at https://minnesotaoah.granicusideas.com/

Minnesota Pollution Control Agency
Office of Administrative Hearings
600 North Robert Street, P.O. Box
64620, St. Paul, Minnesota 55164-0620

Re: Comments on New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837 for portable 3D measurement-enabled video borescope and remote visual inspection systems

To whom it may concern:

Baker Hughes, on behalf of our subsidiary Waygate Technologies, submits the following comments for an unavoidable use determination for our non-destructive testing equipment, as further described below. Many of our products are used for industrial asset monitoring to ensure the safe, reliable, and efficient operation of industrial equipment in power plants, transportation infrastructure, manufacturing plants, and other industrial operations.

1. *Provide a brief description of the type of product including, if applicable, the Global Product Classification (GPC) brick category and code, or if GPC is not applicable than the Harmonized Tariff System (HTS) code.*

Waygate Technologies (a subsidiary of Baker Hughes) designs and manufacturers portable 3D measurement-enabled video borescope or remote visual inspection

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systems. These products are classified under the Harmonized Tariff Schedule under **HTS Code: 9031.49.9000 - Other Optical Instruments and Appliances, others**.

Our video borescope or remote visual inspection equipment are handheld systems that feature a long (typically 2-10m in length), narrow (4-8 mm) insertion tube with an illuminated tip fitted with a high-resolution camera and optics. Images are relayed to an operator screen who can control where the tip pointing via a joystick. Units can operate for years and undergo thousands of bending operations with no degradation to the amount of bend, image quality, or other factors. Proprietary image analysis software allows operators to identify manufacturing defects, damage that occurred during operation, or other issues. Assessments such as decisions to continue operation or to take an asset out of service (e.g, aircraft engine) can be made and documented.

2. *Describe the intended use of the product and explain how it is essential for health, safety or the functioning of society.*

Our inspection equipment is built with a rugged and ergonomic design that allows for precise inspections in the toughest environments including aerospace, power generation, pharmaceuticals, oil and gas, automotive, food and beverage industries, and more. The units are sealed against fluid and particulate ingress, and are rugged against spills, impacts, drops, or temperature extremes. Their use provides industrial, transportation, and power generation asset owners the ability to troubleshoot equipment on-site with minimal disassembly and costly reassembly and requalification.

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Baker Hughes

3. *Describe how the specific use of PFAS in the product is essential to the function of the product. If this use of PFAS is required by federal or state law or regulation, provide citations to that requirement.*

PFAS (fluoropolymers) are used throughout the videoprobe system including: gaskets and seals for ingress protection; wire/cable electrical insulation; and components designed to reduce wear/friction on moving parts. Fluoropolymers such as PTFE, expanded PTFE, Viton, and others provide chemically inert, temperature-resistant, flexible, durable, and low-friction properties critical to the long-term operation of the device.

4. *Describe whether there are alternatives for this specific use of PFAS which are reasonably available.*

Alternatives to certain fluoropolymers that mimic one or two properties (e.g., flexibility, chemical resistance, etc.) do exist, but alternatives that can mimic the broad spectrum of properties, particularly low-surface friction, are few or non-existent.

5. Contact information for the submission.

David E. Johnson, Ph.D.
Technical Regulations and Standards Engineer
Waygate Technologies
dave.johnson@bakerhughes.com
+1-315-554-9222

We appreciate the opportunity to submit this request. Please contact David Johnson or myself if there are any questions with respect to this request.

Sincerely,
Joseph M. Dawley
Joseph M. Dawley
Legal Executive, HSE and Regulatory Law
Joseph.dawley@bakerhughes.com

RECEIVED
By: OAH on 3/1/2024
Joseph Dawley Attachment 2

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Baker Hughes

February 29, 2024

Submitted to eComments website at https://minnesotaoah.granicusideas.com/

Minnesota Pollution Control Agency
Office of Administrative Hearings
600 North Robert Street, P.O. Box
64620, St. Paul, Minnesota 55164-0620

Re: Comments on New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837 for Baker Hughes' valve products

To whom it may concern:

Baker Hughes, on behalf of our subsidiaries listed below, submits this request for an unavoidable use determination for our valve products. The Baker Hughes products that contain PFAS and are subject to these comments include Dresser valves and associated brands, including Consolidated, Masonelian, Becker and Mooney.

To support this request, we are incorporating the request submitted by the Flow Control Coalition, which is a coalition comprised of the following trade associations the Fluid Sealing Association, Hydraulic Institute, the Valve Manufacturers Association and Water and Wastewater Equipment Manufacturers Association. We are members of the Valve Manufactures Association. Please see the attached comments submitted by the Flow Control Coalition as support for our comments.

If you have any technical questions regarding this submittal, please contact Jeanne Beres Jeanne.beres@bakerhughes.com.

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Houston, Texas 77079, USA

Baker Hughes

Baker Hughes, on behalf of our subsidiaries listed below, submits the following comments for an unavoidable use determination for our compression, gas and steam turbine, and our condition monitoring equipment, as further described in the attached file named Baker Hughes UUD Product Request (1 March 2024).xlsx.

These products may contain PFAS polymers of low concern which are indispensable and used in countless industrial processes to support the production, processing, building and manufacturing of oil and gas; chemical; construction; power generation (traditional and new energy sources); mining; pharmaceutical; pulp and paper, water and wastewater; semi-conductor production; construction and data centers; transportation and food & beverage, along with many, many others. They are essential for health, safety and the functioning of society.

The specific PFAS substances used in our products are due to their properties in effective sealing, creating barriers for emissions, reducing energy use, performance in highly corrosive or high temperature environments, when access to the system is difficult and dangerous, and in providing a safe and reliable production process.

The Baker Hughes products that contain PFAS and are subject to these comments include Bently Nevada, Waygate Technologies, Panametrics, Druck, Reutor-Stokes, and Nuovo-Pignone. The attached spreadsheet provides the details of these products and the rationale for this UUD.

If you have any technical questions regarding this submittal, please contact Ranjith Nair at ranjithm.nair@BakerHughes.com.

We appreciate the opportunity to submit these comments. Please contact Ranjith Nair or me if there are any questions.

Sincerely,

Joseph M. Dawley

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Joseph M. Dawley
Legal Executive, HSE and Regulatory Law
Joseph.dawley@bakerhughes.com

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By: OAH on 3/1/2024

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Joseph Dawley Attachment 4

Baker Hughes

February 29, 2024

Submitted to eComments website at https://minnesotaoah.granicusideas.com/

Minnesota Pollution Control Agency
Office of Administrative Hearings
600 North Robert Street,
P.O. Box 64620,
St. Paul, Minnesota 55164-0620

Re: Comments on New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837 for Baker Hughes' valve products

To whom it may concern:

Baker Hughes, on behalf of our subsidiaries listed below, submits this request for an unavoidable use determination for our valve products. The Baker Hughes products that contain PFAS and are subject to these comments include Dresser valves and associated brands, including Consolidated, Masonelian, Becker and Mooney.

To support this request, we are incorporating the request submitted by the Flow Control Coalition, which is a coalition comprised of the following trade associations the Fluid Sealing Association, Hydraulic Institute, the Valve Manufacturers Association and Water and Wastewater Equipment Manufacturers Association. We are members of the Valve Manufactures Association. Please see the comments submitted by the Flow Control Coalition as support for our comments.

If you have any technical questions regarding this submittal, please contact Jeanne Beres Jeanne.beres@bakerhughes.com.

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Houston, Texas 77079, USA

Baker Hughes

We appreciate the opportunity to submit these comments. Please contact Jeanne Beres or me if there are any questions.

Sincerely,

Joseph M. Dawley

Joseph M. Dawley
Legal Executive, HSE and Regulatory Law
Joseph.dawley@bakerhughes.com

SEMICONDUCTOR INDUSTRY ASSOCIATION

RECEIVED
By: OAH on 3/1/2024
Alex Gordon Attachment 1

**Comments of the
Semiconductor Industry Association (SIA)
To the
Minnesota Pollution Control Agency (MPCA)
Resource Management and Assistance Division
Request for Comments
On the
Rulemaking on
PFAS in Products Currently Unavoidable Use Rule**

March 1, 2024

The Semiconductor Industry Association (SIA)[1] appreciates the opportunity to submit a proposal to the Minnesota Pollution Control Agency (MPCA) on its request for comments[2] on the rules governing currently unavoidable use (CUU) determinations about products containing per-and polyfluoroalkyl substances (PFAS).[3] SIA submits this proposal on behalf of its members,[4] the semiconductor industry, at large, and other manufacturers in the semiconductor supply chain.

SIA Request for Semiconductor Uses to be Deemed "Currently Unavoidable Uses"

Under the auspices of SIA, the Semiconductor PFAS Consortium has published technical papers documenting the industry's use of PFAS in various applications, including information regarding the unique functional properties of particular PFAS in our manufacturing processes, the absence of non-PFAS alternatives in meeting performance requirements, and the technical obstacles and long lead times needed to identify and adopt potential substitute chemicals. Each of these technical papers are available for download at https://www.semiconductors.org/pfas/, and we incorporate these papers into these comments by reference.[5] These papers provide the technical basis for our request for Minnesota to ensure the definition of "currently unavoidable use" encompasses the following uses of PFAS throughout the entire semiconductor value chain, or to designate as part of this initial rulemaking that the following uses of PFAS in the entire semiconductor value chain as "currently unavoidable uses":[6]

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[1] SIA is the voice of the semiconductor industry, one of America's top export industries and a key driver of America's economic strength, national security, and global competitiveness. Semiconductors – the tiny chips that enable modern technologies – power incredible products and services that have transformed our lives and our economy. The semiconductor industry directly employs over a quarter of a million workers in the United States, and U.S. semiconductor company sales totaled $275 billion in 2022. SIA represents 99 percent of the U.S. semiconductor industry by revenue and nearly two-thirds of non-U.S. chip firms. Through this coalition, SIA seeks to strengthen leadership of semiconductor manufacturing, design, and research by working with Congress, the Administration, and key industry stakeholders around the world to encourage policies that fuel innovation, propel business, and drive international competition. Additional information is available at www.semiconductors.org.

[2] Minnesota Pollution Control Agency, *Request for Comments: Planned new rules governing currently unavoidable use determinations about products containing PFAS, Revisors ID Number R-4837.* Available at: https://www.pca.state.mn.us/sites/default/files/c-pfas-rule3-01.pdf

[3] *Minnesota Session Law - 2023, Chapter 60, H.F. No. 2310, https://www.revisor.mn.gov/laws/2023/0/Session+Law/Chapter/60/#laws.3.21.2*

[4] Semiconductor Industry Association, *Members*. See: https://www.semiconductors.org/about/members/

[5] We are happy to provide a zip file of these documents, but they are unable to be attached to our submission on the MPCA portal. Please contact agordon@semiconductors.org if the zip file is requested.

[6] Environmental policy has long-embraced the concept of providing an exemption for critical or essential uses of restricted substances, dating to the treaty to phase out ozone-depleting chemicals. Montreal Protocol on Substances that Deplete the Ozone Layer (1987), https://ozone.unep.org/treaties/montreal-protocol. In addition, the scientific and environmental community has endorsed the application of a critical use exemption to the regulation of PFAS. See

- Manufacturing Processes – PFAS-containing chemicals, gases, and materials used in semiconductor manufacturing, including but not limited to the following applications:
  - Surfactants
  - Photo-acid generators (PAGs)
  - Fluorochemicals used in semiconductor manufacturing plasma-enabled etch and deposition
  - Heat transfer fluids (HTFs)
  - Materials used in semiconductor manufacturing assembly test packaging and substrate processes
  - Wet chemistries
  - Lubricants

- Semiconductor Devices – Semiconductor devices, components, and packages

- Fab Equipment, materials, and infrastructure – Semiconductor manufacturing tools, parts, materials, ancillary equipment, and infrastructure used during semiconductor manufacturing or at semiconductor manufacturing facilities

SIA's comments below include additional background on semiconductor manufacturing and PFAS, general comments on the MPCA rulemaking, and specific answers to MPCA's questions.

1. Background on Semiconductor Manufacturing and PFAS

Semiconductors form the essential building blocks of modern technology, enabling innovations that make the world smarter, greener, more productive and efficient, and better connected. Semiconductors enable critical technologies and industries that form the foundation of the U.S. economy, including the automotive industry, defense, electronics, communications, data storage and analysis, legal and regulatory infrastructure, scientific (including materials) research, medicine and medical devices, the green energy transition, transportation (including aviation), and much more. With up to tens of billions of transistors on a single piece of silicon, producing these complex devices requires highly advanced processes and equipment, as well as the use of chemicals, gases, and other materials with specific performance and functional attributes. Today, the smallest transistor is just 3 nanometers in size – 5 atoms thick and 30,000x thinner than a human hair. The fabrication process can include up to 1,400 process steps, with each process step typically involving the use of a variety of unique, highly sophisticated machines and materials. The supply chain for semiconductor manufacturing is extremely complex, as noted by numerous U.S. government publications.[7]

The Madrid Statement on Poly- and Perfluoroalkyl Substances (PFASs), available at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4421777/. In the case of PFAS, a similar, broad-based exemption is necessary to ensure there are no disruptions to the semiconductor value chain.

[7] The White House, 100-day Supply Chain Review, *Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth*, June 2021. See: https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf

Government Accountability Office, GAO-22-105923, *Semiconductor Supply Chain Policy: Considerations from Selected Experts for Reducing Risks and Mitigating Shortages*, July 2022. See: https://www.gao.gov/assets/gao-22-105923.pdf

Department of Defense, *Securing Defense-Critical Supply Chains An action plan developed in response to President Biden's Executive Order 14017*, Feb. 2022. See: https://media.defense.gov/2022/Feb/24/2002944158/-1/-1/1/DOD-EO-14017-REPORT-SECURING-DEFENSE-CRITICAL-SUPPLY-CHAINS.PDF

PFAS are among the inputs essential to chip manufacturing, used in a wide range of industrial processes and consumer products. Although the semiconductor industry accounts for only a small fraction of the world's total PFAS usage, many uses of specific PFAS are essential to semiconductor manufacturing. PFAS have essential uses in a wide variety of applications because they possess certain critical performance and functional attributes needed to manufacture semiconductors as well as the sophisticated equipment and infrastructure needed to support the manufacturing process. The carbon-fluorine bonds and structure of PFAS give them unique physical and chemical properties, such as strong electronegativity, low refractive index, good thermal stability, good barrier properties, hydrophobicity, low dielectric current, thermal resistance, chemical resistance, low surface adherence, resistance to grease and stain, anisotrophic etching capability, selective metal oxide removal, reduced shedding, high-temperature thermal stability, low adhesion strength, chemical inertness, low volatility, UV resistance, flame resistance, and low coefficient of friction, among others. This range of critical properties across the many different types of PFAS and applications, are indispensable in many industrial and consumer applications, including semiconductor manufacturing.

The Semiconductor PFAS Consortium[8] has identified over 1000 uses of PFAS in the semiconductor manufacturing process, fabrication plant equipment, end-use devices and assembled packages, and associated supply chain. Each use is essential to producing the final chip. There are currently no known substitutes for the vast majority of these applications. Identifying, developing, and qualifying suitable substitutes will require new inventions, and if found, the process of introducing substitutes into high volume manufacturing is complex; the process can take anywhere from 5 to 25 years, and in many cases will never be possible.

2. Comments on the MPCA Rulemaking

Given the complexity of semiconductors and related systems, MPCA must recognize that even just one use of PFAS deemed not to be a CUU could inadvertently prohibit the import of semiconductors into the state and cause all semiconductor manufacturing in Minnesota to cease operations.

MPCA should recognize that Minnesota has a vibrant semiconductor industry. In 2023 alone, Minnesota chipmakers, such as Polar, SkyWater, Honeywell, and Seagate, exported over $1.1 billion in semiconductor products. And importantly, Minnesota manufacturers imported $796 million worth of semiconductors that are then incorporated as components into other products.[9] Semiconductor equipment manufacturers in Minnesota, such as Onto Innovation and Tokyo Electron, exported over $200 million worth of machinery. Without a CUU for semiconductor products and the products needed to manufacture semiconductors, these totals would drop to zero. Semiconductor fabrication facilities and equipment manufacturing facilities in the state would be forced to cease operations, and all companies would be prohibited from purchasing semiconductors necessary for their products to function. Such a restriction would inevitably drive business and jobs out of the state.

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[8] In January 2021, SIA facilitated the establishment of the Semiconductor PFAS Consortium, an international group formed to collect the technical data needed to formulate an industry-wide approach and better inform public policy and legislation regarding the semiconductor industry's use of PFAS. The consortium membership is comprised of semiconductor manufacturers and members of the supply chain including chemical, material, and equipment suppliers. To date, the Consortium has published a series of nine technical papers summarizing the uses of PFAS in the semiconductor industry and significant technical challenges to replace these substances in the range of uses in the fabrication process and fab equipment. Additional information is available at www.semiconductors.org/pfas/ Semiconductor PFAS Consortium, Background on Semiconductor Manufacturing and PFAS, May 17, 2023.
[9] U.S. Census Bureau. HTS codes 8541, 8542, and 8486.

MPCA also should be aware of the investments into the state's semiconductor industry made by the Minnesota State Legislature and signed into law by Governor Walz during the 2023 session. Under Chapter 53, Senate File 3035, Minnesota will invest up to $250 million to match federal funds made under the CHIPS and Science Act.[10] The semiconductor presence in Minnesota is on track to expand in the coming years, but without a CUU for semiconductor manufacturing, semiconductor equipment, and the corresponding supply chains, Minnesota will miss out on the opportunity to participate fully in the CHIPS programs, which runs counter to the initiatives undertaken by the state legislature and governor's office.

In order to avoid these significant adverse socio-economic impacts in Minnesota's economy and the quality of life of Minnesota residents, SIA requests that MPCA craft a broad, categorical CUU that exempts from the 2032 PFAS restriction the entire semiconductor value chain, including materials, tools, and processes, and when present in end use devices and assembled packages.

As described earlier in this submission, included in a CUU for the semiconductor industry should be a general category of usage that includes all CUUs throughout the semiconductor value chain, including the upstream semiconductor supply chain industries, the semiconductor manufacturing process itself, as well as the final packaged semiconductor devices that are produced. Examples of CUU PFAS applications in each of these three subcategories are as partially listed below and including:

- Manufacturing processes - Uses within the semiconductor manufacturing process, including but not limited to PFAS ingredients within specialty chemicals and fluids, fluoropolymers and other PFAS used in production of high purity water and in containment and transport of high purity water and chemicals, and uses of fluoropolymers and other PFAS in facility systems.

- Semiconductor devices - Uses within the final packaged semiconductor devices, including but not limited to finished semiconductor devices and component parts such as encapsulants, thermal interface materials, adhesives, coatings, substrates, wiring, connections, and circuit boards.

- Fab Equipment, materials, and infrastructure - Uses in upstream semiconductor supply chain industries, including but not limited to uses of fluoropolymers and other PFAS used in high purity chemical production and packaging, fluoropolymers and other PFAS integrated into semiconductor manufacturing equipment, PFAS used to manufacture the semiconductor manufacturing equipment, and the PFAS substances supplied for use in semiconductor manufacturing.

3. Reservation of Rights

Please note that this submission is on behalf of the semiconductor industry as a whole, but is not intended to preclude the possibility that individual companies within the semiconductor sector may have additional or more specific information that they intend to submit. SIA's

[10] Office of Governor Tim Walz, *Governor Walz Signs One Minnesota Budget into Law*. Available at: https://mn.gov/governor/covid-19/news/?id=1055-579302#:~:text=The%20bill%20invests%20%24500%20million,the%20CHIPS%20and%20Science%20Act. Minnesota Employment and Economic Development, *Minnesota Forward Fund.* Available at: https://mn.gov/deed/business/financing-business/deed-programs/forward-fund/

submission should therefore be understood as being without prejudice to comments that individual companies may choose to submit.

Moreover, please note that this is an *initial* comment – it is intended to provide key background to MPCA on semiconductor uses of PFAS for which alternatives are not “reasonably available” – based on our understanding that MPCA’s current request for comment will inform future regulatory actions. Although we believe that this submission and the documentation that we incorporate by reference here provides more than ample substantiation for ensuring a CUU designation by MPCA as commented here, we reserve the right to submit additional information in subsequent formal rulemakings that MPCA undertakes.

Finally, we note that, like many other sectors of the manufacturing economy in Minnesota, we continue to have significant concerns about Chapter 60, and believe that MPCA could take steps to further reduce the under-appreciated burden imposed under the law on manufacturing facilities and other reporting companies in Minnesota. In addition to adopting broad CUU designations for the 2032 prohibition, MPCA should broadly apply the discretion available under the statute to provide categorical exemptions from the reporting duty.

We remain hopeful that further legislative improvements to the statute are possible, but in the meantime believe that MPCA should exercise its authority through rulemaking to streamline these requirements in a manner that more appropriately balances risks and costs. We focus here only on the CUU designation in response to MPCA’s request for comment on that topic, and look forward to further engagement with MPCA as it elaborates its regulatory interpretations of the statute in the coming months.

4. Answers to Specific Questions

1) Should criteria be defined for “essential for health, safety, or the functioning of society”? If so, what should those criteria be?

Yes, MPCA should employ a broad concept of “essential” that is both consistent with the requirements of the statute and flexible enough to accommodate the possibility that broad exemptions may be required to avoid adverse impacts on the functioning of society. We suggest that MPCA grant CUU exemptions for both PFAS use applications and end products, and for the supply chain production activities required to produce such PFAS applications or end products, when a manufacturer has submitted documentation that an application, product, or category of products is essential to the health, safety, or the functioning of society and that there are no reasonably available alternative substances or technologies for that use, and that a product shall be deemed to provide benefits to the functioning of society.

Moreover, as indicated in the suggested language above, MPCA should clarify that uses of PFAS-containing products in manufacturing operations that take place in Minnesota would be included in the exemption wherever the manufacturing process produces an end product that is itself deemed “essential.” In other words, MPCA should make it clear that the “essential” designation and related exemptions should apply not only to the end product itself, but to each of the products and processes (and manufacturing equipment used) in the supply chain that are necessary to produce that exempted product. It is reasonable for MPCA to make a CUU determination that includes the use of PFAS in a given product as well as all uses of PFAS needed to manufacture such product, so long as there are no reasonably available alternatives.

Although semiconductors, semiconductor manufacturing equipment, and the semiconductor supply chain likely already fall under a common understanding of the phrase, the definition should specifically reference as examples semiconductors, semiconductor manufacturing equipment, and the semiconductor supply chain.

If MPCA does not include specific examples, then MPCA should ensure that "essential for health, safety, or the functioning of society" includes products, product components, and the supply chains necessary to manufacture such products and product components.

2) **Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?**

Yes, costs of PFAS alternatives should be considered in the definition of reasonably available.

A "reasonable" cost threshold should be where the cost of using the alternative is comparable to the cost of using the PFAS.

In determining a cost of use threshold, MPCA should consider that implementing a PFAS alternative, in the vast majority of cases in the semiconductor industry, will cost substantially more than solely the purchase of the substance. Instead, qualifying and integrating a single new substance into high-volume semiconductor manufacturing could take years, hundreds of engineers, the replacement of process technology or equipment, and even the redesign of a given product. Therefore, a "reasonable" cost of use threshold should include consideration of all the costs necessary to implement and use the PFAS alternative.

MPCA also should consider that a single PFAS substance may be replaced by several non-PFAS substances in order to achieve the same performance and characteristics. Therefore a "reasonable" cost threshold should include all substances that may collectively need to be implemented to replace the specific PFAS.

3) **Should unique considerations be made for small businesses with regards to economic feasibility?**

No comment

4) **What criteria should be used to determine the safety of potential PFAS alternatives?**

MPCA should align with any Federal regulation or determination, such as those that may be prescribed by the U.S. Environmental Protection Agency.

5) **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?**

Currently unavoidable use determinations should be made indefinitely, at least for the semiconductor industry, until the uses are no longer currently unavoidable. Any time limitation would be arbitrary, as it is impossible to predict with specificity the pace of innovation and science needed to find and integrate alternatives to PFAS and render existing uses of PFAS "avoidable." An indefinite CUU determination is necessary to allow for business predictability in the state. If semiconductor manufacturers, for example, were at risk of losing their CUU status after a given amount of time, that would be an incentive to invest in capacity elsewhere.

For the semiconductor industry, based on the findings of the Semiconductor PFAS Consortium, in some cases, specific applications of PFAS will never be able to be replaced, and many applications may require years, if not decades, to identify a viable substitute, qualify it, and integrate it into high-volume manufacturing. MPCA should also be aware that in some cases, PFAS substances may be replaced by other PFAS with improved environmental and health profiles.

If, however, MPCA sets a specific time limit for the CUU determination, it should provide a process for extending the CUU.

Significant changes in available information could trigger a re-evaluation. MPCA should invite affected stakeholders to provide comment during any re-evaluation process.

6) **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?**

As previously discussed, MPCA should allow for CUU determinations based on a broad category of products, product components, or product manufacturing processes (e.g., semiconductors, semiconductor manufacturing equipment, and semiconductor manufacturing.) Additionally, MPCA should allow trade associations or other stakeholders to request CUU determinations on behalf of multiple companies or a collective industry. Both of these functions will allow MPCA to streamline the CUU determination process, preserving valuable MPCA and company resources.

The CUU determination process should be based on scientific and technical information relating to whether the use of PFAS in a specific application is currently unavoidable. MPCA should endeavor to minimize the burden of submitting a CUU request, while also ensuring that affected stakeholders are required to provide information sufficient to validate that the use of PFAS is currently unavoidable.

7) **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.**

MPCA should establish a broad CUU that covers the entire semiconductor value chain, including semiconductors when PFAS is present in end-use devices and assembled packages; semiconductor manufacturing equipment; semiconductor manufacturing materials; and all products necessary for the manufacturing of semiconductors, semiconductor manufacturing equipment, and semiconductor manufacturing materials.

- Manufacturing processes - Uses within the semiconductor manufacturing process, including but not limited to PFAS ingredients within specialty chemicals and fluids, fluoropolymers and other PFAS used in production of high purity water and in containment and transport of high purity water and chemicals, and uses of fluoropolymers and other PFAS in facility systems.

- Semiconductor devices - Uses within the final packaged semiconductor devices, including but not limited to finished semiconductor devices and component parts such as encapsulants, thermal interface materials, adhesives, coatings, substrates, wiring, connections, and circuit boards.

- Fab Equipment, materials, and infrastructure - Uses in upstream semiconductor supply chain industries, including but not limited to uses of fluoropolymers and other PFAS used in high purity chemical production and packaging, fluoropolymers and other PFAS integrated into semiconductor manufacturing equipment, PFAS used to manufacture the semiconductor manufacturing equipment, and the PFAS substances supplied for use in semiconductor manufacturing.

8) Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

Yes, initial CUUs will ensure business predictability for relevant stakeholders.

SIA also recommends MPCA ensures that the entire semiconductor value chain is included in the definition of essential for health, safety, or functioning of society.

9) Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination

MPCA should consider adopting a process for reciprocity with other states that promulgate similar regulations on determinations of currently unavoidable uses of PFAS. A CUU of PFAS in one state should be accepted as a CUU by MPCA, and MPCA should work with its peer agencies in other states to ensure they accept CUUs designated in Minnesota. This will be valuable for consistency and interstate trade, and reduce the resource burden on both the regulatory committees reviewing the requests, as well as the companies submitting them.

MPCA also should take into account the limited potential risk of exposure from uses in the semiconductor industry, the chemical management practices in the semiconductor industry, and the fact that these chemicals are not intended to be released from the finished product under normal conditions of use.

5. Additional Information Regarding Semiconductor Industry Uses of PFAS: Critical Applications Throughout Value Chain

The semiconductor industry has invested significantly in identifying PFAS uses in the value chain for semiconductor manufacturing and in semiconductor devices during the past 25 years, in phasing out PFAS use where possible, namely the use of PFOS and PFOA in photolithography,[11] and in regularly evaluating the availability and efficacy of non-PFAS alternative chemicals or alternative processes or materials. The semiconductor industry has

[11] World Semiconductor Council, Joint Statement of the 21st Meeting of the World Semiconductor Council (WSC), May 2017, at pages 24-26 (Annex A). See: https://www.semiconductorcouncil.org/wp-content/uploads/2017/05/21st-WSC-Joint-Statement-May-2017-Kyoto-Final1.pdf

reduced its PFC emissions in plasma etch and chamber cleans, despite increasing usage of PFCs over time.[12] Efforts are ongoing to innovate and implement new PFAS abatement and process optimization technologies. Our industry has been a global leader in these efforts.

These efforts have been increased substantially during the past 3 years in anticipation of the EU "universal PFAS" restriction proposal under REACH. In preparation for the public consultation that took place last year on that proposal, the semiconductor industry established a substantial industry-wide collaboration platform that made deep investments across the sector. That process documented PFAS uses in our value chain, identified the unique functionality and performance attributes that various PFAS chemicals and fluorinated polymers conferred that made them essential to semiconductor production, and evaluated the availability of alternative substances, materials, or processes. This work culminated in over 700 pages of technical reports and substantiation, broken down by broad sub-categories of uses and applications within our sector. These materials, when considered in their totality and incorporated to this submission by reference, constitute more than ample substantiation for our request that MPCA designate all current and future PFAS uses within the semiconductor value chain as CUU applications that are exempt from the 2032 prohibition. All of this information has been made publicly available for download at semiconductors.org/PFAS.[13]

In brief, these papers demonstrate that many different PFAS are used in chemical formulations, components of manufacturing process tools, facilities infrastructure, and packaging used to make the semiconductor devices that are integral to the modern world. The current semiconductor state of the art is critically reliant on the use of PFAS compounds due to the particular properties that these substances provide. The technical papers identify the many functional attributes possessed by certain PFAS in meeting the rigorous performance requirements of fabricating semiconductors. Given their unique properties, it will be extremely difficult, and impossible in most instances, to find viable alternatives, without substantially impeding or reversing the technologies that the modern world currently relies on. In some cases, PFAS with a higher risk-profile may be replaced by PFAS with an improved environmental and health profile – a necessary, stepwise progress trajectory. There are also environmental impacts with not using PFAS, such as the potential for decrease in yield and therefore cause an increase in chemical, water, energy consumption, and waste generation.

The papers address the following individual topics:

1. Background on Semiconductor Manufacturing and PFAS
2. PFAS-Containing Surfactants Used in Semiconductor Manufacturing
3. PFOS and PFOA Conversion to Short-Chain PFAS-Containing Materials Used in Semiconductor Manufacturing
4. PFAS-Containing Photo-Acid Generators Used in Semiconductor Manufacturing
5. PFAS-Containing Fluorochemicals Used in Semiconductor Manufacturing Plasma-Enabled Etch and Deposition
6. PFAS-Containing Heat Transfer Fluids Used in Semiconductor Manufacturing
7. PFAS-Containing Materials Used in Semiconductor Manufacturing Assembly Test Packaging and Substrate Processes
8. PFAS-Containing Wet Chemistries Used in Semiconductor Manufacturing
9. PFAS-Containing Lubricants Used in Semiconductor Manufacturing

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[12] Semiconductor PFAS Consortium, PFAS-Containing Fluorochemicals Used in Semiconductor Manufacturing Plasma-Enabled Etch and Deposition, June 2023, at page 6. See: https://www.semiconductors.org/wp-content/uploads/2023/06/FINAL-Plasma-Etch-and-Deposition-White-Paper.pdf

[13] Semiconductor PFAS Consortium, Semiconductor Industry Association. See: semiconductors.org/PFAS

10. PFAS-Containing Articles Used in Semiconductor Manufacturing

Additionally, a peer-reviewed journal article published by Professor Chris Ober and colleagues at Cornell University summarizes the uses of fluorinated materials in the lithography process and concludes: “The addition of small quantities of fluorinated materials enables patterning capabilities that are otherwise not possible to achieve, and this leads to superior device performance. The compact size of the fluorine atom and its strong electron withdrawing characteristics make it stand out in the periodic table and gives fluorocarbon materials unique properties, unmatched by other chemical compounds.”[14]

As a result of this industry-wide collaboration research effort, we have identified more than 60 distinct categories of critical PFAS uses throughout the semiconductor value chain (with many different sub-applications and specific PFAS chemistries used within each of these general use categories). A general description of those uses is found in the Table A.49 appearing in the industry’s submission made during the EU REACH PFAS consultation.[15]
The contents of this table correlate directly with the information that is likely to be required by MPCA when final rules are established for its PFAS in products notification requirements, including, for instance, a brief description of the type of products, a description of the intended use, a description how the specific uses are essential to the function of the product, and finally, the information about alternatives. It is important to note that the timelines provided in the table for alternatives presume that there are no known alternatives and that such timelines start when a replacement that meets necessary performance requirements has been identified.

As the detailed materials developed by the Semiconductor PFAS Consortium indicate, each of these general use categories, and each of the various sub-applications within these uses, relies on one or more PFAS chemicals and fluoropolymers for critical performance functions, for which alternative chemicals or processes are either not available or, where alternatives may exist, require substantial lead time (with timelines that extend beyond, and sometimes well beyond, 2032) to redesign and requalify equipment and production processes.

The Semiconductor PFAS Consortium also published two additional resource documents, which we incorporate by reference in our submission:

- An overview paper that summarizes the key major use categories and identifies the impacts of premature restrictions on PFAS uses in our sector.[16]
- A socioeconomic impact assessment that is specifically focused on the foreseeable direct and indirect costs of a broad PFAS restriction in Europe, prepared as part of the industry's response to the proposed universal PFAS restriction under REACH. Although this paper is focused on the EU, the types and magnitudes of identified impacts are broadly representative of the effect of analogous restrictions if adopted in Minnesota and throughout the U.S.[17]

[14] Christopher K. Ober, Florian Käfer, Jingyuan Deng, “The essential use of fluorochemicals in lithographic patterning and semiconductor processing,” J. Micro/Nanopattern. Mater. Metrol. 21(1), 010901 (2022), doi: 10.1117/1.JMM.21.1.010901, available at http://dx.doi.org/10.1117/1.JMM.21.1.010901
[15] European Commission, *Annex To The Annex XV Restriction Report*, May 2023. See: https://echa.europa.eu/documents/10162/f71f3bed-e48d-5004-d195-e293c38d0602
[16] Semiconductor PFAS Consortium, “The Impact of a Potential PFAS Restriction on the Semiconductor Sector.” Available at: https://www.semiconductors.org/the-impact-of-a-potential-pfas-restriction-on-the-semiconductor-sector/
[17] Semiconductor PFAS Consortium, “The Socio-economic Impact of a Potential PFAS Restriction on the Semiconductor Value Chain in Europe.” Available at: https://www.semiconductors.org/the-socio-economic-impact-of-a-potential-pfas-restriction-on-the-semiconductor-value-chain-in-europe-2/

Rather than attempt to itemize each such PFAS application and substantiate it individually – a process that is not possible to complete, especially in the limited time provided for this submission, let alone for MPCA to review in a timely fashion – our submission incorporates each of these much more detailed papers by reference. We believe even a cursory review of this evidence will demonstrate to MPCA that we have amply satisfied the burden to demonstrate the essentiality of PFAS for these uses as well as the substantial timelines that would be required to research and develop alternatives for all required uses, test them, qualify them, and integrate them into our value chain within the short period of time available before the 2032 prohibitions take effect.

We request that MPCA consider these materials in formulating a general CUU determination for all PFAS currently in use throughout the semiconductor manufacturing value chain, including (for example) chemicals used in semiconductor manufacturing and related equipment (including chemicals and fluoropolymers in articles, and wet chemicals manufactured for and used in various production applications), as well as final semiconductor products and devices that contain PFAS chemicals and fluoropolymers within the devices and assembled packages.

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SIA appreciates the opportunity to submit this proposal and looks forward to continuing to work with the MPCA in the development and implementation of these rules. Please contact Alex Gordon at agordon@semiconductors.org with any questions.

RECEIVED
By: OAH on 3/1/2024

Kyle Thompson Attachment

PLUMBING MANUFACTURERS INTERNATIONAL

March 1, 2024

Quinn Carr
Minnesota Pollution Control Agency (MPCA),
520 Lafayette Road North,
St. Paul, Minnesota 55155-4194

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Submitted via OAH Rulemaking eComments website at https://minnesotaoah.granicusideas.com/.

RE: MPCA Request for Comments on Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

Dear Mr. Carr,

Plumbing Manufacturers International (PMI) appreciates the opportunity to provide comments to the Minnesota Pollution Control Agency (MPCA) on its *Request for Comments on Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per- and polyfluoroalkyl substances (PFAS)* published in the December 18, 2023, Minnesota State Register.

PMI is an international, U.S.-based trade association representing manufacturers that provide 90% of the plumbing products sold in the United States. PMI members manufacture water-efficient toilets, urinals, faucets, showerheads, and other plumbing products at more than 70 locations across the country for the residential and commercial marketplace. These products are readily available at home improvement stores, hardware stores and showrooms in all 50 states, as well as online. **In Minnesota, plumbing manufacturers contribute $936.7 million to the economy, provide more than 5,600 good paying jobs with their wholesale and retail partners, and generate $319.8 million in wages.**

Given their vital role in all types of construction in delivering safe drinking and industrial water to Minnesota residents, PMI is requesting that all plumbing products utilized in residential and commercial construction, as well as those used in public infrastructure be designated as "currently unavoidable use".

Maine DEP defines "essential for the functioning of society" on its website[1] as: *Essential for the Functioning of Society includes but is not limited to climate mitigation, critical infrastructure,*

[1] https://www.maine.gov/dep/spills/topics/pfas/PFAS-products/cuu.html

delivery of medicine, lifesaving equipment, public transport, and construction. Plumbing products meet several aspects of this definition. Infrastructure is the foundation of a thriving society. As an essential part of critical infrastructure, plumbing systems are key to maintaining the health and safety of the public through reliable delivery of safe, clean water, and removal of waste. These systems significantly contribute to proper sanitation and disease prevention. Plumbing products contribute directly to sustainability by providing critical water supplies to communities and households. These products offer vital functions for critical infrastructure, consumer goods and industrial applications; and contribute to a safe and healthy environment for communities.

Additional Information Regarding the Need for a CUU Designation for All Plumbing Products

Plumbing products are designed for a long service life. For example, plumbing products used in critical infrastructure are designed to last 30 to 50 years and consumer plumbing products such as faucets and showerheads are designed to last for over 10 years. PMI members are in the process of evaluating the presence of PFAS in their supply chains, but it is important to note that to date, it does not appear that PFAS in plumbing products would provide an exposure pathway for consumers. PFAS may be present in some plumbing products in the areas of lubricants, sealants and coatings which provide functions such as flexibility, corrosion and mold prevention, heat and water resistance, and water-tight seals. Lubricants and sealing products containing PFAS are used to ensure that safety-critical gaskets and o-rings used in plumbing products function properly and last an extended period of time in harsh environments. While rarely viewed or touched by a consumer, these components are critical sealing devices preventing leaks in plumbing systems, fire prevention systems, and gas connections. They reduce the risk of potentially dangerous and costly water/gas leaks in and near homes and buildings, all while withstanding challenging environments including harsh cleaning chemicals, extreme temperatures, and high pressures.

Plumbing fixtures/fittings that have contact with drinking water are required to undergo rigorous third-party testing for chemicals that are regulated by the U.S. Environmental Protection Agency (EPA) which is in the process of finalizing the first enforceable national drinking water standards for PFAS.[2] Once those regulatory limits are established, existing third-party certification requirements for plumbing products will reflect those limits.

For some technologies and products, there are no current alternatives for the mechanical properties, longevity, and safety benefits that are provided by PFAS. PFAS bans or phaseouts without appropriate CUU designations could prohibit essential products from being manufactured, sold and distributed. The timing for availability of viable alternatives will take

[2] Federal Register: U.S. Environmental Protection Agency (EPA) – Proposed Rule on the Per- and polyfluoroalkyl substances (PFAS): Perfluorooctanoic acid (PFOA) and Perfluorooctanesulfonic acid (PFOS) National Primary Drinking Water Regulation Rulemaking, Docket: EPA-HQ-OW-2022-0114 https://www.epa.gov/sdwa/and-polyfluoroalkyl-substances-pfas

years or even decades to develop and that's IF alternatives that protect the public water supply can be identified. Alternatives and repair parts often can't be redesigned because the PFAS-bearing part can't be redesigned with non-PFAS bearing material to fit in the same way and still function, or because the manufacturer decides to design a whole new product line rather than develop PFAS-free replacement parts for an existing product line. Analysis reported in the consultation submission by figawa e.V., DGMT, and AE, to the European Chemicals Agency (ECHA)[3] estimates a replacement timeline of up to 33 years for replacement of current plumbing fixtures and fittings with alternatives as follows:

> *A total substitution timeline of 22 years is estimated if provision of spare parts is not included. When spare parts are also included, the substitution timeline extends to 28-33 years. In the long term, the use of substitute products might only be possible in certain areas but would require major design changes. Supply of spare and maintenance parts for existing networks in operation may not be possible and may result in expensive replacements before the end of service life. The vast number of affected networks with such technology would require immense investments. Altogether this could endanger public and industrial water supply and the benefit for the environment is marginal as materials in contact with drinking water are already subject to high standards.*

Federal agencies have recognized products used in construction as essential to the functioning of society. During the COVID-19 pandemic, the U.S. Department of Homeland Security, Cybersecurity & Infrastructure Security Agency (CISA), worked with other agencies to issue a definitive federal list of essential workers by industry sector. The federal government deemed construction and building materials as essential industries, recognizing plumbing as an essential function within these industry sectors. Agencies recognized manufacturing and commercial operations related to all building materials as essential. Building sector products also typically include sealants and adhesives.

Conclusion

Because of the essentiality to society of all plumbing products, PMI requests that they be granted the CUU designation as a class of products rather than requiring individual companies to seek CUU designations by each type of product, requiring analysis of thousands of products, many of which do not contain PFAS or include trace amounts with no consumer exposure.

PMI also recommends that MPCA use similar criterion as Maine DEP for PFAS and requests that MPCA establish an ongoing process for granting CUU designations in the future so that manufacturers and industries that do not receive an initial CUU designation can apply in the

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[3] figawa e.V. *ANALYSIS OF ALTERNATIVES and SOCIO-ECONOMIC ANALYSIS PROVIDED AS COMMENTS TO THE PUBLIC CONSULTATION ON THE REACH RESTRICTION PROPOSAL ON PER- AND POLYFLUOROALKYL SUBSTANCES (PFAS)*, [European Chemical Agency], German Society for Membrane Technology (DGMT) and Aqua Europa (AE), September 22, 2023. https://echa.europa.eu/documents/10162/17233/rest_pfas_rcom_part99_en.docx/580131d4-e84a-b9c7-b190-80dd27e54864?t=1698664416565&download=true Comment Number 8711. Accessed 14 Feb. 2024.

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future as more information on PFAS and its viable alternatives becomes available between now and 2032 when the state's PFAS products ban goes into effect.

Thank you for considering our request. Please let us know if you have any questions or if we can provide additional information.

Sincerely,

Kyle Thompson
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RECEIVED
By: OAH on 3/1/2024

Tony Kwilas Attachment

MINNESOTA CHAMBER OF COMMERCE

GROWING MINNESOTA

March 1, 2024

Commissioner Katrina Kessler
Minnesota Pollution Control Agency
520 Lafayette Road N.
St. Paul, Minnesota 55155

Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

On behalf of the Minnesota Chamber of Commerce (Chamber), a statewide organization representing more than 6,300 businesses and more than a half a million employees throughout Minnesota, we appreciate the opportunity to comment on the Minnesota Pollution Control Agency's (MPCA) request for comments governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS).

As the MPCA proceeds on the rulemaking, it is important to note that PFAS are an integral part of our economy in Minnesota and are vital for climate adaptation and mitigation, energy, public infrastructure (water, waste and transportation), and health care. Their use allows our businesses to remain competitive in a national and global marketplace. The rules and regulations adopted will have significant economic and fiscal impacts on the State of Minnesota.

1) **Should criteria be defined for "essential health, safety or the functioning of society?" If so, what should those criteria be?**

The MPCA should define criteria for "essential health, safety and the functioning of society". There are many chemicals in the PFAS class and all of them should not be regulated the same. PFAS are also regulated on the federal level under the Toxic Substances Control Act, the Federal Food and Drug Act and the Federal Insecticide, Fungicide and Rodenticide Act and these regulations should be considered when creating the criteria. In fact, products required or permitted under federal, or state law or regulation should be presumed essential for the health, safety and functioning of society.

Criteria developed should also take into account the availability of alternatives, their functionality, cost and accessibility in the marketplace. In addition, the criteria must include an assessment of the feasibility and practicality of any prospective alternative which requires the substitute must satisfy the health and safety criteria imposed on the existing product and use.

The concept of "essential" must be broadly interpreted to cover all categories: including, but not limited to transportation, water and waste management, energy production and conservation, appliances, semiconductors, communications, health care, food contact, processing, and manufacturing.

The State of Maine has defined "Essential for Health, Safety or Functioning of Society" and could be used as a starting point for the MPCA:
"Essential for Health, Safety or the Functioning of Society" means products or product components that if unavailable would result in a significant increase in negative healthcare outcomes, an inability to mitigate significant risks to human health or the environment, or significantly interrupt the daily functions on which society relies. Products or product components that are Essential for Health, Safety or the Functioning of Society include those that are required by federal or state laws and regulations. Essential for the Functioning of Society includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, and construction.

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Costs should be considered and broadly defined. First, the alternative must be available at an equivalent price. Also costs for "reasonably available" should consider many factors including technical and economic feasibility of alternatives. Performance, reliability and availability must also be factored into any equation.

Environmental, health and safety impacts of alternatives should be based on objective, quantifiable and peer reviewed data and cost considerations must include changes in productions facilities, safety and re-training of employees, additional disposal costs and the timing necessary for transition. An alternative should not be deemed "reasonably available" unless it is in current mass production and ready for delivery upon demand.

3) Should unique considerations be made for small businesses with regards to economic feasibility?

Small businesses will be greatly impacted by the law and consideration should be given to possible exemptions based on employee count or sales in Minnesota. Testing and reporting requirements will be especially onerous and costly for small businesses and possible exemptions, or to the extent funds are available, grants/loans should be considered to help alleviate the financial burden that will be placed on these small businesses.

4) What Criteria should be used to determine the safety of potential PFAS alternatives?

Existing federal and state law programs should be the starting point for any criteria for alternatives. Any proposed alternative must be subject to the same federal and state assessment and approval process as the product or use proposed to be replaced. Scientific studies and data must be included as well as a reduction of potential risk to human health and the environment. Sustainability impacts on water use, energy efficiency and reliability should also be considered.

5) **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided? Should significant changes in available information about alternatives trigger a re-evaluation?**

The unavoidable use determinations should be ongoing until a scientifically proven, peer-reviewed, economically feasible alternative is identified, and reviewed and approved by the federal or state authority with jurisdiction over the product or its use. If significant changes in available information occur, the interpretation of the information should be applied to the existing use as well as the alternative. Important to note is that any change in the determinations of currently unavoidable use will have a fiscal impact on the economy and should be a factor in any decision.

6) **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not to be determined to be currently unavoidable? What information should be submitted in support of such requests?**

Any process that the MPCA uses for the determination process of currently unavoidable use should be available as soon as possible, and be open, convenient, flexible, efficient, and cost sensitive so as to not burden the agency or the manufacturers who are impacted. Any request that a use be determined to not to be a currently unavoidable use, must provide scientifically, peer-reviewed data regarding the functionality, performance, safety, health and environmental impacts of suggested alternatives. Sufficient timelines and public input should be established for a response to such a request. Finally, an essential component must be the absolute protection of proprietary information and business sensitive information.

7) **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.**

From the Minnesota Chamber of Commerce view, it will be difficult to assess how many members and products will request a currently unavoidable use determination. The State of Maine received over 2,000 requests for an extension to their reporting requirements so that would indicate many products could also seek currently unavoidable use determination. Many sectors are essential to the health, safety and functioning of society and we think it would be safe to assume that the transportation, energy, electronics, medical, communications, defense, manufacturing and food and agriculture industries each will seek currently unavoidable use determination.

8) **Should MPCA make some initial currently unavoidable use determination as part of this rulemaking using the proposed criteria?**

The MPCA should make some initial determinations of currently unavoidable use in the rulemaking process. This would provide some clarity and certainty to manufacturers and the supply chain. Any attempt to streamline an already tedious and strenuous process would be helpful to the business community.

Thank you for the opportunity to provide comments on this proposed rule. Please feel free to contact me with any questions.
Sincerely,

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RECEIVED
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Re: Planned New Rules Governing Current Unavoidable Use Determinations about Products Containing Per- and Polyfluoroalkyl Substances (PFAS)

Revisor's ID Number R-4837
OAH Docket No. 71-9003-39667

Dear Ms. Kessler:

The Association of Equipment Manufacturers (AEM) appreciates the opportunity to comment on the Minnesota Pollution Control Agency's (MPCA) request for comments on the *Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per- and Polyfluoroalkyl Substances (PFAS)*, hereafter referred to as the Planned Rule. We look forward to sharing the expertise and technical knowledge of our industry sectors. We believe it is critically important when developing regulations, that the interest of all stakeholders be considered and understood.

AEM is the North American-based international trade group representing off-road equipment manufacturers and suppliers with more than 1,000 member companies and over 200 product lines in the construction, agriculture, mining, forestry, and utility industries. The equipment manufacturing industry in the United States supports 2.8 million jobs and contributes roughly $288 billion to the economy every year. Our industries remain a critical part of the U.S. economy and represent 12 percent of all manufacturing jobs in the United States. Original Equipment Manufacturers (OEMs) develop and produce a multitude of technologies over a wide range of products, components, and systems that ensure off-road equipment remains safe and efficient, while at the same time reducing carbon emissions and environmental hazards. Finished products have a life cycle measured in decades and are designed for professional recycling of the entire product at the end of life.

The off-road equipment manufacturing industry understands the value and importance of using sound science to inform future policymaking decisions. AEM strives to be a key stakeholder in these policymaking discussions. To ensure that new rules meet their objectives, AEM intends to provide commentary on several MPCA questions listed in the Request for Comments document.

1. **<u>Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?</u>**

Minnesota statutes 116.943 states that:

> *Beginning January 1, 2032, a person may not sell, offer for sale, or distribute for sale in this state any product that contains intentionally added PFAS, unless the commissioner has determined by rule that the use of PFAS in the product is a*

> *currently unavoidable use. The commissioner may specify specific products or product categories for which the commissioner has determined the use of PFAS is a currently unavoidable use.*

The law goes on to grant the commissioner rulemaking authority to make determinations on what constitutes a *current unavoidable use*, and which products may receive an exemption from the requirements of the regulations.

In the request for comment, MPCA asked for feedback from interested stakeholders on whether the agency should define the term *essential for health, safety, or the functioning of society*, presumably to use this definition as a criterion for determining what does and does not constitute a *current unavoidable use*. Off-road OEMs manufacture a wide variety of complex product types that are sold around the world. The market and compliance requirements are growing in number and complexity in an ever-changing regulatory environment. To ensure that policymakers and effected industry stakeholders meet the overarching objectives of a law, AEM strongly believes that regulations should contain clear, understandable, and achievable compliance criteria for businesses and individuals to follow. This will reduce confusion, save time and money, and foster a better understanding between regulators and the regulated community.

The stated aim of the statute focuses on restricting products that contain intentionally added PFAS. However, the exemption standard utilizes a product function, the term *Current Unavoidable Use,* as the only qualifier. It is not clear what the term *use* means within the context of the larger rule. Is this a reference to the chemical's role in the manufacturing process, or the attributes it conveys to the end product? Or is the term *use* meant for the purpose and function of the product itself? To make sure all stakeholders understand the adopted language, it is important to define the term *Use* and understand how it ties into our product lines, before we define *essential for health, safety, or the functioning of society*. With this in mind, AEM supports a definition similar to the one found in the European Union's Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) law, Article 3 (24) [1]:

> a *use* should refer to any processing, formulation, consumption, storage, keeping, treatment, filling into containers, transfer from one container to another, mixing, production of an article or any other utilization. Furthermore, this use must satisfy the need for the technical function provided by the chemical for a specific end use in a particular setting.

This definition provides clarity on the relationship between identified chemicals of concern and their relationship to the product. It also helps harmonize regulatory definitions in multiple jurisdictions around the world, easing the industry's overall compliance burdens.

With the concept of *use* fully defined, we can address the criteria for determining what products could meet the *essential for health, safety, or the functioning of society* threshold. This term should be divided into two different categories, (1) health and/or safety, and (2) the functioning of society.

(1) Is the *use* of the substance necessary for health and/or safety?
  a. Necessity should be assessed to demonstrating and verifying whether a use is necessary for the following elements:
    i. Preventing, monitoring or treating severe health issues
    ii. Sustaining basic conditions for human life and health

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[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006R1907

iii. Managing and preventing health crises and/or emergencies
iv. Personal safety
v. Public safety
vi. Addressing a danger to animal health which cannot be contained by other means.

(2) Is the *use* of the substance critical for the functioning of society?
  a. Criticality should be assessed by demonstrating and verifying whether a use is critical for any of the following elements:
    i. Providing resources or services which are critical for society (Construction, Agriculture, utility, mining, forestry)
    ii. Managing societal risks and impacts from natural and man-made crises and emergencies.
    iii. Protecting and restoring the natural environment

The final criteria should assess potential alternatives.

(1) Are there alternatives that are acceptable from the standpoint of the environment and human health:
  a. Can alternatives for the specific use be identified?
  b. Are the alternatives safer, technically, and economically feasible, and available at scale?
  c. Do alternatives provide the level of performance which is sufficient from a society point of view?

Assuming the product meets these definitions, the product should receive an exemption from the MPCA. Otherwise, the product exclusions will start to have negative impacts on human health, public safety, and the functioning of society as a whole.

2. Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Should Cost of PFAS alternatives be considered in the definition of "reasonably available"?

As defined in the previous section on establishing criteria for determining *essential for health, safety, or the functioning of society*, economic feasibility is a major component of this consideration. If a product is deemed critical to the functioning of society, the PFAS *use* in that product will likely provide the technical functionality to achieve the identified critical end use. When alternatives either do not exist or are so expensive as to make their purchase unattainable, then cost must be considered when making these determinations, due to that fact cost would be the factor jeopardizing the availability of the product for use in the marketplace.

AEM member companies manufacture products that provide critical functions for our modern world. Off-road equipment grows and harvests food, provides emergency repairs to critical infrastructure, constructs buildings and homes, provides municipal waste processing, among many other critical ends uses. While the work provided by off-road equipment is critical, the machines that work them are heavy capital investments for equipment and fleet owners. For these owners, equipment is cost effective for the work they need to perform, but with change they will become more expensive and less cost effective. As these costs pass on to the customer, contractor, or municipality, the consequences will pass on to the public, which expects and needs the services these machines provide. For these reasons, AEM believes costs should be a consideration when considering the definition of "reasonably available".

Reasonable Cost Threshold:

When developing a reasonable cost threshold, it is important to note that the cost of the new material should not be the only consideration used in making this determination. The next section will define some of these concepts more fully, but for the OEM, the costs associated with identifying, testing, validating, and implementing a new material into a product redesign is an expensive, years long activity. These activities are done to make sure new parts and components meet critical performance, durability, safety, and quality requirements, and may dwarf the extra costs associated with a PFAS alternative.

Consequently, the costs associated with using potential PFAS alternatives extend far beyond the product manufacturer. New materials may require more frequent, and more expensive, maintenance costs. They may not provide the same level of durability, leading to a premature obsolescence of the machine and an increase in societal waste generation. Not to mention the added risks associated with using a new material in a very mature industry used to the safety benefits designed into their components and sub-systems. These later points may be difficult to fully quantify, but they have very real consequences in our industry.

Understanding that the cost associated with adopting new materials in complex industries, such as the off-road equipment sector, is not a simple cost differential between two different substances. The real-world costs are based on a series of complex manufacturing activities, knock-on effects through the value chain, and the customer use experience. AEM recommends that MPCA take these other variables into consideration when developing a reasonable cost thresholds.

3. Should unique considerations be made for small businesses with regards to economic feasibility?

The cost of compliance for chemical regulations is quite high for many industries based on a variety of factors. In particular, the off-road equipment industry has had very little expertise and history regarding the identification, collection and storage of data needed to comply with chemical management regulations. This educational issue, endemic throughout the supply chain, is compounded by the wider compliance environment many of these companies operate in. Smaller manufacturers of components often do not store chemicals above the reporting thresholds required under the EPA's CDR or SARA 313 reporting rules. As a result, many companies in our supply chains and industry-at-large never cultivated the systems or expertise needed to gather and store the relevant chemical data for the components and parts they manufacture and distribute. This means that almost all companies in our industry, and most off-chemical manufacturers in other industries, will need to develop the regulatory expertise and compliance systems from scratch. This undertaking will be immensely expensive for any manufacturer, and prohibitively so for small businesses.

Their task is made more difficult due to the CBI protections many bulk chemical manufacturers utilize to conceal the composition of their products, making downstream identification and reporting extremely challenging to accomplish. Additionally, International suppliers follow various global regulations which differ from U.S. mandated chemical reporting requirements, deepening the data collection obstacles faced by our supply chains. Absent a data reporting system adopted globally across our industry sectors that can track and monitor chemical substances throughout the supply chain, it remains an extraordinarily difficult task for a single OEM to know the chemical composition of the articles they currently market in the U.S.

To illustrate these challenges, some manufacturers possess supply chains that run twenty (20) layers deep, with tens of thousands of unique suppliers scattered throughout the world. Collecting data on the presence of PFAS across hundreds of thousands of individual parts from tens of thousands of different companies is a colossal task. The lack of a *de minimis* reporting threshold ensures that manufacturers will need to collect information for all their parts and components to determine the presence, or lack thereof, of PFAS. The effort and time necessary to coordinate, educate, discipline, and gather useful data throughout the supply chain is a daunting task that will take years to organize and execute.

In comments supplied to the EPA, AEM calculated that the cost of accurately identifying and reporting a single chemical for an OEM would cost over half a million dollars. This estimated cost assumes information provided to the OEM is accurate, complete, and delivered on time. It is also important to note that this estimate does not account for any potential redesign and replacement efforts for phasing the chemical out of use in an off-road machine. For a family of chemicals as large as PFAS, the costs will be an order of magnitude higher.

Assuming a company is looking to identify a single PFAS chemical throughout their product lines, and the industry does not experience any disruptions, obstacles, missing data, or dead ends on their path to gathering the required chemical data, it would take roughly 36 months, or 6240 working hours for a single worker per firm[2] to complete the data gathering process. Using the EPA's estimate of a Technical Professional's wage of $80.50/hour[3], that leads to a total cost of $502,320 per firm. With a supply chain of over 10,000 individual companies, that means the total cost of the data gathering effort for the off-road equipment industry is a minimum of $5 billion dollars in accumulated costs. See Table 1 below:

Table 1: Estimated Costs for Off-Road Equipment Industry to Comply with the Data Collection and Reporting Requirements for a Single Chemical Substance

	COST TO EQUIPMENT MANUFACTURING INDUSTRY
NUMBER OF AFFECT FIRMS	10,000
AVERAGE TIME BURDEN PER FIRM (HRS)	6240
TOTAL TIME BURDEN (HRS)	62,400,000
AVERAGE COST PER FIRM	$502,320
TOTAL COST TO INDUSTRY	$5 Billion

If data collection efforts from industry supply chains produce poor quality information, fail to report information downstream, or prove infeasible to execute, the industry will need to turn to laboratory testing for their parts and components. Due to the lack of a *de minimis* threshold, the product manufacturers will need to test each product down to the detection limit to demonstrate compliance with the Planned Rule. Off-road equipment may contain over 100,000 unique parts in a single product, making testing a time consuming and costly endeavor. Assuming every company in the supply chain only manufactures a single product, uses a GC scan at a cost of $1,000 per part, and receives completely accurate results, testing will cost each company roughly $100 million dollars. With over 10,000 firms, the total cost to the equipment manufacturing industry would be over $1 trillion dollars. Furthermore, testing would create additional constraints on industry, as available time and resources at viable testing laboratories would be overrun with industry PFAS testing requests. These testing bottle necks would extend the compliance timeframe out to well over a decade. Without regulatory relief, this effort would be infeasible to execute on an industry wide level. See cost assumptions for testing in Table 2 below:

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[2] Many firms have teams of individuals performing this function, but for the sake of simplicity we will assume a single worker per firm.

[3] EPA (2020). Economic Analysis for the Proposed Rule for Reporting and Recordkeeping Requirements for PFAS. November 2020.

Table 2: Estimated Costs for the Off-Road Equipment Industry to Comply with the Data Collection and Reporting Requirements for a single chemical using Lab Testing of Articles

	COST TO EQUIPMENT MANUFACTURING INDUSTRY
NUMBER OF AFFECT FIRMS	10,000
AVERAGE NUMBER OF PARTS PER FIRM	100,000
TOTAL COST OF GC TEST PER PART	$1,000
AVERAGE COST PER FIRM	$100,000,000
TOTAL COST TO INDUSTRY	$1,000,000,000,000

In reality, the supply chain currently lacks the systems and education required to collect and transmit accurate and complete chemical data to the OEMs. Equipment manufacturers are currently seeing very low quality and inaccurate chemical data from their suppliers. To comply with the data requirements in the rule, most collection efforts will necessitate the use of laboratory testing. Meaning that the cost of compliance in the off-road equipment industry alone will be in the billions of dollars and take years to complete. In this environment, most manufacturers, but small entities in particular, will have an incredible challenge meeting the requirements of the rule. To help these companies survive, AEM suggests that MPCA introduce *de minimis* thresholds, a common universal reporting list of PFAS chemicals, alignment with EPA (and global) chemical rules, simplified reporting requirements, among other administrative changes to reduce the compliance burden.

4. What criteria should be used to determine the safety of potential PFAS alternatives?

When establishing criteria to determine the safety of potential PFAS alternatives it is important to consider an alternative substance under a wholistic approach. It is obvious that when looking at alternatives, policymakers should avoid chemicals that are more persistent, bioaccumulative, and toxic than the PFAS their intended to replace. However, one should also consider the wider safety, environmental, and human health repercussions that potential replacements of PFAS could cause. Generally speaking, policymakers should avoid replacement chemicals that exacerbating existing, or result in new, safety, environmental or health hazards, or eliminate the use of products critical to the functioning of society.

<u>Essential Uses</u>

Off-road equipment must meet highly demanding industry wide technical specifications due to the challenging environments in which these types of machines operate. Manufacturers design their products to operate for decades under extremely harsh, demanding, and arduous work environments. In these environments, materials, parts, and components need to meet rigorous design and testing requirements to ensure the safety of the operator and other workers on the jobsite.

The technical functions of the components and systems help inform the safety and operational design requirements of the machine. These technical characteristics include, but are not limited to, the following variables:

- Pressure - various systems, such as the hydraulic and engine systems, experience extreme pressure environments up to 500 bar.

- Temperature - the engine compartment, regenerative breaking components[4] and exhaust system operate at temperatures as high as 800°C.
    - Off-road equipment must also contend with cyclical temperature cycling due to machine exposure to outdoor conditions; temperatures ranging from as -57°C to 230°C.
- Mechanical – machines expose parts and components to a high degree of mechanical wear and tear. Sealing parts must survive the shear forces due to the mechanical movement of the equipment.
- Chemical resistance - seals interact with various fluids and gases, requiring a high degree of chemical and corrosion resistance to ensure the reliability of exposed parts.
    - Exposure to substances such as fuel, hydraulic fluid, coolant with additives like 2-ethyl hexanoic acid, and carboxylic acids, exhaust gas fumes (highly acidic) and engine oil (highly alkaline).
- Electrical and flammability resistance – the weight, power, and fuel of the machine creates electrical and flammability risks. Components, parts, and systems must include design elements to mitigate these risks.
- Vibration - up to 45.0 mm/s which can cause high frequency fatigue to components due to the repeated strain imposed. The mechanical alternating stress between joint components will make joints undergo cyclic tension and pressure, which may cause the generation, expansion, and extension of cracks.
- UV - Long-term durability against factors such as ultra-violet (UV) light due to exposure to outdoor environments.
- Material Weight – The use of lightweight materials to reduce energy consumption and CO_2 emissions.
- Hazardous Locations - Operation in hazardous or explosive environments requiring ATEX rating (the minimum safety requirements for workplaces and equipment used in explosive atmospheres), such as in chemical plants, mining, and petrochemical applications.
- Durability – Equipment must remain highly reliable over periods of up to, and beyond, 40 years.
- Environmental - Withstand harsh environments, such as:
    - Landfills where machines will experience consistent exposure to a wide variety of substances and mechanical damage.
    - Mining and earth moving equipment where operation in extremely dusty, humid, wet, muddy, and damp environments is necessary. The operation of such equipment is often up to 24 hours a day over extended periods of time. Due to the need to carry heavy payloads over rough terrain, the energy and therefore high temperature requirements of these systems are especially demanding.

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[4] Such as break resistors which recover the heat from breaking to decrease the overall energy requirements of the system.

- Exposure to salt spray due to their operation near the sea.

PFAS provides the material properties required to satisfy these various operating conditions. Without a material equivalent that can meet these technical specifications, the equipment and the individual safety and performance systems will fail, causing immediate and dangerous risks for the machine operator and other workers in the vicinity. It is essential that any replacement material meets the necessary performance requirements and still offers the same safety, durability, and quality attributes offered by the original PFAS chemical.

Risk to Public Policy Goals

The off-road equipment industry stands at the intersection between societal environmental goals and the practical commercial requirements of today's end-users. This position requires manufacturers to strike a perfect balance between the work requirements of their customers and the aspirations of the public and global policymakers. Despite this tension, the off-road manufacturing industry remains committed to providing solutions that can satisfy both stakeholders. As our industry looks to the future, PFAS provides crucial attributes manufacturers need in order to develop new technologies, prevent unintended environmental hazards, and ensure our equipment continues to operate safely.

Environmental concerns

Fluid Leaks:

Almost all off-road equipment requires the use of various fluids to enable the operation of specific machine functions. These fluids run in different systems for numerous purposes. Among these functions:

- hydraulic fluid enables power transfers to the hydraulic systems,
- coolant ensures the engine operates within the ideal temperature range,
- fluid coatings work to prevent corrosion, and
- oils reduce friction between moving parts

While these fluids provide useful functionality to our equipment, they also can cause environmental hazards such as leaks and spills. Equipment manufacturers strive to eliminate these leaks to prevent environmental damage, protect worker safety, and ensure the long-term viability of their products.

Fluoropolymers, such as PTFE and fluoroelastomers, provide crucial characteristics that prevent hose and seal failures throughout the machine. These chemicals possess high temperature, chemical and mechanical resistance, making them ideal for sealing applications. This combination of traits helps ensure the long-term viability of various hoses, seals, gaskets, O-rings, and valves placed throughout the machine. Without fluoropolymers, end-users would likely experience much higher rates of fluid leaks, environmental spills, safety issues, component failures, damage to the machine, and premature obsolescence of the machine itself. Currently there are no known technically, or economically, feasible alternatives to these substances.

Climate Change & Ozone Depletion

Various international stakeholders are working to mitigate the impact that humans have on the climate. Like many other sectors, the off-road equipment industry continues to develop new strategies and solutions to reduce its environmental footprint. These efforts may include replacing current refrigerant options with lower GWP alternatives, developing zero-emission powertrains, or working to build new system efficiencies within the equipment to reduce fuel burn. Fluorinated gases will remain a critical substance in these efforts, without which the path to more environmentally friendly technologies will be much more difficult to achieve.

- Refrigerants: Refrigerants and refrigerant systems are already highly regulated for their contribution to atmospheric ozone depletion, and, more recently, their global warming potential. Recently, our organization successfully concluded an application for the use of HFO-1234yf as a refrigerant in off-road equipment through the EPA's Significant New Alternatives Policy (SNAP) program. Commonly used in the automotive sector, HFO-1234yf not only delivers zero ozone depleting potential (ODP), but also provides a greatly reduced global warming potential (GWP) when compared to its immediate predecessor, HFC-134a.

  Unfortunately, many governmental jurisdictions incorrectly identify these fluorinated refrigerants as PFAS chemicals based on the adoption of overly broad regulatory definitions. For this reason, any family wide restriction on PFAS would invariably restrict the use of this substance as a refrigerant in off-road equipment and eliminate the associated environmental gains.

- Alternative Power: Regulatory bodies have a decades long history of looking at on-road and off-road engines to address air quality criteria pollutant concerns. With a growing focus on climate change, policymakers are also looking at engines to help address concerns over GHG emissions. Manufacturers will need to develop new low carbon powertrain technology solutions to achieve the criteria pollutant and GHG reduction levels set by regulators. Within the off-road sector, manufacturers are researching new alternative power technologies, such as lithium-ion batteries, hydrogen fuel cells, and alternative fuels to provide low carbon solutions to their customers and markets they serve. Once again, PFAS provide the functional characteristics required to help foster the maturity and adoption of these new technologies across the market. Without access to certain PFAS, none of these technologies will remain viable in the future.

Waste Streams

Certain PFAS provide advantageous properties that ensure the long-term functionality of off-road equipment. Preserving the useful life of hoses, seals, gaskets, coatings, and electrical components ensures the machine continues to operate for an extended period under severe conditions. Without the use of certain PFAS, machinery in the field will prematurely fail requiring an accelerated need for new parts and components, thus increasing the generation of waste.

Additionally, future broad-based prohibitions or restrictions of PFAS could jeopardize the off-road industry sector's general recycling and remanufacturing efforts. The off-road sector invests a lot of time and money to ensure their equipment is responsibly recycled, remanufactured, and resold into secondary markets. These efforts reduce the amount of wasted materials the industry produces, prevents equipment from going to landfills, and avoids the premature obsolescence of our products. Any restriction of materials needs to protect against endangering these recycling efforts, and the associated unintended environmental consequences.

Safety Concerns

Safety concerns are perhaps the most important issue the off-road industry attempts to mitigate in their design processes. Heavy equipment, operating in hazardous environments, and under severe stress with various workers on the job site provides ample safety challenges for equipment manufacturers to consider. Under these conditions, machine operators look for reliable and durable equipment with the appropriate safety standards designed into the machine. Several PFAS play a key role in ensuring the products continue to operate safely:

- Fluoropolymers in seals and hoses ensure hydraulic systems maintain pressure. Sudden pressure losses due to hydraulic hose failures can cause loads to drop suddenly on a jobsite, significantly increasing potential harm to workers.
- Heavy equipment operates at very high temperatures, requiring unique chemical solutions to mitigate any potential fire issues. Due to the pressure and temperature stability some PFAS chemistries are used to decrease the potential for fire, thereby protecting worker safety.

Undesirable Alternatives

Any transition to a PFAS alternative must avoid regrettable substitutions. Materials must satisfy national and international legal and regulatory requirements. Furthermore, they must not present an even greater risk to the environment, human health, or present new safety risks to the work site and operator.

Off-road equipment manufacturers require thorough testing and validation of new materials prior to their integration into a final product design. Substance specifications vary based on their intended purpose within the larger machine. Due to the nature of the work, manufacturers often require highly durable and robust materials that can operate consistently under very extreme conditions. Replacing proven materials with alternative substances can, under the right circumstances, produce desirable environmental outcomes. However, transitioning away from irreplaceable or highly specified materials can often lead to higher environmental and human health risks, as well as suboptimal product performance outcomes.

For example, FKM materials provide high chemical, temperature and pressure resistance in gaskets, seals, and hoses. This material performs so well, that it is widely considered to be irreplaceable for the continued operation of most modern equipment. Its closest alternative, ethylene propylene diene monomer (EPDM), also known as synthetic rubber, does not perform well in the high pressure and temperature environments found in modern equipment. More troubling, synthetic rubber utilizes N-methylpyrrolidone (NMP) during its synthesis, which is a regulated Substance of Concern (SoC) in a variety of regulatory jurisdictions.

It is important to ensure that OEMs receive enough time and support when transitioning away from regulated substances. Companies struggle with making informed and responsible decisions when faced with short implementation timeframes, discordant regulatory requirements, and overprescribed rulemakings. Policymakers need to provide appropriate exemptions, time, resources, and public-private collaboration necessary to ensure manufacturer stakeholders can identify and adopt desirable alternatives for their SoC.

With this in mind, AEM recommends that MPCA make sure that, when establishing criteria for PFAS alternatives, the new material must meet the safety, durability, quality, and performance requirements of the original PFAS materials, and must satisfy the need to avoid regrettable substitutions.

5. **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?**

Off-Road Equipment Challenges and Assumption to Finding Alternatives for PFAS

For most PFAS use cases, there are no currently known technical alternatives available for use in off-road equipment that does not compromise the safety, durability, or reliability of the finished product. AEM members produce equipment designed to consensus safety standards and subject to third party certifications, customer requirements, and regulatory testing obligations. Changes to materials and formulations which affect fit, form, function, performance, or safety must undergo extensive testing to ensure any new designs meet internal quality benchmarks, design specifications, and regulatory requirements.

Due to the challenges inherent to the off-road industry, it is extremely difficult to estimate the time needed to identify, test, and qualify alternative chemical substances for each end use. The estimates from AEM and their member companies are based on the following assumptions:

- A suitable and viable technical alternative material exists (although as described above, there are no known current technical alternatives for most PFAS use cases).
- Manufacturers do not encounter dead ends during their material assessments, and suitable characteristics are identified the first-time test are completed.
- Supply chain issues throughout the world do not hamper shipping and transportation timelines.
- The total number of PFAS substances used in off-road equipment is a manageable size (roughly 10-20 chemicals at a time). Manufacturers will try to conduct simultaneous redesign work wherever possible, but they cannot implement changes across all product lines simultaneously as test cells, qualified staff, and other resources are all limited. The higher the number of PFAS substances used in the components and systems of the end-product, the longer the timeline will be.

Any transition away from PFAS requires significant time and resources to simply identify and qualify any PFAS-free material for use in the off-road equipment sector. AEM's member companies estimate that this effort would require a complete re-direction of all engineering resources within each member company to accomplish this task alone. Global engineering resources are extremely limited, with almost all companies facing severe staffing and human resource challenges. As such, off-road equipment manufacturers will need significant additional resources and time to address the qualification requirements for PFAS-free components, due to the fact that any individual company is highly unlikely to have the resources on hand to accomplish this task. This type of activity will impact all other R&D projects and other internal development programs. It is likely that all these activities would pause in order to focus enough resource on PFAS qualification activities. If no exemption were granted, it is highly likely that all product sales, manufacturing activities, and service actions in the state of Minnesota would stop until suitable alternatives are identified, tested, designed, and qualified.

Off-Road Equipment PFAS Replacement Timeline

Off-road equipment operates in some of the most demanding and severe environments over a product life cycle measured in decades. The equipment are highly complex pieces of machinery requiring each manufacturer to undertake component and system level qualifications to ensure the necessary performance characteristics are met.

Working under these design requirements, and the assumptions listed in the previous section, AEM member companies estimate that replacing a manageable number of PFAS substances at one time would take at least 15 years for new equipment and 30 years for replacement parts and components. This estimate assumes the timeline starts at the date at which an alternative has been identified to ensure the OEM can maintain the systems in the machine which safeguard the operator, maintenance personnel, the worksite, and the environment.

These product re-design and validation assumptions have precedence in other chemical management and environmental rulemakings. In their recently published, *Decabromodiphenyl ether and Phenol, Isopropylated Phosphate (3:1); Revision to the Regulation of Persistent, bioaccumulative, and toxic Chemicals Under the Toxic Substances Control act (TSCA)*[5] proposed rule, EPA granted the off-road equipment industry, along with other similar industries, a 15 year transition period for new equipment and 30 year transition period for replacement parts for a single chemical substance; Phenol, Isopropylated Phosphate (3:1) (PIP 3:1). Furthermore, during engine emission rulemakings[6], which focus only on the engine and aftertreatment system redesigns, regulators like EPA, California Air Resource Board (CARB), and the EU Commission provide a 7-13 year transition (depending on the power category) to produce new certified engines. While these two rules are different from the requirements promulgated in Amara's Law (HF2310), the reality is that these two other rules are simpler to comply with and grant the off-road equipment industry extended timelines to implement the design changes needed to meet the requirements of the law.

<u>Criteria for Establishing Timelines for Unavoidable Use Determinations:</u>

The off-road equipment industry provides a useful case study in adopting a cautious approach to establish unavoidable use determination timelines. Off-road machines are large, highly complex products, with specific design requirements, and extremely long supply chains, making large scale design changes impossible to implement in short periods of time. If a suitable alternative exists, it is unlikely that all industries require the same timeline to transition their products away from the use of PFAS. Assuming this is true, it is important to establish certain criteria for determining a timeline.

Speaking on behalf of off-road equipment, MCPA should grant a current unavoidable use determination when there are no PFAS alternatives that are technically suitable, economically feasible, commercially available, legally compliant, and safe. We understand that overtime these conditions may change and will require careful consideration on behalf of industry stakeholders to determine what an appropriate timeline looks like. That said, AEM strongly believes that the any PFAS alternative must satisfy these listed criteria prior to ending a current unavoidable use determination:

- Technically suitable: The PFAS alternative meets or exceeds the technical properties associated with the PFAS equivalent. This ensures that any replacement material provides the safety, quality, durability, and performance characteristics needed for the machine to operate successfully. If the new substance does not meet these technical requirements, the machine is likely to experience elevated safety risks, performance failures, premature obsolescence, and increased waste.

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[5] https://www.federalregister.gov/documents/2023/11/24/2023-25714/decabromodiphenyl-ether-and-phenol-isopropylated-phosphate-31-revision-to-the-regulation-of

[6] https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-control-emissions-air-pollution-nonroad

- Economically Feasible: The PFAS alternative is reasonably priced. If the new alternative is too expensive, the increase in price will threaten the long-term viability of the entire construction, agricultural, mining, utility, and forestry industry.
- Commercially Available: The PFAS alternative is available for purchase at scale. When developing new substances, chemical manufacturers and material processors require time to commercialize these products and distribute enough material for use throughout the global supply chain. OEMs, in turn, require their own time to test and validate new materials prior to adoption.
- Legally Compliant: The PFAS alternative is legally compliant with domestic and international law. Many components in off-road equipment are regulated under other regulatory frameworks. For instance, emissions-related components cannot be altered without notifying and, in many cases, re-certifying the engine with EPA, CARB, the EU, and other regulators. This process takes a substantial amount of time and resources to complete.
- Safe: The PFAS alternative is safe for handling, storage, manufacturing, and use. If the new material does not meet this requirement, it should not be used in the marketplace. This requires extra time and resources to prove.

Off-road equipment manufacturers produce machines to meet a host of different requirements. These include safety, regulatory, environmental, and customer requirements. Validating new components, parts, and systems takes time and cannot be accelerated without sacrificing important features. To achieve a successful outcome and with safe and durable results, a change of this magnitude should be validated and substantiated on an industry level. Other industries operate under similar types of demands. Therefore, it is crucial to keep these criteria in mind when establishing unavoidable use determination timelines.

6. **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?**

The off-road equipment industry manufactures safe equipment using consensus safety standards with decades of experience using components and materials that satisfy well-tried safety principles. Companies in these sectors will innovate and differentiate themselves on performance, efficiency, functionality, and a host of other features, but prefer to move together when it comes to safety. Therefore, to maximize worker safety and avoid largescale market disruptions, it is important that current unavoidable use determinations apply to the industry as a whole and consider industry wide acceptance and approval of potential PFAS alternatives, rather than on a company-by-company basis. This process will mitigate safety risks on the workplace and guarantee a smoother transition when viable PFAS alternatives are identified.

7. **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.**

AEM represents off-road equipment manufacturers and suppliers with more than 1,000 member companies and over 200 product lines in the construction, agriculture, mining, forestry, and utility industries. Off-road equipment encompasses a large variety of products and product types. While many of these products use similar components, parts and systems, their intended function and use cases may differ substantially between equipment types; requiring a more complete definition to fully encompass the off-road sector. Generally, off-road equipment includes the following types of machines:

- Mobile off-road equipment,
- Large scale fixed installation,
- Large scale stationary industrial tools,
- Alternative power applications, and
- Attachments and implements.

The definitions of each of these categories are as follows:

- Off-road mobile machine: any mobile machine, item of transportable industrial equipment, or vehicle with or without bodywork or wheels which:
    - Is not intended for carrying passengers or goods on the road,
    - Includes machinery installed on the chassis of vehicles intended for the transport of passengers or goods on the roads,
    - Installed with a combustion engine – either an internal spark ignition (SI) engine, or a compression ignition diesel engine,

- Large Scale Fixed installations: cover a combination of several types of machines which include, but are not limited to, tower cranes, light towers, crushers, and screeners:

    - A combination of several types of apparatus and, where applicable, other devices;
    - Assembled, installed and de-installed by professionals;
    - With the intention to be used permanently in a pre-defined and dedicated location;
    - And it has to be large-scale.

- Large scale stationary industrial tools: include, but are not limited to, cranes and blow-out preventers.

    - An assembly of machines, equipment and/or components, functioning together for a specific application;
    - Permanently installed and de-installed by professionals at a given place;
    - Used and maintained by professionals in an industrial manufacturing facility or R&D facility;
    - And it has to be large-scale.

- Alternative power applications: Products intended to power off-road equipment, such as batteries, battery packs, and recharge equipment.

- Attachments & implements associated with the above equipment (i.e., towed mowers, sprayers, buckets, forks)

PFAS Use Cases in Off-Road Equipment

The off-road equipment industry, defined by its diverse end-use applications, harsh working environments, and extremely long product lifecycles, demands unique material solutions to meet the safety, environmental and performance requirements of the marketplace. Future regulatory, customer, and societal pressures will continue to push this sector to develop and adopt new technologies to tackle global policy concerns, especially issues around climate change, engine emissions, circular economy concepts, enhanced recycling, energy usage, and sustainable supply chain issues. This complex mixture of impending market conditions requires industry access to distinctive material chemistries to accomplish these goals. Due to their highly specialized and unique properties, PFAS chemicals help provide a critical building block for OEMs to meet these objectives. While some industries may find alternatives to specific PFAS applications with sufficient research and development, there are many critical uses which cannot be replaced. Broad restrictions on PFAS will damage product innovation and could render future technology development goals impossible to achieve.

PFAS Essential Use Cases

Manufacturers design their products to operate for decades under extremely harsh, demanding and arduous work environments. Equipment materials, parts, and components need to meet rigorous design and testing requirements to ensure critical product functions continue to operate safely and effectively on the jobsite. With their many useful chemical and physical traits, PFAS provide crucial characteristics necessary to meet various equipment design challenges.

- Seals: All off-road machines use fluids to ensure the equipment continues to perform their intended functions. Fluid applications include hydraulic fluid, oil, fuel, refrigerants, coolant, among others. Sealing technology, such as O-rings and gaskets, prevents fluid leaks and ensures water, dirt, dust, and debris stays out of the equipment.

  Properly designed seals must meet various design characteristics to ensure they operate in a reliable, continuous, and efficient manner. The mechanical functions inside a off-road vehicle exposes parts and components to various stressors:

  - Pressure - various systems, such as the hydraulic and engine systems, experience extreme pressure environments up to 500 bar.
  - Temperature - the engine compartment and exhaust system operate at temperatures as high as 800 °C.
  - Chemical - seals interact with various fluids, requiring a high degree of chemical and corrosion resistance to ensure the continued operation of exposed parts.
  - Mechanical – machines possess a high degree of mechanical wear and tear, sealing parts must survive the shear forces due to the mechanical movement of the equipment.

  PFAS are the only chemical family known to provide the combination of thermal stability, chemical resistance, low frictional characteristics, and sealing capabilities required to operate in this harsh machine environment. Several PFAS chemicals, known broadly as fluoropolymers, which include Polytetrafluoroethylene (PTFE), Fluoroelastomer (Viton), and Polyvinylidene fluoride (PVDF) possess many of these crucial chemical traits and have no known substitutes, making them irreplaceable for the heavy equipment off-road industry.
  Replacing PFAS with inappropriate material substitutes would compromise the functionality of corresponding parts and components, ensuring increasing failure rates, fluid leaks, safety issues, and shorter vehicle lifetimes.

- Hoses: Similar to seals, hoses are required to transport fluids from one location to another, prevent fluid leaks, and maintain the cleanliness of the equipment's components and systems. Many hoses in the off-road industry use fluoropolymers to safeguard the durability of the machine by protecting its components from various internal pressure, temperature, and chemical stressors.

  Under these conditions fluoropolymer lined hoses, especially those with PTFE, provide a necessary level of protection to ensure the durability and long-term reliability of the component. There are no known viable alternatives for PTFE used in hoses. Alternatives, such as rubber hoses, provide less durability, as well as decreased flexibility and strength over time. Inappropriate alternatives will result in increasing fluid leaks, damage to the machine, loss of fluid power, and increasing safety risks for the operator.

- PTFE Tape: Over the operational lifetime of a machine, leaks will inevitably occur. Operators looking to fix fluid leaks from seals and hoses require the appropriate materials to withstand the normal operating conditions found inside off-road equipment. PTFE tape provides this level of assurance.

- Hydraulic Fluid: Hydraulic fluid enables the transfer of power from the engine to end-use hydraulic systems. The vast majority of off-road equipment rely on hydraulic systems to carry, push, dig or lift heavy loads. Without this important technology, much of the work performed today would require radically different, and less efficient, technology solutions. Prominent examples of machines and systems that use hydraulic power include excavators, cranes, forklifts, lifts, dozers, graders, loaders, shovels, trenchers, and concrete pumping systems, among others.

  Hydraulic fluids must possess a variety of crucial properties to protect the longevity of the hydraulic system and its components. In turn, the durability of these systems helps ensure that the machine continues to operate in a safe and efficient manner. Pin hole leaks, sudden drops in pressure, or contamination of the fluid can all cause serious safety issues for the operator or maintenance team. To avoid these types of safety concerns, hydraulic fluid producers utilize certain PFAS based chemicals to provide the corrosion, chemical, temperature and wear resistance needed for the system to operate smoothly.

- Refrigerants: Temperature management is a crucial product design requirement in the off-road sector. Many machines have enclosed operator cabins near large diesel engine exhaust systems, with few options for ventilation due to environmental concerns. Ensuring equipment operators remain comfortable while working is an important safety and comfort feature needed in modern machines.

  Ideal refrigerants need to possess off-corrosive and off-toxic characteristics with a low global warming potential (GWP), zero ozone depleting potential (ODP) and a low boiling point. Most widely adopted refrigerants, such as hydrofluorocarbons (HFCs), hydrofluoro-olefins (HFOs), and hydrochlorofluoroolefins (HCFO's) are used extensively in the automotive, aerospace, and off-road sectors. These substances break down quickly in the atmosphere into substances that naturally occur in the environment. Unlike most PFAS chemicals of concern, which may last thousands of years without breaking down, most modern refrigerants have an atmospheric lifetime measured in days, months and in some cases years.

  Due to the inconsistencies in defining what is, and what is not, a PFAS chemical, refrigerants sometimes find themselves included with this larger group. Refrigerants, such as HFC-134a and HFO-1234yf, may find themselves in scope of certain PFAS regulatory requirements despite possessing none of the chemical attributes or risk profiles which make PFAS a concern to policymakers. An accurate assessment of these substances using scientifically accurate definitions would help exclude them from the broader definition of a PFAS seen in recent legislative and regulatory actions.

- Paints: Coatings protect off-road equipment from chemical, weather, or water erosion. Well-designed coatings can help extend the useful life, and maintenance requirements, for off-road products, and are highly valued by OEM's and their customers. Many coating providers use PFAS in their paints to improve the flow, spread, and glossiness of the coating, as well as to decrease bubbling and peeling. They are also used in specialty paints to give stain-resistant, graffiti-proof, and water-repellent properties.

- Alternative Power: Policymakers have long sought to reduce the emissions of criteria pollutants and decarbonize the off-road sector. OEMs and engine manufacturers are looking at many new alternative power sources and technology solutions to meet their ESG goals. While the industry will continue to innovate and experiment in this space, it is clear that PFAS chemistries will play a crucial role in many of these future developments. Two of the most widely discussed technology solutions, batteries, and hydrogen fuel cells, use PFAS to fulfill crucial functionality.

    - Batteries utilize chemical binders to hold the internal active materials together to maintain a strong contact between the electrodes and the current collectors. Battery manufacturers use Polyvinylidene Fluoride (PVDF) as a binder in lithium-ion batteries due to its electrochemical and thermal stability, as well as its acceptable binding properties for the cathode. Additionally, certain fluorinated compounds are also used to coat the anodes to prevent unwanted reactions with the electrolyte. Due to their long lasting and chemical stable properties, the fluorinated compounds help extend the useful life of the battery.

      Under standard industry practices, batteries are manufactured in clean-room conditions, preventing the release of any PVDF into the surrounding environment. These closed conditions make it impossible for any PFAS materials to escape. Furthermore, battery recycling operations recover the PVDF through hydrometallurgical treatment processes. The collected PVDF is further broken down and captured by gas scrubbers, preventing any further release.

    - Hydrogen fuel cells use a proton exchange membrane (PEM) to separate the anode and the cathode. The PEM uses fluoropolymers to separate the protons from the electrons at the membrane surface, allowing only the protons to permeate to the cathode. In this technology, the fluoropolymers provide crucial properties that enable the fuel cell to produce electricity. The fluoropolymers used in the fuel cell PEM have no known alternative replacement.

Other examples: fire retardants, electrical insulation (Equipment), personal protection equipment including gloves/shielding/aprons (e.g. Nitrile, Viton)

Based on the critical benefit of the off-road equipment industry to society, the complex nature of these machines and their supply chains, as well as the fact that PFAS provides crucial safety functions and has no known alternatives, AEM recommends MPCA grant off-road equipment a current unavoidable use determination.

8. Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria.

AEM supports the criteria outlined in this comment when considering current unavoidable use determinations as well as the criteria needed to establish realistic timelines for these classifications. Assuming these criteria are adopted and used by MPCA when making their determinations, AEM supports making some initial current unavoidable use determinations as part of this rulemaking.

AEM appreciates your consideration of these comments.

Please feel free to contact me at Jmalcore@aem.org if you have any questions or require any further information.

Best Regards,

Jason Malcore
Senior Director, Safety & Product Leadership
Association of Equipment Manufacturers (AEM)

RECEIVED
By: OAH on 3/1/2024
Lori Austino Attachment

Minnesota Rulemaking for Unavoidable Uses

Submission by DuPont de Nemours, Inc.[1]

March 1, 2024

The following comments are respectfully submitted to MPCA by DuPont de Nemours, Inc.[1] for consideration to support the adoption of rules necessary to implement the entirety of Minnesota Session Law – 2023, chapter 60, article 3, section 21 for currently unavoidable use definition and the determination process.

MPCA Question 1 - Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Response to MCPA question 1 - Yes, there should be criteria for determining "essential for health, safety and functioning of society". Determining criteria for uses that are essential to the health, safety and functioning of society can also help to prevent unintended consequences or regrettable substitutions that may negatively impact society and the environment. The criteria for determining "essential" PFAS should include two key criteria 1) "where alternatives do not exist" and 2) "necessary for the health, safety and functioning of society".

For criterion one, the onus of proof should lie with industry (manufacturers and downstream users) to demonstrate why alternatives do not exist or where the use of PFAS is currently unavoidable. Condition of use where alternatives do not exist should be defined by comparing the physical and chemical attributes of the PFAS directly to the attributes of non-PFAS alternatives. Industry should also be required to demonstrate why the PFAS used in unavoidable uses can be manufactured responsibly, used safely, disposed of properly such that they are safe for human health and the environment relative to the alternatives. Specific physical attributes should also be directly connected to how the need for that attribute supports the health, safety, and critical functioning of society. For example, the superior chemical inertness of PFAS compared to other materials leads to its selection for prevention of corrosion, prevention of leaks of hazardous materials, and avoidance of unwanted chemical reactions. Such events can adversely impact high-purity manufacturing and can lead to explosions, exposures, or toxic contamination.

PFAS uses where alternatives could lead to significant unintended consequences include military defense systems, chemical manufacturing, hazardous chemical storage and transport, production of hydrogen, aerospace fuel systems, semiconductor manufacturing, and pharmaceutical manufacturing. PFAS are also selected for superior high and low temperature performance, whereby certain PFAS have operational temperature ranges far higher, far lower, and far broader than any other alternative materials. These essential uses where temperature is a key factor for safe operation avoid catastrophic failures or limitations in equipment used in military, satellites, ocean navigation, aerospace, communication systems and medical applications supporting the critical functioning of society. The manufacturer and down-stream user collectively can most effectively demonstrate why alternatives are not equivalent, what unintended consequences of substitution may exist and the associated societal benefits.

Such physical properties that cannot be matched by alternatives must also be directly connected to the second necessary criterion: essential for the safety, health, and critical functioning of society. Uses or "use-segments" that are necessary for the health, safety and critical functioning of society should be very carefully defined in the implementation phase of the law. Defining and supporting exemptions for unavoidable uses of PFAS in the rule making phase can support avoiding unintended consequences (failures, exposures, explosions, leaks, etc.), supply

[1] DuPont de Nemours, Inc. includes, and refers to, its fully owned subsidiaries.

chain disruptions, stagnation of economic growth, and slowing or reversing advances in technologies that support sustainability, reducing the impacts of global warming and the reduction of greenhouse gas emissions. Defining and supporting exemptions for unavoidable uses of PFAS in the rule making phase also helps to minimize actions that do not materially protect human health and the environment and reduce the potential for negative impacts to the health, safety, and critical functioning of society due to regrettable substitutions or unintended consequences.

While MPCA will need to obtain broad input and carefully consider necessary use-segments, the following currently unavoidable, general uses that support significant societal benefits are provided below as a starting point:

- Medical applications, pharmaceutical precursors, medical devices, and equipment that is deemed necessary to protect society from disease, etc. (consider consulting pharma, medical device manufacturers, or healthcare workers)
- Military uses/applications (see DoD report[2]) or consult the military or military equipment manufacturers)
- F-Gases where alternatives do not exist, F-gases (particularly low global warming potential F-Gases) where they protect society, our food system and communication systems from the effects of global warming, including advances in technologies such as the use of fluorinated polymers in HVAC systems to improve energy efficiency and protect critical infrastructure and data storage systems.
- F-Gases used as foam insulating agents (also known as blowing agents) where alternatives do not exist. Such materials contribute to energy efficiency via their unmatched foam expansion, air sealing and thermal insulating properties and work to protect society, our food and pharmaceutical supply, critical infrastructure, and decarbonize the buildings in which we live and work.
- PFAS used to support the safety and critical functioning of chemical manufacturing and the storage of essential hazardous, corrosive, or explosive substances
- PFAS used to support the safety and critical functioning of transport vehicles (train, planes, automotive, ocean-going vessels, and other passenger and cargo transport vehicles)
- Navigation, communication, and defensive safety systems
- PFAS including fluoropolymers and fluoroelastomers necessary for Semiconductor manufacturing– please see https://www.semiconductors.org/pfas/ for more information
- Lubrication systems and sealing systems operating under harsh conditions where alternatives do not exist
- Municipal, industrial, and agricultural water and wastewater treatment systems that utilize unique polymeric PFAS to improve water security and efficient recycle and reuse
- Analytical standards, analytical testing equipment, monitoring systems required for critical measurements, detection, signaling and safety monitoring
- Energy exploration, conservation, research and harvesting including hydrogen, Solar, wind, oil, hydroelectric and gas where recovery occurs under harsh conditions, or the asset lifetime is critical to the economic feasibility of the alternative energy technology.
- PFAS used to support reducing the impacts of climate change, conservation of natural resources and the realization of the UN strategic development goals which include reducing global warming, energy conservation, protection biological diversity

It is also important to note that the “unavoidable” uses of PFAS in the list proposed above support uses with significant societal benefit and are produced in industries with regulatory compliance and waste disposal obligations. These uses do not contribute to widespread human or environmental exposure because PFAS are used sparingly only where alternatives do not exist, are manufactured, and used in controlled industrial settings, and are disposed of in ways that do not contribute to environmental contamination (consumed and converted, incinerated, disposed

[2] Critical Per- and Polyfluoroalkyl substances Pursuant to Section 347 of the James M Inhofe National Defense Authorization Action for Fiscal Year 2023 (Public Law 117-263), August 2023

of in hazardous waste landfills or recycled). If these use-segments or uses of PFAS are deemed unavoidable uses, the entire supply chain including the production of raw materials needs to be considered as exempted.

MPCA Question 2 - Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Response to MPCA Question 2 – Yes, the cost of alternatives should be considered in determining the definition of "reasonably available".. For applications supporting safety and critical functioning of society, PFAS are typically more expensive than most alternatives and are therefore usually only used when alternatives do not meet very specific critical property attributes. PFAS are chosen for their performance attributes, not because they are more affordable; therefore, the cost of alternatives is already a consideration in the use of PFAS. In Europe as part of the ECHA PFAS Restriction Proposal, costs associated with converting to alternatives where alternatives exist (including lengthy product re-qualifications) are considered and are used to support derogation (transition) periods. Additionally, down-stream users who can convert to alternatives will also need to account for the costs of unintended consequences that may result from converting from PFAS to non-PFAS alternatives. These costs and unintended consequences may include unplanned releases or worker exposures, the need for additional redundant systems, higher potential for explosions, increased safety requirements, higher operating costs, increased down time, reduced maintenance intervals, reduced product lifetime, abandonment of capital assets (to costly to retrofit), increased maintenance costs, lack of spare parts for long service equipment, unplanned systems specification changes and resultant practices, and supply chain disruptions. The cost of a PFAS alternative could negatively impact both the ability of users to manufacture their products and the cost of the final product in commerce, pricing alternative materials and products too high for their critical uses which are essential for health, safety, or the functioning of society. As is standard in commerce, newly invented compounds come at a high premium to industry, placing them out of reach for some end uses. It will be important for the cost threshold of an alternative to be considered in relation to the specific end use category. The definition of a "reasonable" cost threshold is dominated by the specific end use, requirements for performance and the complexity of infrastructure impacts and therefore is difficult to specify. It should be noted that it took nearly 7 decades, until 2021 to finally phase out of leaded gasoline (one product) globally after determining it was a health and environmental hazard in the 1950s.

MPCA question 3 - Should unique considerations be made for small businesses with regards to economic feasibility?

Response to MPCA question 3 – In short, yes. Small businesses may be disproportionately impacted by PFAS restrictions. Other states have recognized this (see small business exemption under Maine PFAS Q&A - https://www.maine.gov/dep/spills/topics/pfas/PFAS-products/). If testing is required for verification, small businesses may not have the financial means to pay for testing. Because testing is complex and because external laboratories capable of testing are limited, testing costs for even large companies is challenging. Additionally, if small toll manufacturers have a mix of PFAS and non-PFAS tolling operations, or if their processing equipment relies on hardware that uses PFAS, needing to replace capital or losing the PFAS tolling portion of their operation could cause their operation to no longer be viable.

MPCA question 4 - What criteria should be used to determine the safety of potential PFAS alternatives?

Response to MPCA question 4 -

The safety of non-PFAS alternatives should be directly compared to the safety of the PFAS under evaluation for substitution. Avoidance of regrettable substitutions is a common practice in industrial product stewardship and process safety management procedures. The key is ensuring that toxicology and exposure data exists under the use and disposal conditions and that the full lifecycle impacts are considered. It is important to ensure that the alternative is not a regrettable substitution.

One example of a regrettable substitution would be substituting an alternative in place of a PFAS polymer that is considered a "Polymer of Low Concern"[3] [4] by scientists and coined as "safe and essential" by the Plastics Europe FluoroPolymers Group (FPG). While persistent (they are designed to be durable and sustainable), they are not considered toxic, mobile, biologically available or bioaccumulative. Replacing a fluoropolymer or fluoro-elastomer with a non-PFAS alternative could therefore be a regrettable substitution. For example, polyvinylidene difluoride (PVDF -a polymer used in many medical applications and in water treatment) and FFKM (a perfluoro-elastomer used in harsh conditions, including sealing applications involving hazardous substances) both belong to the class of high molecular weight fluoropolymers/fluoro-elastomers that are considered polymers of low concern. In just these two examples, fluoropolymers/fluoro-elastomers are safer compared to non-PFAS alternatives because they are more chemically inert. I f additional information is needed for the MPCA to consider exempting fluoropolymers and fluoroelastomers based on essentiality and safety, industry and various associations (ACC, CEFIC, PlasticsEurope - FPG and other trade organizations representing the auto industry and semiconductor manufacturing) can provide numerous reports and evidence to suggest that in essential use applications, fluoropolymer and fluoro-elastomers are safe compared to non-PFAS alternatives as they are essentially inert, non-toxic, not mobile, not biologically available and do not bioaccumulate.

Another example are fluorinated gases (F-gases) hydrofluoroolefins and hydrochlorofluoroolefins, generally referred to as HFOs, that are used in specialty foams including extruded polystyrene board stock (XPS) and low-pressure spray polyurethane foam (LP SPF) insulation and sealants. HFOs are safer alternatives to high global warming potential hydrofluorocarbons (HFCs) and are safer than highly flammable hydrocarbons. XPS and LP SPF foam technologies have recently transitioned to HFOs as required by various state, federal (e.g., US AIM Act), and international air regulations (e.g., greenhouse gas and/or global warming regulations). HFO chemistries have unsaturated carbon bonds and only one fully fluorinated carbon with estimated environmental half-lives on the order of just a few days and have not been found in drinking water sources or food. These gases and volatile liquids have extensive chemical-specific toxicological profiles and safety assessments available and are not considered toxic or bioaccumulative. HFOs are a key component of insulating and sealing foams, which have specific unique properties to meet numerous end-use requirements. There are no technically- proven, safer alternatives to HFOs in XPS or LP SPF foams.

MPCA question 5 - How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

Response to MPCA question 5 - Unavoidable use determinations should remain in place until safer and more sustainable alternatives are discovered/identified and can be implemented. Significant changes in available information about alternatives or new scientific data should trigger a re-evaluation. Alternatively, re-evaluation could be time based. For example, Minnesota could consider re-evaluation of CUU 10 years after implementation. A third possibility would be to require industry to notify the MCPA when alternatives are found. Most product development timelines for applications supporting the safety, health and critical functioning of society are on a minimum 10-year development timeline, many are even significantly longer.

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[3] Henry, B. J., et al. (2018). "A critical review of the application of polymer of low concern and regulatory criteria to fluoropolymers." Integr Environ Assess Manag 14(3): 316-334.

[4] Korzeniowski, S. H., et al. (2022). "A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers." Integr Environ Assess Manag.

MPCA question 6 - How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

Response to MPCA question 6 - Yes, stakeholders (manufacturers, industry users and downstream users) should be accountable (burden of proof) to request an unavoidable uses determination. However, this may put a significant initial and ongoing burden on MPCA. MPCA could choose to describe/include unavoidable use determinations by segment in the implementation phase of the law. If that is not acceptable to MPCA, MPCA would need to set up a request system/program for companies to request an unavoidable use determination. MPCA would also then need to identify subject matter experts to review and approve unavoidable uses on an ongoing basis.

Including unavoidable use determinations (as exemptions) in the implementation phase with a provision to re-evaluate after some period of time or as new data becomes available is likely a more manageable alternative for industry and MPCA. MPCA also needs to consider how to protect confidential and/or proprietary information.

The second question in 6, includes the following question, "Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable?" Stakeholders should only be allowed to request a use that is currently avoidable. Unavoidable uses should only be able to be requested by a user or manufacturer within the same product category because they would have the ability to provide substantiating evidence and data to support the request. In this case, the unintended consequences would still need to be thoroughly examined by the MCPA committee before making an informed decision.

The answer to the third question in 6, "What information should be submitted in support of such requests?", will be highly dependent upon the PFAS and category of use. In general, information should be quantitative and include documented research and performance data for the PFAS and alternatives. This information should not only include technical feasibility at a market scale, but also the relative cost of the alternative, impact to the final product cost to the consumer and confirmation that the PFAS used to make or in the product supports the safety, health, and critical functioning of society. Please note, in order to request information to "make a determination", MCPA will need a process to handle what is likely to be considered confidential and/or proprietary information.

MPCA question 7 - In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

Response to MPCA question 7 - The following information includes 7 examples of what may be considered by MPCA to support a determination of unavoidable use.

Unavoidable Use example 1: PFAS used in <u>Photolithography in Semiconductor Manufacturing</u>

DuPont's photolithography business urges the state to review the information at https://www.semiconductors.org/pfas/ which documents essential use of PFAS substances within the semiconductor industry. In short, all applications in the semiconductor industry where PFAS are currently used will likely be submitted for currently unavoidable use determinations by us and/or other participants in the semiconductor manufacturing industry.

Unavoidable Use example 2: PFAS used in <u>specialty lubricants (including dry film lubricants) and greases used under harsh conditions</u>

The use of PFAS polymers in lubricants (including dry film lubricants) and greases, used under harsh conditions where alternatives do not exist, in the following industries should be considered unavoidable uses: transportation (aviation, automotive, ocean-going vessels, rail transport), defense and military, electrical power generation and distribution, medical equipment, energy recovery and harvesting (natural gas, hydrogen, oil, wind, hydroelectric), electrical systems (lubrication of high voltage circuit breakers), and in the petrochemical nuclear, and chemical industries. These are unavoidable uses because alternatives do not perform at very high temperatures, very low temperatures, simultaneously over a wide range in temperatures, are not chemically inert, and/or may not be compatible with or able to lubricate plastics or composite materials use for lightweighting EVs.

The use of alternatives that cannot meet very specific key physical attributes may lead to unintended consequences like cross contamination from additives that are not inert or more hazardous, increase corrosion rates, unexpected catastrophic failures, increased lubrication and maintenance cycles, increase equipment down time, increased maintenance or parts replacement costs, fires or explosions, generation or release of hazardous substances (decomposition products) or limiting operability of existing equipment supporting safe operation of equipment designed to support the safety, health and critical functioning of society. High and low temperature performance, oxidative stability and inertness of fluorinated lubricants is needed across multiple industries which include, but are not limited to, aerospace, space shuttles, medical cryogenics, etc.) whereby inertness and oxidative stability also prevents contamination in high purity manufacturing such as food processing, pharmaceutical manufacturing, power generation or where corrosion inhibition can prevent explosions, fires, or release of toxic byproducts.

Unavoidable use example 3: the use of polymeric PFAS in <u>wire insultation materials</u> used for transport (rail, aerospace, military) and oil extraction equipment operating under harsh conditions

The use of polymeric PFAS such as polytetrafluoroethylene - PTFE (CAS 9002-84-0), fluorinated ethylene propylene – FEP (CAS 25067-11-2) and perfluroalkoxy alkane – PFA (CAS 26655-00-5) that are used in specialty wiring materials in applications in aerospace, military, transport, and downhole pump wire insulation where alternatives do not exist, should be considered unavoidable uses.

A combination of properties afforded by these wiring insulation materials in powertrain applications in rail, aerospace, military, and extraction equipment is essential due to the challenging operating conditions. For aerospace applications, wires are specified according to heat resistance and voltage rating as described in standards such as Standard SAE AS4372C[5]. Other critical properties include arc resistance, flame resistance, low smoke emission, and a 30+ year service life to name a few. The essential requirements for wiring used in rail transport powertrain applications are high continuous operating temperature, broad chemical resistance, low moisture uptake, corona resistance and a 20+ year service life. Arc tracking is the ability for electrical discharges to scorch the insulating material and leave an electrically conductive carbon deposit. This phenomenon is avoided with these PFAS materials.

Such defects have been implicated in air disasters that have resulted in heavy loss of life[6]. Therefore, high resistance to arc tracking, as measured and required by standard IEC 60112:2020, is an essential property offered by these PFAS materials. All civil and military aircraft utilize polymeric PFAS extensively in their design. To put this into perspective, one large aircraft may contain approximately 300 miles of wires and cables, in around 100,000 individual

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[5] "Performance Requirements for Wire, Electric, Insulated Copper or Copper Alloy" Standard SAE AS4372C published by SAE International (2019) available at https://www.sae.org/standards/content/as4372c/

[6] "Air transportation safety investigation report A98H0003" by the Transportation Safety Board of Canada https://www.tsb.gc.ca/eng/rapports-reports/aviation/1998/a98h0003/a98h0003.pdf accessed 2 June 2023

cable lengths[7]. If this use of PFAS was not considered an unavoidable use, current aircraft could not be serviced or repaired and would need to come out of service. Re-qualifying this quantity of components for all designs of commercial aircraft would be an incredible undertaking. A socioeconomic assessment outlining the air transport industry, although not directly created to look specifically at the impacts of PFAS, provides an appreciation of the breadth of industries and economic sectors that would be profoundly impacted by disruptions to air transport[8] [9].

Powertrain applications in rail and extraction also require >200°C service capability. The insulation must also be robust and resistant to corrosive materials such as oils and cooling fluids due to the challenging operating environment. Reliability is essential since downtime and repair is disproportionately expensive in these specific applications. Rail motor technology continues to move towards higher operating voltages and switching speeds which enables greater power handling for faster and more efficient train control[10] but requires wire insulation which must withstand corona discharge degradation. To ensure that motors can continue to operate, the corona resistance of the insulation must be increased by decreasing the dielectric constant of the insulating material which is best afforded by using polymeric PFAS materials[11]. Although there are many designs of motor for different types of rail application (including locomotives, metro vehicles, and high-speed trains) all motors use different combinations of these polymeric PFAS insulting materials.

Unavoidable use example 4: the use of <u>perfluoroelastomer machined/molded parts</u> (O-rings, seals, gaskets, etc.) in aerospace, military/defense, energy recovery and processing (wind, oil, gas, hydrogen, and hydroelectric), semiconductor manufacturing and industrial processing (chemical, pharmaceutical and nuclear)

The use of perfluoroelastomer machined or molded parts (O-rings, gaskets, seals, etc.) used in applications that support the safety and critical functioning of society in industries such as aerospace and military/defense applications, energy recovery and processing (wind, oil, gas, hydrogen, hydroelectric), semiconductor manufacturing and industrial processing (chemical, pharmaceutical and nuclear), operating under harsh conditions, where alternatives do not exist, should be considered as currently unavoidable uses.

Perfluoroelastomers offer a unique combination of superior thermal stability, chemical resistance (inertness), and sealing effectiveness under both static and dynamic conditions that is unmatched by any other alternatives.

Perfluoroelastomer machined/molded parts are used as sealing elements in the form of O-ring or custom seal geometries in various mechanical parts, shaft bearings, bushings, T-Seals, boots, stacks, V-rings, packing systems, valves, pumps, wireline and drilling tools, mechanical seals in rotating equipment (e.g., pumps, mixers), compressors, filters, couplings, spraying heads, cleaning installations, dosing systems, sampling systems, filling equipment,

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[7] "Maintaining profitability under pressure for wire harness manufacturers" by Steve Caravella, white paper published by Siemens, available at https://resources.sw.siemens.com/en-US/white-paper-maintain-aerospace-profitability-through-digitalization

[8] "Air Connectivity" published by IATA (2020) https://www.iata.org/en/iata-repository/publications/economic-reports/air-connectivity-measuring-the-connections-that-drive-economic-growth/ accessed 2 June 2023

[9] "Aviation Benefits: contributing to global economic prosperity" published by ICAO (2018) https://unitingaviation.com/news/economic-development/aviation-benefits-for-a-better-future/ accessed 2 June 2023

[10] "Trends in high-speed railways and the implications on power electronics and power devices" by T. Uzuka 2011 IEEE 23rd International Symposium on Power Semiconductor Devices and ICs, San Diego, CA, USA, 2011, pp. 6-9, doi: 10.1109/ISPSD.2011.5890777

[11] "Review and Trends in Traction Motor Design: Primary and Secondary Insulation Systems" by S. Nategh et al. Proceedings 2018 XIII International Conference on Electrical Machines (ICEM) pp2607-2612 DOI: 10.1109/ICELMACH.2018.8506858

centrifuges, instrumentation (e.g., level gauges, flowmeters, gas analyzers, laboratory equipment), fuel burners, ozonators, bonded door, poppet valves, plasma chambers, isolation valves, wafer handling, viewports, gas line feeds, gas injection, and electrostatic chucks. The versatility of perfluoroelastomer parts allows for customized geometries to meet specific sealing requirements in a diverse range of seal types such as T-seals, packers, S-seals, V-rings, stacks, boots, X-rings, tri-lobes, electrostatic chucks, protective seals, bonded doors, and metal bondings.

Based on thorough analysis of alternatives, including advances of research and investment over the last 20 years by industry, it can be concluded that technically suitable alternatives do not exist in the critical applications described above while providing comparable physical attributes needed for safety and critical functioning of society. Currently available alternatives lack the critical physical attributes noted above and if substituted could lead to critical or even catastrophic failures such as releases of hazardous materials, process contamination and unexpected failures in critical applications. It is also important to note that due to the high cost of manufacturing perfluoroelastomers compared to other potential alternatives, these materials are only used in applications where alternatives do not exist.

Unavoidable use example 5: The use of fluoropolymer composite molded/machined parts and shapes in high performance industrial operating environments where chemical resistance, strength, light-weighting and low coefficient of friction is required

The use of fluoropolymer composite molded/machined parts and shapes in applications that support the safety and critical functioning of society in applications such as, but not limited to, chemical processing, telecommunications, transportation (including aerospace, rail, ocean going vessels, transport vehicles including electric vehicles), semiconductor manufacturing, military and defense, energy harvesting and processing (i.e., hydrogen, oil, hydroelectric and natural gas), and industrial manufacturing, operating under harsh conditions, where alternatives do not exist, should be considered as currently unavoidable uses.

Fluoropolymer composite parts and shapes have durability which allow long service life (entire lifetime of the system) and avoidance of catastrophic failures when operating under harsh conditions. Like other fluoropolymers these fluoropolymer composite materials (molded and machined shapes and parts) demonstrate exceptional temperature resistance, mechanical strength, chemical resistance, and resistance to wear (self-lubricating) unmatched by any alternative. These materials have afforded advances in fuel efficiency in aircraft and automotive vehicles, light-weighting for electric vehicles, and have supported the transformation from a fossil fuel economy into a renewable energy economy (including electric, wind and hydrogen). These fluoropolymer composite materials have unmatched durability and chemical resistance characteristics which are critical for managing chemical emissions in industrial chemical processes from a wide variety of hazardous chemicals for which these materials are compatible. These fluoropolymer composite materials also play a critical role in semiconductor fabrication, both in containing toxic chemical environments and preventing defects in integrated circuits.

Some specific applications include use in aircraft wear strips and track liners for wing frame braking and vibrational wear control in engine nacelles, in high temperature applications that prohibit the use of oil lubrication (threat of fire/combustion), in aircraft bushings operating under high G-forces, in industrial applications including wind energy liners, in spherical bearings for military and defense equipment, in energy recovery operations in oil and gas where valves, pumps, fittings, and seals need to operate under extreme temperature, speed, force and pressure and in semiconductor manufacturing for wafer cleaning and resist stripping where extremely aggressive wet chemical / plasma conditions and elevated temperatures exist.

Based on thorough analysis of alternatives, including advances of research and investment over the last 20 years by industry, it can be concluded that technically suitable alternatives for fluoropolymer composite materials do not exist in the critical applications described. Currently available alternatives lack the needed critical physical attributes and if substituted could lead to critical or even catastrophic and unexpected failures in critical applications. These materials also provide durability to extend the lifetime of critical costly assets and infrastructure. It is also important to note that due to the high cost of manufacturing perfluoropolymer composites compared to other potential alternatives (steel metallic composites, other non-fluorinated plastics), these materials are only used in applications where alternatives do not exist.

Unavoidable Use example 6: The use of PVDF micro- and ultrafiltration membranes in <u>water and wastewater treatment systems</u>

Water treatment membranes made from the fluoropolymer polyvinylidene fluoride (PVDF, [-C2H2F2-] CAS # 24937-79-9) enable domestic, agricultural, and industrial water users to fulfill their progress to practice more sustainable water and wastewater management. Water security and human health improve tremendously when water and wastewater treatment is enabled by fluoropolymer micro- and ultrafiltration (MF/UF) membranes for the removal of bacteria, pathogens, viruses, and suspended molecules/particles. Many socioeconomic analyses related to water and wastewater treatment around the world have been published.[12] [13] [14] [15] [16] [17] [18] These reports emphasize that no society is immune to water's impact. Shortages of safe water and wastewater management can disrupt homes, schools, industry, agriculture, and even public health and safety. Alternatives to PVDF have been studied alongside other polymer types like polysulfone (PS) and polyether sulfone (PES) for making membranes, but due to the combined mechanical robustness, chemical tolerance, and excellent separation properties, after nearly 30 years of research and optimization, 77% of the MF/UF membranes used globally in water and wastewater treatment systems are PVDF based.

Water treatment membranes are federally regulated for safe use by the FDA. PVDF is an approved substance for use as a component of articles intended for repeat use in contact with food (21CFR177.2510).

Unavoidable Use example 7: The use of hydrofluoroolefin HFO-1234ze(E) and hydrochlorofluoroolefin HCFO-1233zd(E) in <u>specialty insulating and sealing foams.</u>

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[12] Gomez, M.; Perdiguero, J.; Sanz, A. "Socioeconomic factors affecting water access in rural areas of low and middle income countries" Water 2019, 11(2), 202;

[13] Kong, Y.-L.; Anis-Syakira, J.; Fun, W.H.; Balqis-Ali, N.Z.; Shakirah, M.S.; Sararaks, S. "Socio-economic factors related to drinking water source and sanitation in Malaysia" Int. J. Environ Res. Public Health 2020, 17, 1799

[14] Dolan, F.; Lamontagne, J.; Link, R.; Hejazi, M.; Reed, P.; Edmonds, J. "Evaluating the economic impact of water scarcity in a changing world" Nature Comm. 2021, 12, 1915; 2023 UN environment programme "Measuring Progress: Water-related ecosystems and the SDGs"

[15] https://www.twdb.texas.gov/waterplanning/data/analysis/doc/2016/FINAL-2016%20Socioeconomic%20Impact%20-%20Region%20K.pdf

[16] Water Pollution Economic Effects: https://www.thebalancemoney.com/water-pollution-effects-causes-and-solutions-4775830#:~:text=of%20this%20pollution . The%20Bottom%20Line,waste%20discharges%2C%20and%20uncontrolled%20runoff

[17] https://www.worldbank.org/en/news/press-release/2019/08/20/worsening-water-quality-reducing-economic-growth-by-a-third-in-some-countries

[18] 2023 UN environment programme "Measuring Progress: Water-related ecosystems and the SDGs "Putting unnecessary technology constraints on the ability to purify water and wastewater should be avoided to insure a more water secure future for generations to come.

DuPont is a downstream user of fluorinated gases ("F-Gases"), in particular hydrofluoroolefins (HFOs) HFO-1234ze(E) and HCFO-1233zd(E) (hereafter referred to as "HFO ze & zd"). This narrow subset of two ultra-low global warming potential HFO compounds are used as foam insulating blowing agents in low-pressure spray polyurethane foam (LP SPF) products and extruded polystyrene board stock (XPS) products. Alternatives to HFO ze & zd do not exist today for these insulating foam blowing agents in LP SPF and XPS. Substantial research spanning over a decade has been done to date to identify alternatives to fluorinated gases in these uses, considering an exhaustive set of options available today and driven by the US AIM Act[19] [20] and subsequent US EPA regulations including the recent Technology Transition[21] regulation[22] and the long standing Significant New Alternatives Program[23] under the amended Clean Air Act of 1990[24], and the Montreal Protocol and its Kigali Amendment[25]. That research has revealed that, different from some other foam insulation technologies, no technology alternatives to HFOs are available today that can meet the requirements of LP SPF and XPS product applications in the U.S.

The LP SPF and XPS sub-use sector represents a relatively small business field in Minnesota with only 1 XPS manufacturing site in Minnesota. Across the US, there are only 5 LP SPF product manufacturers and 3 XPS product manufacturers in total that may sell product into MN. As a result, we expect only a few relevant users or manufacturers of these products will provide comments to MPCA on the use of HFOs in these specialty foams.

The volume of HFO ze & zd foam blowing agents used in the LP SPF and XPS markets are very small. The HFO ze & zd used in this sector are not persistent, not bioaccumulative, and not toxic substances, as demonstrated by the REACH dossiers[26] [27] and many other public documents including the 2023 United Nations Environment Programme (UNEP) report[28]. The HFO ze & zd used in this sub-sector can theoretically break down into trifluoroacetic acid (TFA), which has been classified as a persistent substance, at a theoretical yield of 0% to a maximum of 4%.[29] [30] [31] [32] However, according to a recent United Nations Environmental Effects Assessment Panel (UN EEAP) study conclusion, "TFA does not bioaccumulate nor is it toxic at the low to moderate exposures currently measured in the environment or those predicted in the distant future."[33]. This conclusion is further supported by the REACH persistent, bioaccumulative and toxic PBT assessment of TFA which notes "… it is neither fulfilling the criteria for toxic and

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19 https://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title42-section7675(a)&num=0&edition=prelim

20 https://www.epa.gov/climate-hfcs-reduction/background-hfcs-and-aim-act

21 https://www.epa.gov/climate-hfcs-reduction/technology-transitions

22 https://www.epa.gov/climate-hfcs-reduction/regulatory-actions-technology-transitions

23 https://www.epa.gov/snap/regulations-proposed-rules-and-final-rules-determined-epa

24 https://www.epa.gov/clean-air-act-overview/1990-clean-air-act-amendment-summary

https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-2-f&chapter=27&clang=_en

26 https://echa.europa.eu/de/registration-dossier/-/registered-dossier/31292/2/3

27 https://echa.europa.eu/de/registration-dossier/-/registered-dossier/10762/2/3

28 https://ozone.unep.org/system/files/documents/EEAP-2022-Assessment-Report-May2023.pdf

29 Nilsson, E.J.K., Nielsen, O.J., Johnson, M.S., Hurley, M.D., Wallington, T.J., (2009) Atmospheric chemistry of cis-CF3CH=CHF: Kinetics of reactions with OH radicals and O3 and products of OH radical initiated oxidation. Chemical Physics Letters, 473,233–237. https://doi.org/10.1016/j.cplett.2009.03.076

30 Mads P. Sulbaek Andersen, Johan A. Schmidt, Aleksandra Volkov, Donald J. Wuebbles, A three-dimensional model of the atmospheric chemistry of E and ZCF3CH=CHCl (HCFO-1233(zd) (E/Z)), Atmospheric Environment Volume 179, April 2018, Pages 250-259. Calculates <2% TFA per CF3 molecule. Structural relevance to HFO-1336mzz isomers resulting in <4% TFA

31 Wallington et al (2014): Atmospheric chemistry of sort-chain haloolefins: Photochemical ozone creation potentials (POCPs), global warming potentials (GWPs), and ozone depletion products (ODPs). Chemosphere, 129, pp 135-141.

32 Feiya Qing, Qin Gua, Liang Chen, Hengdao Quan, Junji Mizukado, (2018) Atmospheric Chemistry of E-CF3CH═CHCF3: Atmospheric chemistry of E-CF3CH=CHCF3: Reaction kinetics of OH radicals and products of OH-initiated oxidation, Chem Phys Lett, 706, 93-98

33 https://ozone.unep.org/system/files/documents/EEAP-2022-Assessment-Report-May2023.pdf

bioaccumulative (PBT-substances), nor the criteria for very bioaccumulative substances (very persistent-very bioaccumulative (vPvB) substances according to REACH directive".[34] The emissions of TFA associated with HFO use are not expected to pose an environmental or health concern based on the exposures expected through at least the end of the modeled time range, year 2100, as reported by the UN EEAP.[35]

LP SPF and XPS play a critical role in achieving Minnesota's climate goals; by enabling energy efficiency gains through insulation and air sealing functionality delivered through its application. Manufacturers of different types of insulation products may comment that their products meet some of the unique features of XPS or LP SPF, however there is no drop-in replacement product in the market which meets all unique properties and requirements of the applications. Those other "not-in-kind" insulation products are not alternatives to XPS or LP SPF. XPS and LP SPF products will continue to play a key role in meeting policy objectives under the Minnesota *Next Generation Energy Act of 2007*36 and Minnesota's Climate Action Framework that includes a top 6 goal of "Clean energy and efficient buildings37 38 For example, LP SPF and XPS help enable energy efficiency targets required to meet policy objectives. Since there are no technical alternatives to produce LP SPF and XPS without HFO ze & zd, these solutions would be eliminated from the market at entry into force, thereby compromising the ability of Minnesota to achieve its climate goals. It would also eliminate the LP SPF and XPS solutions from the market and remove these solutions as a tool for reducing greenhouse gas (GHG) emissions in buildings through the improved energy efficiency that LP SPF and XPS deliver. The impacted value chain that would be forced to exit the market includes product formulators, contract manufacturers, distributors, professional users, and end-use sites of the products including commercial buildings such as hospitals and schools in the State.

MPCA question 8 - Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

Response to MPCA question 8 - Yes, as affirmed by the comments provided above in response to questions 1 – 7 above.

MPCA question 9 - Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

Response to MPCA question 9 –

No additional questions or comments.

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[34] https://echa.europa.eu/de/registration-dossier/-/registered-dossier/5203/2/3

[35] https://ozone.unep.org/system/files/documents/EEAP-2022-Assessment-Report-May2023.pdf

[36] https://www.revisor.mn.gov/laws/2007/0/Session+Law/Chapter/136/?keyword_type=exact&keyword=The+Next+Generation+Energy+Act

[37] https://climate.state.mn.us/sites/climate-action/files/Climate%20Action%20Framework.pdf

[38] https://www.pca.state.mn.us/air-water-land-climate/climate-change-initiatives

RECEIVED
By: OAH on 3/1/2024

March 1, 2024
Commissioner Katrina Kessler
Minnesota Pollution Control Agency
% Office of Administrative Hearings
600 North Robert Street
P.O. Box. 64620
St. Paul, MN 55164

RE: *Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS)*
Revisor's ID Number R-4837

Dear Commissioner Kessler,

Minnesota Center for Environmental Advocacy ("MCEA")[1] and CURE[2] appreciate the opportunity to provide comment on the Minnesota Pollution Control Agency's ("MPCA") Request for Comment on the proposed new rules governing currently unavoidable use determinations about products containing per- and polyfluoroalkyl substances ("PFAS").

The purpose of this comment is primarily to respond to MPCA's first, fourth, and fifth questions for consideration identified in the request for comments:

> (1) Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?
>
> (4) What criteria should be used to determine the safety of potential PFAS alternatives?
>
> (5) How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided? Should significant changes in available information about alternatives trigger a re-evaluation?

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[1] MCEA is a Minnesota non-profit organization whose mission is to use the law, science, and research to preserve and protect Minnesota's natural resources, its wildlife, and the health of its people. For over forty years, MCEA has worked with citizens and government decision-makers to protect and improve the quality of Minnesota's environment.
[2] CURE protects and restores resilient communities and landscapes by harnessing the power of people who care about them. We are rural-based, with staff across Minnesota. CURE knows rural people, lands, and ecosystems are vital to helping solve some of the biggest problems faced by Minnesota and the nation.

The final rules MPCA adopts pursuant to this rulemaking must be designed to protect human health. MPCA is well aware that PFAS are harmful in shockingly low concentrations, and that swift and strong action must be taken to prevent additional PFAS loading into Minnesota's landscapes, surface waters, and groundwater. For decades, chemical manufacturers have misled the public and regulators by falsely claiming that PFAS are safe. As a result, PFAS have been added to countless consumer and industrial products and research and development into safe alternatives has lagged.

Industry has reaped enormous profits by manufacturing and adding harmful chemicals to everyday products used by children, pregnant mothers, and vulnerable Minnesotans, deceiving regulators and the public by withholding toxicological information demonstrating the true threat posed by PFAS. This law - Minn. Stat. § 116.943 - must put an end to the practice of putting profit over human health. The Legislature has spoken loudly: Minnesota is closed for business to products containing intentionally-added PFAS. MPCA must uphold this clear legislative directive by ensuring that only those products that are indeed essential are allowed to remain on our shelves. MCEA and CURE offer the following suggestions for how MPCA can ensure exactly that.

A. MPCA Should Employ the Precautionary Principle Throughout This Rulemaking

MPCA should employ a precautionary approach here to protect the health of Minnesotans from PFAS bioaccumulation. A precautionary approach advocates for decisive regulatory action in the face of the unknown extent of health and societal costs of PFAS in our environment and drinking water. The principle states that: "where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."[3] Despite the many decades that PFAS has been used in the United States, the chemical complexity and numerosity of PFAS has resulted in a deficient scientific understanding of PFAS. Of the thousands of known PFAS, the vast majority have not been thoroughly evaluated for toxicity, though all of them appear to have the characteristic of long-lived persistence in the environment.[4]

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[3] Rio Declaration on Environment and Development, UN Conference on Environment and Development, 13 June 1992, Princ. 15, UN Doc. A/CONF.151/6/Rev.1 (1992).

[4] For California regulators' take on why toxicity at low levels plus persistence across all PFAS is a serious concern, see Cal. Env't Prot. Agency, Dep't of Toxic Substances Control, Safer Consumer Prod. Program, *Factsheet on PFASs in Consumer Products: Key Points for Decision Makers* (2023), https://dtsc.ca.gov/wp-content/uploads/sites/31/2023/09/PFAS-Factsheet.pdf [hereinafter "DTSC Fact Sheet"].

The continued use of PFAS will irreversibly raise the level of environmental and human exposure because of PFAS's environmental persistence. The carbon-fluorine bond is one of the strongest known chemical bonds, which makes it very difficult to break down.[5] This characteristic causes PFAS to be resistant to degradation, which means that any additional releases will cause environmental concentrations to increase and remain elevated for the foreseeable future. Raised environmental concentrations increases the probability of the occurrence of already known health effects and other, unknown, risks. The high persistence of PFAS within the environment and our lack of knowledge on the chemical structures, properties, and toxicological profiles of PFAS led over 200 scientists to advocate within the 2015 Madrid Statement that production and use of PFAS should be limited.[6] Unfortunately, since 2015, the quantity and usage of PFAS has only proliferated.

Applying the precautionary principle would lead to the inescapable conclusion that all PFAS use must be rapidly reduced or else irreversible harm will cause unmanageable consequences.[7] The extreme persistence of all PFAS is reason alone to regulate it as a class so as to avoid the chemical industry switching to a new type of PFAS every time an older one is shown to be harmful.[8] If regulation waits until environmental concentrations of PFAS rise and all adverse effects are identified, human and environmental exposure to PFAS and its associated effects will not be easily reversible.

Remediation technologies for PFAS that would clean the entire impacted landscape are prohibitively expensive and experimental and are therefore unlikely to contribute much to lowering PFAS environmental concentrations.[9] These emerging

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[5] Lindsey Konkel, *The P-Sufficient Approach: A strategy for Regulating PFAS as a Class,* 129 ENV'T HEALTH PERSPS. 054002-1, 054002-1-2 (2021), https://ehp.niehs.nih.gov/doi/full/10.1289/ehp9302.

[6] Arlene Blum et al., *The Madrid Statement on Poly- and Perfluoroalkyl Substances (PFASs)*, 123 ENV'T HEALTH PERSPS. A 107, A 107-08 (2015), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4421777/; Ian T. Cousins et al., *The Concept of Essential Use for Determining When Uses of PFASs Can be Phased Out* 21 ENV'T SCI.: PROCESSES & IMPACTS 1803, 1803-15 (2019), https://pubs.rsc.org/en/content/articlelanding/2019/em/c9em00163h.

[7] This is also the position of California's hazardous substances regulators. *See* DTSC Fact Sheet, *supra* note 4.

[8] Simona Andreea Bălan et.al., *Regulating PFAS as a Chemical Class Under the California Safer Consumer Products Program*, 129 ENV'T HEALTH PERSPS. 025001-1, 025001-04 (2021), https://ehp.niehs.nih.gov/doi/epdf/10.1289/EHP7431.

[9] Ian T. Cousins at al., *The Precautionary Principle and Chemicals Management: The Example of Perfluoroalkyl Acids in Groundwater*, 94 ENV'T INT'L 331, 331-40 (2016), https://www.sciencedirect.com/science/article/abs/pii/S0160412016301775?via%3Dihub.

technologies are also ineffective at addressing many types of contamination and do not work at all for some short-chain PFAS.[10] In short, a failure to rapidly reduce PFAS will further externalize cleanup costs and public health harms to the State. Minnesotans should not be forced to pay the tab for continued use of PFAS while manufacturers pass years claiming to be in the process of developing safe alternatives.

A precautionary strategy for PFAS regulation is needed to offset the future costs of PFAS by improving regulatory compliance and reducing the negative consequences of allowing PFAS in essential products long-term. As the scientific understanding of PFAS progresses, we will undoubtedly face wide-scale contamination that will require remediation with technologies that are not yet scalable and affordable. As we work to address this problem, now is not the time to push the financial impacts of PFAS use to future generations. Addressing the problem in a swift and decisive manner, to "turn off the tap" of PFAS entering Minnesota and its environment, will reduce our future PFAS remediation burden and allow time for remediation technology to develop to meet market demands.

B. Thorough Reporting and Examination of all Intentionally Added PFAS is Essential to Determine Whether the Product and PFAS Function are Currently Essential

A robust reporting requirement is vital to determining whether the product and function of PFAS is essential. Therefore, MPCA should resist any efforts to relax reporting requirements. Reporting requirements under Minn. Stat. § 116.943, subd. 2 mandate manufacturers to submit information to the commissioner that includes a description of the product, the purpose of PFAS in the product, and the amount of PFAS.[11] Reporting is required for new products "sold, offered for sale, or distributed in the state" and must be updated when there is significant change to the information or at the request of the commissioner.[12] All products, whether meant for personal, residential, commercial, or industrial use, must be treated the same.[13]

Minnesota requirements are bolstered by updated Environmental Protection Agency ("EPA") Toxic Substances Control Act ("TSCA") rules for PFAS. EPA rulemaking under TSCA Section 8(a)(7) will require most manufacturers and importers to report to EPA by 2025 all PFAS that are known or reasonably ascertainable to be known that have been used in articles since January 1, 2011.[14] The scope of this PFAS reporting requirement includes PFAS identifiable by CAS number as well as those with accession numbers,

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[10] *Id.*
[11] Minn. Stat. § 116.943, subd. 2.
[12] Minn. Stat. § 116.943, subd. 2(c).
[13] Minn. Stat. § 116.943, subd. 1(q).
[14] 15 U.S.C. § 2607(a)(7); 40 C.F.R. pt. 705.

generic names containing "fluor," and confidential chemicals without any identifying information.[15]

MPCA's reporting mandate here should be appropriately construed to include all PFAS. The whole class of PFAS should be evaluated with extreme caution, and all PFAS should be presumed dangerous until evaluated. Minnesota's current definition of PFAS demands such an application when it defines PFAS to include any of "a class of fluorinated organic chemicals containing at least one fully fluorinated carbon atom."[16] This encompasses all PFAS intentionally added to products, whether viewed as slightly safer than counterparts or not.

Products containing emerging short-chain PFAS should be evaluated equally as strictly as long-chain PFAS. PFAS are a diverse class of chemicals that transport differently in the environment depending on the length of their fluoroalkyl chains.[17] Manufacturers have replaced some long-chain PFAS, such as long-chain PFOA and PFOS, with short-chain PFAS due to claims that the shorter chain length makes them less prone to bioaccumulation and therefore less of a danger to human health. However, short-chain PFAS are much less well-studied than traditional long-chain PFAS, which makes a full assessment of the bioaccumulative and toxic effects difficult. Furthermore, it is apparent that short-chain PFAS are as environmentally persistent as long-chain substances and tend to be highly mobile once released into the environment.[18]

C. Criteria for "Essential for Health, Safety, or the Functioning of Society" and Potential PFAS Alternatives Should Incorporate the Essential-Use Concept

MPCA should incorporate the essential-use concept when defining criteria for evaluating whether a use of PFAS is "essential for health, safety, or the functioning of society and for which alternatives are not reasonably available."[19] The essential-use approach determines whether PFAS use within a given product is essential by applying three considerations: (1) whether the product is currently essential for health, safety, or the functioning of society, (2) whether the function the PFAS provides as part of the product is essential, and (3) if the product and function are necessary, whether a viable

[15] 15 U.S.C. § 2607(b)(7).
[16] Minn. Stat. § 116.943, subd. 1(p).
[17] Asa J. Lewis et. al., *Exposure Pathways and Bioaccumulation of Per- and Polyfluoroalkyl Substances in Freshwater Aquatic Ecosystems: Key Considerations* 822 SCI. TOTAL ENV'T 153561 (2022), https://www.sciencedirect.com/science/article/abs/pii/S0048969722006532?via%3Dihub.
[18] Arlene Blum et al., *supra* note 6.
[19] Minn. Stat. § 116.943, subd. 1(j).

alternative exists.[20] This approach assesses current uses of PFAS with the ultimate goal of phasing out all non-essential uses. Products containing intentionally added PFAS must serve an essential use to society and the function of PFAS within the product must be unavoidable due to a lack of viable alternatives.

The essential-use concept is a policy approach that will help guide MPCA as it defines the contours of the non-essential use ban. MPCA can take guidance from the growing number of countries and U.S. states employing the essential-use concept in PFAS regulation. Essential use originated from the Carter administration's amendments to TSCA in 1978, which banned "non-essential" aerosol sprays, and the 1987 Montreal Protocol.[21] In 2015, the Global PFAS Science Panel first proposed the idea of regulating PFAS as a group of substances under the essential use concept.[22] Essential use has been developed as a regulatory tool in the European Commission's chemical strategy and several European states have separately committed to phasing out all non-essential uses of PFAS by 2030.[23] Several U.S. states have also employed the essential-use concept when considering how to phase out the use of intentionally added PFAS in products.[24]

The regulation of PFAS globally is likely to inform PFAS manufacturing norms and affect the presence and concentrations of PFAS in products that are imported into Minnesota. By applying the essential-use concept, MPCA will harmonize Minnesota's non-essential use ban with other jurisdictions that have taken aim at PFAS. This ensures Minnesota will remain part of the global marketplace and that manufacturers will not have to adopt special provisions to do business in Minnesota.

1. MPCA Must Determine Whether a Product Containing PFAS and the PFAS Function Within that Product Are Essential

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[20] Ian T. Cousins et al., *Finding Essentiality Feasible: Common Questions and Misinterpretations Concerning the "Essential-Use" Concept* 23 ENV'T SCI. PROCESS IMPACTS 1079, 1081 (2021), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8372848/.

[21] Kathleen Garnett & Geert Van Calster, *The Concept of Essential Use: A Novel Approach to Regulating Chemicals in the European Union,* 10 TRANSNAT'L ENV'T L. 159, 164 (2021), HTTPS://WWW.CAMBRIDGE.ORG/CORE/JOURNALS/TRANSNATIONAL-ENVIRONMENTAL-LAW/ARTICLE/CONCEPT-OF-ESSENTIAL-USE-A-NOVEL-APPROACH-TO-REGULATING-CHEMICALS-IN-THE-EUROPEAN-UNION/E28E6A1A716C1E4E536FFD9E733FC09A.

[22] *Id.* at 160.

[23] *Id.*; ELEMENTS FOR AN EU-STRATEGY FOR PFAS 3 (2019), https://www.documentcloud.org/documents/6586418-EU-Strategy-for-PFASs-FINAL-VERSION-December-19. The report was presented to other EU Member States during the European Environment Council on 19 December 2019 by Denmark, the Netherlands, Sweden, and Luxembourg.

[24] *Policies for Addressing PFAS*, SAFER STATES, https://www.saferstates.org/priorities/pfas/ (last visited Feb. 29, 2024).

MPCA should not apply an approach that excludes whole product sectors as essential; each intentional use of PFAS within a product must be examined separately to determine whether it is truly essential. Under Maine's "PFAS in Products" law,[25] essential for the functioning of society is defined similarly to Minnesota, except that it includes a set of non-exclusive product sectors where PFAS may be essential. Essential "includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, and construction."[26] Minnesota law holds no such reference to product sectors, and therefore further supports the consideration of PFAS in products on an individual basis. For example, if PFAS was used to make stain resistant fabric covers for bus seat cushions, this function is not essential to society merely because it fits within the public transportation sector.

MPCA should view other jurisdictions' conclusions on whether a product with intentionally-added PFAS qualifies for an essential use exemption as probative evidence MPCA can consider when making its own independent evaluation. For example, if another state or the EU were to deem artificial turf containing PFAS non-essential, this information should inform, but not automatically make, MPCA's decision.[27] The bar for the exception should be significantly higher when other jurisdictions have already rejected the reasoning proffered.

PFAS should be banned from products that cannot be justified by any health or social welfare explanation. For example, lithium-ion batteries contain PFAS in the electrolyte, electrodes, and other battery components. [28] A wide range of products are made from this technology, from laptops to children's toys. Short-term disposable uses of PFAS in lithium-ion batteries should be prohibited. To the extent that any PFAS use in lithium-ion batteries is ultimately deemed necessary, a large sector of cheap disposable products should be blocked from sales pending product-by-product justification. Many of these products are sold online, and MPCA will have to work with online sellers to assure that they do not allow sales into Minnesota of prohibited classes of products.

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[25] Me. Rev. Stat. Ann. tit. 38, § 1614.

[26] *PFAS in Productions: Currently Unavoidable Uses*, ME. DEP'T OF ENVTL. PROT., https://www.maine.gov/dep/spills/topics/pfas/PFAS-products/cuu.html (last visited Mar. 1 2024). This definition is incorporated into Maine's legislation.

[27] Kyla Bennett, *Artificial Turf - A Plague on the Earth*, PUB. EMP. FOR ENV'T RESP. (Nov. 13, 2023), https://peer.org/commentary-artificial-turf-a-plague-on-the-earth/. Unfortunately, a large amount of the artificial turf on the market sheds PFAS as well as other harmful chemicals and microplastic pollution.

[28] Jennifer Guelfo et. al., *The Dirty Side of Clean Energy: Lithium Ion Batteries as a Source of PFAS in the Environment*, NATURE PORTFOLIO (2023), https://www.researchsquare.com/article/rs-3150504/v1.

2. **"Reasonably Available" Should Encompass Alternatives that Achieve Similar Functionality and Performance**

Non-essential uses of PFAS should encompass products where safer alternatives that can achieve similar, but not identical, functionality and performance are available to substitute for the current PFAS use.[29] MPCA should not construe "reasonably available" to mean that an alternative must perform identically to the product containing PFAS. The term "reasonably available" should allow small decreases in the effectiveness or performance of the product for a PFAS alternative. Small changes in the functionality of a product can be acceptable and reasonable, especially where the effectiveness of substitutes will improve with further research. The goal of eliminating PFAS use cannot be effectively achieved with a definition for this term that would only allow substitutes that exactly match or exceed the functionality of the previous PFAS use.

Where safer alternatives are not immediately available, the definitions within Minn. Stat. § 116.943 should be construed broadly to encourage the development of alternatives for currently unavoidable uses. Some PFAS uses are currently unavoidable because they provide vital functions that presently lack a viable alternative. However, the essential nature of the product should not be considered permanent. Limiting the category of "currently unavoidable use" to those uses that are truly a health and human safety priority will incentivize further development of alternatives to PFAS.

Also, MPCA must recognize that when it comes to the sale of goods, the global marketplace is designed to respond to regulations such as this one. If an alternative product is currently available in another market, such as Europe, but is not yet for sale in Minnesota, that alternative should still be considered "reasonably available." Only in circumstances where there is a permanent or near-permanent obstacle to obtaining the alternative product, such as anti-dumping controls or high enough tariffs to make imports effectively impossible, should the alternative be deemed unavailable to the U.S. economy. New product alternatives will rapidly develop in response to jurisdictions with similar prohibitions on PFAS-containing products; manufacturers must be prepared to adopt these alternatives.

3. **MPCA Regulations Should Be Enforced with the Intention of Phasing Out All Essential Uses in the Future**

MPCA should clarify that all products deemed to have a currently unavoidable use will be required to phase out PFAS in the future. Designating a currently unavoidable use gives manufacturers time to develop non-PFAS alternatives. It does not excuse

[29] Monika A. Roy et al., *Combined Application of the Essential-Use and Functional Substitution Concepts: Accelerating Safer Alternatives*, 56 ENV'T SCI. & TECH. 9842, 9842-46 (2022), https://pubs.acs.org/doi/10.1021/acs.est.2c03819.

industry taking no action and continuously arguing that no PFAS alternative applies to their product. The European Union has proposed a full ban, encompassing even essential products, that would start in 2039.[30] Minnesota law does not currently suggest a date for full phase-out, but its use of "currently" in "currently unavoidable use" necessitates consideration of a time when all PFAS use is deemed avoidable due to technological advances.

D. "Currently Unavoidable Use" Determinations Should Employ Regular Review of Alternatives

MPCA should employ an iterative process that requires regular review of alternatives to determine whether the use of PFAS in a product still qualifies as unavoidable. This review is necessary to ensure a product once deemed essential is not granted an overly generous or permanent exemption from Minnesota' ban on PFAS. All PFAS have harmful effects that come at a high cost to public health and the environment. PFAS are water-soluble, which allows them to accumulate in human and animal tissues, such that its presence can be measured years after exposure. PFAS have been proven to be harmful to human health at concentrations measured in parts per trillion and exposure has been linked to a range of devastating human health problems including certain forms of cancer, elevated cholesterol, liver disease, decreased fertility, thyroid problems, adverse developmental effects, and changes to immune system and hormone function.[31] Children, pregnant women, and workers exposed to PFAS on the job are especially vulnerable to these effects.

MPCA should operate from the presumption that any unavoidable use finding expires after one year unless the manufacturer makes a showing that there is no alternative at the time that the exception would expire. This expiration must happen every year no matter whether MPCA has finished processing the prior year's submission – a manufacturer's submission must not be effectively a shield to future regulation or prohibition if MPCA does not act within a set time. Only MPCA's action to renew an exception should count as a renewal, and failure to act should return the PFAS-containing product to the regular default: a prohibition on its sale in Minnesota. The goal of this legislation is to force market changes to find alternatives to PFAS. Without an aggressive plan to regularly review exemptions, the health of all Minnesotans and the environment remain at risk and the intent of the legislation is imperiled.

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[30] Stephen Gardner, *Ban on PFAS Use and Production Proposed in European Union*, BLOOMBERG L. (Feb. 7, 2023), https://news.bloomberglaw.com/environment-and-energy/ban-on-most-pfas-use-and-production-proposed-in-european-union.

[31] Carol F. Kwiatkowski et al., *Scientific Basis for Managing PFAS as a Chemical Class*, 7 ENV'T SCI. & TECH. LETTERS 532, 532-43 (2020), https://pubs.acs.org/doi/10.1021/acs.estlett.0c00255.

Products containing PFAS that have life-saving effects, such as medical implants, provide a good case for a currently unavoidable use designation if there is no currently available alternative. Although PFAS may play a role in the effectiveness and durability of medical implants,[32] allowing products to continue to use PFAS in the long-term poses a health threat to the device's users and to society at large, which will be exposed to PFAS from the manufacturing, use, and disposal of such devices. Regularly employing review of currently unavoidable use will incentivize involving toxicology and safety concerns early in medical device development.

E. Additional Information is Relevant to MPCA's Interpretation of "Currently Unavoidable Use"

MPCA provided additional questions for comment, and MCEA and CURE briefly respond to several of these here.

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"?

No, that is not evident on the face of the legislation and would unjustifiably expand the exemption beyond what was intended by the Minnesota Legislature. Mere costs do not make an alternative unavailable, and MPCA lacks the expertise to set prices across the entire market for goods to administer a "reasonably available" standard for the wholesale and retail prices of thousands of products and goods. How would a cost standard be applied to trade secret chemical mixtures used by few companies with few suppliers? Will MPCA need economists with expertise in every relevant field to assess cost submission data? If the federal government has a trade sanction against a particular product, that situation may go beyond a cost issue and functionally make something unavailable while the sanction is in effect.

3) Should unique considerations be made for small businesses with regards to economic feasibility?

No, products containing PFAS that are produced from small and big businesses are equally persistent and equally harmful to human health and the environment. Allowing additional feasibility considerations for small businesses could incentivize larger companies to spin off their PFAS-manufacturing units to exploit the exception. Larger chemical companies have already used these strategies to limit themselves from

[32] Sainath Babu, *Navigating the Complex World of PFAS Regulation for Medical Devices*, MED INST. (Oct. 20, 2023), https://medinstitute.com/blog/navigating-the-complex-world-of-pfas-regulation-for-medical-devices/.

PFAS liability.[33] The Minnesota Legislature did not intend for smaller businesses to be given the ability to bypass their carefully constructed PFAS regulations which are intended to apply broadly to all manufacturers.

6) How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

Members of the public, outside experts, and competitors should be given every opportunity to identify uses that are avoidable, either because the product is not essential or because there are available alternatives. Such third-party submissions should only be required to allege a prima facie showing of facts or arguments that goods are avoidable. Manufacturers should then be required to rebut that showing with substantial evidence because they have significantly better access to information about product inputs and alternatives considered. If a manufacturer is not able to bring substantial evidence to rebut a prima facie argument, MPCA should remove the product from the exception.

Ultimately, the amount of information required by a third-party submitting a request for MPCA to consider a faulty exception should be considerably less than would apply to a manufacturer's response to a challenge. This would favor public participation and public health by empowering community members to meaningfully participate in the process, and it would help MPCA to make Minnesota a safer place to live.

8) Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

No, that would merely complicate the task for MPCA prior to finishing this already historic rulemaking. Application of the rules should not be conflated with setting protective standards for public health and the environment. If no product can meet MPCA's standards after the rules are finished then the public will be more protected from PFAS contamination, an overall benefit to society.

[33] *Dupont Completes Spin-off of the Chemours Company*, CHEMOURS (July 1, 2015), https://www.chemours.com/en/news-media-center/all-news/press-releases/2015/dupont-completes-spin-off-of-the-chemours-company; James Bruggers, *Chemours and Dupont Knew About Risks But Kept Making Toxic PFAS Chemicals, UN Human Rights Advisors Conclude,* INSIDE CLIMATE NEWS (Feb. 26, 2024), https://insideclimatenews.org/news/26022024/un-chemours-pfas-north-carolina/.

Conclusion

MCEA and CURE strongly urge MPCA adopt and enforce broad definitions of PFAS that apply the essential use concept to closely restrict the amount of products that qualify for the currently unavoidable use exception. This principle requires MPCA assess each product containing PFAS on its essentiality, and MPCA should not allow an exception merely because the product fits within a sector that has an important role in society, like health or renewable energy. An alternative that is "reasonably available" within this framework should include alternatives that have slight or excusable decreases in effectiveness. This is necessary to best meet the policy goal of eliminating PFAS in manufactured products and honors the precautionary principle's approach of prioritizing human and environmental health.

A precautionary approach to defining and ultimately enforcing Minnesota's ban on products containing PFAS will also help defend the health and safety of Minnesota citizens and the environment by considering the dangers of bioaccumulation. Scientific uncertainty on the toxicity of PFAS must compel MPCA to rapidly accelerate the adoption of comprehensive PFAS bans, not an excuse to wait until more detailed information is available on the many thousands of PFAS chemicals in use in Minnesota today. Regular review of essential use determinations and removal of products from this exception will be vital for effectively phasing out PFAS use to best keep Minnesotans and the environment safe.

Respectfully submitted,

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Before the
Minnesota Pollution Control Agency
Request for Comments
Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing PFAS
Revisor's ID Number R-4837

Comments of the Chemical Users Coalition

The Chemical Users Coalition ("CUC") appreciates the opportunity to provide our comments on the Planned New Rules Governing Currently Unavoidable Use ("CUU") Determinations about Products Containing PFAS (the "Planned Rule") that will be promulgated by the Minnesota Pollution Control Agency (the "MPCA" or the "Agency") pursuant to Minnesota Statutes 116.943, subdivision 5(c) ("Amara's Law"). CUC is an association of companies from diverse industries that are interested in chemical management policy from the perspective of those who use, rather than manufacture, chemical substances.[1] CUC encourages the development of chemical regulatory policies that protect human health and the environment while simultaneously fostering the pursuit of technological innovation. Aligning these goals is particularly important in the context of chemical management policy in a global economy. CUC Members have been actively engaged with federal and state regulators on PFAS-related legislation and regulation.

The MPCA, in the Request for Comments, is seeking comments on specific questions: The following are CUC's responses to those specific questions on which the MPCA requested input.

1. Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Amara's Law defines "currently unavoidable use" as "a use of PFAS that the commissioner has determined by rule under this section to be essential for health, safety, or the functioning of society and for which alternatives are not reasonably available." CUC suggests that greater clarity and detail from MPCA should be provided in the upcoming rulemaking to explain the criteria to determine when a PFAS use will qualify as "essential for health, safety or the functioning of society." MPCA should, in a rule, define these terms so that the regulated community clearly understands the criteria MPCA will use to judge essentiality.

CUC recommends that products or product components that are "essential for health, safety or the functioning of society" are those that, if unavailable, would result in a significant increase in negative healthcare outcomes, an inability to mitigate significant risks to human health or the

[1] The members of CUC are Airbus S.A.S., The Boeing Company, Carrier Corporation, HP Incorporated, IBM Company, Intel Corporation, Lockheed Martin Corporation, the National Electrical Manufacturers Association, Raytheon Technologies Corporation, Sony Electronics, Inc., and TDK U.S.A. Corporation.

environment, or significantly interrupting the daily functions on which society relies. CUC also recommends that there should be an opportunity under the rules developed for applicants seeking a CUU determination may demonstrate PFAS or a PFAS use is "essential for health" without the need to also show that without the PFAS or its use there would be a "significant increase" in "negative health outcomes". This would allow room for the development of (and the Agency's ability to exempt) uses that are innovative and (at present) unforeseen, and which would otherwise become subject to the 2030 ban. Furthermore, products or product components that are "essential for health, safety or the functioning of society" also include those that are required by federal or state laws and regulations or are necessary for the purposes of national security, defense or space exploration. Products or product components that are "essential for the functioning of society" are those that are used in or to address climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, aerospace, aeronautics, public safety and defense, and construction.

The interpretation of the phrase "alternatives are not reasonably available" must also be defined clearly by MPCA. CUC recommends that MPCA should take into account, when defining the term, that certain products, including but certainly not limited to products and components in the aerospace and defense sector, are often subject to batteries of qualifications tests, customer approvals, and "Type Certifications" with various regulatory bodies such as the Department of Defense and Federal Aviation Administration. Therefore, alternatives that appear initially to be available may not be reasonably available because they must be subjected to these processes that may take years to qualify and complete.

Furthermore, in many sectors there are often no readily available substitutes due to safety concerns. While a substitute (including a non-PFAS alternative) may exist on the market, it may be the case that such a substitute is more flammable, toxic, or otherwise unsafe—leading to an unwanted regulatory outcome (and possibly regrettable substitutions). MPCA must carefully factor in regrettable substitution when defining the "reasonable availability of alternatives."

To better understand what products are "essential," MPCA should consider conducting analyses to project the impact to the State if/when products from various sectors can no longer be sold due to the sales restriction under Amara's Law. The findings from such analyses should be made public and provided to the state legislature.

Additionally, MPCA should consider the possibility of making CUU determinations based on the specific use of PFAS, and not solely on a finished-products level. This categorical approach could ease the regulatory burden both on industry and on the agency, as industry would not need to have each specific product "evaluated" for essentiality, and MPCA would not need to consider myriads of individual products.

2. Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

CUC recommends that cost be taken into consideration, and economic analyses should be conducted to determine whether alternatives are "reasonably available." CUC believes that anytime use of alternative substances is mandated, a significant increase in cost to manufacturers and in generation of waste is anticipated. Due to the research and development required to manufacture products using alternatives, the trial and error will lead to increased production costs and generation of products that do not function as needed and that will need to be discarded. The research and development activity also could lead to a diversion of resources from production of the product and consequently product shortages resulting in harm to the larger economy.

Furthermore, despite undertaking research activities, there is no guarantee that a manufacturer will identify alternatives that are available. The goal of the research and development process is to determine if, using alternative substances, products that perform just as well as the original products can be manufactured. Similar to what was done when developing the original products, the alternative products would also be required to obtain the same quality certifications, satisfy the same customer standards, and meet required safety evaluations. This is estimated to take a significant amount of time and money, which is another "cost" factor involved in the regulatory structure imposed by the statute.

In addition, costs must also be considered for replacement and spare parts for products that have long useful lives, such as those used by the aerospace and defense sector, among others. The inability to procure and sustain such products over the entire life cycle undermines the intended functionality of the products and may lead to early obsolescence, a costly and potentially dangerous situation that must be avoided, particularly in the case of replacement and spare parts found in products utilized for national security.

If these costs associated with the use of alternatives have significant negative impact upon business and society, such alternatives are not "reasonably" available.

3. Should unique considerations be made for small businesses with regards to economic feasibility?

CUC believes that MPCA must consider the magnitude of the economic impact that may be experienced by regulated small businesses, the total number of regulated small businesses that may experience the economic impact, and the percentage of regulated small businesses that may experience the economic impact. A small business may not be able to conduct research and development, redesign production methods, or purchase alternative substances due to prohibitive costs. Once MPCA has quantified and qualified the impact, it should develop criteria to establish what is indeed "economically feasible" for a small business.

4. What criteria should be used to determine the safety of potential PFAS alternatives?

CUC suggests that MPCA consider the following factors:

- Whether the alternative substance is subject to any restrictions on its use, concentration, or specific properties.
- Considering the toxicological data on the alternative substance, including studies on acute and chronic toxicity, carcinogenicity, and reproductive effects (or the potential lack of such data for new alternatives that have not been adequately studied).

- Assessing the likely exposure levels and potential risks to workers during product manufacturing, or to consumers during the other phases of the product's lifecycle, considering use patterns, frequency, and duration as well as disposal.
- Whether the alternative substance interacts negatively with other materials in the product or packaging, potentially leading to safety concerns.
- Assessing if that use of the alternative substance could compromise the integrity, durability, or safety of the overall product.
- The environmental impact of the alternative substance, including its biodegradability and potential harm to ecosystems.
- Reported adverse events related to use of the alternative substance.

All of these factors should be assessed by comparing the current (PFAS-containing) product in contrast to the "alternative" under consideration. Furthermore, the "safety" assessment might need to involve a "comparative-risk" determination that includes whether an alternative may be available and should be considered for use which may contain PFAS, but a variety of PFAS for which there are fewer health or environmental concerns, in which case, its use as a phased-in alternative should be considered and encouraged over time.

5. How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

CUC recommends that "currently unavoidable use determinations" should be effective for at least five years, as, under Amara's Law, PFAS is a group of substance that may potentially encompass thousands of chemicals. A significant amount of time will be needed for research and development and for adequate supply to be made available for alternatives. However, CUC also suggests that MPCA consider indefinite exemptions, until further information is available, for products/sectors where it is clear that alternatives do not exist and are not reasonably anticipated to be identified in the foreseeable future. The CUC also supports the indefinite renewal of currently unavoidable use determinations.

CUC also strongly recommends that MPCA adopt a review and resolution process for newly identified PFAS in products. The statutory and impending regulatory definitions of PFAS are extremely broad and the supply chains complex, creating an inevitable situation of discovering PFAS post implementation of the program. A review and resolution process would enable business entities to present rationale or justification for newly identified currently unavoidable use(s) as well as time for MPCA to make determinations and/or grant exemptions based on criticality and unavoidable use.

6. How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

Relying on agency rulemaking for individual product determinations will result in a significant burden being placed on MPCA, and MPCA simply will not be able to manage determination requests in a timely fashion. In order to ensure that exemptions for currently unavoidable uses can be considered and responded to in a timely and efficient manner, CUC recommends that MPCA establish an administrative process by which commercial entities may seek a determination that a use is currently unavoidable. MPCA should identify the kinds of evidence it would consider credible and sufficient to support a timely determination. MPCA should be required to make that determination administratively and in accordance with a deadline (e.g., 60 days).

MCP should consider at least the following factors in determinations:

- The cost of acquiring and processing the alterative substance compared to the existing ones.
- Changes in manufacturing processes that may affect overall production costs.
- Whether an underlying federal or state requirement necessitates use of the PFAS for the purposes of national security, defense, aviation, or space exploration.
- Whether products or product components are "essential for the functioning of society" including those that are used in or to address climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, aerospace, aeronautics, public safety and defense, and construction.
- The likely exposure potential and levels for consumers during the product's lifecycle, considering usage patterns, frequency, and duration.
- Whether any potential alternative materials can meet the required specifications, performance standards, and quality benchmarks for the product.
- The impact of an alternative on the longevity and reliability of the final product.
- The availability of a consistent and reliable supply of the alternative materials.
- The reliability and stability of the suppliers providing the new materials.
- Safety standards and regulations applicable to the use of the alternative materials.
- Whether an alternative material will be compatible with existing manufacturing equipment and processes.
- The environmental impact of the new substance in products throughout their lifecycle, from extraction to disposal.
- Needed testing, prototyping, and (re)qualification for any alternative substance to identify any issues or improvements needed.

MPCA should be cognizant of the fact that product manufacturers may face some challenges providing information about PFAS present in products. Upstream suppliers may be reluctant to provide manufacturers with specific information about the type of PFAS used. Upstream suppliers may claim that the use of PFAS is essential but may not provide details due to confidentiality concerns. MPCA should allow the use of supplier statements to substantiate a manufacturer's request. To facilitate this, MPCA should set up a system that would allow upstream suppliers to provide confidential information directly to MPCA. Furthermore, MPCA should develop and implement a review and resolution process to allow for newly discovered currently unavoidable uses that are identified post implementation of the program.

CUC suggests that MPCA should consider coordination with other jurisdictions, such as Maine, to create an approach that allows manufacturers to submit currently unavoidable use requests that can apply to multiple jurisdictions.

7. **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.**

CUC Member companies, rather than CUC itself, we be submitting such product and company-specific requests. However, see CUC's further input in our response to item 9, below.

8. **Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?**

We highly suggest MPCA make some initial determinations as to what uses of PFAS constitute "currently unavoidable use." The investigation of the use of PFAS is anticipated to take a significant amount of time and resources. If initial determinations can be made (for example for categories of product uses), that would alleviate some of the burden on the industry to find alternatives that may not exist and would allow the industry to focus on complying with the regulatory requirements where there are feasible alternatives.

Initially, CUC recommends that any PFAS containing products or product components that are "essential for health, safety or the functioning of society" as well as those that are required by federal or state laws and regulations or are necessary for the purposes of national security, defense or space exploration be granted a categorical exemption or considered a currently unavoidable use. Products or product components that are "essential for the functioning of society" are those that are used in or to address climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, aerospace, aeronautics, public safety and defense, and construction.

9. **Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.**

CUC suggests that MPCA consider Interstate Chemicals Clearinghouse Alternatives Assessment Guide as a resource to be used in developing the criteria and process for alternative assessment.

CUC also considers (in addition to the suggestions above) the following categories of PFAS uses that would be suitable starting points for MPCA to propose as CUUs when seeking further public comment. The categories listed below are ones which CUC Members consider to be "essential" due to their criticality to health, safety, and the public welfare and for which CUC Members understand there are no current “drop in” chemical alternatives that meet the technical and performance standards required for such products and uses.

- Certain medical devices and appliances (such as MRI and other imaging equipment) with PFAS-containing components (and their replacement parts) that are not specifically subject to an authorization which would qualify as a “federal preemption” determination.
- Products, supplies and spare (replacement) parts that are necessary for the purposes of national security, defense or space exploration, including but not limited to aircraft, naval vessels, communication/radar systems, satellites, and space vehicles.
- Gear, apparel, and personal protection equipment used by first responders such as fire fighters, EMTs, and rescue workers.
- Transportation equipment containing PFAS-containing parts and components such as aircraft, rail cars and train engines (including service equipment and replacement parts),
- PFAS containing waste disposal and waste movement equipment and storage devices for such materials.
- Appliances and equipment used in harnessing “clean” energy (e.g., windmills, solar panels).
- Energy storage equipment, such as batteries and other components in electric vehicles and stationary devices.
- PFAS used in the production of semiconductors, circuit boards, and related electronic products and their components. This should include PFAS used in the semiconductor manufacturing process; PFAS used in the production of semiconductor manufacturing equipment (and in replacement parts for such equipment); as well as PFAS that may remain present in semiconductors and the final packaged semiconductor devices that are produced. This CUU determination should extend to PFAS contained within electronic equipment and related devices which include semiconductors among their component parts or contain transistors, wiring, insulation, connections, housings, and electronic component parts that may include PFAS for purposes of ensuring reliability, limiting electronic interference, providing for safety, and other critical performance attributes.
- To the extent not included among those items CUC has identified above, our Members also support MPCA providing CUU determinations for PFAS uses in electrical equipment that contribute to meeting the nation’s goals relating to climate preservation, electrification, energy security, human health and safety, and product reliability, durability, and sustainability. These products should include electronic components found in medical devices (e.g., imaging equipment and pacemakers), electronic sensors, industrial automation relays and soft starters, gas-insulated power grid equipment, insultation for wiring, and PFAS uses critical for the safe operation of essential and emergency lighting equipment,
- All uses of PFAS and PFAS-containing products and materials necessary to manufacture the products described above.

Conclusion

CUC appreciates the opportunity to submit the foregoing comments and reserves its right to submit additional or modified comments at a later date. We would welcome the opportunity to meet with the MPCA staff to address our comments and to assist in crafting implementing rules.

RECEIVED
By: OAH on 3/1/2024
Rebecca Poindexter Attachment

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Empowering patients. Enriching lives.

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Letter of Support

Mozarc Medical stands firmly behind efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. Additionally, we express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. It's important to acknowledge that PFAS play a vital role in ensuring product functionality and meeting stringent safety standards.

In line with our commitment to finding balanced solutions, Claigan Environmental has developed a comprehensive Currently Unavoidable Uses (CUU) proposal, which is being submitted to the states of Maine and Minnesota. Their proposal is founded upon rigorous laboratory testing and incorporates valuable insights gathered from diverse stakeholders including our company. By engaging experts from various industries, Claigan Environmental has adopted a collaborative approach to address this complex issue.

Mozarc Medical actively participated in the consultation process and supports Claigan Environmental's submission. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS while mitigating adverse impacts on businesses, communities, and public health.

Rebecca Poindexter
R&D Director
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RECEIVED
By: OAH on 3/1/2024
Peter Lance Attachment

FLUIDSEALING ASSOCIATION

Letter of Support

The Fluid Sealing Association stands firmly behind efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. However, we express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. It's important to acknowledge that fluoropolymer and fluoroelastomer PFAS play a vital role in ensuring product functionality and meeting stringent safety standards.

In line with our commitment to finding balanced solutions, Claigan Environmental has developed a comprehensive Currently Unavoidable Uses (CUU) proposal, which is being submitted to the states of Maine and Minnesota. This proposal is founded upon rigorous laboratory testing and incorporates valuable insights gathered from diverse stakeholders. By engaging experts from various industries, Claigan Environmental has adopted a collaborative approach to address this complex issue.

The Fluid Sealing Association actively participated in the consultation process and supports Claigan Environmental's submission with respect to the industrial sealing devices which include mechanical seals, compression packing, gaskets and expansion joints and their components. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS while mitigating adverse impacts on businesses, communities, and public health.

Peter M. Lance
FSA Executive Director
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RECEIVED
By: OAH on 3/1/2024

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March 1, 2024

Submitted via https://minnesotaoah.granicusideas.com/

Katrina Kessler
Commissioner
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, Minnesota, 55155-4194

Re: Comments of Interest Party, The Vision Council
Planned New Rules Governing Currently Unavoidable
Use Determinations about Products Containing Per-and
Polyfluoroalkyl substances (PFAS); Revisor's ID Number R-4837

Dear Commissioner Kessler:

The Vision Council (TVC), as an interested party, respectfully comments on the Minnesota Pollution Control Agency's (MPCA) planned new rules governing currently unavoidable use determinations for products containing per- and polyfluoroalkyl substances (PFAS). Serving as the global voice for vision care products and services, including optical laboratories, The Vision Council is a nonprofit organization representing the manufacturers, suppliers, and retailers of the optical industry through education, advocacy, and consumer outreach. Our members include companies that manufacture, import, and distribute prescription and non-prescription spectacle lenses, prescription eyeglasses, spectacle frames, non-prescription sunglasses, non-prescription reading glasses, low vision products and ophthalmic equipment, as well as optical retail companies that sell these class I medical devices.

While our membership is working to identify the full scope of the use of PFAS in optical products, we have identified that certain lens coatings contain PFAS. Lens coatings are applied to spectacle lenses – both prescription and nonprescription (also called plano) – to provide different special properties for cosmetic, safety and comfort reasons. These include coatings that impart anti-reflective ("AR"), scratch resistance, UV-protection, tints, blue-blocking and anti-fog properties to the lens, and which may contain PFAS. Thus, these comments, while submitted on behalf of the eyewear manufacturing and distributing industries, are particularly relevant to those members who manufacture and use such lens coatings.

In its request for comments, MPCA has requested response to a set of questions. TVC comment as follows.

1. *Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?*

Left without a more detailed definition or criteria giving meaning to that term, individuals and companies must sort through the range of definitions of "essential" to determine whether a PFAS in their product meets the threshold of a currently unavoidable use. MPCA must set out criteria to avoid the subjectivity of construing whether "essential" contemplates "indispensable" or "very important" or "necessary" or "needed." TVC submits that MPCA should adopt criteria supporting a broad interpretation of what constitutes essential. By doing so, the entire clause can be interpreted to promote the goal of removing PFAS where their presences are unconnected to health benefits, safety enhancement or societal betterment, but at the same time does not foreclose the ability of manufacturers and distributors to prove an unavoidable use because MPCA adopted a strict definition of essential that subsumes the currently unavoidable use exception in all but very limited cases.

2. *Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold.*

Costs must be considered as a factor in determining when something is "reasonably available." Not just the actual cost of replacing one chemical with another. MPCA must understand that engineering out a PFAS from a specific substance used to make a particular product is more complex than simply swapping out a PFAS for a replacement chemistry. There is a cost in determining the appropriate alternative, one reflected in the research and development needed to find a workable substitute and then possibly to reconfigure production facilities to effectuate the changes. It does not stop there, however. Focusing on medical devices[1] such as those made by TVC members, changes made to existing FDA cleared devices could trigger new regulatory requirements and testing to clear those changes for U.S. commerce. And newly refigured products may need new customer approval, which could result in time delays or even lost business. In other words, addressing what constitutes "reasonably available" will not lend itself to defined

[1] FDA regulated medical devices are outside the scope of the state's 2032 PFAS ban but are still subject to the reporting requirements that go into effect in 2026.

cost thresholds but by necessity require ad hoc review based on the specific facts at hand.

3. *Should unique considerations be made for small businesses with regard to economic feasibility?*

Yes, unique, or heightened consideration, must be given to small businesses when it comes to evaluating the economic feasibility of such companies' ability to meet the requirements of the law. The various costs identified in response to question 2 above hit small businesses especially hard for obvious reasons.

4. *What criteria should be used to determine the safety of potential PFAS alternatives.*

At this time, TVC is unable to offer meaningful comments on this question and defers to comments filed by entities with relevant research and development resources and current data on this issue.

5. *How long should PFAS currently unavoidable for use determination be good for? How should the length of the currently unavoidable use determination be decided? Should significant changes in available information about alternatives trigger a re-evaluation?*

Unavoidable use determinations should remain in effect until safer alternatives are developed and economically feasible. MPCA should promulgate regulations providing for re-authorization or new evaluation of products benefitting from an existing unavoidable use determination. Such a re-authorization requirement would be triggered when safer, replacement substances are developed and market-available for that product and which could be utilized instead of the exempt PFAS.

6. *How should stakeholders' requests to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, should stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?*

As MPCA has yet to set out the process by which an entity may request a currently unavoidable use determination, TVC reserves the right to comment when such plan is published for comment. At a minimum, however, such a process must be flexible and subject to broad application for similar products made of similar

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PFAS-containing substances. Otherwise, determinations too limited in application will simply engender more reviews of similar products, taxing the resources of MPCA, slowing down the review process for all currently unavoidable use determinations, and adding layers of cost to both the private parties and the state. The process should incorporate ease of submission, opportunity for quick agency turn-arounds, and broad application to, and self-certification of, similar products of similar substances.

TVC does not see a benefit of creating a means by which entities can solicit a determination that a substance does not qualify for a currently unavoidable use determination, nor do we support such a process. Furthermore, TVC questions whether the current statute contemplates such a process and believes that in light of the absence of any statutory authority for a converse reporting requirement, any such rulemaking at this time would be ultra vires.

7. *In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.*

As addressed earlier in this letter, TVC recognizes that certain coatings used on prescription and plano lenses contain PFAS. Because these coatings contain PFAS, various health and safety benefits are imparted to spectacle lenses used in eyeglasses (one of the most widely used medical devices in the U.S.), sunglasses, reading glasses, and other eyewear utilizing lenses. These coatings have been utilized for decades, so their removal from the market would set back eyecare to the pre-coating era.

8. *Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?*

Yes. TVC believes that publication of some determinations at this time will benefit both stakeholders and the state as the parties move forward to rolling out a comprehensive methodology allowing for the issuance of currently unavoidable use determinations.

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9. *Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavailable use determinations.*

None currently.

Thank you for your consideration of our comments. Please feel free to contact either of us if you require any more information regarding this letter.

Sincerely,

A Mills

Ashley Mills
Chief Executive Officer

Rick Van Arnam

Rick Van Arnam
Regulatory Affairs Counsel

RECEIVED
By: OAH on 3/1/2024

Heather Darrah Attachment 1

THOMAS ASSOCIATES, INC. EXECUTIVE MANAGER

pti power tool institute, inc.

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March 1, 2024

TO: Minnesota Pollution Control Agency
520 Lafayette Rd. N.
St. Paul, MN 55155-4194

Transmitted electronically via https://minnesotaoah.granicusideas.com/

SUBJECT: Planned New Rules Governing Current Unavoidable Use Determinations about Products Containing Per- and Polyfluoroalkyl Substances (PFAS)
Revisor's ID Number R-4837
OAH Docket No. 71-9003-39667

The Power Tool Institute (PTI) is pleased to be provided with an opportunity to submit comments to the Minnesota Pollution Control Agency relating to currently unavoidable uses (CUU) of PFAS. PTI is a trade association of the leading power tool manufacturers in the United States.

Our member companies include:

- Chervon North America, Inc.
- Festool USA, LLC
- Hilti, Inc.
- Koki Holdings America Ltd.
- Makita U.S.A., Inc.
- Robert Bosch Tool Corporation
- Stanley Black & Decker Corporation
- STIHL Incorporated
- Techtronic Industries – North America

Our members manufacture both corded and cordless power tools, the latter of which is a fast growing segment of the power tool industry. Cordless power tools rely heavily on rechargeable lithium-ion batteries. PFAS is a critical component in the cells of rechargeable batteries. PFAS is also used in the construction of power tools to provide lubrication, sealing, resistance to environmental stressors, and electrical insulation.

1. Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Multiple states have active bills in their legislature relating to the regulation of PFAS in products. To reduce the burden of tracking PFAS use in products spread across multiple definitions of "essential for health, safety, or the functioning of society", the State of Minnesota should consider how other states and organizations have defined this term. For example, during Maine's recent comment period they provided the following definition for ***Essential for Health, Safety or the Functioning of Society:***

"…means products or product components that if unavailable would result in a significant increase in negative healthcare outcomes, an inability to mitigate significant risks to human health or the environment, or significantly interrupt the daily functions on which society relies. Products or product components that are Essential for Health, Safety or the Functioning of Society include those that are required by federal or state laws and regulations. Essential for the Functioning of Society includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, and construction."[1]

Furthermore, PFAS is also a concern at the international level. The Royal Society of Chemistry published an article in the journal Environmental Science: Processes & Impacts, *The concept of essential use for determining when uses of PFASs can be phased out.*[2] The article is attached as Annex A. This paper includes a discussion of essentiality categories to help facilitate the phase of out non-essential uses of chemicals of concern, with PFAS as the example. Policy makers should consider using a sound, consensus based scientific methodology that has been used internationally to establish criteria that defines "essential for health, safety, or the functioning of society". This would help streamline future PFAS regulation.

2. Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Yes, costs of PFAS alternatives should be considered in the definition of "reasonably available". These costs should include more than any increased cost of raw materials. They should consider the cost to implement a PFAS alternative. Costs include the resources required to research, test, evaluate, and implement the alternative in the manufacturing process. PTI members manufacture products to meet consensus developed safety standards, customer requirements, and other applicable regulations. Proving and maintaining compliance to safety standards often involves stringent design control and third party certification. Evaluating potential alternatives takes time and resources. Validation testing must be performed to ensure a PFAS alternative meets all design, quality, performance, and safety specifications. Only after all these criteria have been met would a manufacturer commit the additional financial resources required to update a third party certification to include the PFAS alternative material. Policy makers should consider the cost of implementing a PFAS alternative within the definition of "reasonably available."

3. Should unique considerations be made for small businesses with regards to economic feasibility?

Ensuring the cost of power tools is not unnecessarily increased is relevant for the economic feasibility of small business. Power tools are frequently seen as an investment by those in the skilled trades such as mechanics, technicians, machinists, electricians, plumbers,

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[1] Maine Department of Environmental Protection, PFAS in Products: Currently Unavoidable Uses, Maine Department of Environmental Protection (Last updated January 10, 2024)

[2] ***Environ. Sci.: Processes Impacts***, 2019,**21**, 1803-1815

carpenters, roofers, and others in the construction industry. Workers in these roles are commonly employed by small, local, businesses with close ties to the communities they serve.

4. **What criteria should be used to determine the safety of potential PFAS alternatives?**

PFAS is currently used in a large variety of products across the economy. It is important policymakers first understand the impact a PFAS's current use in the product has on the environment and human health. They also need to understand the impacts of potential PFAS alternative. Policymakers should avoid requiring PFAS alternatives that exacerbate or result in new environmental and human health hazards.

5. **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?**

PFAS CUU determinations should not be time limited. As described in item 2, it takes considerable time to evaluate and implement a PFAS alternative in a product, assuming an alternative is available. PTI members' positions as manufacturers of consumer/professional products means they are downstream from where the PFAS is added at the component (i.e. battery, gasket, plastic housing) level. Members are heavily dependent on their suppliers to understand the multitude of places PFAS is used in a product and what, if any, alternatives may be available. If alternatives are not available, end-product manufacturers are dependent on chemical, raw material, and other component suppliers to develop and provide a PFAS-free alternative.

6. **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?**

Stakeholders should request to have a PFAS use considered for CUU determination by product category. As mentioned in item 2 above the power tool industry manufactures products to meet consensus developed safety standards. These standards are developed by industry experts that understand the implications of component modification on the end-product. There is a high level of compliance to these safety standards, while allowing companies to differentiate based on performance, ergonomics, and various other features. Allowing an individual manufacturer or supplier to hold a CUU exemption would give unfair advantage and create differences in the market that may impact product safety. Allowing CUU exemption by product category also keeps industries in alignment when PFAS alternatives are identified and implemented into consensus safety standards.

7. **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.**

PFAS is essential to the function of power tools in two distinct ways, the cell construction of a rechargeable battery (if the tool is cordless) and the overall construction of the tool.

A. Rechargeable Lithium-ion Batteries and their Chargers

Rechargeable lithium-ion cells are the building blocks of the power tool battery pack design. PFAS are used in the manufacture of these battery cells. A technical report from the European Battery Industry Association RECHARGE is attached (Annex B). This in-depth report consists of detailed descriptions of various types PFAS uses in batteries, the emission risks posed by PFAS in batteries, and the availability of alternatives. The below table summarizes the types of PFAS in the RECHARGE report which do not have viable alternatives for their use.[3]

Table 1. RECHARGE Summary on PFAS use in Batteries

PFAS Type	**Why is it used and where**
PVDF	In binders in the active material mass: • Enables a uniform distribution of the slurry • Protects the composite electrode from corrosion and the electrolyte from depletion • Tailors the viscosity of the slurry
PTFE	In binders in the active material mass: • Mechanical cohesion to enable electrode integrity • Lubricant to allow the electrode particles to slide over each other during electrode formation • Hydrophobic properties – Lower water absorption during mixing
Various PFAS including LiTFSI, LICF3SO3 (triflate)	In electrolytes: • Increase electrolyte stability by capturing water and avoiding hydrogen fluoride emissions
PFA, VDF-HFP, FKM	In gaskets: • Very thin high-performance gaskets with chemical and thermal stability and high permeation resistance can be formed to provide stability to high power and high temperature cells
PTFE, PVDF	In coatings on separators: • Separate the negative and the positive electrodes whilst not participating in electrochemical reactions, preventing short-circuit • Ensure 35%-45% porosity with a pore size of 200nm to 1μm
PTFE, FEP, PFA, VDF, HFP, FKM	In valves, gaskets, washers: • Prevent leakage of the electrolyte from the inside and penetration of moisture from the outside

[3] RECHARGE, Application for derogation from PFAS REACH restriction for specific uses in batteries, (April, 2023)

Lithium-ion battery chemistry is needed specifically for power tools because of its high energy density. Lithium-ion cells in power tools must be able to efficiently charge, hold their charge, and discharge efficiently with varying loads. Users expect to charge a battery within the time it takes to discharge a fully charged battery. This could consist of longer periods of low power use or short bursts of high power. Battery performance is expected to be maintained throughout a variety of thermal operating conditions, such as the natural temperature variations throughout the year. In addition, sufficient safety and mechanical robustness of the cells must be ensured as hand-held and transportable power tools are operated near the human body. Energy to weight ratio is also key for hand-held power tools, as the tool must be able to be handled ergonomically and safely for extended periods of time (e.g., when working on rooftops). There is currently no alternative cell technology that can compete with these performance requirements and is available for large scale production.

B. Power Tool Construction

The second way PFAS is essential to power tools is in their construction. The following is a non-exhaustive list of power tools that use PFAS: Band Saws, Belt Sanders, Circular Saws, Cut-off Tools, Detail Sanders, Disc Sanders, Drywall Sanders, Drill/Drivers (Powered), Finishing Sanders, Impact Drivers, Jigsaws, Jointer Planers, Mitre Saws, Mixer/Vibrator, Nail Guns, Nibblers/Shears, Oscillating Multitools, Reciprocating Saws, Rotary Multitools, Rotary Saws, Routers, Screw Guns, Screwdrivers (Powered), Staplers (Powered), Straight/Die Grinders, Surface Grinders, Surface/Thickness Planers, Table Saws, Tappers, Wall Slotter (Powered), Chain Saws (Powered). Many power tools also incorporate Electric Torches/Flashlights as accessories.

Power tools frequently contain fluoropolymers(PVDF, PTFE, or FKM) in components due to the tools' expected long lifespans. Fluoropolymers are used in high-performance plastics, such as those in gaskets and O-Rings. These sealing components prevent leaks of air, oil, grease, and ensure water, dirt, dust, shavings, and other debris stays out of the equipment.

PFAS also have applications in lubricants. Fluoropolymers have a low coefficient of friction, making them ideal for reducing the frictional forces within power tools. These forces are found in various moving parts on the tool such as gears, bearings, and sliding mechanisms. Ensuring power tools are operating smoothly means better overall performance, better energy efficiency, a reduction in the likelihood of mechanical blockages, and reduced heat generation. A reduction in heat lowers the likelihood of overheating and ensures component life is not shortened due to heat stress.

Power tools are exposed to harsh environments such as those that are damp, dusty, oily, salty, contain other corrosive substances, or are directly in ultra-violet(UV) light. They are frequently used on materials that generate dust, such as wood, concrete, and metal. A power tool must be able to handle the environmental stresses placed on it during normal operation. Fluoropolymers provide a protective layer on metal and plastics. This safeguards the internal components and extends the lifespan ensuring that power tools remain reliable and durable, even in challenging working conditions. This protective layer also facilitates easy cleaning and maintenance of power tools. The non-stick properties of PFAS prevent debris, dust, and other contaminants from adhering to the tool's surface, simplifying the cleaning process. Power tools with PFAS coatings are easier to wipe down, increasing their overall lifespan. Power tools must also be capable of withstanding impacts and long periods of vibration during normal use. The addition of fluoropolymers to the housing and components make them resilient to these effects.

PFAS are also used in the electrical systems of power tools beyond batteries. They ensure that plastics around high-temperature parts such as the battery and electric motor are heat-resistant and flame-retardant. They are regularly used in used in electrical insulation on wires and cables.

8. **Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?**

Yes, the MPCA should make CUU determinations certain product categories as a part of this initial rulemaking. These CUUs should not be time limited due to the essential nature of certain product categories and the lack of PFAS alternatives, due to limited scalable production options and/or ongoing research.

9. **Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.**

In future collection of CUU or other PFAS information, manufacturers should be held to the EPA definition of "known to or reasonably ascertainable by", when evaluating sources of PFAS in complex supply chains. The definition is as follows:

> "*means all information in a person's possession or control, plus all information that a reasonable person similarly situated might be expected to possess, control, or know*" [4]

In closing, PTI is grateful to the Minnesota Pollution Control Agency for the opportunity to comment on new rules governing determinations of CUU of PFAS in power tools. Please feel free to contact us with any questions regarding our comments.

Sincerely,
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[4] 40 CFR 704.3 "Known to or reasonably ascertainable by"

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The concept of essential use for determining when uses of PFASs can be phased out

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Because of the extreme persistence of per- and polyfluoroalkyl substances (PFASs) and their associated risks, the Madrid Statement argues for stopping their use where they are deemed not essential or when safer alternatives exist. To determine when uses of PFASs have an essential function in modern society, and when they do not, is not an easy task. Here, we: (1) develop the concept of "essential use" based on an existing approach described in the Montreal Protocol, (2) apply the concept to various uses of PFASs to determine the feasibility of elimination or substitution of PFASs in each use category, and (3) outline the challenges for phasing out uses of PFASs in society. In brief, we developed three distinct categories to describe the different levels of essentiality of individual uses. A phase-out of many uses of PFASs can be implemented because they are not necessary for the betterment of society in terms of health and safety, or because functional alternatives are currently available that can be substituted into these products or applications. Some specific uses of PFASs would be considered essential because they provide for vital functions and are currently without established alternatives. However, this essentiality should not be considered as permanent; rather, constant efforts are needed to search for alternatives. We provide a description of several ongoing uses of PFASs and discuss whether these uses are essential or non-essential according to the three essentiality categories. It is not possible to describe each use case of PFASs in detail in this single article. For follow-up work, we suggest further refining the assessment of the use cases of PFASs covered here, where necessary, and expanding the application of this concept to all other uses of PFASs. The concept of essential use can also be applied in the management of other chemicals, or groups of chemicals, of concern.

Environmental significance

PFASs are manmade organic contaminants that can be found everywhere in the global environment, largely as a result of their high persistence and wide use. Based on concerns regarding their high persistence and other hazardous properties, it has been argued that the production and use of PFASs should be limited to essential uses only. In this paper, we translate the concept of "essential uses" or "essentiality" into three criteria to determine when uses of PFASs are essential, or not, and demonstrate how the criteria can be applied to different use cases of PFASs. This approach can inform and encourage manufacturers, retailers and end users to consider phasing out and substituting uses of PFASs. Thus, the uses and related emissions of PFASs can be systematically limited and the long-term harm to human health and the environment can be avoided.

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Introduction

Per- and polyfluoroalkyl substances (PFASs) are a group of more than 4700 substances[1] that have been produced since the 1940s and used in a broad range of consumer products and industrial applications.[2] The multiple uses of PFASs have been well-illustrated by the FluoroCouncil.[3] PFASs can be broadly divided into low molecular weight and high molecular weight (polymeric) substances. The polymeric PFASs can be further subdivided into side-chain fluorinated polymers, fluoropolymers and perfluoropolyethers.[2] The review of Buck *et al.*[2] and the FluoroCouncil website[3] should be consulted for a detailed description of the structures, classes and uses of low and high molecular weight PFASs as that background will not be provided here.

Since 2000 there have been a number of voluntary industry phase-outs and regulatory actions to cease the manufacture and use of long-chain perfluoroalkyl acids (PFAAs; defined as including perfluoroalkane sulfonic acids (PFSAs) with perfluoroalkyl chains containing 6 carbons or more, and perfluoroalkyl carboxylic acids (PFCAs) with perfluoroalkyl chains containing 7 carbons or more) and their precursors, which can transform in the environment or within organisms to long-chain PFAAs. The most common replacements for the above defined long-chain PFAS chemistries are shorter-chain PFASs, *e.g.* PFAAs with fewer fluorinated carbons than long-chain PFAAs, and perfluoroether-based substances (PFASs with perfluoroalkyl segments joined by ether linkages).[4] Although some of these replacement PFASs are less bioaccumulative, they are all similarly highly persistent in the environment as their predecessors.[5,6] PFAAs which are considered short-chain and non-bioaccumulative may also lead to high internal concentrations if people are continuously exposed to high levels. Moreover, short-chain PFAAs, such as perfluorobutanoic acid (PFBA) and PFHxA, tend to be highly mobile and to move readily into ground and surface waters once released to the environment where they can reside for decades to centuries.[7–10] As a result of their high environmental persistence, widespread use and release of any PFAS, even polymeric PFASs,[11] will lead to irreversible global contamination and exposure of wildlife and humans, with currently unknown consequences.[12–14]

Based on concerns regarding the high persistence of PFASs and the lack of knowledge on chemical structures, properties, uses, and toxicological profiles of most PFASs currently in use, it has been argued by more than 200 scientists in the Madrid Statement that the production and use of PFASs should be limited.[12] Indeed, in the textile sector, some brand names and retailers have recognized the problems associated with PFASs and have already taken significant steps to phase out all uses of PFASs in their consumer products.[15–18]

It is neither practical nor reasonable to ban all uses of PFASs in one step. Some specific applications may serve a critical role for which alternatives currently do not exist. However, if some uses of PFASs are found not to be essential to health, safety or the functioning of today's society, they could be eliminated without having to first find functional alternatives providing an adequate function and performance. Elimination of non-essential uses of PFASs could form a starting point for a process that leads to a global phase-out (*e.g.* through the Stockholm Convention on Persistent Organic Pollutants). To critically evaluate the idea that PFASs are essential in modern society, the essentiality of PFASs should be carefully tested against the available evidence for each of their uses. Given the thousands of PFASs on the market and their many uses, this is a formidable but necessary task. Before proceeding in this task, a definition of essentiality, or essential use, is needed. If PFASs are considered non-essential in a given use, then a phase-out of PFASs from that use can be implemented. The aims and structure of this paper are therefore to: (1) define the concept of essential use or essentiality, (2) apply the concept to various use categories of PFASs to determine the feasibility of limiting use, as showcases of the concept, and (3) outline the remaining challenges for phasing out uses of PFASs in society and provide recommendations for further work. It is not our intention to conduct conclusive assessments for our selected use cases of PFASs on the individual use level. Follow-up work may be needed to cover each use case in more detail, where necessary, and to expand the application of the concept to all other uses of PFASs.

The concept of 'essential use'

This approach is based on the example of the Montreal Protocol, which phased out the use of ozone-depleting chlorofluorocarbons except for certain 'essential' uses, and which defined the concept of 'essential use' in Decision IV/25.[19] The two elements of an essential use are that a use is "necessary for health, safety or is critical for the functioning of society" and that "there are no available technically and economically feasible alternatives". To identify uses of PFASs that are non-essential, we combine the definition of essentiality with several categories of PFAS uses. Overall, this leads to the three categories summarized in Table 1.

For uses in category 1 ("non-essential" uses), a phase-out *via* a ban or restriction of PFASs can be prepared because these uses are not necessary for the betterment of society in terms of health, safety and functioning. The technical function of the PFAS (if it has one) in the use case could be considered "nice to have" (*e.g.* non-stick frying pans) but it is not essential. In many cases the "nice to have" function can be fulfilled through substitution with fluorine-free alternatives. Even where there are no alternatives to PFAS for providing the "nice to have" function, the use case can be banned or phased out because it is not essential.

Uses in category 2 ("substitutable" uses) fulfill important functions but are assessed to be non-essential because there are alternatives available that can be substituted into these products or applications and provide the necessary technical function and performance. It may be needed to make the alternatives more well-known and more easily available, but there is no fundamental obstacle to removing PFASs from these uses. Upon increased market uptake, the costs can be expected to decrease.[20,21]

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Table 1 Three essentiality categories to aid the phase out of non-essential uses of chemicals of concern, exemplified with PFAS uses

Category	Definition	PFAS examples
(1) "Non-essential"	Uses that are not essential for health and safety, and the functioning of society. The use of substances is driven primarily by market opportunity	Dental floss, water-repellent surfer shorts, ski waxes
(2) "Substitutable"	Uses that have come to be regarded as essential because they perform important functions, but where alternatives to the substances have now been developed that have equivalent functionality and adequate performance, which makes those uses of the substances no longer essential	Most uses of AFFFs, certain water-resistant textiles
(3) "Essential"	Uses considered essential because they are necessary for health or safety or other highly important purposes and for which alternatives are not yet established[a]	Certain medical devices, occupational protective clothing

[a] This essentiality should not be considered permanent; rather, a constant pressure is needed to search for alternatives in order to move these uses into category 2 above.

Uses in category 3 ("essential" uses) are considered necessary and currently have no established alternatives to PFASs that provide the necessary technical function and performance. Innovative research and development may be needed to identify chemical or engineering alternatives and to make them technically and economically feasible. By identifying these opportunities, strong market incentives will be created for industry to develop such alternatives. In support of this approach research and innovation funding could be made available specifically for this purpose, and to support start-up companies that intend to develop and market new alternatives.

Implementation of this conceptual framework could give rise to 'grey zones' where it may not be straightforward to assign a use to a particular category. For example, a grey zone might appear between categories 1 and 2 because some uses of PFASs may be considered as nice-to-have by some (stain-proof and waterproof outdoor jacket for everyday use) and as necessary by others. Similarly, a grey zone could turn up between categories 2 and 3 because the availability and performance of alternatives is being debated (*e.g.* AFFFs used by the military for extinguishing fuel fires). In order to avoid/minimize such 'grey zones' in the implementation of this conceptual framework, clear criteria and relevant processes need to be pre-defined. This would require follow-up work that is beyond the scope of the present paper.

Technical performance standards may play a role in defining whether the use of PFASs is or is not considered "essential" in certain cases. Technical performance standards are detailed specifications concerning how a product should perform in certain circumstances and are often voluntary. However, they may be used to define whether a product is of sufficient quality to be placed on the market or to be purchased through public procurement. For example, some European Union product-related legislation sets so-called "essential requirements" for certain products and then delegates the task of defining how to meet those requirements to European standard-setting bodies, such as the European Committee for Standardization (CEN). The International Standardization Organization (ISO) and national bodies such as the German Technischer Überwachungsverein (TÜV) may also set certification requirements that may be important in the design of the product performance, and how to demonstrate it. The case studies below provide several examples of how technical standards may affect whether a use of PFASs is "essential" or not.

Case studies of uses of PFASs

Below we provide descriptions of several ongoing uses of PFASs. We discuss whether the uses of PFASs are essential or non-essential based on the categorization in Table 1.

Personal care products and cosmetics. PFASs have been found in a range of different cosmetics and personal care products including hair products, powders, sun blocks, and skin creams.[22] The fluorinated ingredients in some of the products that have been chemically analyzed are listed in Schultes *et al.*[22] and include a range of fluorosurfactants and in some cases the fluoropolymer, polytetrafluoroethylene (PTFE). The use of certain PFASs in these products may lead to direct human exposure and potential health effects following dermal or oral uptake. It is not clear whether any technical function provided by the PFASs is truly necessary. After a recent campaign by a Swedish NGO publicizing the presence of PFASs in certain cosmetics, it was relatively easy for several major retailers and brands of cosmetics to quickly announce phase outs of PFASs, for example, L'Oréal, H&M, Lumene, The Body Shop, Isadora, and Kicks.[23] If PFASs in these products were needed for their technical function (possibly liquid repellency and/or to aid spreading over and into the skin) then drop-in alternatives appear to have been readily available given the rapid phase out by retailers. The use of PFASs in personal care products falls under category 1 in Table 1.

Ski waxes. Whereas most skiers use hydrocarbon-based glide waxes, fluorinated glide waxes are also available, though much

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more expensive. The fluorinated waxes are favored by competitive skiers because they are highly water repellent and result in better glide compared to hydrocarbon-based waxes. The PFASs used in fluorinated ski waxes are diblock semifluorinated *n*-alkanes (SFAs) mixed with normal paraffins.[2] PFCAs, including perfluorooctanoic acid (PFOA), have also been found in fluorinated ski waxes provided as solids or in powder form.[24] The presence of SFAs in snow and soil samples from a ski area in Sweden was recently demonstrated[25] and professional ski wax technicians working for the Swedish national cross-country ski team were shown to be highly exposed to PFCAs.[26]

From July 2020 onwards, PFOA and related substances (*e.g.* substances which might form PFOA in the environment) will be banned in all products sold in the EU, including ski waxes, due to its recent addition to the REACH Annex XVII list of restricted substances (entry 68). No essential use of PFASs in ski waxes was found in the restriction process and this use category is therefore clearly non-essential. Functioning hydrocarbon-based ski waxes were in use before the fluorinated waxes were introduced. The development of fluorinated waxes was driven by their exceptional technical performance and market opportunity. Fluorinated waxes provide a "nice to have" function that is not essential, and therefore this use case falls under category 1 in Table 1. However, European ski teams are continuing to use fluorinated waxes. The exception is Norway which in Oct 2018 announced that it has banned the use of fluorinated ski waxes in U16 categories in national competitions.[27]

Fire-fighting foams. Class B firefighting foams are formulated to extinguish fires of flammable liquids, such as liquid hydrocarbon fuels. Those currently available are either; (i) aqueous film-forming foams (AFFF), fluoroprotein foams (FP), or film-forming fluoroprotein foams (FFFP), all of which contain fluorosurfactants (*i.e.* they contain PFASs) and (ii) fluorine-free class B foams (F3) using proprietary mixtures of hydrocarbon or silicone surfactants.[28] PFAS-containing AFFFs historically contained long-chain PFAAs (and their precursors),[29] but since 2015[30] the foam manufacturers have eliminated long-chain PFAAs (and their precursors) from their products. Current fluorotelomer-based AFFF formulations contain fluorosurfactants that may transform to short-chain PFAAs (primarily PFHxA and shorter-chain PFAAs) in the environment, which are thought to be less bioaccumulative and less toxic than their longer-chain predecessors. However, short-chain PFAAs are extremely persistent and mobile, and if clean-up of soil or water is later needed, it will be extremely expensive and time-consuming, if at all possible.[13,31]

Fluorine-free class B foams were first developed in the early 2000s by the 3M Company and since then many other companies have marketed fluorine-free class B foams.[28] Many of the currently available fluorine-free foams meet the standard firefighting performance certifications applicable to PFAS-containing AFFF and related foams.[28]

Though some debate continues concerning whether PFAS-containing foams remain necessary for certain scenarios, *e.g.*, fires at refineries or involving very large fuel tanks, in recent years, a number of commercial airports, chemical industry facilities, oil and gas platforms, fire brigades and some national defense forces around the world have switched to using fluorine-free foams based on demonstrated operational performance in extinguishing fuel fires. However, US military forces are currently prevented from switching to fluorine-free foams because the applicable technical standard MIL-F-24385F(SH) – though revised in 2017 to reduce PFOA and PFOS in AFFFs – still requires fluorinated chemistry in addition to setting a performance-based requirement. Note that in October 2018, the US Congress enacted a bill[32] permitting civilian airports across the US to use non-fluorinated alternatives. Hydrocarbon-based foams have been shown to be biodegradable with only localized, short-term problems associated with their release during extinguishing fires or spillages. The silicone-based foams may contain low residual amounts of cyclic siloxanes (*e.g.* decamethylcyclopentasiloxane or D5), which have been judged to be persistent and bioaccumulative.[33] Both D5 and D4 (octamethylcyclotetrasiloxane) are listed as Substances of Very High Concern under REACH, primarily because of their vPvB (very persistent, very bioaccumulative) properties.[34]

In summary, the fluorine-free foams that have been developed and improved since the early 2000s are promising from an operational perspective[35–37] and also from an environmental and human health perspective. Some military maintain that only PFAS-containing AFFF can provide the necessary performance requirements, particularly in the case of large fuel fires. Because of ongoing debate, this use category therefore currently falls under category 2 or 3 in Table 1.

Durable water and stain repellency in textiles. Liquid repellency in textile products can range from an optional "nice-to-have" property in leisure jeans to an essential protection needed in occupational protective clothing.[38] The textile sector often refers to these chemistries as durable water repellents (DWRs), but the leading market technology repels more than just water. Since their introduction in the 1950s, the highest level of repellency for both oil/stain and water has been achieved with side-chain fluorinated polymers. Substitution to 'short-chain' side-chain fluorinated polymers (typically C^6 or C^4 perfluoroalkyl chains) has taken place in recent years. However, there is concern regarding the extreme persistence and lack of human health data for short-chain PFAAs.

A variety of new non-fluorinated DWR alternatives has been developed to create repellent textile surfaces, with a variety of polymer architectures, including linear polyurethanes, hyperbranched polymers and nanoparticles.[38] The functional moieties in terms of liquid repellency consist of either saturated alkyl chains (*i.e.* hydrocarbons) or polydimethylsiloxane (PDMS) chemistry (*i.e.* silicone polymers).[38] Although hazards associated with non-fluorinated DWRs are not yet fully understood, the development of biodegradable alternatives is an important step. Similar to the silicone-based surfactants used in firefighting foams, the silicone-based DWRs may contain residual amounts of persistent cyclic siloxanes (*e.g.* D4 and D5).

Non-fluorinated DWRs have been shown to provide high water repellency equal to short-chain fluorinated polymers and are suitable substitutes for consumer outdoor clothing.[39]

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Indeed, a number of leading brands already provide water-repellent outdoor jackets marketed as *e.g.* "fluorine-free".

However, in the case of both non-polar and polar liquids with very low surface tension (such as olive oil or gastric fluid), so far only short-chain fluorinated polymers have been shown to provide effective protection.[40] Such protection may be important in certain occupational settings where a specified level of performance is required.

Medical textiles are an example of where technical standards to protect human lives require a certain performance that may be difficult to meet without the use of PFASs. The European standard EN 13795 defines how the essential requirements set forth in the EU Medical Devices Directive (93/42/EEC)[41] should be met with respect to surgical gowns, drapes and clean air suits. Along with setting performance requirements aimed at preventing the transmission of infectious agents between patients and medical staff, EN 13795 also stipulates the test methods for evaluating whether the performance requirement is met. The test method EN 20811[42] – resistance to liquid penetration – measures the pressure at which water will penetrate the fabric and is used to determine whether the fabric will provide sufficient protection against contamination from penetration by *e.g.* bodily fluids. Current non-fluorinated DWRs may not provide sufficient liquid repellency for non-polar bodily fluids with low surface tension. An alternative is to use surgical gowns coated with a plastic laminate, which offer sufficient protection against biological fluids containing potentially harmful viruses and bacteria but may not be sufficiently breathable for longer operations.

Similarly, performance standards set by the US National Fire Prevention Association for protective clothing for firefighters and other emergency responders for water repellency, oil/stain repellency and breathability are currently not possible to meet without fluorinated chemistry. Other types of occupational clothing, *e.g.* in the oil and gas sector, may require a similar combination of water and oil/stain repellency as well as breathability. At least for now, these uses of PFASs may be considered essential and are, therefore, in category 3, until effective and safer alternatives are available.

In summary, non-fluorinated DWRs are available that provide good water repellency (and certain stain repellency) meeting consumer requirements and expectations for most outdoor apparel, casual wear, and business attire (category 2). In some cases, the use of fluorinated DWRs in textiles is "nice to have" (*e.g.* water-repellent surfer shorts), but is non-essential and falls under category 1. Only a few uses of PFAS in textiles, *e.g.* the occupational protective clothing market, where repellency of a wider range of liquids as well as breathability are necessary, fall under category 3 in Table 1. In those cases, innovative solutions are needed to provide non-fluorinated alternatives.

Food contact materials. Food contact materials (FCMs) cover a range of materials that at some stage come into contact with food. This includes (industrial) food-production equipment and machinery, food packaging, and kitchen utensils like non-stick forms and pans. Growing consumer concern over environmental and health impacts of plastic packaging has led to an increasing market pressure for alternative packaging, including paper.[43] This may result in increasing exposures to PFAS-containing paper-based materials.

The types of fluorochemistry used to protect paper and board have changed over time.[44] Initially, long-chain PFASs were used and were phased out in the 2000s.[44] Current fluorinated paper and board products are largely based on "short-chain" fluorotelomer-based polymeric products, which are side-chain fluorinated polymers containing perfluoroalkyl side chains, typically with six perfluorinated carbons,[44] and poly- and perfluoropolyethers.[45–48]

Despite reassurances by the chemical manufacturing industry that short-chain fluorinated products are safe, there is concern that PFASs will migrate into food and cause harm to human health.[44] Non-fluorinated alternatives have subsequently entered the market in recent years. For example, COOP Denmark A/S, a Danish consumer goods retailer, has succeeded in completely removing PFASs from all its products since September 2014.[49]

Although the current polymer chemistry used in paper and board in food contact materials is similar to that used in textiles, paper and board are often made for single use, whereas textiles (*e.g.* outdoor jackets) need to be durable over the lifetime of a garment. However, some paper and board products need to provide repellency to oil for weeks to months (*e.g.* butter wrappers), whereas others (*e.g.* fast-food wrappers) only require oil repellency for a matter of minutes. The substitution strategies for paper and board are therefore different than for DWRs in textiles given the difference in materials and performance requirements, and may even be different among food contact applications.

There are generally two types of barriers against grease or fat for paper and board, a physical or a chemical barrier.[44] A physical barrier preventing penetration of a liquid into the paper may be sufficient in certain types of single use applications. The chemical barrier, which is the approach used in fluorinated products, repels the grease in the food due to the very weak physico-chemical interaction between grease and paper surface. Two of the most common types of paper that provide a physical barrier against grease are Natural Greaseproof paper[50] and vegetable parchment,[51] providing a dense cellulose structure that prevents the grease from soaking into the paper. There are also various non-fluorinated chemical barriers that can provide similar repellency to grease as fluorinated repellents, including hydrocarbon- and silicone-based alternatives.[52] A third alternative is to add physical barriers such as aluminum or plastic coatings to the paper to provide protection.[53]

In food production, PFASs are mainly used as non-stick fluoropolymer (*e.g.* PTFE) coatings of (metal) surfaces to lower friction (which protects the equipment from abrasion), to minimize adhesion (which allows better cleaning of surfaces), as non-stick- or heat- and acid-resistant fluoroelastomer membranes on conveyor belts, and as lubricant oils and greases in machinery.[54–57] Many of the same uses exist in household kitchen utensils and appliances. These uses are described in

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industry patents and commercial materials,[54] but the levels and types of PFASs have been studied only to a limited extent.[58,59]

Non-stick kitchenware is normally produced by either spraying or rolling layers of PTFE onto the surface of the kitchenware. One could argue that the non-stick is a "nice to have" function rather than an essential function given that it is possible to cook food without the non-stick functionality. If the non-stick coating is considered an essential function in a modern society, then other possible non-stick coatings are available, including: enamelled iron-, ceramic-, and anodized aluminium coatings.[60]

In summary, non-fluorinated alternatives have been historically available for all applications of paper-and-board food packaging and the use of fluorinated protective coatings has never been essential (category 1). For example, COOP, a major grocery retailer in Denmark, has found alternatives for all products that previously used PFASs.[49,61] For non-stick cookware there are also non-fluorinated non-stick alternatives which work well in households and this is also not an essential function (category 1). In the food production industry non-fluorinated conveyor belts, lubricants and greases exist, but it is not clear currently whether functional alternatives to fluoropolymer protection against abrasion exist (categories 2 or 3).

Medical devices. Another use of fluoropolymers is as coatings in catheters, stents and needles to reduce friction and improve clot resistance and to provide protein-resistance in filters, tubing, O-rings, seals, and gaskets used in kidney dialysis machines and immunodiagnostic instruments.[3,54,62] The safety evaluation of these devices for use in humans was discussed by Henry *et al.* (2018).[63] After review, multiple regulatory agencies have concluded that the use of PFASs in these products, including in devices implanted into patients' bodies, does not pose an appreciable risk because the fluoropolymers are not bioavailable.[63–65] It is however unclear whether impurities of fluoropolymer processing aids such as PFOA and HFPO-DA were included in the regulatory reviews.

In summary, the inclusion of fluoropolymers into medical devices confers several benefits and does not appear to pose substantial health risks to those who are exposed to these devices through procedures or who have received implants. However, the production and disposal of these devices will continue to lead to the release of PFASs into the environment unless steps are taken to eliminate environmental releases. The use of PFASs in medical devices falls under categories 1–3 in Table 1 (depending on specific use). However, due to limited information in the public domain, it is currently unclear if all medical devices need fluoropolymers or only certain types of medical devices need fluoropolymers.

Pharmaceuticals. There are a wide range of fluorine-containing pharmaceuticals.[66] Since the first fluorine-containing drug was approved by the U.S. Food and Drug Administration (FDA) in 1955, nearly 150 fluorinated drugs have reached the market and about 30% of newly approved drugs contain fluorine constituents including fluoroalkyl groups (a smaller subset can be defined as PFASs). According to Zhou *et al.* (2016),[66] fluorinated drugs encompass all therapeutic areas, are structurally diverse, and are among the most-prescribed and/or profitable in the U.S. pharmaceutical market.

Fluorination of pharmacological agents is often used to enhance their pharmacological effectiveness, increase their biological half-life, and improve their bioabsorption.[66] Some agents are analogous to the long-chain PFASs, such as several types of artificial blood formulations and drugs for the lungs of prematurely born children (for example: perfluorooctyl bromide, an eight-carbon bromine-substituted PFAS[67]). However, most fluorine-containing pharmaceuticals have only one or two fluorine atoms. A smaller number of drugs contain one or two trifluoromethyl groups ($-CF_3$), or the perfluoroalkyl moiety C_nF_{2n+1} as defined by Buck *et al.* (2011).[2] As these agents become more widely produced, prescribed, and used, disposal of these fluorinated drugs (*e.g.* through municipal wastewaters) is likely to lead to increasing environmental releases of various PFASs. A transformation product of nearly all of the anesthetics is trifluoroacetic acid (TFA or CF_3COOH), which can arise from several metabolic or atmospheric degradation pathways[68] and has been a cause of environmental concern.[69–71]

In summary, the addition of 1–3 fluorine atoms or trifluoromethyl groups to various pharmaceutical agents has improved their efficacy, half-lives, and bioabsorption and does not appear to pose substantial health risks to those who take them, relative to analogous non-fluorinated drugs. However, their production and disposal will continue to lead to the release of PFASs into the environment unless steps are taken to eliminate environmental releases. Releases of human metabolic excretion products may pose an additional environmental concern (contamination of water and greenhouse gases) as these drugs become more widely used. The uses of $-CR_2F$, $-CRF_2$, and $-CF_3$ groups in pharmaceuticals should not be evaluated for essentiality as a single group, as specific applications will likely fall under either categories 2 or 3 in Table 1; there are functional non-PFAS alternatives for some pharmaceutical applications, whereas for other uses the pharmaceuticals have life-saving functions.

Laboratory supplies, equipment and instrumentation. PFAS-containing products, in particular fluoropolymers, are also ubiquitous in laboratories, laboratory supplies and analytical instrumentation. Initially this caused major concerns regarding PFAS contamination of environmental and biological samples during PFAS analysis and maintaining quality control in PFAS analysis.[72,73] The PFASs are used because they have high resistance to chemicals and heat, weak interaction with other substances and low permeability, which prevent chemicals/analytes from being adsorbed to the surface and absorbed into the material.

In the laboratory, there are easily identifiable fluoropolymer (*e.g.* PTFE) and fluoroelastomer-based products (*e.g.* Viton). Examples include the use of fluoropolymer-based vials, caps and tape, and fluoropolymers in the solvent degassers of liquid chromatography (LC) instruments. Non-PFAS replacements may be available, depending on the purpose. Personal protective equipment can also contain PFASs, including protective gloves and protective mist/anti-fog coatings of glass (*e.g.* PFPE). These applications can in general be substituted without major

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loss of functionality or performance; recommendations for PFAS-free alternatives are often provided as part of guidance to prevent cross-contamination when sampling or analyzing environmental matrices for PFAS.[74–76]

As part of field or laboratory collection of particles of different sizes, some filters are made of or are coated with PFASs to minimize sorption of compounds to the filter itself, such as glass fiber filters, or ultrafiltration filters. As an alternative plastic filters/vials with a low solid surface energy can be used (*e.g.* polypropylene (PP), polytetramethylene oxide (PTME) and polyamide (nylon)).[46,77]

More difficult to replace are fluoropolymer and fluoroelastomer seals (O-rings), and fluoropolymer-based tape within internal components of existing instrumentation. As a result of advances in analytical instrumentation, in particular ultra high-performance liquid chromatography (UHPLC), the use of fluoroelastomers is widespread as seals and membranes and PTFE as inert surfaces inside analytical instruments and in some cases as tubings. The tubing can be replaced by polyetheretherketone (PEEK) or stainless steel tubing without a loss of performance in most applications. Some applications rely on fluorinated solvents (*e.g.*, trifluoroethanol) and acids (trifluoroacetic acid, pentafluorobutanoic acids *etc.*) added to reversed phase LC-MS solvents, and specialty LC-columns are based on fluorinated materials. Non-fluorinated alternatives exist for both these uses.

Perfluoropolyether-based lubricants are also used as oils and greases in pumps and equipment; this can cause laboratory background contamination. Oil-free pumps exist and are reducing the laboratory background contamination, which is beneficial for both the analyses and workers' health. To address concerns related to instrument contamination by PFASs, manufacturers offer a delay column to keep the instrument-borne PFASs from eluting with target analytes during the same time window.

For the vast majority of laboratory applications, PFAS alternatives have been used historically or have been newly developed. Therefore, most applications fall within categories 1–2 in Table 1 and *i.e.*, they are non-essential and replaceable. A small number of current laboratory applications may fall within category 3 as being essential and without appropriate alternatives, and thus further innovation for effective substitution is required.

Perfluorosulfonic membranes. These are fluoroelastomers that exist in many forms and are used in a wide range of chemical synthesis and separation operations and in analytical instrumentation. These membranes are often used in processes that displace less efficient historical methods that use more energy and/or generate hazardous materials and byproducts.[78,79] Nafion® (CAS Number 66796-30-3) is the brand name for a perfluorosulfonic acid membrane from Chemours (formerly DuPont) that consists of a perfluorosulfonic acid copolymer with pendant sulfonic acid groups. It is stable in strongly oxidizing conditions and high temperatures. The density of sulfonic acid groups can be controlled during synthesis to select for variable ion exchange capacity, electrical conductivity, and various mechanical properties.

One of the earliest principal uses of Nafion was as a membrane in the chlor-alkali process, which is the large-scale industrial process that uses brine and electricity to produce the common chemical feedstocks, chlorine gas and sodium hydroxide.[80] Historically these high-volume chemical commodities were prepared with brine in either asbestos diaphragm cells or mercury electrode cells. Both methods generate substantial quantities of hazardous wastes through either the mining and the fabrication of suitable asbestos membranes or the release of aqueous and volatile mercury wastes. Use of Nafion copolymer as a membrane in the electrochemical cell allows for excellent conductance of ions necessary for the process, while maintaining separation of the two parts of the cell under highly caustic conditions.

Perfluorosulfonic acid membranes are also used in high-efficiency fuel cells where, in one example, hydrogen and oxygen are pumped into different chambers within a cell that are separated by the membrane, giving rise to a continuous supply of electricity for various specialty applications. Perfluorosulfonic acid membranes are also used as an acid catalyst in a wide range of chemical conversions leading to decreased energy inputs and higher-purity products.

While it can be argued that perfluorosulfonic acid membranes have made many chemical preparation processes more efficient and cleaner, it is also important to acknowledge that the impacts from their production and use are still poorly understood. Research at one fluorochemical production site in Bladen County, North Carolina has documented that Nafion-related wastes have been released into the nearby Cape Fear River since at least 2012.[81] Moreover, the relatively advanced drinking water treatment plant in the city of Wilmington, North Carolina, has been unable to remove these Nafion-related wastes[82,83] giving rise to a situation where approximately 99% of the residents of Wilmington now have measurable concentrations of Nafion Byproduct 2 in their blood.[84] No human health data are currently available for Nafion Byproduct 2, and the human half-life of this material is likely to be on the order of months to years.[83] The production of perfluorosulfonic acid membranes has provided great utility by improving the efficiency of large-scale chemical syntheses while also reducing the emissions of other known hazardous byproducts (asbestos and mercury), but the current production process leads to the release of at least one persistent byproduct with near universal exposure in a downstream community.

The use of perfluorosulfonic acid membranes is currently judged to be category 3 (essential) in the chlor-alkali process. Before the use of Nafion, there were concerns for worker safety and the environment associated with mercury and asbestos. The use of Nafion as an alternative was the direct result of the chlor-alkali industry addressing these concerns. In the case of the use as a proton exchange membrane (PEM) in fuel cells, there are alternatives to perfluorosulfonic acid membranes,[85] but these are under development and not used as commonly as Nafion (category 2). Although there is a lack of functional alternatives for certain applications, it is reasonable to insist that emissions of persistent and potentially toxic wastes from

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the production and use of perfluorosulfonic acid membranes be quantitatively determined and minimized.

Discussion

The Montreal Protocol has provided a successful blueprint to assess the essentiality of a class of widely used persistent chemicals found to have significant human and environmental health risks. Because of their extreme environmental persistence, and increasing data on their adverse effects including human health-related endpoints, PFASs are a prime opportunity for applying a similar approach to protect human health and the environment through the removal of these chemicals from non-essential uses. Our review of several key uses of PFASs demonstrates that currently a global phase-out of PFASs will be complicated, but it also indicates a number of starting points. In particular, different phase-out strategies will be required for each essentiality category. The essentiality of PFASs in the different use categories, based on our three categories in Table 1, is summarized in Table 2. Within a few of the larger use categories (*e.g.* textiles) certain uses of PFASs appear to be easier to phase out (*e.g.* leisure rain jackets) than others (occupational protective clothing) due to different technical performance requirements.

Alternatives assessment

Even if PFASs are assessed, according to the criteria in Table 1, to be non-essential in a particular use, and functional alternatives are available, this is only a first step to phase out and responsibly substitute PFASs. It cannot be generally assumed that non-fluorinated alternatives will be less harmful to human health and the environment than the PFASs they are replacing. The scientific discipline of alternatives assessment has established processes and best practices for identifying, evaluating, comparing, and selecting safer alternatives to chemicals of concern based on hazards, performance, and economic viability.[86–88] This process can be applied to PFASs used in material components, finished goods, manufacturing processes, or technologies. Not all substitutions require direct replacements of a fluorinated compound with a non-fluorinated alternative (*i.e.* chemical alternative); a technological or engineering innovation (*i.e.* functional alternative) can be equally successful[4] and should always be encouraged/prioritized over chemical alternatives. Multiple alternatives should be assessed for a given PFAS until an acceptable substitution is found. Often, once an alternative is found for one use case, it may be easily adapted for other use cases of that chemical as well. In the assessment, once possible non-hazardous alternatives are identified, it is also important to consider multiple endpoints[89] such as energy use, material use (incl. food waste, water use, packaging/machinery use and durability), and land-use (*e.g.* paper *vs.* plastic *vs.* glass), to avoid burden-shifting between different environmental and human impacts.

When considering chemical alternatives for PFASs, the focus should be on the service the product should deliver. The compound should therefore be evaluated for performance using the specifications required for the product, as opposed to comparing directly to the PFAS being replaced. Additionally, the potential for health hazard and potential for exposure – combined, these elements establish the health risks associated with the alternative – must be considered for the general public and vulnerable populations. Finally, additional considerations such as product longevity, persistence in the environment, and sustainability may be considered. Currently there are several established frameworks and evaluation metrics available for conducting alternative assessments.[86,90] In the absence of a thorough evaluation, regrettable substitutions can occur.

Table 2 Essentiality of PFASs in selected use categories

Use	Table 1 Category[a]
Personal care products including cosmetics	1
Ski waxes	1
Fire-fighting foams (commercial airports)	2
Fire-fighting foams (military)	2 or 3
Apparel (medical: long operations)	3
Apparel (protective clothing oil and gas industry)	3
Apparel (medical: short operations, everyday)	2
Apparel (military: occupational protection)	2 or 3
Waterproof jacket (general use)	2
Easy care clothing	1
Food contact materials	1, 2 or 3
Non-stick kitchenware (fluoropolymers)	1 or 2
Medical devices (fluoropolymers)	1, 2 or 3
Pharmaceuticals	2 or 3
Laboratory supplies, equipment and instrumentation	1, 2 or 3
Perfluorosulfonic membranes in fuel cells	2
Perfluorosulfonic membranes in chlor-alkali process	3

[a] Note that the categories in the above table represent the current evaluation and may change in the future.

Challenges and opportunities in chemical regulation

The Madrid Statement[12] recommends limiting the use of PFASs in society. Although all PFASs are highly persistent (or lead to highly persistent transformation products), many of them do not comply with the usual concerns considered in international chemical regulation. It can be argued that their extremely high persistence alone should be cause for regulation and substitution,[13,14] but the practical regulatory tools to implement this approach are currently lacking.

Within the context of the EU REACH Regulation, it has been argued[91] that the most effective way of regulating short-chain PFASs (as with the regulation of long-chain PFASs) is to identify them as Substances of Very High Concern under REACH Article 57, followed by a REACH Annex XVII restriction. Indeed, the EU has considered (*e.g.* in the case of the restriction of PFOA and its related chemicals), and is continuously considering ways to group PFASs in recognition of the impossibility of regulating more than 4700 PFASs individually.

Another relevant regulatory framework is the UN Stockholm Convention on Persistent Organic Pollutants, which includes

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exempted uses similar to the essential-use exemptions under the Montreal Protocol. Under the Convention, the Conference of the Parties (COP) considers listing new persistent organic pollutants for elimination (Annex A), or restriction (Annex B), and/or involuntary production (Annex C) based on a recommendation from the Convention's Persistent Organic Pollutants Review Committee (POPRC). The Convention requires that the COP, "taking due account of the recommendations of the Committee, including any scientific uncertainty, shall decide, in a *precautionary* manner, whether to list the chemical, and specify its related control measures, in Annexes A, B and/or C" (Art. 8, Para. 9). As part of its deliberation of whether to list a chemical, the COP also considers whether to allow for any "specific exemptions" and/or "acceptable purposes". "Specific exemptions" is time-limited with one period of five years with the possibility of one extension for another five years, whereas the time period for the applicability of "acceptable purposes" is more open-ended.

Currently, there is no clearly defined criteria for identifying "specific exemptions" and "acceptable purposes" set in the text of the Stockholm Convention. Such "essential use-like" exemptions are primarily identified through the work of the POPRC on a case-by-case basis. However, the COP has subsequently adopted detailed criteria for consideration of requests to extend specific exemptions. For production exemptions, the requesting party must have submitted a justification for the continuing need for the exemption that establishes that the extension is necessary for health or safety, or is critical for the functioning of society; included a strategy in its national implementation plan aimed at phasing out the production for which the extension is requested as soon as is feasible; taken all feasible measures to minimize the production of the chemical and to prevent illegal production, human exposure and release into the environment; and the chemical must be unavailable in sufficient quantity and quality from existing stockpiles. Finally, in the case of a party with an economy in transition, the party must have requested technical or financial assistance pursuant to the Convention, in order to phase out as soon as feasible the production for which the extension is requested (see COP Decision SC-2/3, "Review process for entries in the Register of Specific Exemptions"[92]).

We are convinced that having clear legal guidelines for what constitutes an essential use (a process started in this present work) will benefit the Stockholm Convention and other regulatory frameworks by providing guidelines for determining how to apply the essential use-like exemptions, *i.e.*, by balancing costs *versus* the societal benefits of the use of a substance or product. A clear definition of essential use ensures that only those applications that are necessary for health or safety (or other purposes highly important to society as a whole) and for which non-fluorinated alternatives are not yet available could receive exemptions when chemicals are listed under the Convention. Further, this approach would protect those uses that are legitimately deemed essential until appropriate substitutions can be identified.

The way forward

Innovation in the development of alternatives to PFASs is ongoing and many functional alternatives that provide adequate technical performance have been developed and put into practice for some use categories. However, in other use categories little innovation is under way, due to lack of financial or regulatory drivers to change methods/production, significant technical challenges, lack of awareness of the market opportunities, or the small size of the market. Innovation is being encouraged in countries like Denmark (*e.g.* substitution of PFASs in textiles) and in Sweden through the availability of government funding for industry-academic partnerships (*e.g.* the POPFREE project[93] to encourage small companies to develop non-fluorinated alternatives to PFASs). Furthermore, one of the four key areas in ECHA's 2018 strategy on substitution[94] is to 'Develop coordination and collaboration networks between all stakeholders, ranging from institutions, member states, industry, academia and civil society'.

In some cases, the PFASs in a product or use will be determined as the only compound capable of delivering the required level of performance for that application. In these cases, it is recognized that immediate phase out will not be feasible. But this assessment is only based on current technologies. With clear legislative incentives, new technologies will typically be developed, and consequently PFAS uses in category 3 should continue to be reviewed for potential removal or replacement by new entrants to the market. In fact, use cases identified as category 3 should be the targets of industry and academic programs to develop innovations that may succeed in removing or replacing the PFAS with more sustainable functional alternatives. This system creates a market pressure to be the first to develop new technologies.

Chemical regulation on the other hand progresses slowly compared to product innovation, and assessment of individual PFASs is not feasible for protecting public health. It is simply unlikely that society and industry will spend the money and time to generate adequate data to risk assess >4700 PFASs. Therefore, we strongly recommend a grouping approach be employed, and for PFASs to be regulated as a group. Since regulation of the many thousands of PFASs by authorities is likely to be time consuming, it is important for industry (in particular product designers and manufacturers) to take voluntary measures that will contribute substantially in reducing the emissions of PFASs and their presence in products. There have already been several examples of retailers who through private procurement have phased out PFASs from their supply chains (*e.g.* IKEA, Lindex, and H&M in Sweden,[15,17,95] COOP in Denmark,[61] Vaude in Germany,[96] L'Oreal in France[97]), which in turn puts pressure on chemical manufacturers to find safer alternatives.

We are convinced that our criteria on essential use can inform and encourage other retailers to consider phasing out and substituting PFASs in their products. These types of voluntary measures will in turn help regulators by demonstrating that functional alternatives exist. When policy makers face stakeholder groups from both sides, they can use data-

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driven essentiality assessments to support their decision making, *e.g.*, to show why certain uses are not necessary and therefore can be restricted. This will speed up regulatory actions in support of phasing out non-essential uses of PFASs, without risk to health or safety applications.

It is a formidable task to apply the essential use concept to all use cases of PFASs in detail. We have made a start here by illustrating how the concept can be applied to several use cases of PFASs, but to have a conclusive assessment for each use case described in this review, follow-up work may need to be covered in more detail (expanded, subdivided and refined) and engage relevant stakeholders with the necessary in-depth knowledge, where necessary. Although here we have focused on PFASs, the concept of essential use can also be applied in the management of other chemicals, or groups of chemicals, of concern.

Conflicts of interest

This paper does not necessarily reflect the opinion or the policies of the German Environment Agency or the European Environment Agency.

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ADVANCED RECHARGEABLE & LITHIUM BATTERIES ASSOCIATION

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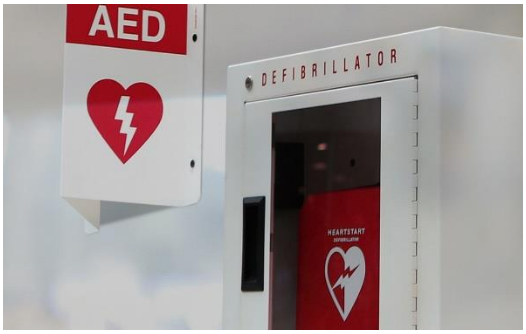
Application for derogations from PFAS REACH restriction for specific uses in batteries



April 2023

First submission

By RECHARGE

RECHARGE Members

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Executive Summary

The PFAS (Per and polyfluoroalkyl substances) REACH restriction proposal will have a major impact on the battery industry. This document provides RECHARGE’s feedback to the public consultation and the latest proposal of 22 March. For specific applications where PFAS are used in batteries, RECHARGE is **requesting derogations and additional transition times to provide sufficient time for the battery industry to identify and implement alternative non-PFAS solutions**.

Batteries are a main enabler for the transition towards low-emission mobility, decarbonised energy generation and digitalisation. Batteries power a wide range of general public applications such as smartphones, tablets, power tools, hearing aids, defibrillators, safety lighting in public buildings, and provide many services to industry such as back-up power for mission critical industrial assets (from nuclear power plants to data centres), energy storage systems for electrical grids, traction power to forklift trucks and AGV’s, and deliver energy to a wide variety of machines such as drones, rockets, satellites and IoT objects. Batteries also provide power to an increasing number of mobility solutions such as e-bikes, e-scooters and electric vehicles. They generate significant economic growth and provide jobs for millions of people.

This document details what types of PFAS are used in batteries and why, whether there are non-PFAS alternatives available, what are the tonnages of PFAS consumed and emitted, the socio-economic impact assessment of the proposed PFAS restriction for the battery value chain and finally proposes best practices that the battery industry and legislators could implement to further minimise emissions. All statements provided in this document are supported by scientific evidence.

Contents

1 Introduction and scope

RECHARGE represents over 60 organisations spanning all aspects of the battery value chain. The scope of this document as feedback to the ECHA consultation includes the following types of high performance, advanced rechargeable and lithium batteries:

- Lithium-ion rechargeable batteries (also known as Li-ion batteries)
- Lithium (Li) primary batteries (also known as primary Lithium batteries)
- Nickel–based rechargeable batteries (Ni-Cd and Ni-MH)
- Metal air batteries
- Zinc oxide batteries
- Silver oxide batteries
- Sodium-ion (Na-ion) rechargeable batteries
- Zinc-ion (Zn-ion) rechargeable batteries
- Solid-state batteries
- Lithium metal rechargeable batteries
- Other battery technologies currently under research

The only type of rechargeable battery which does not use PFAS is lead-acid batteries. However, lead-acid batteries have a low energy density. Lead-acid batteries cannot be used as suitable alternatives for the technologies presented above and applications they serve. These technologies serve applications where a variety of performances are required, amongst which are high energy, high power, very long life, superior reliability, ability to withstand extreme temperatures. Lead-acid batteries have limited capacity in these respects and cannot be considered as suitable alternatives. In addition, lead compounds used for battery manufacturing and lead metal have been recommended by ECHA for inclusion on Annex XIV respectively in the 6th and 11th recommendations.

Batteries are a main enabler for the transition towards low-emission mobility, decarbonised energy generation and digitalisation. Batteries power a wide range of **general public** applications such as smartphones, tablets, power tools, hearing aids, defibrillators, safety lighting in public buildings, and provide many services to **industry** such as back-up power for mission critical industrial assets (from nuclear power plants to data centers), **energy storage systems** for electrical grids, traction power to forklift trucks and AGV’s, and deliver energy to a wide variety of machines such as drones, rockets, satellites and IoT objects. Batteries also provide power to an increasing number of **mobility** solutions such as e-bikes, e-scooters and electric vehicles. They generate significant economic growth and provide jobs for millions of people. Batteries are essential to ensure the sustainable development of society and provide critical environmental and social benefits.

This document has been produced using information provided by our members, company reports, governmental publications, patent reviews and academic articles. All statements provided in this document are supported by scientific evidence.

This is a first submission. RECHARGE will update this document with additional information during the public consultation.

2 Why are PFAS used in batteries and where?

Batteries are comprised of two electrodes, a separator and an electrolyte, as schematized in Figure 1. Each electrode consists of an active material mass which is coated onto a current collector.

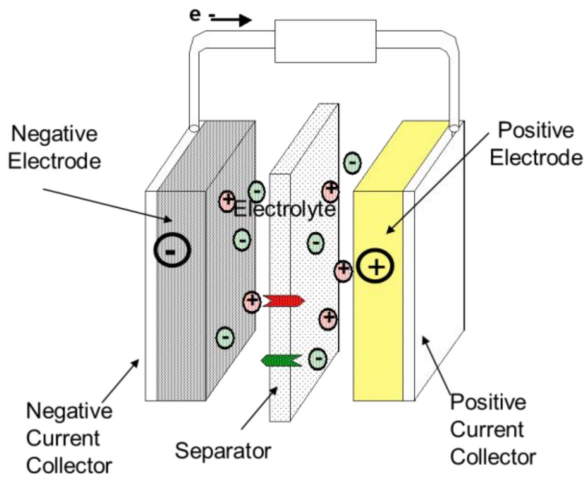

Figure 1. Components of a battery

PFAS have very unique properties:

- Water, oil and dirt repellent
- Durable under extreme conditions (high temperature, pressure, and aggressive chemicals)
- Electrical and thermal insulation.

As chemical resistance and tolerance to a high range of working temperatures are crucial for batteries, PFAS are used in key components for all high performance and lithium battery technologies. PFAS are used in key components in:

- Active material masses
- Electrolytes
- Valves, gaskets, washers & membranes
- Coatings

2.1 PFAS used in active material mass of electrodes

Each electrode is a composite which is manufactured by coating an active material mass onto a current collector (as shown in Figure 2). The active material mass comprises an active material, conductive additives (when needed) and a binder material.

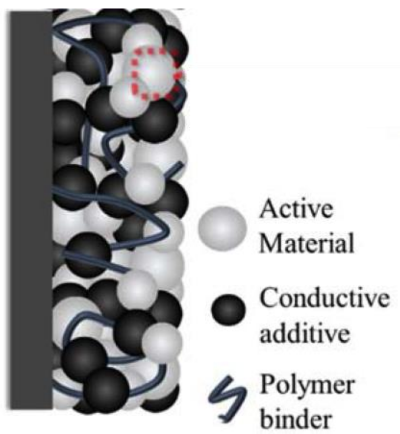

Figure 2: Composite electrode materials

Binder material is used to hold the active material particles together within the composite electrode and to provide a strong connection between the electrode and the current collector. The binder material plays an important role in the manufacturability of the battery and in the battery performance.

Due to their unique properties, both Polytetrafluroethylene (PTFE) and Polyvinylidine difluoride (PVDF – both homopolymer and copolymer) are used as binder materials in the active material masses in electrodes in a wide range of battery technologies, as detailed in Table 1.

Table 1. Binders used in active material masses for different battery technologies

Battery technology	Positive electrode	Negative electrode	Electrolyte
Li-ion (wet-process)	**PVDF** with NMC, NCA, LCO, LMO, LFP active masses	SBR/CMC with graphite anode, **PVDF** with LTO anode	Liquid organic electrolyte
Li-ion (dry process)	**PTFE** with NMC active mass	SBR/CMC with graphite anode	Liquid organic electrolyte
Na-ion	**PVDF** with PBA, Na-NFM and phosphate based active masses	**PVDF** with hard carbon anodes	Liquid organic electrolyte
Solid-state LMP	PEO with LFP active mass	No binder required for metallic lithium anode	Polymeric layer including PEO and **PVDF**
Ni-based rechargeable batteries	**PTFE** with Ni(OH)2 foam active mass	**PTFE** with Cd or MH electrode	Liquid alkaline electrolyte
Primary Li-SOCl2	**PTFE** with carbon anode	No binder required for metallic lithium	SOCl2 electrolyte
Primary Li-SO2	**PTFE** with carbon anode	No binder required for metallic lithium	SO2 electrolyte
Primary Li-MnO2	**PTFE** with Mn02 active mass	No binder required for metallic lithium	Liquid organic electrolyte
Primary Zn-Air	**PTFE** with MnO2 active mass	**PTFE**-membrane	Liquid alkaline electrolyte
Lithium metal rechargeable	**PVDF (and PTFE), with** with NMC, NCA, LCO, LMO, LFP	No binder required for metallic lithium	Liquid organic electrolyte, PE/PP or cellulose separator

2.1.1 PVDF used in active material mass of electrode

Although the PVDF binder comprises only a small portion of the composite electrode (typically 2–5% of the mass of the electrode[1]), the binder plays four important roles in battery performance. The PVDF binder:

- helps to disperse the active material and the conductive additive in the solvent during the fabrication process, enabling a homogeneous distribution of the slurry,
- holds the active material and the conductive additive together and connects them to the current collector, ensuring the mechanical integrity of the solid electrode without significantly impacting electronic or ionic conductivity (see Figure 2),
- acts as an interface between the composite electrode and the electrolyte. In this role, the PVDF binder protects the composite electrode from corrosion and the electrolyte from depletion while facilitating ion transport across this interface,
- tailors the viscosity of the slurry to allow a smooth coating onto the current collector during electrode manufacturing.

PVDF has several unique properties that enable it to fulfil these critical roles:

- **Mechanical properties**, including stiffness, toughness and hardness as well as good adhesion to the active material, the conductive additive, and the current collector. PVDF ensures the flexibility of electrode for cylindrical designs. The positive electrode binder must be able to withstand the forces that result from the expansion and contraction of active materials during charge/discharge cycles,
- **Thermal properties**, particularly thermal stability, are also important, both for the high temperatures commonly used for curing and drying during electrode fabrication and also for operation of the battery at various temperatures,

[1] Cholewinski, A., Si, P., Uceda, M., Pope, M., & Zhao, B. (2021). Polymer Binders: Characterization and Development toward Aqueous Electrode Fabrication for Sustainability. *Polymers*, *13*(4), 631–. https://doi.org/10.3390/polym13040631

- **Good dispersive capabilities** are important to help distribute the slurry evenly over the current collector during fabrication,
- **Chemical and electrochemical stability** are essential properties to enable the binder to function for long periods and over numerous cycles without degradation of the battery. The positive electrode binder must not react with any other components or intermediates formed during operation. In particular, the positive electrode binder must remain stable at the high and low voltage potentials experienced by the cathode. PVDF is the only proven material that can sustain a large voltage range from 0 to 5V at industrial scale for various battery designs (cylindrical, prismatic and pouch cell) and high-capacity cells. This stability guarantees its safe use in the electrochemical environment of the lithium cell.

All Lithium-ion battery manufacturing processes use PVDF as the binder material for all types of positive electrodes. Many other binder materials have been evaluated as replacements for PVDF, however all other materials have been found to oxidise at the high voltage at the positive electrode.

PVDF was previously also used as the binder material for all negative electrodes, however companies using graphite negative electrodes have successfully substituted PVDF with water-based CMC/SBR binder materials. For other types of negative electrodes using higher voltage materials such as lithium titanate oxide (LTO), NTO (Niobium Titanate Oxide)[2] the use of PVDF binder material is required because no research on alternative non-PFAS binders has proved sufficiently conclusive for transfer to industrialization to date.

For Sodium-ion rechargeable batteries, some research is ongoing regarding non-PFAS SBR/CMC binder materials for some hard carbon/PBA cells but this research work has not yet been scaled up. PVDF is preferred with some other PBA materials[3] and with hard carbon[4].

[2] Next-Generation SCiB™ supporting smart mobility in the age of MaaS, Using Niobium Titanium Oxide (NTO) as a next-generation anode material. (n.d.). https://www.global.toshiba/ww/products-solutions/battery/scib/next/nto.html
[3] Wessels, C., D., Motallebi, S., (2020). Electrolyte Additives for Electrochemical Devices. Patent No.: US 10 862 168 B2. https://app.dimensions.ai/downloads/patents?ucid=US-10862168-B2
[4] Barker, J. & Heap, R., (2020). Metallate Electrodes. United States Patent. Patent No.: US 10 756 341 B2. https://patentimages.storage.googleapis.com/4e/07/f0/c9dd46a4691e63/US10756341.pdf

Next generation Lithium-ion battery developments are focussed on producing cathodes using a dry process which avoids the need for NMP solvent. This dry process will significantly reduce energy consumption and lower environmental footprint. However, the dry process requires the use of PTFE or PVDF as the cathode binder material[5,6].

2.1.2 PTFE used in active material masses of electrode

Industry outreach has confirmed that all leading manufacturers of primary batteries based on the technologies listed in Table 1 use PTFE, or another fluoropolymer, as the binder material for the positive electrode. PTFE is used as the binder material for the positive electrode in Lithium primary batteries to provide three main functions:

1. Mechanical cohesion between the positive electrode particles to enable electrode integrity during cell assembly and throughout the lifecycle of the battery storage and use,
2. Lubricant to allow the electrode particles to slide over each other during electrode formation (compression) giving uniform electrode density that is important to consistent battery performance and longevity,
3. Lower water absorption during mixing (PTFE is a hydrophobic material) and more complete drying during electrode baking - low moisture content is critical in Lithium chemistry.

PTFE provides a unique combination of properties that are essential for the performance and durability of Lithium primary batteries:

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[5] Xi, X., Mitchell, P., Zhong., L. & Zou, B., (2009). Dry particles based adhesive and dry film and methods. Unites States Patent Application Publication. Publication No.: US 2009/0239127 A1 http://pdfs.oppedahl.com/US/20090239127.pdf

[6] *BMW Poster at IBA 2022,*
Degen, F., & Kratzig, O. (2022). Future in Battery Production: An Extensive Benchmarking of Novel Production Technologies as Guidance for Decision Making in Engineering. IEEE Transactions on Engineering Management, 1–19. https://doi.org/10.1109/TEM.2022.3144882;
Li, Y., Wu, Y., Wang, Z., Xu, J., Ma, T., Chen, L., Li, H., & Wu, F. (2022). Progress in solvent-free dry-film technology for batteries and supercapacitors. *Materials Today (Kidlington, England)*, *55*, 92–109. https://doi.org/10.1016/j.mattod.2022.04.008;
Lu, Y., Zhao, C.-Z., Yuan, H., Hu, J.-K., Huang, J.-Q., & Zhang, Q. (2022). Dry electrode technology, the rising star in solid-state battery industrialization. Matter, 5(3), 876–898. https://doi.org/10.1016/j.matt.2022.01.011

- **High chemical stability** against the solvents used in Lithium primary batteries (such as thionyl chloride, sulphur dioxide and organic solvents),
- **High electrochemical stability**, which is necessary due to the high voltages (up to 3.9 V),
- **High temperature stability** to withstand the temperature necessary for drying the electrodes and provide stability in high temperature applications,
- **Good adhesion properties** to hold the active mass together in the electrode and provide adhesion to the current collector,
- **Good dispersion properties** to ensure the uniformity during the manufacturing of the electrodes,
- **Unique fibrillation properties**, very low concentrations are needed to hold the active mass in place without covering the active mass surface, this provides excellent porosity, which is needed for good penetration of the electrolyte,
- **Mechanical flexibility** to allow the winding of the electrode during cell assembly.

Polyvinyl alcohol (PVA, CAS 9002-89-5) or Poly(acrylic acid) (PAA, CAS 9003-01-4) may be added to the positive electrolyte binder material to create void volume after baking, this helps with electrolyte absorption.

PTFE is also used as the binder material for the positive and negative electrodes in industrial stationary Ni-Cd and Ni-MH rechargeable batteries.

2.2 PFAS used in electrolytes

PFAS is used in the electrolytes for Lithium-ion rechargeable, Lithium primary, Lithium metal rechargeable, and Sodium-ion rechargeable batteries.

In rechargeable batteries, LiPF6 (which is not a PFAS) has been widely used in older battery technologies for many years. However, recent advances in battery technology have established the use of PFAS substances as state-of-the-art for high performance batteries today, including as additives and as Lithium salt with PFAS anion. These include Lithium salts of PFAS monomers such as Li-Triflate

(CAS 33454-82-9), LiTFSI (CAS 90076-65-6), LiBETI (CAS 132843-44-8), LiFAP (LiPF3(CF2CF3)3n and LiTDI (CAS 761441-54-7). Examples of PFAS additives include Tris(2,2,2-trifluoroethyl)borate (TFEB CAS 659-18-7) and Trifluorotoluene (TFT CAS No. 98-08-8). PFAS substances are also used as gelifiers for Lithium-ion polymer batteries. Sodium bis(trifluoromethylsulfonyl)imide (NaTFSI CAS 91742-21-1) may be used for Na-ion batteries.

These advanced PFAS substances have properties which increase the electrolyte stability through chemical mechanisms such as capturing water and avoiding hydrogen fluoride emissions. The increased stability of the electrolyte provides significant increases in lifetime duration of the battery and battery operating temperature range. The PFAS substances are widely used in next generation Lithium-ion rechargeable batteries and particularly in the case of solid-state batteries.

For Lithium metal rechargeable batteries, polyfluorinated ether solvents, such as 1,1,2,2-Tetrafluoroethyl 2,2,3,3-tetrafluoropropyl ether, are essential to ensure adequate battery cycling lifetimes. This chemically inert solvent (in particular to Li metal) has unique properties that can reduce the viscosity of the cell and therefore the conductivity of the Lithium metal rechargeable batteries.

For Lithium primary batteries, the lithium manganese dioxide (Li-MnO2) electrochemical system is widely used in coin cells and cylindrical consumer cells such as CR2 and CR123A (one of the main electrochemical systems used for Lithium primary batteries), as well as in many cylindrical Lithium primary cell types for industrial applications. Li-MnO2 cells contain an electrolyte composed of organic solvents and a lithium salt. Lithium perchlorate (CAS 7601-90-3) has traditionally been used as the lithium salt, however lithium perchlorate has been found to act as an endocrine disruptor. Lithium perchlorate is the subject of ongoing regulatory management options analysis (RMOA) and is expected to become restricted. As a result, many manufacturers of primary Lithium batteries have already transitioned to using Li-Triflate (CAS 33454-82-9) and LiTFSI (CAS 90076-65-6) for cylindrical Li-MnO2 cells in general, and LiBETI (CAS 132843-44-8), LiFAP (LiPF3(CF2CF3)3n and LiTDI (CAS 761441-54-7) especially for high power Lithium primary cells (similar to the substitution observed in in rechargeable Lithium-ion cells). The use of the PFAS salts instead of lithium perchlorate also provides increased stability and performance as well as higher safety levels. Perchlorates in dry form are explosive materials which can explode in case of a thermal runaway of the battery or a fire.

2.3 PFAS used in valves, gaskets, washers, permeable membranes

PFAS is used in valves, gaskets, washers, and permeable membranes for Lithium-ion rechargeable, Lithium primary, solid-state batteries, Lithium metal rechargeable and Zinc air batteries.

Gasket sealings and washers, shown in Figure 3 for cylindrical cells and Figure 4 for prismatic cells[7], are critical components in batteries to prevent leakage of the electrolyte from the inside and penetration of moisture from the outside. Electrolyte leakages can cause short circuits and severe safety issues.

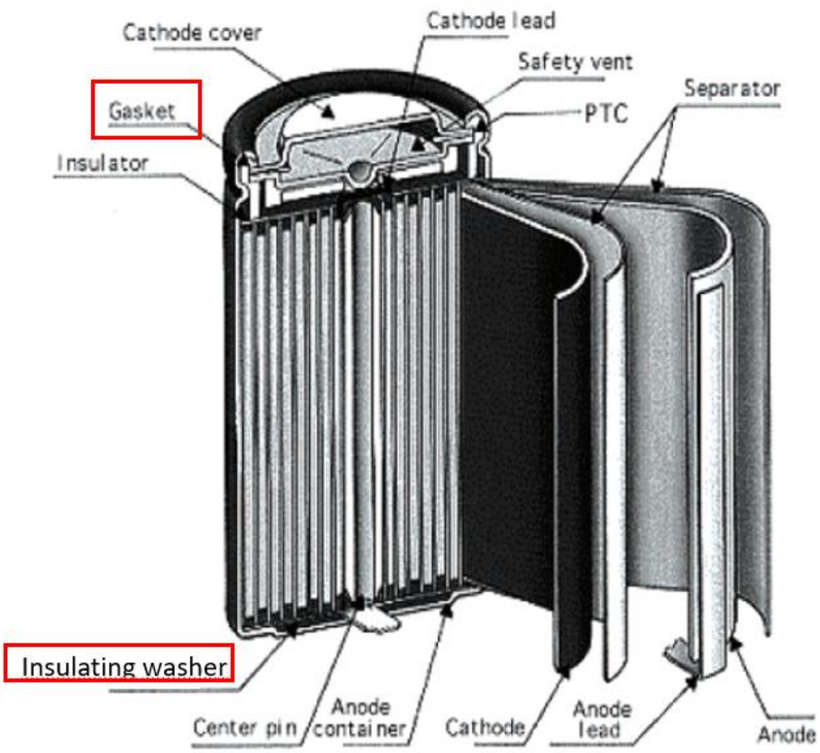

Figure 3. Gasket and washer in a cylindrical cell

[7] Arora, P., & Zhang, Z. (John). (2004). Battery Separators. *Chemical Reviews*, *104*(10), 4419–4462. https://doi.org/10.1021/cr020738u

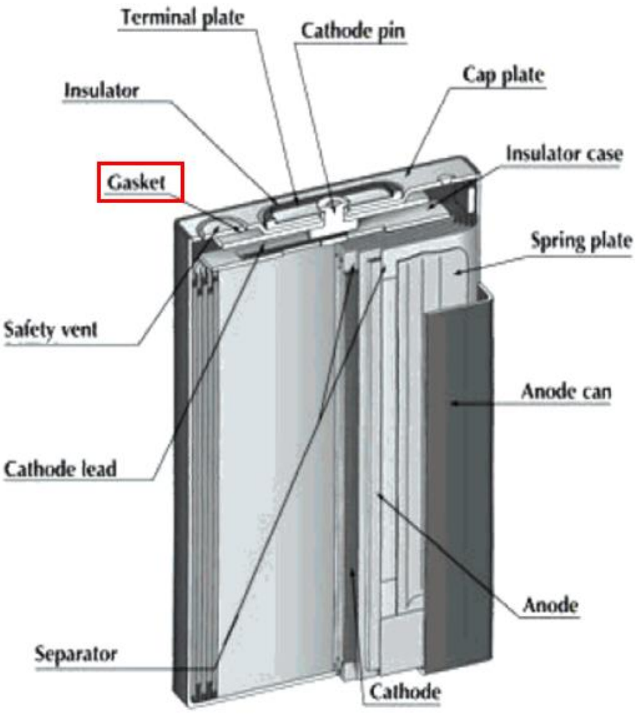

Figure 4. Gasket in a prismatic cell

For some applications used in mild temperature ranges, non-PFAS gasket sealing materials like PBT or PEI provide an adequate sealing performance. However, in high energy density Lithium-ion rechargeable and Lithium metal rechargeable batteries (e.g., high power batteries for automotive, industrial applications and power tools) it is crucial to employ very thin high-performance gaskets with high chemical and thermal stability, and high permeation resistance. This stability for high power and high temperature cells can only be provided by PFAS-based materials such as PTFE, PFA, FEP, VDF, HFP and FKM.

PTFE is not used for sealing gaskets in Li-MnO2 primary Lithium batteries. However, some industrial primary Lithium batteries use Li-SOCl2 and Li-SO2 electrolytes which are much more aggressive materials. SOCl2 is highly reactive and can violently release hydrochloric acid upon contact with water and alcohols. Sealing gaskets and washers for these much more aggressive materials require the use of PFAS-based materials such as FEP, PTFE, glass fiber with PTFE coating. These PFAS-based materials are critical to ensure the long lifetime of the battery, typically around 20 years. FEP is the preferred material for use in internal washers of high-power spiral primary Lithium Li-SOCl2 batteries because it provides excellent insulating properties and prevents internal shorts, thereby ensuring safe design and operation.

PTFE glass fiber washers are also used in Li-MnO2 and Li-SO2 industrial batteries to increase safety, especially in high temperature applications and safety-sensitive applications such as aviation. However, it may be possible to replace PTFE with another high-temperature non-PFAS polymer in these applications.

Zinc air batteries have the highest energy density of any practical battery system and operate by allowing oxygen to access the battery and react with the zinc. The oxygen is reacted on a catalytic surface inside the cell. Air permeable PTFE membranes are necessary to allow air to enter the battery whilst also preventing the release of the alkaline electrolyte from the battery. PTFE has unique hydrophobic properties and air permeability properties to achieve this critical function.

2.4 PFAS used in separator coatings

The separator is an indispensable part of batteries which separates the negative electrode from the positive electrode to prevent internal short circuits, whilst not participating in electrochemical reactions. At present, the most commonly used commercial separators are polyolefin separators, such as polypropylene (PP), polyethylene (PE) and multi-layer composite separators (PP-PE-PP)[8]. The layer materials are processed to make them porous by including tiny pores or voids at 35-45% porosity. The typical pore size is 200 nm - 1 μm which is large enough for the lithium ions to move smoothly through the separator.

Commercial tri-layer PP/PE/PP separators take advantage of the difference in the melting point of PP (165°C) and PE (135°C), using PE as the shutdown layer and PP to protect structural integrity. When the cell temperature rises near the melting point of the PE layer, the PE layer will melt at a temperature of 135°C and close the pores in the separator to stop the current flow while the PP layer, which has a

[8] Costa, C. M., Lee, Y. H., Kim, J. H., Lee, S. Y., & Lanceros-Méndez, S. (2019). Recent advances on separator membranes for Lithium-ion battery applications: From porous membranes to solid electrolytes. *Energy Storage Materials*, *22*, 346-375. https://doi.org/10.1016/j.ensm.2019.07.024

higher melting temperature than PE, remains solid. However, such protection is only effective below the melting point of PP.

To provide better thermal and mechanical stability, commercially available ceramic coated separators have been developed. Ceramic particles, such as alumina, silica, or zirconia can be mixed with polymeric binders and slurry-coated onto the polyolefin separators. In comparison to PP layers, ceramic coatings offer a better electrolyte wettability, which translates into better Li-ion transport through the separator and therefore a better performance of the battery. Although ceramic coatings have proven effective in improving the thermal stability of separators, the effectiveness of the protection is still limited by the thermal stability of the polymeric binder used.

Some companies use PVDF as the binder material for the ceramic coating to provide good adhesion to the electrolyte/composite electrode, as well as providing good adhesion of the ceramic coating to the separator. Other companies have developed non-PFAS binders which also provide good levels of adhesion to the separator and the electrolyte/composite electrode. Some organisations are researching the use of binder-free, thin-film ceramic-coated separators which may be able to provide improved safety for Lithium-ion batteries[9].

2.5 PFAS used in solid-state batteries

Several technical solutions are considered as fundamental to solid-state batteries, particularly for the development of solid-state electrolytes:

a. Polymer
b. Ceramic Sulfide
c. Ceramic Oxide

Polymer electrolyte is used in Lithium-metal-polymer (LMP) solid-state batteries and is already in production. Another solid electrolyte is based on ceramic sulfide. A third category of solid-state batteries are based on ceramic oxides. The last two are still under development at present.

[9] Gogia, A., Wang, Y., Rai, A. K., Bhattacharya, R., Subramanyam, G., & Kumar, J. (2021). Binder-Free, Thin-Film Ceramic-Coated Separators for Improved Safety of Lithium-ion Batteries. *ACS Omega*, *6*(6), 4204–4211. https://doi.org/10.1021/acsomega.0c05037

The architecture of LMP batteries is illustrated in Figure 3 and is based on using polymers as electrolytes and managing their chemical interfaces.

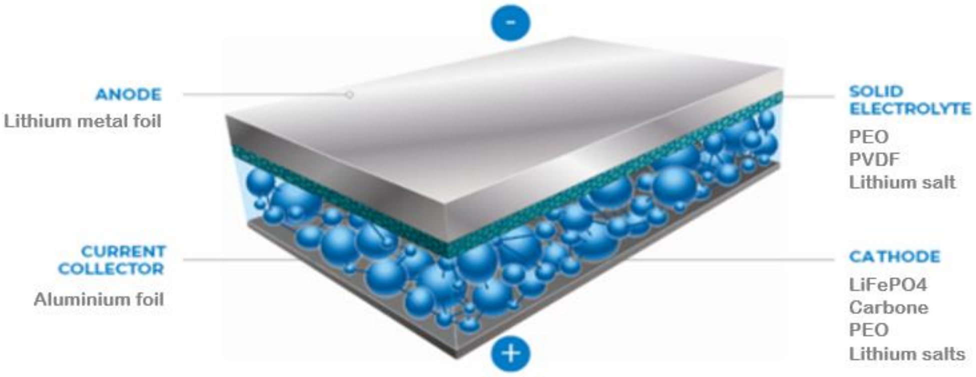

Figure 5. Schematic diagram of an LMP solid-state battery

The Lithium salt LiTFSI is used for the electrolyte and the cathode because it:

- has good conductivity allowing high power performance,
- is compatible with water (it does not hydrolyze and since there is water within the process, a salt that is stable in water is needed)
- is compatible with Lithium (also needed given the anode is Li-Metal)

PVDF is used as a binder in the electrolyte to provide mechanical strength and to act as an interface between the electrolyte and the electrodes.

These PFAS represent less than 5% of the cell's weight, but their role is crucial for the battery. PFAS are foreseen as even more important for the next generation of solid-state batteries. TFSI will be part of the cell recipe for its superior conductivity performances. PVDF is also expected to be a key component to ensure good adhesion between the cathode and the current collector.

3 Missing uses – analysis of alternatives

Table 2. Summary of derogation/transition period requests for various PFAS types, used in different types of batteries depending on current alternatives or alternatives in development

PFAS type	Where used in the battery	Type of battery	Alternatives available today?	Alternatives in development?	Derogation / transition period
PVDF	Binder in active material mass	Li-ion wet process (except for the graphite anode), Na-ion, Lithium metal rechargeable, solid-state	No	Preliminary research programmes funded by EU and Germany Govt	13.5 years
PTFE	Binder in active material mass	Li-ion dry process and semi-dry process, Lithium primary, Ni-Cd, Ni-MH, Zinc oxide, Metal air, Silver oxide, Zinc-ion rechargeable, Lithium metal rechargeable, solid-state	No	No	13.5 years
Various PFAS including LiTFSI, $LICF_3SO_3$ (triflate)	In electrolytes	Li-ion rechargeable, Lithium primary, Lithium metal rechargeable, Na-ion rechargeable batteries	Not for high performance/ next generation batteries	No - PFAS prevents 20% degradation of battery life.	13.5 years

PFAS type	Where used in the battery	Type of battery	Alternatives available today?	Alternatives in development?	Derogation / transition period
PTFE, FEP	Gaskets, washers	Chemically aggressive environments where PFAS is needed for electrochemical stability such as Lithium primary batteries using Li-SO_2 and Li-$SOCl_2$	No	No	13.5 years
PFA, VDF, HFP, FKM	Gaskets	High energy density batteries which require very thin high-performance gaskets such as Lithium-ion rechargeable batteries, Lithium metal rechargeable batteries	No other polymers have required mechanical properties and electrical insulation properties.	No	13.5 years
PTFE	Oxygen permeable membrane	PFAS hydrophobic properties are needed to facilitate air permeation and prevent alkaline electrolyte leakage in Zinc air batteries	No	No	13.5 years
PVDF, PTFE	Solid electrolyte/ gel polymer electrolyte	Solid-state batteries	No	No	13.5 years

PFAS type	Where used in the battery	Type of battery	Alternatives available today?	Alternatives in development?	Derogation / transition period
PTFE, PVDF	In coatings on the separator	Li-ion rechargeable, Lithium primary	Yes	Yes	Transition time of 6.5 years
PTFE, FEP, PFA, VDF, HFP, FKM	In valves, gaskets, washers	Li-ion rechargeable, Lithium primary, solid-state batteries where specific PFAS properties identified in section 3.1.4, 3.1.5 are not required	Yes	Yes	Transition time of 6.5 years

3.1 Uses where alternatives are not yet available

For the below uses where there are no alternatives available today, the chemicals industry will need to invest in research and development to build up the capacity and value chain for new innovative chemistries. The chemicals industry will need to make significant changes to existing research and development roadmaps which will be driven by industry demand for these new chemistries in Europe. In addition to research and development efforts, there is an immediate need for industrial investments to secure the manufacturing and the supply of chemicals to sustain the battery value chain in Europe. There is considerable uncertainty about the future of industry demand in Europe and therefore the timelines for these investments by the chemicals industry are not known. As a result, the battery industry requires derogation periods of at least 13.5 years for each of the below applications. If after the end of 13.5 years there are still no alternatives for specific applications, then the battery industry will need to apply to renew the derogation period for these specific applications.

3.1.1 Use of PVDF as the binder of the active material masses

PVDF is used as the binder material in the active masses for electrodes for Li-ion wet process (except for the graphite anode), Na-ion, Lithium metal rechargeable, and solid-state batteries. For the positive electrode, all attempts to replace PVDF binder materials with other polymers have caused cell performance and manufacturability issues. For the positive electrode, the degradation of alternative binder systems in the electrolyte has been demonstrated.

PVDF binder material is expensive (about 8-10 Euro/kg) and wet processes require the use of n-methyl-pyrrolidone (NMP) solvent (which is also expensive at about 2-6 Euro/kg) to dissolve the PVDF so that the slurry containing the binder material, active material and conductive additive can be dispersed evenly across the metal current collectors. NMP is classified in the EU as toxic to reproduction and its use is restricted under entry 71 of REACH Annex XVII. As a result, the use of NMP requires expensive solvent extraction and recovery systems. NMP also has a high boiling point of 210°C and so the curing and drying process has a high carbon footprint.

In view of the costs of PVDF and the health and safety concerns around the use of NMP solvent, many organisations have carried out research to try to find alternatives to PVDF as a binder material and NMP as the solvent. A peer reviewed academic article[10] indicates that PVDF as a latex can be used as the binder for the positive electrode with water as the solvent instead of NMP. Next generation Lithium-ion battery developments are focussed on producing positive electrodes using a dry process which avoids the need for NMP solvent. This dry process will significantly reduce energy consumption and lower the environmental footprint. However, the dry process still requires the use of PTFE or PVDF as the binder material for the positive electrode.

For Lithium-ion rechargeable batteries, PVDF was previously also used as the binder material for the negative electrode as well as for the positive electrode. For graphite negative electrodes, companies have successfully substituted PVDF with water-based CMC/SBR binder materials. CMC/SBR is now the most common commercially used binder material for the graphite negative electrodes due to its good

[10] Li, J., Lu, Y., Yang, T., Ge, D., Wood, D. L., & Li, Z. (2020). Water-Based Electrode Manufacturing and Direct Recycling of Lithium-ion Battery Electrodes—A Green and Sustainable Manufacturing System. *iScience*, *23*(5), 101081–101081. https://doi.org/10.1016/j.isci.2020.101081

cell performance, lower cost and reduced environmental impact[11]. For other types of negative electrodes using higher voltage materials such as Lithium titanate oxide (LTO), NTO (Niobium Titanate Oxide)[12] the use of PVDF binder material is required because no research on alternative non-PFAS binders has proved sufficiently conclusive for transfer to industrialization to date.

For Sodium-ion rechargeable batteries, some research is ongoing regarding non-PFAS SBR/CMC binder materials for some hard carbon/PBA cells but this research work has not yet been scaled up. PVDF is preferred with some other PBA materials[13] and with hard carbon[14].

The European Commission has recently funded the GIGAGREEN research project on dry alternatives and water-based binder systems for the positive electrode which propose to utilise a range of polymers including CMC/SBR, poly(acrylic acid), sodium alginate, polyurethanes and catechol-bearing polymers[15]. Whilst these initial research studies have indicated that these aqueous binder systems may have good adhesion properties, further research and development is required to investigate whether these alternatives have adequate chemical, mechanical, and electrical properties[16]. There are significant concerns about whether water-based CMC/SBR technology will have the necessary rheology and stability to match with today's positive electrode active materials such as LCO, NMC, NCA, LNMO, LFP. There are specific concerns about the use of water in the slurry production and the electrode coating, drying and calendaring processes, particularly if the water is not completely removed before the battery is assembled.

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[11] Hawley, W. B., & Li, J. (2019). Electrode manufacturing for Lithium-ion batteries—Analysis of current and next generation processing. *Journal of Energy Storage*, *25*(C), 100862–. https://doi.org/10.1016/j.est.2019.100862

[12] Next-Generation SCiB™ supporting smart mobility in the age of MaaS, Using Niobium Titanium Oxide (NTO) as a next-generation anode material. (n.d.). https://www.global.toshiba/ww/products-solutions/battery/scib/next/nto.html

[13] Wessels, C., D., Motallebi, S., (2020). Electrolyte Additives for Electrochemical Devices. Patent No.: US 10 862 168 B2. https://app.dimensions.ai/downloads/patents?ucid=US-10862168-B2

[14] Barker, J. & Heap, R., (2020). Metallate Electrodes. United States Patent. Patent No.: US 10 756 341 B2. https://patentimages.storage.googleapis.com/4e/07/f0/c9dd46a4691e63/US10756341.pdf

[15] Funding & tenders, Towards the sustainable giga-factory: developing green cell manufacturing processes (GIGAGREEN). (n.d.). https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/how-to-participate/org-details/999999999/project/101069707/program/43108390/details

[16] Cholewinski, A., Si, P., Uceda, M., Pope, M., & Zhao, B. (2021). Polymer Binders: Characterization and Development toward Aqueous Electrode Fabrication for Sustainability. *Polymers*, *13*(4), 631–. https://doi.org/10.3390/polym13040631

The Germany Government has funded the DigiBatt Pro 4.0[17] research project which also includes development of water-based binder systems for positive electrodes. As part of this research project, positive electrodes of around 100 metres in a lab scale with roughly 1/100 to 1/50 the scale of mass production have been produced using a nickel rich NCM cathode active material, $LiNi_{0.83}Co_{0.12}Mn_{0.05}O_2$. The cells could be successfully charged and discharged 1,000 times at 25°C before they fall below 80% of initial capacity. Whilst this research project appears to show promising results for very high nickel content batteries, correspondence with the project partners highlights that:

- Positive electrodes manufactured using water-based binder materials show increasing impedance/resistance with increasing numbers of charging and discharging cycles,
- The stability of the charging and discharging cycles is substantially lower than state-of-the-art positive electrodes using PVDF binder materials,
- The rapid increase in pH alkalinity of the water-based binder materials results in a very short shelf life for the mixed slurries, this would be very challenging for an industrial process as the mixture would go out of specification very quickly.

Further investigation of this research project confirms it focussed on a very specific high nickel NCM cathode active material at a moderate cell voltage of 4.2V. There is no evidence that this water-based binder material could be developed to meet the performance targets for positive electrodes with LCO chemistries operated at higher voltages, which is what many electronic devices use today.

It is also important to note that this research project focussed on a very specific cylindrical 21700 cell form factor used in certain automotive and power tool applications. Performance in this specific form factor is not directly transferrable to other cell form factors used in other applications. There are many unknowns which would need to be investigated before this technology could be adopted in other chemistries and other form factors, including:

- cycle life and calendar life and impedance growth under wide range of temperatures

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[17] "*DigiBattPro 4.0 - BW*" - Digitized Battery Production 4.0 - Fraunhofer IPA. (n.d.). Fraunhofer Institute for Manufacturing Engineering and Automation IPA. https://www.ipa.fraunhofer.de/en/reference_projects/digibattpro.html

- swelling, fast charge cycling is unknown,
- electrode processibility for multilayer pouch cells and uniformity of coating is unknown,
- correspondence with the project partners highlighted that the positive electrodes manufactured using water-based binder materials show higher cell resistance and faster growth in resistance with increasing numbers of charging and discharging cycles with the high nickel NCM cathode active material. This trend is anticipated to become worse when industry moves to cathode active material operating at higher voltage, higher energy and higher power.

Furthermore, replacing the PVDF cathode binder likely requires the development of new cathode active material and Aluminium current collectors that are compatible with a new binder and solvent system. Water is known to cause poor cycle life and increased impedance growth in Lithium-ion cells. A new grade of active cathode powder may need to be developed to increase particle surface protection against water.

Replacing the PVDF cathode binder with new binder and solvent also requires development of a compatible electrode and cell manufacturing process and equipment. The necessary process and equipment change at mass production scale is unknown at this point and will be different for different companies depending on which alternative technology they pursue. The performance of mass production line produced PVDF free battery may have significant performance gaps compared with current batteries. Addressing these performance gaps may require a significant number of iterations of materials improvement, production process change and cell performance testing.

Given the above, we estimate that efforts to develop and commercialise high performance non-PFAS cathode binder, Al foil, active materials and corresponding cell manufacturing processes would take at least 10 years, followed by 5 years to commercialise the new technologies.

3.1.2 Use of PTFE as the binder of the active material masses

PTFE is used as the binder material in the active masses for electrodes for Li-ion dry process and semi-dry process, Li primary, Ni-Cd, Ni-MH, Zinc oxide, metal air, Silver oxide, Zinc-ion rechargeable, Lithium metal rechargeable and solid-state batteries.

There are currently no alternatives to PTFE due its unique combination of properties that are essential for the performance and durability of these batteries, especially for the:

- **fibrillation properties**, which produce an excellent mechanical electrode surface without covering the surface of the active material,
- **chemical properties**, including chemical stability in very aggressive environments,
- **hydrophobic properties**.

Alternative non-PFAS materials such as Polyvinyl alcohol (PVA, CAS 9002-89-5) and Poly(acrylic acid) (PAA, CAS 9003-01-4) have been tested as potential binder materials for the positive electrode and have been found to fail due to performance and manufacturability issues. The degradation of these alternative binder systems in the electrolyte has been demonstrated.

No research has been concluded on whether some of non-PFAS alternatives that are being investigated as potential replacements for PVDF as binders in Lithium-ion rechargeable batteries (see 3.1.1) may also be applicable to Lithium primary batteries. As a consequence, the timescale needed to investigate, develop and qualify alternatives for PTFE binder of the active material mass for Lithium primary batteries would be even longer than in the case of Lithium-ion rechargeable batteries.

3.1.3 Use of PFAS in electrolytes

Various PFAS substances are used in the electrolytes for Lithium-ion rechargeable, Lithium primary, Lithium metal rechargeable, and Sodium-ion rechargeable batteries. LiPF6 (which is not a PFAS) has been widely used in older battery technologies for many years. However, LiPF6 has been found to cause degradation in Li-ion cells, primarily from its thermal decomposition or hydrolysis to form acidic species. Recent advances in battery technology have established the use of PFAS substances as state-of-the-art for high performance batteries today, including as additives and as Lithium salt with PFAS anion.

PFAS electrolytes are used in advanced batteries to provide higher stability, increased performance and higher safety levels. This stability is provided by the high strength of the carbon-fluorine bond in the PFAS which is not present in the older electrolytes. As a result, the PFAS electrolytes provide 20% more battery life compared to $LiPF_6$ electrolytes. This increased battery life provides sustainability benefits by extending the lifetime of the product.

In rechargeable batteries, Lithium salts of PFAS monomers such as Li-Triflate (CAS 33454-82-9), LiTFSI (CAS 90076-65-6), LiBETI (CAS 132843-44-8) and LiFAP ($LiPF_3(CF_2CF_3)_{3n}$ are used to provide stability, performance and higher safety levels. There are no non-PFAS alternatives available today which provide similar stability, performance and safety levels. We estimate that research and development efforts to identify non-PFAS alternatives would take at least 10 years, followed by 5 years to commercialise the new electrolyte chemistry.

For Lithium primary batteries, Lithium salts based on monomolecular PFAS have been developed to replace the endocrine disruptor Lithium perchlorate and to improve the performance and durability of Lithium primary batteries (especially Lithium manganese dioxide batteries). Non-PFAS alternatives for Lithium perchlorate are currently not known and would have to be newly developed.

For Lithium metal rechargeable batteries, polyfluorinated ether solvents, such as 1,1,2,2-Tetrafluoroethyl 2,2,3,3-tetrafluoropropyl ether, are essential to ensure adequate battery cycling rates and lifetimes. This chemically inert solvent (in particular, inert to Li metal) has unique properties that can reduce the viscosity of the cell and therefore the conductivity of the Lithium metal rechargeable batteries. Non-fluorinated solvents can be used in combination with fluorinated ones, but not as a complete replacement primarily due to their lower chemical stability in conjunction with a metal Lithium electrode. There are no non-PFAS alternatives available today.

We estimate that research and development efforts to identify non-PFAS alternatives for electrolytes would take at least 10 years, followed by 5 years to commercialise the new electrolyte chemistries.

3.1.4 Use of PTFE & FEP in gaskets & washers in chemically aggressive environments

There are no alternatives to use of PTFE and FEP in gaskets and washers used in chemically aggressive environments such as the SO_2 and $SOCl_2$ substances used in electrolytes in primary Lithium batteries. SO_2 and $SOCl_2$ are very powerful oxidising agents which degrade almost all polymer types except PFAS materials. Degradation of the gasket and washer would result loss of battery component properties and release of the electrolyte. These primary industrial batteries using these electrolytes are required to operate for 20 years, significant research and development efforts will be needed to identify suitable alternatives which can provide the needed safety and long-term performance.

Polyimidazoles and fully chlorinated PVC may be some potential non-PFAS alternatives which may provide sufficient chemical stability against thionyl chloride in some applications. Thick bound fiberglass materials may also provide possible solutions. However, for chemically aggressive environments, more research on alternative materials is needed before the testing and final qualification can start, so that a derogation of 13.5 years is considered to be necessary.

3.1.5 Use of PFA, VDF, HFP, FKM in gaskets in high performance batteries which require very thin high performance gaskets

There are no alternatives to use of PFA, VDF, HFP, FKM in gaskets in high performance Lithium-ion rechargeable and Lithium metal rechargeable batteries (e.g., high power batteries for automotive, industrial applications and power tools) which require very thin high performance gaskets.

High power and high energy density batteries require very thin high performance gaskets[18]. Gaskets provide insulation between the positive and negative sides of the housings, a proper thermal functionality of the gasket is essential. This application needs a stable and compressive polymer which provides high levels of insulation to withstand the very high currents up to 280 amps which are found in these high performance batteries. Figure 6 compares the compressive properties of PFAS compared to other resins[19].

[18] Lui, J., Aoyama, T., Tsuda, H. & Sukegawa, M., (2019). Long-term reliability evaluation of fluororesin gasket for electrode of automotive lithium-ion battery using simulation. *VIII International Conference on Computational Methods for Coupled Problems in Science and Engineering*. https://upcommons.upc.edu/bitstream/handle/2117/190005/Coupled_2019-24-Long-term%20reliability%20evaluation.pdf

[19] Battery materials, Fluorochemicals, Daikin Global. (n.d.). https://www.daikinchemicals.com/solutions/products/battery-materials.html#anchor04

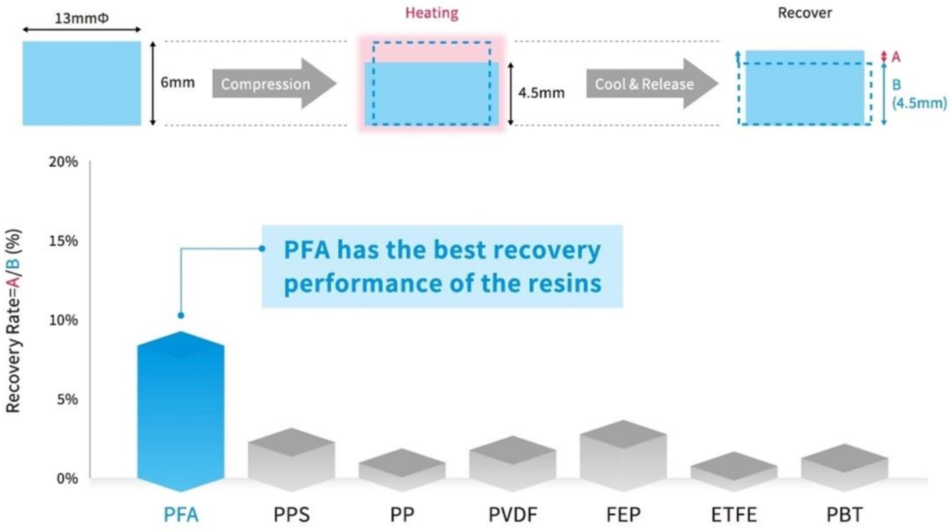

Figure 6. Compressive properties of polymer resins

PFAS provide a unique combination of electrical insulation and hydrophobic properties. Figure 7 compares the moisture permeation properties of PFAS compared to other resins[20]. As a result, the efficiency of the gasket performance is improved because of the reduced humidity absorption even when used at very low thickness.

[20] Ibid

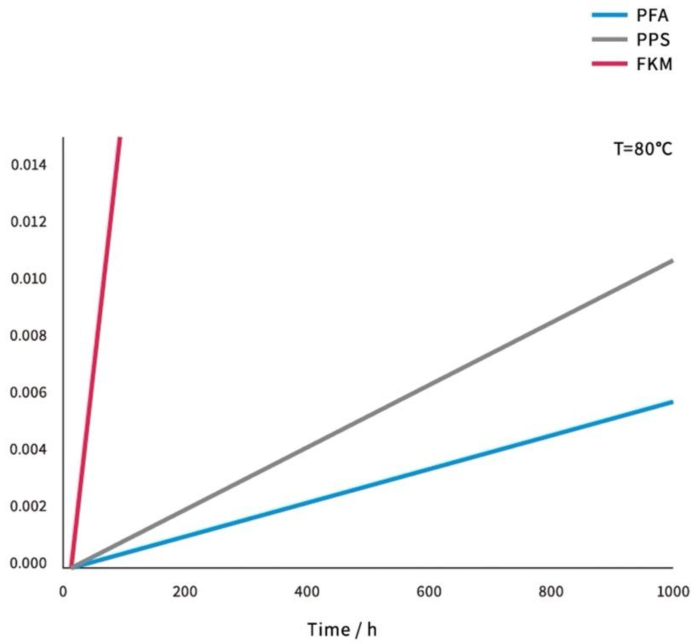

Figure 7. Moisture permeation of polymers

It will take significant time and effort for industry to investigate whether there are alternative polymers that can be used instead of PFAS in these gaskets. We estimate that research and development efforts to identify non-PFAS alternatives would take at least 10 years, followed by 5 years to commercialise the alternatives.

3.1.6 Use of PTFE in oxygen permeable membranes in Zinc air batteries

There are no known alternatives for use of PTFE in oxygen permeable membranes in Zinc air batteries or other types of alkaline metal-air batteries.

Zinc air batteries operate by allowing oxygen to access the battery and react with the zinc. The oxygen is reacted on a catalytic surface inside the cell. Air permeable PTFE membranes are necessary to allow air to enter the battery whilst also preventing the release of the alkaline electrolyte from the battery.

PTFE has unique hydrophobic properties and air permeability properties which allow gas molecules to pass through the membrane whilst at the same time preventing the release of the alkaline electrolyte. Extensive research would be needed to find alternatives. We estimate that research and development efforts to identify non-PFAS alternatives would take at least 10 years, followed by 5 years to commercialise the alternatives.

3.1.7 Use of PTFE / PVDF in solid electrolyte/ gel polymer in solid-state batteries

There are no available alternatives to the use of PVDF / PTFE as a binder in the solid electrolyte/ gel polymer in solid-state batteries. The PVDF / PTFE has unique properties that provide mechanical strength and act as an interface between the electrolyte and the electrodes in solid.

PVDF and co-polymers of PVDF are uniquely placed to enable solid electrolyte/gel polymers in batteries due to the presence of strong electron-withdrawing functional group (–C–F)[21]. These properties include high polarity, excellent thermal and mechanical strength, compatibility with organic solvents and chemical stability[22].

Extensive research would be needed to find alternatives. Research and development efforts to identify non-PFAS alternatives would take at least 10 years, followed by 5 years to commercialise the alternatives.

3.2 Uses where substitution is technically feasible but more time is required

As highlighted below, where substitution is technically feasible, the steps involved in substituting new materials into several subcomponents in a company's battery manufacturing process are considerably more complicated than in other industry sectors and therefore the battery industry requires a longer transition period of 6.5 years. Each new subcomponent needs to be developed and tested separately, and then the combination of the new subcomponents needs to be tested in the new battery and the product applications. Each company's battery manufacturing equipment and process lines also have unique aspects which are specific to that company's products and applications. Some companies may

[21] Manuel Stephan, A. (2006). Review on gel polymer electrolytes for lithium batteries. *European Polymer Journal*, *42*(1), 21–42. https://doi.org/10.1016/j.eurpolymj.2005.09.017

[22] Barbosa, J. C., Dias, J. P., Lanceros-Méndez, S., & Costa, C. M. (2018). Recent Advances in Poly(vinylidene fluoride) and Its Copolymers for Lithium-Ion Battery Separators. *Membranes (Basel)*, *8*(3), 45–. https://doi.org/10.3390/membranes8030045

need to make significant changes to their manufacturing equipment and process lines to accommodate the new subcomponents.

The below consecutive steps 1 to 4 are representative of the battery industry and present an optimistic scenario where no complications arise such as additional certification requirements or unforeseen customer validation requirements. For example, a significant amount of R&D resource will be needed to carry out the development of new subcomponents and the battery industry may face a shortage of qualified technical staff to carry out this work. In addition, a large amount of battery models and finished products containing batteries which are on the market today will need to be recertified and there may not be sufficient third-party certification companies available in the market today to provide these needed recertification services.

The battery industry will make every effort to work within a 6.5 years transition time. However, there may be some types of subcomponents where industry experience finds that it is not possible to achieve substitution within the 6.5 years and so the battery industry may need to apply for an extension to this transition period.

Step 1: Substitute material identification for one subcomponent: up to 12 months

Each company's battery manufacturing process is customised to meet the needs of that company's products. In many cases there are a range of chemistries that could be considered as alternatives for a specific subcomponent. The first step is assessment and laboratory verification to identify which target substitute material is likely to provide the best combination of properties for the specific subcomponent in the company's products. The identification of a target substitute material for one subcomponent alone can take up to 12 months. For example, in the case of the binder for the ceramic coating on the separator, companies which are currently using PVDF will need to evaluate several different alternatives to identify the best material for their application. There are several alternatives in use today which will need to be considered.

Step 2: Separate development of each new subcomponent: 14 - 21 months

This is the process of using the target substitute material to develop the new subcomponent and then to test it in a cell with an existing, already proven chemistry. This step is necessary to isolate the new subcomponent as the only variable that has changed in the cell. Once the cells are built, the testing of the cell cycling process can begin. It takes about 7 months to carry out 1000 test cycles of the cell build containing the new subcomponent, to check that it can meet swelling, impedance, capacity retention and other technical requirements after 1000 cycles. Some companies also need to carry out environmental testing of the subcomponent such as long-term storage at elevated temperatures. A cell build can fail the cycles tests, therefore most companies assume at least one additional iteration of the cell build will be required to refine the specific chemistry of the target substitute material. Therefore, this stage can take several multiples of 7 months, at least 14 to 21 months.

Step 3: Combination of all new subcomponents and chemistry development: 18 - 36 months

This is the process of integrating and developing all the new subcomponents into a next generation cell chemistry package. Each new subcomponent would need to be qualified as part of this larger chemistry package.

The integration and development process requires several cell builds to find a combination of components and process conditions that meets all electrochemical and safety requirements. Depending on the testing capacities at the company, some companies may need to carry out between 3 and 6 cell builds, as some cell builds may fail testing. It takes about five months to develop each cell build and carry out tests of the initial 250 cycles so that sufficient data can be collected to accurately inform the development of the next cell build. The final cell chemistry needs to be tested at 1000 cycles which takes 7 months. Therefore, it may take around 18 - 36 months to arrive at a validated battery chemistry which is ready to be integrated into a new product.

Step 4: Integration into existing product design and new product designs, and into manufacturing processes: 24 - 48 months

The next step is to integrate the new validated battery chemistry into existing product designs and new product designs, and to carry out testing on finished assembled products to ensure they meet all electrochemical, process, safety and reliability requirements and certifications. This requires requalification of the new battery in all existing products which are already in production in Europe. Companies will need to make changes to their manufacturing equipment and process lines to qualify the manufacturing of the new subcomponents, the integration of the new subcomponents into the cell and the integration of the new battery into existing and new products. These changes to manufacturing equipment and process lines may be significant and require extensive time and capital investment.

Product requalification is a very time-consuming exercise which will require extensive resources over many years. The completion of this task will require sufficient test house capacity and transition time to requalify all battery-powered products which are used in Europe for safety, performance and lifetime. Additionally, the process of re-certifying batteries for existing product designs may trigger other regulatory updates unrelated to the new subcomponents that could otherwise have been avoided. For a company with a wide range of existing product designs, this can take around 24 - 48 months.

4 PFAS consumption in tonnes and emissions during battery life cycle

4.1 PFAS consumption in tonnes

Further information will be provided in subsequent submissions.

4.2 Emissions during the battery life cycle

NOTE: This text repeats the information already provided by RECHARGE in the second call for evidence submitted in October 2021. Updated information will be included in subsequent submissions.

4.2.1 Emissions during battery manufacturing

For technologies using PVDF as binder

PVDF is mixed with its organic solvent NMP and other electrode components. A PDVF latex can also be used. This wet mix is then coated on a metallic foil. This electrode is further heated below the degradation temperature of PVDF. The dried electrode is then further used for cell manufacturing. Empty bags of PVDF, PVDF containing residues from the processes as well as scrap cathodes are collected as chemical wastes and disposed of according to applicable European regulations.

For technologies using PTFE as binder

PTFE dispersion is mixed with electrode components and carbon black. This wet mix is then processed and heated below the degradation temperature of the PTFE. The dried mix is then further used for cell manufacturing.

Empty drums of PTFE dispersion, PTFE containing residues from the processes as well as scrap cathodes are collected as chemical wastes and disposed of according to applicable European regulations.

Potential residues of PFAS from binders or electrolyte (either empty packaging or cleaning solutions) are always collected as chemical wastes and disposed of according to applicable European regulations. **No unintended and uncontrolled PFAS emissions are foreseen during battery manufacturing.**

4.2.2 Emissions during battery use

During battery manufacturing, active substances, binders (like PTFE and PVDF) and additives are embedded in a mechanical substrate to form electrodes. These electrodes are then further assembled with the other battery components such as separator, electrolyte, connectors, gaskets, washers and casing to obtain a finished battery. This battery is defined in the REACH regulation as "an article with no intended release" meaning that, **under normal and reasonably foreseeable conditions of use, no end-user of this battery will be exposed to any chemical substances. No PFAS emissions are foreseen during battery use.**

4.2.3 Emissions during battery recycling

Battery recycling is mandatory in Europe since 2006 according to the Battery Directive and will remain mandatory with higher recycling targets in the upcoming Battery Regulation. Fluoropolymers are totally decomposed (as compounds), during the pyrometallurgical recycling processes. The fluorine reports to the flue dust. Flue dust is further processed in a hydro-metallurgical process to extract specific remaining metal content. Also, the PFAS containing waste streams and product streams from the hydrometallurgical recycling process may be treated in high temperatures where fluoropolymers are totally decomposed (as compounds). **No unintended and uncontrolled PFAS emissions are foreseen during battery recycling.**

Further information will be provided in subsequent submissions.

5 Socio economic impact assessment for battery value chain

Further information will be provided in subsequent submissions.

6 Why RECHARGE seeks derogations and additional transition times, and industry best practices

Further information will be provided in subsequent submissions.

Glossary

FEP	Fluorinated ethylene propylene
HFP	Hexafluoropropylene
LiCF3SO3	Lithium trifluoromethanesulfonate
Li-ion	Lithium ion battery
LiSO2	Lithium sulfur dioxide battery
LiSOCl2	Lithium-thionyl chloride
LiTFSI	also known as TFSIL,i Lithium bis(trifluoromethanesulfonyl)imide
LMP	Lithium-metal-polymer
LTO	Lithium titanate oxide
Na-ion	Sodium ion rechargeable battery
NFM	Layered oxide of Ni, Fe, Mn (for Na-ion)
Ni-Cd	Nickel Cadmium battery
Ni-MH	Nickel metal hydride battery
NTO	Niobium Titanate Oxide
PBA	Prussian Blue Analogues
PFAS	Per and polyfluoroalkyl substances
PTFE	Polytetrafluoroethylene
PVDF	Polyvinylidine difluoride (both homopolymer and copolymer)
VDF	Vinylidene fluoride
Zn-ion	Zinc-ion rechargeable batteries

RECEIVED
By: OAH on 3/1/2024
Heather Rhoderick Attachment 1

March 1, 2024

Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, Minnesota, 55155-4194
Attn: Office of Administrative Hearings (OAH) Rulemaking
eComments website (https://minnesotaoah.granicusideas.com/)

RE: Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), ID Number R-4837

Dear Minnesota Pollution Control Agency:

On behalf of the Fluid Sealing Association,[1] Hydraulic Institute,[2] the Valve Manufacturers Association,[3] and Water and Wastewater Equipment Manufacturers Association[4] (collectively, the "Flow Control Coalition"), we respectfully submit these considerations for the Minnesota

[1] Founded in 1933, the FLUID SEALING ASSOCIATION® (FSA) is an international trade association. Member companies are involved in the production and marketing of a wide range of fluid sealing devices primarily targeted to the industrial market. The Fluid Sealing Association membership includes a number of companies in Europe and Central and South America, but is most heavily concentrated in North America. Fluid Sealing Association members account for a majority of the manufacturing capacity for fluid sealing and containment devices in the Americas market.

[2] Founded in 1917, the Hydraulic Institute spent much of the past century playing a leading role in development and implementation of pump standards on behalf of manufacturers, system engineers and end-users. As the nationally and internationally recognized representative of the US pump industry, the Hydraulic Institute works with rulemaking bodies such as the US Department of Energy (DOE) as well as standards setting organizations such as ISO, API, AWWA, *etc*.

[3] Founded in 1938, the Valve Manufacturers Association of America is the only North American trade association that represents the interests of manufacturers, suppliers and distributors of valves, actuators, and controls. VMA's mission is to serve the growth and innovation of the U.S. and Canadian industrial valve industry globally by providing the forum which enhances a positive business operating environment, increases knowledge and education, advances technology innovations, and facilitates business and government connections.

[4] The Water and Wastewater Equipment Manufacturers Association (WWEMA) is a trade association representing water and wastewater technology and service providers since 1908. We advocate, inform, and connect our members with key policy and decision-makers and help our members increase their competitiveness and profitability in the U.S. and abroad. Our members supply the most sophisticated leading-edge technologies and services, offering solutions to every water-related environmental problem and need facing today's society.

Pollution Control Agency (MPCA) during the rulemaking process regarding the Currently Unavoidable Use (CUU) determination. These comments provided from the industrial flow and pressure control industry represent the best information available at this time, however as the process progresses the Flow Control Coalition will continue to review and provide additional information as requested. The Flow Control Coalition appreciates the opportunity to provide this information and applauds Minnesota's efforts to implement common sense reforms that enable the State to better understand and regulate PFAS in products.

The Flow Control Coalition represents industrial industries that are vibrant, innovative and responsible. The member companies of the Coalition play an integral role in supporting the production of products essential to improving the quality of daily life of the public and protecting the planet. Industrial flow control equipment is relied on in many industries, most notably power generation (traditional and new energy sources); national defense; construction and data centers; semi-conductor production; mining; pharmaceutical; pulp and paper; water and wastewater; oil and gas; chemical; transportation; food and beverage and many others.

Certain Fluoropolymers are Essential for Many Critical Applications

The Flow Control Coalition supports Minnesota's efforts to address PFAS shown to meet environmental and human health toxicity criteria, such as perfluorooctanoic acid (PFOA) and perfluorooctane sulfonic acid (PFOS). However, restricting all substances that contain a fully fluorinated carbon atom (or are captured by a similarly expansive definition of "PFAS") is excessively broad and would have significantly *negative* impacts on the economy, environment, safety, national defense, and our way of life.

Many PFAS polymers are of low toxicological concern and are indispensable to countless industrial processes that support the safe production and processing of oil and gas, chemicals, pharmaceuticals, semi-conductors, electrical/nuclear power, and food, as well as numerous other important industrial applications. For many of these applications, PFAS are essential for health and safety reasons, and necessary to enable the functioning of critical industrial operations.

High molecular weight fluoroelastomers and fluoropolymers (*e.g*., PTFE, PTFE, FKM, FFKM, ePTFE, PCTFE, mPTFE, PFA, eTFE, FEP, PVDF, PFPE, FEPM, and ECTFE) are used in the manufacture of gaskets, seals, pumps, coatings, chemical piping and industrial valves, all of which are integral to the production of products core to maintaining modern life. These solid, molded products have negligible potential for worker or consumer exposure or other safety concerns while handling the product. The use of these fluoroelastomers and fluoropolymers enables production of a wide range of everyday products used by almost every American, including semiconductors, cell phones, food and beverages, pharmaceuticals, renewable energy systems, transportation, pulp and paper products, and more. They are also integral in the technology used in efforts to achieve zero carbon goals and in the production, transportation, and storage of hydrogen.

When present in the products manufactured by our member companies, PFAS are used due to their unique properties that provide for effective sealing, creating barriers for emissions, reducing energy use, and performance in highly corrosive or high temperature environments. Highly reliable performance is particularly important when access to the production system is difficult and dangerous, and to provide a safe and reliable production process.

The decision to use PFAS substances in these applications is the product of highly complex and costly engineering determinations. In the flow control industry, highly skilled engineers work to design the entire flow control system to meet detailed specifications required by accepted standards and regulations designed to protect health, safety, the environment, and efficient operations.

Simply put, if there were reasonably available alternatives that delivered the same level of performance in these critical applications, they would be used. In fact, given the cost of PFAS chemicals, the industry would welcome effective alternatives. Unfortunately, such alternatives are not available at this time for the critical applications our industry serves.

Accordingly, the Flow Control Coalition recommends that MPCA adopt a CUU determination for industrial flow and pressure control products, for the reasons discussed further below.

Considerations for Evaluating Currently Unavoidable Use Determinations

In the following section, we address the specific questions posed by MPCA regarding considerations in evaluating CUU determinations. As detailed below, there would be a significant number of CUU determinations for a wide variety of fluid handling and flow control products for which PFAS are essential for proper and safe performance. In the following discussion and attached list, we identify the products and the reasons why the use of PFAS currently (and for the foreseeable future) is unavoidable. Because of the extensive number of products, and the many properties for which PFAS may be utilized, we have attempted to be as efficient as possible in explaining why a CUU designation is appropriate. The Flow Control Coalition would be happy to provide further detail if that would be helpful to Minnesota throughout the rulemaking process.

1. <u>Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?</u>

Yes. "Essential for Health, Safety or the Functioning of Society" means products or product components that if unavailable would result in a significant increase in negative healthcare outcomes, an inability to mitigate significant risks to human health or the environment, or significantly interrupt the daily functions on which society relies.

Products or product components that are Essential for Health, Safety or the Functioning of Society include those that are required by federal or state laws and regulations. Essential for the Functioning of Society includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, and construction.

"Critical infrastructure" specifically should include the industrial flow and pressure control equipment that ensures the safety and effectiveness of the applications noted above.

2. <u>Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?</u>

Yes. A reasonable cost threshold of 'comparable' should be set and should, at a minimum, meet the following criteria:

- The alternative material should **be safer**, perform **comparable to PFAS,** and be considered a **drop-in replacement** (i.e. no redesign of the product is required to accommodate performance deficiencies or vulnerabilities).
- The alternative material should be at a **comparable cost** to the existing PFAS material.
- The alternative material should be **commercially available at-scale** and from multiple suppliers.

If any of the three criteria is not met, the material should be considered a "not reasonable" alternative. An exact quantifiable definition of 'comparable' is difficult to set as cost varies significantly by product and application.

Given those criteria, an "alternative" should mean a substance or chemical that, when used in place of PFAS, results in a functionally equivalent product and that, when compared to a PFAS that it could replace, would reduce the potential for harm to human health or the environment, or has not been shown to pose the same or greater potential for harm to human health or the environment as that PFAS. Alternatives include reformulated versions of products, including versions reformulated by removal or addition of one or more chemicals or substances, that result in the reduction or removal of intentionally added PFAS from the product. Alternatives also include changes to the manufacturing process that result in the reduction or removal of PFAS from a product.

To our knowledge, there are no known commercially available alternatives at this time that provide the same level of protection to health, safety and the environment, or that deliver the same efficiency in manufacturing or service.

Further, even if a new alternative can be identified, or if an existing, older material is to be reintroduced, it will still need to be tested and certified for use in the specific application, and product designs would need to be reengineered. This entails testing the materials regarding functionality (*i.e.*, performance, stability and quality) and obtaining certifications from or adoption by the appropriate regulatory or standard-setting bodies. This is a drawn-out, time-consuming process, and it is difficult to estimate the number of years that it would take to find viable alternatives to current PFAS uses.

3. Should unique considerations be made for small businesses with regards to economic feasibility?

Not applicable.

4. What criteria should be used to determine the safety of potential PFAS alternatives?

Due to the complexity of the question, this needs further evaluation. An additional request for comments should be issued so that further comments on this question can be submitted with the time needed to develop a submission response.

5. How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

Despite the substantial financial incentives to replace PFAS, we are not aware of companies offering new materials as a drop-in replacement and capturing this valuable market, which is a strong indication that, in many cases, especially in industrial applications, that no alternatives exist.

Consequently, an **estimated** time period for a granted CUU should be set at a minimum of 10 years **after** a safe and reasonably available alternative (as defined above) is identified. This timeframe would allow for identification of alternatives and verification and validation testing, which can be upwards of 10 years in highly regulated industrial environments. This estimate assumes that a suitable alternative will be identified within the first few years of the CUU time period.

6. How should stakeholders request to have a PFAS use be considered for currently unavailable use determinations by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

Due to the complexity of the question, this needs further evaluation. An additional request for comments should be issued so that further comments on this question can be submitted with the time needed to develop a submission response.

7. In order to get a sense of what type of and how many products may seek a currently unavailable uses determination, please share what uses and products you may submit a request for in the further and briefly why.

Fluid handling or flow control is a complex process that requires numerous components including but not limited to industrial pumps, motors, drives, pipes, seals, gaskets, coatings, piping, and valves. These components work in unison to handle a variety of fluids each with different characteristics and in a variety of situations or use cases. While each type of system cannot be listed here because of the wide array of products used in the processing and production in so many industries, we have attached a list of critical products that contain PFAS (e.g., PTFE, FKM, FFKM, ePTFE, PCTFE, mPTFE, PFA, eTFE, FEP, PVDF, PFPE, FEPM, ECTFE) that are commonly used to handle difficult materials in very specific environments and situations. The attached list includes relevant GPC/HTS product category codes and provides generic uses of PFAS in the product. While we attempted to be as inclusive as possible to provide a general idea of how many applications are currently unavoidable uses and do not have alternatives available, it should be noted that there could be additions to this list.

8. Should MPCA make some initial currently unavoidable use determination as part of this rulemaking using the proposed criteria?

The Flow Control Coalition recommends that MPCA adopt an initial CUU determination for the industrial flow and pressure control products identified in the attached list.

* * * *

The member companies of the Coalition play an integral role in supporting the production of products essential to improving the quality of daily life of the public and protecting the planet. Industrial flow control equipment is critical to many industries, most notably oil and gas; chemical;

national defense; construction; power generation (traditional and new energy sources); mining; pharmaceutical; pulp and paper; water and wastewater; semi-conductor production; construction and data centers; transportation; food and beverage and many others. These industries are found in every state and globally. Because of the breadth of the industry, there must be consistency among all 50 states and the federal government when CUU determinations and approaches to these determinations are made.

The Flow Control Coalition appreciates the opportunity to submit these comments. For further information or to discuss these comments, please contact:

Fluid Sealing Association: Peter Lance, pete@fluidsealing.com, (610) 971-4850

Hydraulic Institute: Michael Michaud, mmichaud@pumps.org; (862) 242-5180

Valve Manufacturers Association: Heather Rhoderick, hrhoderick@vma.org; (202) 331-4039

Water and Wastewater Equipment Manufacturers Association: Claudio Ternieden CTernieden@WWEMA.org; (703) 444-1777

Respectfully,

/s/

Peter Lance, Executive Director, Fluid Sealing Association
Michael Michaud, Executive Director, Hydraulic Institute
Heather Rhoderick, President, Valve Manufacturers Association
Claudio Ternieden, Executive Director & Corporate Secretary, Water and Wastewater Equipment Manufacturers Association

Product Description	GPC/HTS Code	Use of PFAS	Alternatives
Backflow Preventer Parts / Accessories	10005865	Fluoroelastomer/polymer seals	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Backflow Preventers	10005866	Fluoroelastomer/polymer seals	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Backflow Test Kits	10005863	Fluoroelastomer/polymer seals	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Vacuum Breakers	10005864	Fluoroelastomer/polymer seals	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Overhung Pumps	10008340	Fluoroelastomer/polymer seals, Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Between Bearings Pumps	10008341	Fluoroelastomer/polymer seals, Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Vertically Suspended Pumps	10008342	Fluoroelastomer/polymer seals, Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Submersible Pumps	10008343	Fluoroelastomer/polymer seals, Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Fire Hydrant Systems	10008344	Fluoroelastomer/polymer seals, Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Screw Pumps	10008345	Fluoroelastomer/polymer seals, Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Peristaltic/Roller Pumps	10008346	Fluoroelastomer/polymer seals, Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Vane Pumps	10008347	Fluoroelastomer/polymer seals, bearing components, wear disc, valve coating, magnetic couplings, vanes, push rods Flame resistant plastics used in wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Progressive Cavity Pumps	10008348	Fluoroelastomer/polymer seals, bearings, stators, joint sealing Flame resistant plastics used in wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".

Product Description	GPC/HTS Code	Use of PFAS	Alternatives
Gear Pumps	10008349	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Lobe Pumps	10008350	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Piston Pumps	10008351	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Plunger Pumps	10008352	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Diaphragm Pumps	10008353	Fluoroelastomer/polymer seals, valve seats, check valves, diaphragms, pump head components, tubing, valving, pistons, Flame resistant plastics used in cables, wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Pneumatics Pumps	10008354	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Industrial Pumps - Electric Engines	10008355	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Industrial Pumps -Combustion Engines	10008356	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Industrial Pumps – Replacement Parts / Accessories	10008364	Replacement parts would use various PFAS for repair of pumps (seals, components, etc)	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Fire Fighting Equipment	10008382	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Industrial Pumps - Engines	11030100	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Industrial Pumps – Replacement Parts / Accessories	11050100	Replacement parts would use various PFAS for repair of pumps (seals, components, etc)	Alternate materials do not exist that meet the MDEP definition for "Alternative".

Product Description	GPC/HTS Code	Use of PFAS	Alternatives
Pumps	10004055	Fluoroelastomer/polymer seals, bearing components, molded plastic components, Tribologic components, coatings Flame resistant plastics used in cables, wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Valves/Fittings - Water and Gas	10004024	Fluoroelastomer/polymer seals, valve liners	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Valves/Fittings Accessories/Replacement Parts - Water and Gas	10008011	Includes multiple PFAS materials for replacement/repair. (e.g. bearings, gaskets, compression packings, seals, seats, linings)	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Underfloor Heating	10004003	Fluoroelastomer/polymer seals Flame resistant plastics used in cables, wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Relays/Contactors	10005570	PFAS critical for meeting UL and NEC flammability safety standards	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Switches	10005586	PFAS critical for meeting UL and NEC flammability safety standards	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Inverters	10008390	PFAS critical for meeting UL and NEC flammability safety standards	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Distribution Boards/Boxes	10005583	PFAS critical for meeting UL and NEC flammability safety standards	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Circuit Assemblies/Integrated Circuits	10005661	PFAS critical for meeting UL and NEC flammability safety standards. Used in coatings for water resistance	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Thread Sealant (Paste)	3403.19.00.00	Fluoropolymer friction reducer and thread sealant critical to NPC piping systems and system sealing. Chemical resistance, Gas permeability, coefficient of friction, non-hardening properties.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Thread Sealant (Tape)	3403.19.00.00	Fluoropolymer friction reducer & thread sealant critical to piping systems and system sealing. Chemical resistance, Gas permeability, coefficient of friction, non-hardening properties.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Lined Hoses	3917.39.00.10 3917.21.00.00 4009.42.00.50 3917.33.00.00 3917.29.00.90 3917.39.00.50	Temperature and chemical resistance	Alternate materials do not exist that meet the MDEP definition for "Alternative".

Product Description	GPC/HTS Code	Use of PFAS	Alternatives
Lined Pipes Valves and Fittings	7306.19.10.10 8481.30.20.90 8481.80.30.65 8481.80.30.20 7307.19.90.80 8481.80.90.50 7307.99.10.00 7306.19.10.50 8481.80.10.90 8481.80.30.30 8481.80.30.75	Temperature and chemical resistance	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Sealants	10003204	Chemical resistance, Gas permeability, Diffusion coefficient	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Adhesives		Chemical resistance, Gas permeability, Diffusion coefficient	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Lubricating Greases	10005268	Long period operation, High temperatures, Low friction/low wear, Good gliding properties, Resistant to aggressive chemicals and reagents	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Lubricating Oils/Fluids	10005267	Long period operation, High temperatures, Low friction/low wear, Good gliding properties, Resistant to aggressive chemicals and reagents	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Lubricating Products Variety Packs	10005270	Long period operation, High temperatures, Low friction/low wear, Good gliding properties, Resistant to aggressive chemicals and reagents	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Lubricating Waxes	10005269	Long period operation, High temperatures, Low friction/low wear, Good gliding properties, Resistant to aggressive chemicals and reagents	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Grinder/Macerator	10002611	Fluoroelastomer/polymer seals, bearing components	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Mechanical Seals	10008364	Fluoroelastomer/ polymer seals	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Compression Packing	6815.19.00.00 3901.10.50.30 5911.90.00.40 6815.13.00.00 6815.19.00.00	Fluoropolymer yarns and yarn coatings. Chemical resistance, Gas permeability, temperature capability and coefficient of friction.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Reciprocating Seals	3926.90.45.00	Fluoropolymer/ Fluoroelastomer base material for molded/machined seals. Chemical resistance, Gas permeability, temperature capability and coefficient of friction.	Alternate materials do not exist that meet the MDEP definition for "Alternative".

Product Description	GPC/HTS Code	Use of PFAS	Alternatives
Rotary Seals	3926.90.45.00 4016.93.00.00	Fluoropolymer/Fluoroelastomer base material for molded/machined seals. Chemical resistance, Gas permeability, temperature capability and coefficient of friction.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Gasketing	3920.99.10.00 3920.99.50.00 3921.90.40.90 4002.59.00 3904.61.00.90 3926.90.45 3920.10.00.00	Fluoropolymer and fluoroelastomer base material for sheets, tapes, fabricated parts. Chemical resistance, Gas permeability, temperature capability, compressibility and coefficient of friction.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Flange Guards (Fabric)	5407.71.00.60	Fluoropolymer fibers/yarns/ fabrics. Chemical resistance, Gas permeability, temperature capability and coefficient of friction.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Expansion Joints	4016.93 3926.90.90 7307.99.00 4016.99 3926.90.90 3926.90.99	Fluoropolymer and fluoroelastomer base material, coating, liner or cover. Chemical resistance, Gas permeability, temperature capability and coefficient of friction, flexural toughness	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Diaphragms	8413.91 3926.90.45	Fluoropolymer and fluoroelastomer base material. Chemical resistance, Gas permeability, temperature capability and coefficient of friction, flexural toughness	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Industrial Valves & parts	9032 8481	Includes multiple PFAS materials based on the specific application need; multiple performance characteristics depending on application.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Actuators	8412 8471	Includes multiple PFAS materials based on the specific application need; multiple performance characteristics depending on application.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
O-Rings	4016.93.0000	Includes multiple PFAS materials based on the specific application need; multiple performance characteristics depending on application, to include chemical and temperature resistance; reduce friction	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Spring energized seals	8481	Specialty seals used in extreme temperatures to restrict emissions to atmosphere in cryogenic applications	Alternate materials do not exist that meet the MDEP definition for "Alternative".

Fluid Sealing Association: Peter Lance, pete@fluidsealing.com, (610) 971-4850
Hydraulic Institute: Michael Michaud, mmichaud@pumps.org; (862) 242-5180
Valve Manufacturers Association: Heather Rhoderick, hrhoderick@vma.org; (202) 331-4039
Water and Wastewater Equipment Manufacturers Association: Claudio Ternieden CTernieden@WWEMA.org; (703) 444-1777

RECEIVED
By: OAH on 3/1/2024
Peter Glessing Attachment

MedicalAlley

03/01/24

RE: Request for Comment on PFAS in Products Currently Unavoidable Use Rule

Commissioner Kessler,

Medical Alley and our network of more than 800 partners represent one of the most diverse and influential healthcare communities in the world. We are a critical partner and connection point between companies, talent, and the broader Medical Alley community, which employs more than half a million Minnesotans.

We are responding to the Minnesota Pollution Control Agency's Request for Comment on the PFAS in Products Currently Unavoidable Use Rule.

Under the Products Containing PFAS statute, the term "currently unavoidable use" appears four times – once under Subdivision 1(j) for definitional purposes and three times under Subdivision 5(c) for enforcement purposes.

Subdivision 8(b) states:

> Subdivisions 4 and 5 do not apply to a prosthetic or orthotic device or to any product that is a medical device or drug or that is otherwise used in a medical setting or in medical applications regulated by the United States Food and Drug Administration.

Medical Alley interprets this rulemaking to exclude medical devices, medical drugs, medical products, orthotic devices, or prosthetic devices, pursuant to the language under Subdivision 8(b), which includes the materials necessary to manufacture the aforementioned products. Medical Alley supports this exclusion.

Please reach out to Medical Alley Senior Director of Policy and Advocacy Peter Glessing (PGlessing@medicalalley.org) with any questions.

Sincerely,

Roberta Antoine Dressen
President/CEO Medical Alley

John Keane Attachment

RECEIVED

By: OAH on 3/1/2024

AHAM
ASSOCIATION OF HOME APPLIANCE MANUFACTURERS

1111 19TH STREET NW | SUITE 1150
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AHAM.ORG

March 1, 2024

By E-mail

Katrina Kessler
Commissioner
Minnesota Pollution Control Agency
520 Lafeyette Road North
St. Paul, Minnesota 55155-4194

Re: Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

Dear Commissioner Kessler,

On behalf of the Association of Home Appliance Manufacturers (AHAM), I would like to provide our recommendations regarding the rules governing currently unavoidable use determinations for products containing PFAS.

AHAM represents manufacturers of major, portable and floor care home appliances, and suppliers to the industry. Nowadays, American families are spending even more time in their homes, and they need to help ensure that their home is safe, sanitary, able to prepare and preserve food, and that they have access to clean water. Our industry believes that home appliances, whether it is a major, portable or a floor care appliance, are essential to everyday life, adding a life enhancing benefit and keeping people healthy and nourished. These benefits allow people to focus on family time, spend additional hours on work, and gain hours back into the day. The comments below cover all major, portable, and floor care appliances.

AHAM's members produce hundreds of millions of products each year. They design and build products at the highest levels of quality and safety. As such, they have demonstrated their commitment to strong internal safety design, monitoring, and evaluation/failure analysis systems. AHAM supports the intent to protect consumers against all unreasonable risks, including those associated with the exposure to potentially harmful chemicals. AHAM also firmly supports the appropriate use of PFAS chemicals in appliances. Together with industry design practices, test requirements, and redundant safety mechanisms, PFAS chemicals play an important role in the safety of household appliances.

AHAM conducted a member survey in a good faith effort to determine the extent to which PFAS is used in home appliances and the estimated time needed to phase out PFAS in those use cases. To the best of AHAM members' knowledge, appliances contain PFAS chemicals but in low amounts. PFAS are used for their self-lubricating properties and great resistance to high temperature, chemical aggression, and pressure. In the table below is detailed information about applications of specific PFAS chemicals found in appliances. It is important to note that they are often confined to internal components and parts, such as bolts, washers and gaskets, plastic brackets, and wire terminals. This material is added during the manufacturing process, which reduces the potential for any consumer exposure during use or transmission to the environment.

Examples of PFAS Applications in Home Appliances

Applications	Parts containing PFAS	PFAS	PFAS properties
Parts	Insulation on cables, wires, connectors, etc.	PTFE, PFA, FEP, PVDF	Electrical insulation, heat resistance, flame retardancy
	Rubber seals, gaskets	PVDF, PTFE	Heat resistance, chemical resistance, gas barrier
	Gears, ball bearings	PTFE, PVDF	lubrication, heat resistance
	Interior coatings of cookware	PTFE	Corrosion resistance, heat resistance, self-lubricating
	Flame retardants of plastic parts	PTFE, KFBS	Flame retardancy
Battery materials	Binder of Lithium-ion batteries, gaskets	PVDF	Heat resistance, chemical resistance, gas barrier
Chemicals	Refrigerant for Refrigerators, air conditioner, chillers, Foam Blowing agents	Hydrofluoroolefins (HFO/HCFO's)	Refrigerant, cooling
	Greases, lubricants	PTFE, PFPE[1]	Lubrication, chemical resistance, gas barrier

In addition, a number of AHAM member respondents also indicated limited testing solutions are currently available, making it challenging to identify and discriminate different PFAS and determine concentrations. As such, AHAM member respondents stated it is not easy to find laboratories capable and willing to test and/or verify the absence/presence of PFAS, and such testing could be prohibitively expensive and may require several repeat tests for accuracy. Manufacturers rely on accurate information from their suppliers. As a result, regulators should consider these challenges in currently unavoidable use determinations.

AHAM urges the State of Minnesota to take a more robust and complete approach for assessing alternatives, which considers overall safety, performance, innovation, and sustainability factors. Proposals to regulate PFAS should be narrowed to consider the level of use within appliances, and whether the chemicals are accessible to the user. Therefore, a universal PFAS restriction in appliance in such a short period would not be feasible and PFAS applications to internal

[1] PTFE: Polytetrafluoroethylene, PFA: Perfluoroalkyl polymer, FEP: Fluorinated ethylene propylene, PVDF: Polyvinylidene fluoride, PFPE: Perfluoropolyether, KFBS: Nonafluorobutanesulfonates

components of appliances should be separated from potential risks of any consumer exposure during use.

Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Yes- In 2021, the State of Maine became the first state to enact a comprehensive PFAS ban[2], and the Maine Department of Environmental Protection is currently undergoing rulemaking around Currently Unavoidable Uses. In their submission requirements, the Department of Environmental Protection has requested how PFAS is essential for health, safety, or functioning of society. By establishing this definition, manufacturers and suppliers can provide real life examples of how PFAS is essential to human health and the environment. Some specific uses of PFAS's would be considered essential because they provide vital functions as established by federal law and are currently without established alternatives that provide the same fire and heat suppression needed for safety reasons. For example, refrigerant gases play a crucial role in maintaining the comfort and convenience we enjoy in our day-to-day lives in food preservation from our home to our favorite restaurant. These PFAS have been mandated into federal law based on their less global warming potential and to their necessity to society in achieving environmental objectives, including the mitigation of climate change.

More generally, the concept of "essential" must be interpreted broadly to be workable. Under a narrow definition, refrigeration would not be essential since society can theoretically continue to function without these refrigeration products. However, this narrow interpretation ignores the critical role that refrigeration plays in supporting good health by preventing food spoilage and preserving pharmaceuticals.

Maine defines "Essential for Health, Safety or the Functioning of Society,"

> Means products or product components that if unavailable would result in a significant increase in negative healthcare outcomes, an inability to mitigate significant risks to human health or the environment, or **significantly interrupt the daily functions on which society relies**. Products or product components that are Essential for Health, Safety or the Functioning of Society include those that are required by federal or state laws and regulations. Essential for the Functioning of Society includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, and construction.

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2 An Act To Stop Perfluoroalkyl and Polyfluoroalkyl Substances Pollution
https://www.mainelegislature.org/legis/bills/display_ps.asp?ld=1503&PID=1456&snum=130

Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Yes- It is expected that these PFAS prohibition requirements will result in additional costs to manufacturers, sellers, and distributors of priority consumer products containing PFAS chemicals in Minnesota. Transitioning to alternatives could have a different price for each appliance as one manufacturer may use one alternative while other manufacturers may use alternatives to meet specific product requirements. Considerations around the availability of the alternative should include a.) what is the approximate cost and availability of other materials that may be required for use of the potential alternatives including required product design changes, b.) what will be the approximate costs and supply chain implications for redesigning the product, including product testing and recertification, and c.) how long would it take a manufacturer to transition.

The costs would occur because manufacturers would have to reorient their production and investment patterns, and some would have to integrate or develop new chemistries, redesign, or reformulate the product, and recertify new products to meet safety standards, performance requirements, and aesthetic preferences. Such complex recertification and re-qualification procedures are very time-consuming, both because of the lack of testing bodies and their technical complexity. Ceasing production of their already third-party safety certified product would be the only option if there are no viable and non-burdensome alternatives. These cost and access considerations could have a dramatic effect for Minnesota consumers.

Another important thing to consider in this prohibition are older service parts that are no longer in serial production. Manufacturers and suppliers should not be forced to retool/redesign obsolete parts that are used to service appliances. There should be determinations made around older service parts.

What criteria should be used to determine the safety of potential PFAS alternatives?

Electronics are certified to end-product safety standards. The National Electrical Code requires all electrical products to be listed which requires certification to the appropriate safety standard. If the revised products meet the Minnesota requirements but do not meet the safety requirements required for certification and listing, then these appliances will not be approved for use in the State of Minnesota. The reality is that the use of potential substitutes could significantly deteriorate the quality, safety, and durability of the products. If regrettable substitutes were used, there would be increased safety risks, including the danger of flammability with many products.

Federal regulations should also be considered. For example, in 2020 the American Innovation and Manufacturing (AIM) Act was signed into law which authorizes the Environmental Protection Agency to address hydrofluorocarbons (HFCs) by providing new authorities in three main areas: to phase down the production and consumption of listed HFCs, manage these HFCs and their substitutes, and facilitate the transition to next-generation technologies through sector-based restrictions. A new alternative refrigerant with lower global warming potential would be considered a PFAS under this law and would have to be removed under the law. Further information below on HFO's.

Ultimately, switching to PFAS-free materials is critical in terms of effort and cost. However, in some cases there are not technically available alternatives to date. Therefore, all PFAS laws should include methods to apply for exemptions for critical uses. We appreciate this rulemaking process. New critical use cases may occur in the future as we receive information from suppliers and PFAS testing methods change/improve, so there should be an open-ended application process for exemptions to cover future discoveries.

Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

Yes- AHAM supports the MPCA proposing initial CUU determinations as part of the rulemaking process. This will help create greater market certainty and ensure more of the products Minnesotans rely on for daily life can remain accessible. Even for prohibitions many years away, manufacturers are already working through their global supplies to find alternatives. It is critical for the MPCA to offer exemptions to spur the search for alternatives. A manufacturer of an appliance may have upwards of 5,000 suppliers for potentially 100,000 components across product lines. Also, there may not be sufficient third-party certification companies available to provide these required recertification services in a timely manner. Once an alternative is found, manufacturers have expected 3-5 years to switch over to new parts as quality and products often require recertification and re-qualification procedures which are very time-consuming and can take several years. We would request that MPCA initiate initial CUU determinations in the next stages of the rulemaking process.

In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why.

Below are several requests for Currently Unavoidable Use Determinations:

Hydrofluroolefins (HFO's)/Hydrochlorofluoroolefins (HCFO)

HTS Code- SOLSTICE LBA 290379

As mentioned earlier, under this prohibition, hydrofluroolefins (HFO's) and hyrdochlorofluoroolefins (HCFO's) would be included. This includes an environmentally friendly foam blowing agents that are used in refrigeration and environmentally friendly refrigerants used in air conditioning. HFO/HCFO's are also essential as lubricants and anti-drip agents. These specialized gases are an integral part of various cooling systems, including refrigerators, air conditioners, and heat pumps. Refrigerant gases play a crucial role in maintaining the comfort and convenience we enjoy in our day-to-day lives. It is important for MPCA to work with stakeholders when the requirements could conflict with federal law (AIM Act[3]) which authorizes EPA to

[3] "American Innovation and Manufacturing Act of 2020" https://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title42-section7675(a)&num=0&edition=prelim

facilitate the next generation of foam blowing agents, which are captured under the statutory definition, to combat climate change. The Department of Defense recently identified refrigeration, air conditioning, cooling, and electronics thermal control as a mission critical application in their recent report on the Critical Uses of PFAS report.[4]

HCFOs are ultra-low Global warming, climate friendly alternatives for use as refrigerator insulation foam blowing agents. Other states have also acted to ban HFC use, and the U.S. Environmental Protection Agency (EPA) encouraged and effectively drove a transition to these and other low global warming potential (GWP) refrigerants through ozone depletion and climate focused phase-out's of CFC's, HCFC's, and HFC compounds. This HCFO chemical was approved under EPA's Significant New Alternatives Policy (SNAP) program, which included an environmental review. EPA's new definition functionally excludes foam blowing agents and refrigerants from the definition. By deeming HFO blowing agents "acceptable," EPA has determined that HCFO and foam blowing agents "reduce overall risk to human health and the environment compared to other substitutes for the particular end-use."[5] These newer refrigerants have a lower impact on the ozone layer, reducing the potential for ozone depletion and contributing the energy efficiency and sustainability. Additionally, they have lower global warming potential (GWP) compared to their predecessors, making them less harmful to the Earth's climate. Prohibition or restriction of HCFOs would require a total re-design of models and retooling of entire appliance manufacture facilities at significant cost. MPCA should consider a definition of PFAS in accordance with EPA's definition, as established under Toxic Substances Control Act (TSCA)[6]. AHAM proposes that HFOs and HCFOs be identified as Currently Unavoidable Use.

PFAS found in Electronic Components/Wiring and Cables

PFAS are often used throughout the appliance industry at different points within the supply chain. Electronic components like transformers, relays, connectors, buzzers, semiconductors, encoders, printed circuit boards, switches, NTC sensors, capacitors often contain PFAS. PFAS in these components offer a number of key properties, such as flame retardancy, chemical inertness, and dielectric strength, which make them desirable for applications in electronic products because these typically involve high temperatures and voltages. It has been noted by industry that for existing designs, PFAS cannot be easily substituted in printed circuit/wiring boards without a complete redesign of the equipment (including the mechanical dimensions of the product) thus it is difficult to substitute PFAS for spare parts. Importantly, most of these uses are internal to the product where the consumer would not come into contact with PFAS.

Another electronic product category is wiring and cables. Many household electrical appliances have a cable for the power supply. Cable sheaths must be resistant to flying sparks so that they are

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[4] Department of Defense "Report on Critical Per- and Polyfluoroalkyl Substance (PFAS) Uses" https://www.acq.osd.mil/eie/eer/ecc/pfas/docs/reports/Report-on-Critical-PFAS-Substance-Uses.pdf, p.14

[5] https://19january2017snapshot.epa.gov/snap/overview-snap_.html

[6] https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/risk-management-and-polyfluoroalkyl-substances-pfas#:~:text=Overview%20of%20PFAS%20Actions%20under,fighting%20foams%2C%20and%20wire%20insulation.

not set on fire. The insulating layer around the outside of each wire or cable can be made from a variety of plastic or rubber materials and are often made from fluoropolymers due to their resistance to heat and fire, corrosion, moisture, and cracking. Due to lack of potential alternatives and threat to consumer safety, we would request a determination around electronic components found internally, not in contact with human touch.

Cookware

The law also establishes prohibition on cookware with intentionally added PFAS within Minnesota by 2025. This is the first in the nation prohibition of PFAS in cookware which includes durable houseware items that are used to prepare, dispense, or store food. With this comes a very short timeline, January 1, 2025, where time is of the essence when retailers need months in advance to get products on shelves. Although this is not part of the rulemaking process, we do want to ensure compliance with the law is clear and feasible. Two states- California[7] and Colorado[8] have instituted cookware labeling requirements, but no state has enacted an outright prohibition. Under Minnesota law:

> "Cookware" means durable houseware items used to prepare, dispense, or store food, foodstuffs, or beverages. Cookware includes but is not limited to pots, pans, skillets, grills, baking sheets, baking molds, trays, bowls, and cooking utensils.

Regarding appliances, these products are very complex products with wirings, circuit boards, & many internal components. The products in the 2025 prohibition involve products (cosmetics, dental floss, ski wax) that have direct human contact and most of them are simple, single-material products including pots and & pans under the cookware definition unlike appliances which have hundreds of components with internal electrical components that are inaccessible to human touch. We understand the need to address PFAS released from landfills, but major appliances are recycled at a high rate and at end of life often take on new value as an important manufacturing raw material, including scrap steel. In major appliances, ferrous material can account for 40 to 60 percent of the product's total weight. For smaller portable appliances, there have been studies around recent waste characterization in several states and the quantities of appliance related materials found in the waste stream during the course of these studies and it ranged from as low as 0.11 percent in Maine to 2.49 percent in Michigan.[9] Specifically to Minnesota which has the first in the nation to have an electronics take-back law, there is data to show that appliances are recycled appropriately. According to MPCA data, electronics were only at 1.2% of waste steam.[10]

With the "includes but not limited to" language, it opens the door to unclear product scope. In the deliberation around the California law, an amendment was adopted that removed "but is not limited to" language so that cookware is only the items listed in the bill. Minnesota should work with other

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7 https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220AB1200

8 https://leg.colorado.gov/bills/hb22-1345

9 Analysis of Appliance Recycling in the U.S. and Canada Portable and Floor Care Appliances, Burns & McDonnell, 2017.

10 https://www.pca.state.mn.us/sites/default/files/w-sw1-60.pdf

states to clarify and harmonize the cookware definition to include only products that meet all the following criteria: contain intentionally added PFAS; intended for cooking because the product is "cookware;" and only surfaces that are in contact with food during the cooking process. With a very tight timeline for this cookware prohibition, manufacturers are still working to understand the law to ensure full compliance because products are sold to a national marketplace providing economies of scale resulting in lower costs and more product availability to consumers. Ultimately, any prohibition requires redesign and potentially pulling items off shelves which could lead to less consumer choice and consumers potentially going to neighboring states to buy cookware products. **We would request enforcement discretion for cookware products with internal electronic components containing PFAS because these components are not in contact with human touch and are necessary for safety and/or fire suppression.**

Fluoropolymers

HTS Code- HTS 3904.61 & 3904.69

Another category that falls under the current definition of PFAS used in the home appliance industry is fluoropolymers. Fluoropolymers includes but is not limited to PVDF, FEP, PFA, PTFE, etc. They are used because of their specific and critical properties applied to electrical, and mechanical components, such as washers, plastic brackets, pipes, flexible connections, filters, wire terminals and insulations, lithium-ion batteries, gaskets, gears, packings, bearings, and lubricants. Fluoropolymers are used due to their unique combination of self-lubricating, resistance to high temperature, resistance to high pressure, durability, resistance to abrasion, and resistance to friction. Unlike non-polymeric PFAS, which are mobile, can bioaccumulate, and can have toxicity concerns, fluoropolymers have not been demonstrated to have negative health concerns and are a material of choice for sensitive applications such as medical devices. It is important to note that there is no guarantee that alternatives can be found that will not compromise the high performance, durability, and functionality of household appliances and the continuity of supply for spare parts.

Below are tables to illustrate that fluoropolymers are in most appliances to provide sealing & insulation as well as used for specific parts in contact with food such as high-performance pipes, and connections.

Product	GPC Code
Wine Chillers	10001939
Ovens	10001950
Microwave Ovens	10001952
Dishwashers	10001964
Range Cookers/Stoves	10003690
Refrigerators	10003694

Product	HTC Code
Food Processors	85094000
Water Kettle	85161080
Electric Oven	85166090
Coffee Makers	85167100

Toaster	85167200

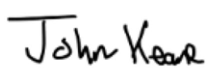
Specifically, regarding coffee makers, PFAS substances only come into contact with food/water for a short time. The use of PFAS in greases in the food and drinking water sector, such as water taps, ceramic valves, are there to decrease friction and wear. Of note, these greases meet the performance requirements of several regulatory standards for drinking water contact, including UBA guidelines, NSF/ANSI 61, ACS, and Water Regulation Advisory Scheme (BS6920:2000).

One of the example fluoropolymers that is used as material in contact with food is Polytetrafluoroethylene (PTFE). Manufacturers use coatings that have a small amount of PTFE for water, scratch resistance, heat resistance, with a good flexibility in manufacturing stage, as well as a long-life durability in use. PTFE pipes for hot water are used because of their unique combined resistance to high pressure, high temperature and high durability under these conditions. Manufacturers and suppliers have reported no feasible substitutes for these coatings.

All these fluoropolymers mentioned here are used to fulfill not only the specific feature needed by the use, but also the electrical and flammability requirements of the product, as well as to maintain the long durability of these parts that reduce the wasting of the product itself. Ultimately, the impact of restriction could potentially lead to significant increases in manufacturing costs which raise costs on consumers.

Thank you for considering our views on this rulemaking and please contact me at jkeane@aham.org or 202-872-5955 if you would like to discuss this in more detail.

Respectfully submitted,



John Keane
Manager of Government Relations

AHAM represents manufacturers of major, portable and floor care home appliances, and suppliers to the industry. AHAM's membership includes over 150 companies throughout the world. In Minnesota, the home appliance industry is a significant and critical segment of the economy. The total economic impact of the home appliance industry to Minnesota is $3.6 billion, more than 20,000 direct and indirect jobs, $468.5 million in state tax revenue, and more than $1.2 billion in wages. The home appliance industry, through its products and innovation, is essential to U.S. consumer lifestyle, health, safety, and convenience. Through its technology, employees and productivity, the industry contributes significantly to U.S. jobs and economic security. Home appliances also are a success story in terms of energy efficiency and environmental protection. New appliances often represent the most effective choice a consumer can make to reduce home energy use and costs.

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By: OAH on 3/1/2024

Nichol Robinson Attachment

FUJIFILM
Value from Innovation

FUJIFILM Holdings America Corporation
200 Summit Lake Drive
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March 1, 2024

Submitted via e-Comments as Requested to:
https://minnesotaoah.granicusideas.com
Attention: Minnesota Pollution Control Agency
PFAS Currently Unavoidable Uses Pursuant to §116.943, subdivision 5(c)
Revisor's ID number R-4837

Re: Planned New Rules Governing Currently Unavoidable Use (CUU)

FUJIFILM Holdings America Corporation (FUJIFILM) is a global conglomerate comprised of more than 20 affiliate companies spanning across a broad spectrum of industries including medical and life sciences, semiconductor, electronic, chemical, graphic arts, information systems, motion picture, broadcast and photography. Our relentless pursuit of innovation is focused on providing social value and enhancing the lives of people worldwide.

We submit these comments in response to the Minnesota Pollution Control Agency's (MPCA) solicitation of proposals for currently unavoidable use (CUU) determinations pursuant to Minnesota Statutes §116.943, subdivision 5(c)("Amara's Law") regulating the use of perfluoroalkyl and polyfluoroalkyl substances (PFAS) in products.

To avoid significant adverse socio-economic impacts on Minnesota's economy and the quality of life of Minnesota residents, FUJIFILM requests that MPCA craft a broad CUU exemption that exempts from the 2032 PFAS restriction all uses of PFAS in all materials and processes in the industrial product value chain, including when present in end products. Industrial products that should be considered for exemption include but not limited to:

- **Gas Separation Membranes**
- **Magnetic Tape**
- **Membrane Filters for Microfiltration**
- **Microfilm**
- **Industrial X-Ray Film**
- **Pressure Measurement Film**
- **Medical X-Ray Film**

Industrial Uses of PFAS: Critical Applications Throughout the Supply Chain

1. **Gas Separation Membranes (Apura™):**
    - Enhance natural gas processing efficiency and environmental sustainability.
    - Reduce CO2 emissions by up to 60% compared to traditional methods.
    - Enable carbon capture and storage (CCS) and enhanced oil recovery (EOR) programs.
2. **Magnetic Tape:**
    - Offer reliable, affordable, and sustainable long-term data storage (over 50 years).
    - Reduce e-waste by 80% compared to hard disk drives.
    - Enhance data security with air gap protection against cyberattacks.

3. **Membrane Filters for Microfiltration:**
   - Facilitate the purification of various liquids, including water, beverages, and pharmaceuticals.
   - Contribute to public health and product quality by removing harmful elements.
   - Play a crucial role in diverse industries like electronics and pharmaceuticals.
4. **Microfilm:**
   - Provide a secure and long-lasting (500-year shelf life) archiving solution for invaluable records.
   - Eliminate the need for data migration and ensure future accessibility without reliance on electricity or computers.
   - Contribute to environmental sustainability by reducing e-waste and carbon emissions.
5. **Non-destructive Testing (NDT) using Industrial X-Ray Film:**
   - Ensure the quality and safety of various products across industries.
   - Play a crucial role in advanced manufacturing and cost-saving practices.
   - Offer high reliability, versatility, and permanent information records.
6. **Pressure Measurement Film (Prescale™):**
   - Revolutionize pressure analysis by visualizing pressure distribution for diverse applications.
   - Improve process optimization, quality control, and efficiency in various industries.
   - Reduce material waste, prolong tool life, and ultimately yield higher quality products.
7. **Medical X-Ray Film:**
   - Crucial diagnostic tool in healthcare, facilitating the visualization of internal structures for the identification and assessment of various medical conditions.
   - Non-invasive nature and ability to capture detailed images contribute to accurate and timely diagnoses, supporting effective patient care.
   - The affordability and accessibility of X-Ray Film continue to make it an indispensable resource, ensuring widespread availability and contributing significantly to healthcare delivery in diverse communities.

Shared Commitment to PFAS Alternatives

FUJIFILM has invested significantly in identifying and implementing PFAS alternatives across our supply chain. Given the unique properties, our extensive research and development efforts have yet to identify a suitable alternative that replicates the critical performance characteristics essential for the above-listed industrial products. Should a feasible alternative become available in the short or medium term, we will require extensive lead time extending beyond the 2032 deadline to redesign and revalidate the materials, equipment and production processes.

FUJIFILM respectfully requests that MPCA consider the unique use cases presented above in developing a general exemption for PFAS used in the listed products. We remain committed to finding a suitable alternative and will readily adopt it once available. While actively seeking alternatives, we require a flexible approach to the 2032 deadline to ensure a responsible transition without compromising product performance.

We appreciate the opportunity to contribute to the discussion surrounding MPCA's planned rulemakings. If you have any questions or would like to discuss our position, please contact Nichol Robinson by phone at 312-924-5829 or by email at nrobinson@fujifilm.com.

Sincerely,

Nichol J. Robinson
EHS Manager, Regulatory and Product Compliance
FUJIFILM Holdings America Corporation

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By: OAH on 3/1/2024

Claigan
Less Journey. More Results.

Claigan Environmental Inc.
10 Brewer Hunt Way, Suite 200
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Letter of Support

IDEXX Laboratories Inc. stands firmly behind efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. However, we express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. It's important to acknowledge that PFAS play a vital role in ensuring product functionality and meeting stringent safety standards.

In line with our commitment to finding balanced solutions, Claigan Environmental has developed a comprehensive Currently Unavoidable Uses (CUU) proposal, which is being submitted to the states of Maine and Minnesota. This proposal is founded upon rigorous laboratory testing and incorporates valuable insights gathered from diverse stakeholders. By engaging experts from various industries, Claigan Environmental has adopted a collaborative approach to address this complex issue.

IDEXX Laboratories Inc. actively participated in the consultation process and supports Claigan Environmental's submission. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS while mitigating adverse impacts on businesses, communities, and public health.

Diana L Rondeau

Diana Rondeau
Director Global Product Compliance
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Ronald Shebik Attachment

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www.hussmann.com

March 1, 2024

Office of Administrative Hearings (OAH)
c/o Rulemaking *eComments* website
https://minnesotaoah.granicusideas.com/
Minnesota Pollution Control Agency (MPCA)
Attention: Resource Management and Assistance Division

Re: MPCA Request for Comments on Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

These comments are submitted by Hussmann Corporation in response to the Minnesota Pollution Control Act (MPCA) request for comment regarding PFAS and Currently Unavoidable Use.

Hussmann, a North American leader in providing display merchandisers, refrigeration systems, installation and service to food retailers around the world would first like to thank MPCA staff for providing stakeholders an opportunity to comment on PFAS and CUU. Hussmann, a member of AHRI, has worked diligently throughout the development of state and federal PFA proposals to better understand the impact on HVACR equipment.

Hussmann supports MPCA's efforts to reduce harm to human health and the environment. However we also recognize the unique challenges to manufacturing associated with the PFAS family of over 12,000 unique chemicals. For our commercial refrigeration regulated product even simple chemical substitutions can take years and cost millions of dollars. The chemical substitution process requires identifying chemicals in a complex, global supply chain, trying to find an alternative (if one is available), and then initiating the complicated, time-consuming, and expensive process of product redesign. Product redesigns include research, development, testing, and implementation which is a lengthy process of several years as this equipment is subject to mandatory testing (e.g., for energy efficiency, safety, earthquake, and food safety etc.) for even a single chemical change. It has taken nearly 18 months to work with our supply chain to search for any occurrence of phenyl isopropylated phosphate (PIP) (3:1).

For these reasons, we urge MPCA to consider not only human health and the environment but also business continuity and survival when proposing new burdensome or potentially unachievable mandates. Government and industry must work together to develop deliberate, effective, thoughtful, and reasonable approaches to PFAS management.

Hussmann supports comments submitted by AHRI. These Hussmann comments in this letter are intended to address only commercial refrigeration equipment applications and provide additional detail and clarity to the AHRI comments.

Hussmann Supports the AHRI Recommendation to Establish HVACR-WH Products as a Category of Currently Unavoidable Uses

In their comments AHRI proposes that MPCA establish a category for "HVACR-WH" which includes heating (including space heating), ventilation, air conditioning, refrigeration (items such as but not all inclusive to display cases, racks, condensing units, evaporative unit coolers, chillers), and water heating equipment and their components and parts including replacement parts, refrigerants, and materials and servicing needs.

Brief Description of the Type of Product – Refrigeration Equipment

Brief Description of Refrigeration Equipment - Typical Product Lines:

"Refrigeration Equipment" [1]

- Refrigeration Equipment products generally include manufactured items such as freezers (commercial, residential, and laboratory/medical), refrigerators, warehouse refrigeration (large storage), coolers, walk-in coolers, walk-in freezers (restaurants, retail food stores), reach-in refrigeration, cold rooms, refrigerated vending machines and icemakers, heat transfer products (including evaporative open towers), and evaporative, adiabatic, and dry coolers and condensers, thermal energy storage units, evaporators and their controls, refrigeration racks, refrigerated cases and merchandizers, prep equipment, condensing units, air cooled condensers, unit coolers, self-contained refrigeration, ice machines, dispensing equipment, blast chillers, mobile/transport refrigeration, refrigeration racks (Low, Medium and High Temp), blast chillers, coolers, and freezers, self-contained cases and merchandizers and similar products
- Replacement Parts generally include manufactured items such as compressors and fans, electric motors, batteries, and parts thereof, original equipment manufacturer (OEM) parts including fans, motors, drive systems, heat exchangers, structural and non-structural framing and panels, compressor parts, filters, valves, seals, gaskets, compressors, thermal expansion valves, heat exchangers, fans and blowers, motors, and similar products.

- Most existing systems use an HFC (or HCFC) refrigerant with lifetimes of up to 25-30 years. This equipment must be serviced and maintained and there are currently no available non-HFC alternatives.
- HVACR Servicing Needs Equipment generally include manufactured items such as vacuum pumps, gage manifolds, refrigerant service cylinders, and similar products.

Refrigeration product is an essential need and critical for the proper preservation of perishable food product, vaccines, medicine, blood plasma, and more. As mentioned earlier refrigeration is a heavily regulated product. And while meeting increasing environmental (Environment Protection Agency AIM as an example) and energy conservation efficiencies (Department of Energy EPCA - Energy Policy and Conservation Act) our industry continues to face challenges in the supply chain, leading to long lead times for many products. Additional burdens and disruption to the supply chain by obsoleting materials is catastrophic to our industry.

Hussmann Corporation, either individually or as part of AHRI, is available to answer any additional questions you may have about refrigeration products. Please feel free to reach out to me directly if you have any questions.

Sincerely,

Ron Shebik
Director, Government Affairs and Product Regulation
Hussmann Corporation
314-550-8043
Ron.shebik@hussmann.com

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By: OAH on 3/1/2024

March 1, 2024
https://minnesotaoah.granicusideas.com/discussions/39667-minnesota-pollution-control-agency-request-for-comments-on-pfas-in-products-currently-unavoidable-use-rule/topics/submit-a-comment-290

IDEXX Laboratories Inc. Response to Request for Comments on: Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

Thank you for the opportunity to provide feedback on the planned new rules government currently unavoidable use products.

By way of background, IDEXX manufactures human, animal (pet and livestock), dairy, and water diagnostic products, including complex electronic instruments primarily in Maine. Our products test for, among other things, infectious diseases that can be zoonotic (spreadable from animals to humans, such as SARS CoV2) or cause significant impact to the food supply (such as African Swine Fever and Mad Cow Disease). IDEXX's diagnostic products help enable the health and well-being of people, livestock, and pets, and help ensure the safety of milk and water, here in Minnesota, throughout the United States, and in more than 175 countries globally.

IDEXX offers not only diagnostic solutions to most of the animal production chain but also provides services that, for example, help animal producers manage vaccination more efficiently, reduce the use of antibiotics, re-introduce animals in herds after treatments, optimize reproduction cycles, and ensure early and definitive identification of highly contagious and life-threatening diseases that threaten human and animal populations.

Our focus on human and animal health diagnostic products allies us with the Program's environmental protection goals. Indeed, Reduction of harmful environmental contaminants is at the core of our business. However, it is crucial that that essential products such as IDEXX's remain available and of the same high quality and performance within IDEXX's heavily regulated marketplace. Accordingly, IDEXX submits the following information in support of a CUU designation for its products.

IDEXX requests a currently unavoidable use (CUU) designation for the following categories of products, each of which is essential for human and animal health and safety, as well as the functioning of society:

1. Diagnostic devices and equipment used in veterinary medicine. PFAS are used in the manufacture of such diagnostic devices and equipment, which are essential for the prevention, and detection of animal diseases, including zoonotic diseases, and are critical to the health of pets and livestock, the latter which could affect the supply of food and/or human health. If veterinary diagnostics were unavailable, there would be a significant increase in negative human and animal healthcare outcomes, as well as an inability to mitigate significant risks to human and animal health.

2. Diagnostic devices and equipment used in human medicine. PFAS are used in the manufacture of such diagnostic devices and equipment, which are essential for the prevention, detection, and treatment of disease in humans. If human diagnostics were unavailable, there would be a

significant increase in negative healthcare outcomes, as well as an inability to mitigate significant risks to human health.

3. Diagnostic devices and equipment used for water quality testing. PFAS are used in the manufacture of such diagnostic devices and equipment, which are essential for monitoring of clean potable water, wastewater, and recreational water. If water quality diagnostics were unavailable, there would be a significant increase in negative human and animal healthcare outcomes, as well as an inability to mitigate significant risks to human and animal health.

4. Manufacturing equipment that contains PFAS chemicals. PFAS are used in the manufacturing equipment and raw materials used to manufacture components of diagnostic devices and equipment and diagnostic devices and equipment itself, including (but not limited to) gaskets, O-rings, filters, membranes, tubes, inner layers of chemical reactors, primary packaging materials, tubes in analytical equipment, and tape used to build inert laboratory scale equipment. The manufacturing equipment necessary to make IDEXX's veterinary diagnostic, human diagnostic, and water quality testing products is essential because if unavailable, there would be a significant increase in negative human and animal healthcare outcomes, as well as an inability to mitigate significant risks to human and animal health.

1) Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

IDEXX manufactures human, animal (pet and livestock), dairy, and water diagnostic products that, if unavailable, would result in significant impacts to the health of people, pets and livestock. The products we design and produce in Maine are exported to ~175 different countries and territories, including Minnesota.

Our products test for infectious diseases, including those that spread from animals to humans such as SARS coronavirus 2, and that endanger the food supply, such as African Swine Fever. Our diagnostic solutions help animal producers manage vaccination programs more efficiently and reduce the use of antibiotics.

Veterinarians and pet owners across Minnesota rely on IDEXX Companion Animal products to help our pets lead longer and fuller lives. The relationships IDEXX has with veterinary practices allow us to develop and advance the veterinary standard of care around the world.

IDEXX has a subsidiary company, OPTI Medical Systems that develops and provides human diagnostic products around the world. Our human diagnostics are used in emergency rooms and intensive care units in more than 100 countries to aid in critical care diagnoses. In early 2020, OPTI launched its OPTI® SARS-CoV-2 RT-PCR Covid test.

Our water testing products are relied on throughout Minnesota, including the Minnesota Departments of Health and Agriculture, water utilities of Minneapolis and St. Paul, and more than 500 local public health laboratories, water utilities and wastewater treatment plants across the state. Additionally, more than 2.5 billion people worldwide rely on our test to ensure safe drinking water. We offer solutions for drinking water, wastewater monitoring, and recreational water.

IDEXX products provide significant global support for veterinary care of animals that supply the global markets for food sources and help diagnose and control zoonotic diseases (diseases that can infect both animals and humans). IDEXX's inability to supply our products would result in significant global impacts. For example, transboundary animal diseases (TADs) that could result from the loss of IDEXX products cause livestock production losses (which may be very high if the disease in question spreads very rapidly, particularly if it causes high levels of mortality) and considerable disruption to trade, causing particular concern in countries where export is an important source of revenue for the livestock sector. The prevention and control of TADs add to the cost of livestock production and to the national veterinary budget. Zoonotic TADs (those that can infect humans and cause human disease) cause economic impacts from human sickness and costs to public health systems. Governments spend scarce resources controlling outbreaks of TADs and applying prevention measures, farmers must deal with the impacts in their livestock production systems, and consumers experience the effects of local or widespread market disruptions caused by TADs.

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold? And 4) What criteria should be used to determine the safety of potential PFAS alternatives.

MPCA asks questions about the cost and safety aspect of alternatives. Alternatives should be evaluated on a cost/benefit basis. Often costs to determine if there are alternatives to existing product already can outweigh the socio-economic impacts. It is likely the threshold costs will vary considerably among industries and products. Veterinary medicines differ from human medicines in that there are generally no third-party payers in veterinary medicine, meaning the customer/animal owner bears the full cost of the product. Many of our products support disease eradication programs around the world. As such, disruption in animal testing for disease programs can have significant consequences to the health of people and animals on a global scale.

3) Should unique considerations be made for small businesses with regards to economic feasibility?

IDEXX provides no comments on this matter.

5) How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

These critical diagnostic tests used to keep our pets, food and water safe are subject to stringent regulatory frameworks around the world, and in the US under the jurisdiction of the United States Food and Drug Administration and the United States Department of Agriculture pursuant to the federal Virus-Serum-Toxin Act, 21 U.S.C. § 151, et seq. Accordingly, our products and their components, including the use of PFAS within our products, cannot simply be switched out for products that do not contain PFAS. Instead, our products are subject to heavily regulated processes that involve years of research and development, regulatory review, and governmental approvals before they can reach market. As one example, the IDEXX diagnostic kit used to test for mad cow disease is written into EU laws. Those laws would need to be changed to change that diagnostic kit.

The length of time to change a regulated health product, either animal or human, needs to be measured in decades, as many of our products have long life cycles. Transitioning to alternatives requires research, followed by generation of data to support the change, followed by regulatory approved from the governing agency.

Our ability to identify PFAS in our diagnostic products is limited to currently available test methods or data provided by our suppliers. Current test methods are developed only in response to national regulations, such as the EPA and pending EU-wide requirements. This means that while Minnesota's legislation calls for identifying all of the more than 10,000 PFAS compounds, internationally recognized labs currently offer screening tests for only about 70 recognized compounds. International test methods are developed as a result of nationally regulated compounds, and it takes years to develop targeted methods that meet the regulations. The Minnesota legislation simply does not account for these practical limitations in PFAS testing capability.
We have invested in multiple systems and technology solutions to monitor regulated lists of chemicals, which includes systems that gather information from more than 100,000 global suppliers. Even still, IDEXX estimates that we have definitive information of PFAS use in only about 1% of our purchased materials. IDEXX buys more than 10,000 unique components or materials sourced from roughly 1,000 global suppliers used to manufacture IDEXX products. A single analyzer that tests for chemistry analytes in animal samples can contain more than 1,000 unique parts.

IDEXX is still investigating our complex supply chain and continue to gather details on use of PFAS in our products. Additionally, we have partnered with Claigan Environmental to better understand the use of PFAS in the electronics sector. Attached hereto as **Appendix A** is IDEXX's letter in support of the Claigan February 29, 2024, CUU submission ("Industry PFAS CUU Project PFAS Currently Unavoidable Uses (CUU) Submission by Industry"), which we incorporate herein by reference.

In conclusion, any human or veterinary diagnostics or water quality testing approved to restore or protect the health and welfare of animals and people and the processes used to produce the products should be considered as necessary for health and therefore considered a currently unavoidable use. This designation should include the entire manufacturing process and not only the final diagnostics. We therefore respectfully request to take this into account when publishing the rule.

Diana Rondeau

Director of Global Product Compliance
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(207)556-8906
Diana-rondeau@idexx.com

Appendix A

Claigan
Less Journey. More Results.

Claigan Environmental Inc.
10 Brewer Hunt Way, Suite 200
Kanata, ON, Canada, K2K 2H5

Letter of Support

IDEXX Laboratories Inc. stands firmly behind efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. However, we express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. It's important to acknowledge that PFAS play a vital role in ensuring product functionality and meeting stringent safety standards.

In line with our commitment to finding balanced solutions, Claigan Environmental has developed a comprehensive Currently Unavoidable Uses (CUU) proposal, which is being submitted to the states of Maine and Minnesota. This proposal is founded upon rigorous laboratory testing and incorporates valuable insights gathered from diverse stakeholders. By engaging experts from various industries, Claigan Environmental has adopted a collaborative approach to address this complex issue.

IDEXX Laboratories Inc. actively participated in the consultation process and supports Claigan Environmental's submission. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS while mitigating adverse impacts on businesses, communities, and public health.

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Director Global Product Compliance
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By: OAH on 3/1/2024
Daniel Mustico Attachment

Outdoor Power
Equipment Institute

transmitted to: minnesotaoah.granicusideas.com

March 1, 2024

Katrina Kessler
Commissioner
Minnesota Pollution Control Agency (MPCA)
520 Lafayette Road N
St. Paul, MN 55155-4194

re: Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per- and Polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

Dear Ms. Kessler:

The Outdoor Power Equipment Institute (OPEI) writes on behalf of its members to provide stakeholder comments as MPCA considers new rules pertaining to the currently unavoidable uses of PFAS in products. OPEI strongly believes that MPCA consideration of all stakeholder views, especially when based on technical expertise, sound science, and data, is critical to MPCA's promulgation of this regulation.

The Outdoor Power Equipment Institute (OPEI) is an international trade association representing the manufacturers and their suppliers of non-road gasoline powered engines, personal transport & utility vehicles, golf cars and consumer and commercial outdoor power equipment (OPE). OPE includes lawnmowers, garden tractors, trimmers, edgers, chain saws, snow throwers, tillers, leaf blowers and other related products. OPEI member companies and their suppliers contribute approximately $18 billion to US GDP each year. OPEI members currently distribute their products across all 50 states, through a diversity of retail outlets including independent dealers.

OPEI members manufacture complex durable goods with tens of thousands of component parts. They share common supply chains, in both substance and complexity, with the heavy non-road equipment and automotive sectors. However, unlike those sectors, OPEI members include some small-to-medium size businesses

OPEI and its members understand and appreciate the regulatory consideration of the impacts of PFAS and its uses in society, which is currently occurring across government at the Federal, state and international levels. The following comments, recommendations and requests are contributions to the important process of considering stakeholder input, based on technical expertise and data, to assist in implementing Minnesota state law. We also hope that stakeholder input can assist across governments, to prevent the implementation of disparate regulations which place undue burdens on consumers, businesses, and government alike. The following is responsive to most of the questions posed by MPCA, and where noted OPEI aligns with the *attached* comments submitted by the Association of Equipment Manufacturers, filed with MPCA separately, which OPEI works with in representing shared members and industry sectors.

1. **Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?**

OPEI supports the comments of the Association of Equipment Manufacturers.

2. **Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?**

OPEI supports the comments of the Association of Equipment Manufacturers.

3. **Should unique considerations be made for small businesses with regards to economic feasibility?**

OPEI supports the comments of the Association of Equipment Manufacturers.

4. **What criteria should be used to determine the safety of potential PFAS alternatives?**

OPEI supports the comments of the Association of Equipment Manufacturers.

5. **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?**

OPEI supports the comments of the Association of Equipment Manufacturers.

6. **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?**

OPEI supports the comments of the Association of Equipment Manufacturers.

7. **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.**

OPEI represents 110 member manufacturers and their suppliers of outdoor power equipment. Our members manufacture and ship approximately 35 million products each year in the U.S., including hundreds of different product lines, and thousands of models. OPE is used in both residential (consumer) and commercial applications, including lawn and garden, construction, agriculture, forestry and tree care, and utility. OPE is powered by gasoline-, diesel-, and propane-powered engines, battery and AC (electric) powered motors, and other sources.

OPE includes the following significant assembled and component product categories:

- Power applications including non-road gasoline and diesel-powered engines, electric motors, batteries, battery packs, and recharge equipment;
- Non-road mobile machinery[1];
- Consumer and commercial lawn & garden equipment and outdoor power equipment (e.g., lawnmowers, garden tractors, trimmers, edgers, chain saws, snow throwers, tillers, leaf blowers, cut-off machines, drills, pressure washers);
- Utility terrain vehicles / all-terrain vehicles / side-by-sides;
- Golf cars, and;

[1] Any mobile machine, item of transportable industrial equipment, or vehicle with or without bodywork or wheels which: 1) is not intended for carrying passengers or goods on the road, 2) includes machinery installed on the chassis of vehicles intended for the transport of passengers or goods on the roads, 3) installed with a combustion engine – either an internal spark ignition (SI) engine, or a compression ignition diesel engine.

- Attachments and implements associated with the above equipment (i.e., mower decks, snow throwers, sprayers).

OPEI member products are broadly used by consumers and businesses across the state of Minnesota, for everyday residential and commercial purposes. In many applications, outdoor power equipment provides essential value and services for societal health and safety. Significant application sectors include:

Lawn and Garden:

Lawn mowers and other wheeled (ground-supported) turf care equipment, handheld products (e.g., trimmers, blowers) and other various forms of outdoor power equipment are essential for safe and healthy managed landscapes, whether it be the backyard or public spaces (e.g., parks, sports fields, commercial properties).

Also included in this broader residential sector, essential for health and safety, are generators for home power in the cases of undue outages, including natural disasters, and pressure washers for general home cleaning and maintenance.

Construction:

The construction sector involves building, repairing, and maintaining infrastructure, including housing, commercial real estate, and public infrastructure. Common OPE uses in these sectors, essential to commercial work, are generators, cut-off saws, and utility vehicles.

Agriculture:

The agricultural sector includes the cultivating of crops and the raising of livestock. Virtually all products manufactured by OPE members can be essential to commercial and residential farm operations, but examples include lawnmowers and turf care equipment, forestry and tree care OPE including chain saws, log splitters, and chipper shredders, utility vehicles, and generators.

Forestry/Tree Care:

The forestry and tree care sector includes commercial and residential applications, to manage forests and woodlands, and the backyard. Common OPE utilized in this sector includes chain saws, pole saws, log splitters, chipper shredders, generators, and utility vehicles.

Utility/Public Safety:

The utility sector includes the maintenance of public infrastructure, both in urban and rural settings, including operations for electric power, natural gas, water supply, and sewage among others. OPE utilized in this sector can include lawnmowers and other various forms of OPE for landscape management in public spaces and on public roadways, and various other maintenance, repair, safety related tasks. Also included here are public safety entities and emergency responders who rely on OPE.

OPEI members design and manufacture a diverse range of assembled whole-good and component products, ensuring their safety and performance in diverse operating environments, which in some cases can be demanding and severe. OPEI members also rely on extensive supply chains which in some cases can be 20 layers deep and include suppliers manufacturing both domestically and abroad. OPE products can also have 10,000 or more unique parts per product, many of which may rely on PFAS for critical functions and characteristics.

Some OPE products can expect prolonged service lives exceeding 10 years, which further increase the need for robust design considerations. To meet these requirements, OPE components rely in many cases on PFAS when they are the only known materials with the technical characteristics to provide the necessary safety functions while withstanding, particularly over extended lifetimes, the following types of physical impacts.

- Pressure up to 500 bar.
- Temperatures as high as 1500°F and cyclical temperatures of -70 to +450°F.
- A high degree of mechanical wear and shear forces.
- Electrical and flammability resistance.
- Vibration up to 45.0mm/s causing alternating stress between joint components.
- Chemical resistance to substances such as fuel, hydraulic fluid, coolant with additives like 2-ethyl hexanoic acid, and carboxylic acids, exhaust gas fumes (highly acidic) and engine oil (highly alkaline).
- Long-term durability (10 years or more) against factors such as ultra-violet (UV) light, mechanical damage, dusty, humid, wet, muddy, damp environments, and exposure to salt spray.
- Lightweight composition to ensure the energy consumption required to operate certain systems is minimized.
- Operation in hazardous or explosive environments.

OPE and its applications are diverse, always with unique considerations, but in consideration of currently unavoidable uses of PFAS, these substances provide important safety and performance characteristics to common components. Among others these include high temperature durability, low friction properties, resistance to sticking, resistance to corrosion, resistance to fuel, water repellency, electrical contact stability, waterproofing, binding characteristics, and evaporative emission protections. Specific OPE components, common to most products are:

- **Seals:** OPE uses fluids to ensure the equipment performs its intended functions. Fluid applications include hydraulic fluid, oil, fuel, refrigerants, coolant, among others. Sealing technology, such as O-rings and gaskets, prevents fluid leaks and ensures water, dirt, dust, and debris stays out of the equipment.

- **Hoses:** Similar to seals, hoses are required and critical to the transmission of fluids from one location to another. Many hoses in the OPE industry use fluoropolymers to safeguard the durability of the machine by protecting its components from various internal pressure, temperature, and chemical stressors.

- **Fluorinated fuel tanks:** Provide a chemical resistance and low permeation barrier that allow federal (EPA) emission standards[2] to be met. PFAS has been found to be an unintentional impurity in these products.

- **Paints:** These coatings protect OPE from natural, chemical, weather, or water erosion and damage. Paint coatings help extend the useful life, and maintenance requirements, for many forms of OPE. Many paint suppliers use PFAS in their paints to improve the flow, spread, and glossiness of the coating, as well as to decrease bubbling and peeling. They are also used in specialty paints to give stain-resistant, and water-repellent properties.

- **Refrigerants/Coolants:** Temperature management is a crucial product design requirement in the OPE industry. Regulating and controlling engine and product temperatures ensures proper operation for peak performance within the temperature limits of the materials used.

- **Hydraulic Fluid:** Hydraulic fluid enables the transfer of power from the engine to end-use hydraulic systems in some forms of OPE. Hydraulic fluid is also heavily used within our manufacturing facilities and is a critical element for functionality in building OPE.

- **Exterior Finishes and Materials:** UV protection is critical for parts and components such as dashboards, handlebar grips, fenders, seat covers, etc. PFAS acts in a way with these pieces, so that

[2] 40 C.F.R Part 1060, Control of Evaporative Emissions from New and In-Use Nonroad and Stationary Equipment

it protects from extended outdoor use and UV exposure by not severely degrading the exterior piece(s) by drying and/or cracking the piece(s) beyond normal wear and tear or safe functionality.

- **Electrical:** Protective coatings on electrical wires and within electrical systems insulate and protect key electronic functionalities for all OPE. PFAS is regularly found within these protective coatings.
- **Batteries:** Batteries utilize chemical binders to hold the internal active materials together to maintain a strong contact between the electrodes and the current collectors. Battery manufacturers use Polyvinylidene Fluoride (PVDF) as a binder in lithium-ion batteries due to its electrochemical and thermal stability, as well as its acceptable binding properties for the cathode. Additionally, certain fluorinated compounds are also used to coat the anodes to prevent unwanted reactions with the electrolyte. Due to their long lasting and chemical stable properties, the fluorinated compounds help extend the useful life of the battery.

8. Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

OPEI supports the comments of the Association of Equipment Manufacturers.

Thank you for consideration of these comments on behalf of OPEI members. I can be contacted as detailed below.

Best regards,

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attachment AEM comments to MPCA, March 1, 2024

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Katrina Kessler
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Re: Planned New Rules Governing Current Unavoidable Use Determinations about Products Containing Per- and Polyfluoroalkyl Substances (PFAS)

Revisor's ID Number R-4837
OAH Docket No. 71-9003-39667

Dear Ms. Kessler:

The Association of Equipment Manufacturers (AEM) appreciates the opportunity to comment on the Minnesota Pollution Control Agency's (MPCA) request for comments on the *Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per- and Polyfluoroalkyl Substances (PFAS)*, hereafter referred to as the Planned Rule. We look forward to sharing the expertise and technical knowledge of our industry sectors. We believe it is critically important when developing regulations, that the interest of all stakeholders be considered and understood.

AEM is the North American-based international trade group representing off-road equipment manufacturers and suppliers with more than 1,000 member companies and over 200 product lines in the construction, agriculture, mining, forestry, and utility industries. The equipment manufacturing industry in the United States supports 2.8 million jobs and contributes roughly $288 billion to the economy every year. Our industries remain a critical part of the U.S. economy and represent 12 percent of all manufacturing jobs in the United States. Original Equipment Manufacturers (OEMs) develop and produce a multitude of technologies over a wide range of products, components, and systems that ensure off-road equipment remains safe and efficient, while at the same time reducing carbon emissions and environmental hazards. Finished products have a life cycle measured in decades and are designed for professional recycling of the entire product at the end of life.

The off-road equipment manufacturing industry understands the value and importance of using sound science to inform future policymaking decisions. AEM strives to be a key stakeholder in these policymaking discussions. To ensure that new rules meet their objectives, AEM intends to provide commentary on several MPCA questions listed in the Request for Comments document.

1. <u>Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?</u>

Minnesota statutes 116.943 states that:

> *Beginning January 1, 2032, a person may not sell, offer for sale, or distribute for sale in this state any product that contains intentionally added PFAS, unless the commissioner has determined by rule that the use of PFAS in the product is a*

> *currently unavoidable use. The commissioner may specify specific products or product categories for which the commissioner has determined the use of PFAS is a currently unavoidable use.*

The law goes on to grant the commissioner rulemaking authority to make determinations on what constitutes a *current unavoidable use*, and which products may receive an exemption from the requirements of the regulations.

In the request for comment, MPCA asked for feedback from interested stakeholders on whether the agency should define the term *essential for health, safety, or the functioning of society*, presumably to use this definition as a criterion for determining what does and does not constitute a *current unavoidable use*. Off-road OEMs manufacture a wide variety of complex product types that are sold around the world. The market and compliance requirements are growing in number and complexity in an ever-changing regulatory environment. To ensure that policymakers and effected industry stakeholders meet the overarching objectives of a law, AEM strongly believes that regulations should contain clear, understandable, and achievable compliance criteria for businesses and individuals to follow. This will reduce confusion, save time and money, and foster a better understanding between regulators and the regulated community.

The stated aim of the statute focuses on restricting products that contain intentionally added PFAS. However, the exemption standard utilizes a product function, the term *Current Unavoidable Use,* as the only qualifier. It is not clear what the term *use* means within the context of the larger rule. Is this a reference to the chemical's role in the manufacturing process, or the attributes it conveys to the end product? Or is the term *use* meant for the purpose and function of the product itself? To make sure all stakeholders understand the adopted language, it is important to define the term *Use* and understand how it ties into our product lines, before we define *essential for health, safety, or the functioning of society*. With this in mind, AEM supports a definition similar to the one found in the European Union's Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) law, Article 3 (24) [1]:

> a *use* should refer to any processing, formulation, consumption, storage, keeping, treatment, filling into containers, transfer from one container to another, mixing, production of an article or any other utilization. Furthermore, this use must satisfy the need for the technical function provided by the chemical for a specific end use in a particular setting.

This definition provides clarity on the relationship between identified chemicals of concern and their relationship to the product. It also helps harmonize regulatory definitions in multiple jurisdictions around the world, easing the industry's overall compliance burdens.

With the concept of *use* fully defined, we can address the criteria for determining what products could meet the *essential for health, safety, or the functioning of society* threshold. This term should be divided into two different categories, (1) health and/or safety, and (2) the functioning of society.

(1) Is the *use* of the substance necessary for health and/or safety?
  a. Necessity should be assessed to demonstrating and verifying whether a use is necessary for the following elements:
    i. Preventing, monitoring or treating severe health issues
    ii. Sustaining basic conditions for human life and health

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006R1907

iii. Managing and preventing health crises and/or emergencies
iv. Personal safety
v. Public safety
vi. Addressing a danger to animal health which cannot be contained by other means.

(2) Is the *use* of the substance critical for the functioning of society?
   a. Criticality should be assessed by demonstrating and verifying whether a use is critical for any of the following elements:
      i. Providing resources or services which are critical for society (Construction, Agriculture, utility, mining, forestry)
      ii. Managing societal risks and impacts from natural and man-made crises and emergencies.
      iii. Protecting and restoring the natural environment

The final criteria should assess potential alternatives.

(1) Are there alternatives that are acceptable from the standpoint of the environment and human health:
   a. Can alternatives for the specific use be identified?
   b. Are the alternatives safer, technically, and economically feasible, and available at scale?
   c. Do alternatives provide the level of performance which is sufficient from a society point of view?

Assuming the product meets these definitions, the product should receive an exemption from the MPCA. Otherwise, the product exclusions will start to have negative impacts on human health, public safety, and the functioning of society as a whole.

2. Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

<u>Should Cost of PFAS alternatives be considered in the definition of "reasonably available"?</u>

As defined in the previous section on establishing criteria for determining *essential for health, safety, or the functioning of society*, economic feasibility is a major component of this consideration. If a product is deemed critical to the functioning of society, the PFAS *use* in that product will likely provide the technical functionality to achieve the identified critical end use. When alternatives either do not exist or are so expensive as to make their purchase unattainable, then cost must be considered when making these determinations, due to that fact cost would be the factor jeopardizing the availability of the product for use in the marketplace.

AEM member companies manufacture products that provide critical functions for our modern world. Off-road equipment grows and harvests food, provides emergency repairs to critical infrastructure, constructs buildings and homes, provides municipal waste processing, among many other critical ends uses. While the work provided by off-road equipment is critical, the machines that work them are heavy capital investments for equipment and fleet owners. For these owners, equipment is cost effective for the work they need to perform, but with change they will become more expensive and less cost effective. As these costs pass on to the customer, contractor, or municipality, the consequences will pass on to the public, which expects and needs the services these machines provide. For these reasons, AEM believes costs should be a consideration when considering the definition of "reasonably available".

Reasonable Cost Threshold:

When developing a reasonable cost threshold, it is important to note that the cost of the new material should not be the only consideration used in making this determination. The next section will define some of these concepts more fully, but for the OEM, the costs associated with identifying, testing, validating, and implementing a new material into a product redesign is an expensive, years long activity. These activities are done to make sure new parts and components meet critical performance, durability, safety, and quality requirements, and may dwarf the extra costs associated with a PFAS alternative.

Consequently, the costs associated with using potential PFAS alternatives extend far beyond the product manufacturer. New materials may require more frequent, and more expensive, maintenance costs. They may not provide the same level of durability, leading to a premature obsolescence of the machine and an increase in societal waste generation. Not to mention the added risks associated with using a new material in a very mature industry used to the safety benefits designed into their components and sub-systems. These later points may be difficult to fully quantify, but they have very real consequences in our industry.

Understanding that the cost associated with adopting new materials in complex industries, such as the off-road equipment sector, is not a simple cost differential between two different substances. The real-world costs are based on a series of complex manufacturing activities, knock-on effects through the value chain, and the customer use experience. AEM recommends that MPCA take these other variables into consideration when developing a reasonable cost thresholds.

3. Should unique considerations be made for small businesses with regards to economic feasibility?

The cost of compliance for chemical regulations is quite high for many industries based on a variety of factors. In particular, the off-road equipment industry has had very little expertise and history regarding the identification, collection and storage of data needed to comply with chemical management regulations. This educational issue, endemic throughout the supply chain, is compounded by the wider compliance environment many of these companies operate in. Smaller manufacturers of components often do not store chemicals above the reporting thresholds required under the EPA's CDR or SARA 313 reporting rules. As a result, many companies in our supply chains and industry-at-large never cultivated the systems or expertise needed to gather and store the relevant chemical data for the components and parts they manufacture and distribute. This means that almost all companies in our industry, and most off-chemical manufacturers in other industries, will need to develop the regulatory expertise and compliance systems from scratch. This undertaking will be immensely expensive for any manufacturer, and prohibitively so for small businesses.

Their task is made more difficult due to the CBI protections many bulk chemical manufacturers utilize to conceal the composition of their products, making downstream identification and reporting extremely challenging to accomplish. Additionally, International suppliers follow various global regulations which differ from U.S. mandated chemical reporting requirements, deepening the data collection obstacles faced by our supply chains. Absent a data reporting system adopted globally across our industry sectors that can track and monitor chemical substances throughout the supply chain, it remains an extraordinarily difficult task for a single OEM to know the chemical composition of the articles they currently market in the U.S.

To illustrate these challenges, some manufacturers possess supply chains that run twenty (20) layers deep, with tens of thousands of unique suppliers scattered throughout the world. Collecting data on the presence of PFAS across hundreds of thousands of individual parts from tens of thousands of different companies is a colossal task. The lack of a *de minimis* reporting threshold ensures that manufacturers will need to collect information for all their parts and components to determine the presence, or lack thereof, of PFAS. The effort and time necessary to coordinate, educate, discipline, and gather useful data throughout the supply chain is a daunting task that will take years to organize and execute.

In comments supplied to the EPA, AEM calculated that the cost of accurately identifying and reporting a single chemical for an OEM would cost over half a million dollars. This estimated cost assumes information provided to the OEM is accurate, complete, and delivered on time. It is also important to note that this estimate does not account for any potential redesign and replacement efforts for phasing the chemical out of use in an off-road machine. For a family of chemicals as large as PFAS, the costs will be an order of magnitude higher.

Assuming a company is looking to identify a single PFAS chemical throughout their product lines, and the industry does not experience any disruptions, obstacles, missing data, or dead ends on their path to gathering the required chemical data, it would take roughly 36 months, or 6240 working hours for a single worker per firm[2] to complete the data gathering process. Using the EPA's estimate of a Technical Professional's wage of $80.50/hour[3], that leads to a total cost of $502,320 per firm. With a supply chain of over 10,000 individual companies, that means the total cost of the data gathering effort for the off-road equipment industry is a minimum of $5 billion dollars in accumulated costs. See Table 1 below:

Table 1: Estimated Costs for Off-Road Equipment Industry to Comply with the Data Collection and Reporting Requirements for a Single Chemical Substance

	COST TO EQUIPMENT MANUFACTURING INDUSTRY
NUMBER OF AFFECT FIRMS	10,000
AVERAGE TIME BURDEN PER FIRM (HRS)	6240
TOTAL TIME BURDEN (HRS)	62,400,000
AVERAGE COST PER FIRM	$502,320
TOTAL COST TO INDUSTRY	$5 Billion

If data collection efforts from industry supply chains produce poor quality information, fail to report information downstream, or prove infeasible to execute, the industry will need to turn to laboratory testing for their parts and components. Due to the lack of a *de minimis* threshold, the product manufacturers will need to test each product down to the detection limit to demonstrate compliance with the Planned Rule. Off-road equipment may contain over 100,000 unique parts in a single product, making testing a time consuming and costly endeavor. Assuming every company in the supply chain only manufactures a single product, uses a GC scan at a cost of $1,000 per part, and receives completely accurate results, testing will cost each company roughly $100 million dollars. With over 10,000 firms, the total cost to the equipment manufacturing industry would be over $1 trillion dollars. Furthermore, testing would create additional constraints on industry, as available time and resources at viable testing laboratories would be overrun with industry PFAS testing requests. These testing bottle necks would extend the compliance timeframe out to well over a decade. Without regulatory relief, this effort would be infeasible to execute on an industry wide level. See cost assumptions for testing in Table 2 below:

[2] Many firms have teams of individuals performing this function, but for the sake of simplicity we will assume a single worker per firm.
[3] EPA (2020). Economic Analysis for the Proposed Rule for Reporting and Recordkeeping Requirements for PFAS. November 2020.

Table 2: Estimated Costs for the Off-Road Equipment Industry to Comply with the Data Collection and Reporting Requirements for a single chemical using Lab Testing of Articles

	COST TO EQUIPMENT MANUFACTURING INDUSTRY
NUMBER OF AFFECT FIRMS	10,000
AVERAGE NUMBER OF PARTS PER FIRM	100,000
TOTAL COST OF GC TEST PER PART	$1,000
AVERAGE COST PER FIRM	$100,000,000
TOTAL COST TO INDUSTRY	$1,000,000,000,000

In reality, the supply chain currently lacks the systems and education required to collect and transmit accurate and complete chemical data to the OEMs. Equipment manufacturers are currently seeing very low quality and inaccurate chemical data from their suppliers. To comply with the data requirements in the rule, most collection efforts will necessitate the use of laboratory testing. Meaning that the cost of compliance in the off-road equipment industry alone will be in the billions of dollars and take years to complete. In this environment, most manufacturers, but small entities in particular, will have an incredible challenge meeting the requirements of the rule. To help these companies survive, AEM suggests that MPCA introduce *de minimis* thresholds, a common universal reporting list of PFAS chemicals, alignment with EPA (and global) chemical rules, simplified reporting requirements, among other administrative changes to reduce the compliance burden.

4. What criteria should be used to determine the safety of potential PFAS alternatives?

When establishing criteria to determine the safety of potential PFAS alternatives it is important to consider an alternative substance under a wholistic approach. It is obvious that when looking at alternatives, policymakers should avoid chemicals that are more persistent, bioaccumulative, and toxic than the PFAS their intended to replace. However, one should also consider the wider safety, environmental, and human health repercussions that potential replacements of PFAS could cause. Generally speaking, policymakers should avoid replacement chemicals that exacerbating existing, or result in new, safety, environmental or health hazards, or eliminate the use of products critical to the functioning of society.

Essential Uses

Off-road equipment must meet highly demanding industry wide technical specifications due to the challenging environments in which these types of machines operate. Manufacturers design their products to operate for decades under extremely harsh, demanding, and arduous work environments. In these environments, materials, parts, and components need to meet rigorous design and testing requirements to ensure the safety of the operator and other workers on the jobsite.

The technical functions of the components and systems help inform the safety and operational design requirements of the machine. These technical characteristics include, but are not limited to, the following variables:

- Pressure - various systems, such as the hydraulic and engine systems, experience extreme pressure environments up to 500 bar.

- Temperature - the engine compartment, regenerative breaking components[4] and exhaust system operate at temperatures as high as 800°C.
    - Off-road equipment must also contend with cyclical temperature cycling due to machine exposure to outdoor conditions; temperatures ranging from as -57°C to 230°C.
- Mechanical – machines expose parts and components to a high degree of mechanical wear and tear. Sealing parts must survive the shear forces due to the mechanical movement of the equipment.
- Chemical resistance - seals interact with various fluids and gases, requiring a high degree of chemical and corrosion resistance to ensure the reliability of exposed parts.
    - Exposure to substances such as fuel, hydraulic fluid, coolant with additives like 2-ethyl hexanoic acid, and carboxylic acids, exhaust gas fumes (highly acidic) and engine oil (highly alkaline).
- Electrical and flammability resistance – the weight, power, and fuel of the machine creates electrical and flammability risks. Components, parts, and systems must include design elements to mitigate these risks.
- Vibration - up to 45.0 mm/s which can cause high frequency fatigue to components due to the repeated strain imposed. The mechanical alternating stress between joint components will make joints undergo cyclic tension and pressure, which may cause the generation, expansion, and extension of cracks.
- UV - Long-term durability against factors such as ultra-violet (UV) light due to exposure to outdoor environments.
- Material Weight – The use of lightweight materials to reduce energy consumption and CO_2 emissions.
- Hazardous Locations - Operation in hazardous or explosive environments requiring ATEX rating (the minimum safety requirements for workplaces and equipment used in explosive atmospheres), such as in chemical plants, mining, and petrochemical applications.
- Durability – Equipment must remain highly reliable over periods of up to, and beyond, 40 years.
- Environmental - Withstand harsh environments, such as:
    - Landfills where machines will experience consistent exposure to a wide variety of substances and mechanical damage.
    - Mining and earth moving equipment where operation in extremely dusty, humid, wet, muddy, and damp environments is necessary. The operation of such equipment is often up to 24 hours a day over extended periods of time. Due to the need to carry heavy payloads over rough terrain, the energy and therefore high temperature requirements of these systems are especially demanding.

[4] Such as break resistors which recover the heat from breaking to decrease the overall energy requirements of the system.

- Exposure to salt spray due to their operation near the sea.

PFAS provides the material properties required to satisfy these various operating conditions. Without a material equivalent that can meet these technical specifications, the equipment and the individual safety and performance systems will fail, causing immediate and dangerous risks for the machine operator and other workers in the vicinity. It is essential that any replacement material meets the necessary performance requirements and still offers the same safety, durability, and quality attributes offered by the original PFAS chemical.

Risk to Public Policy Goals

The off-road equipment industry stands at the intersection between societal environmental goals and the practical commercial requirements of today's end-users. This position requires manufacturers to strike a perfect balance between the work requirements of their customers and the aspirations of the public and global policymakers. Despite this tension, the off-road manufacturing industry remains committed to providing solutions that can satisfy both stakeholders. As our industry looks to the future, PFAS provides crucial attributes manufacturers need in order to develop new technologies, prevent unintended environmental hazards, and ensure our equipment continues to operate safely.

Environmental concerns

Fluid Leaks:

Almost all off-road equipment requires the use of various fluids to enable the operation of specific machine functions. These fluids run in different systems for numerous purposes. Among these functions:

- hydraulic fluid enables power transfers to the hydraulic systems,
- coolant ensures the engine operates within the ideal temperature range,
- fluid coatings work to prevent corrosion, and
- oils reduce friction between moving parts

While these fluids provide useful functionality to our equipment, they also can cause environmental hazards such as leaks and spills. Equipment manufacturers strive to eliminate these leaks to prevent environmental damage, protect worker safety, and ensure the long-term viability of their products.

Fluoropolymers, such as PTFE and fluoroelastomers, provide crucial characteristics that prevent hose and seal failures throughout the machine. These chemicals possess high temperature, chemical and mechanical resistance, making them ideal for sealing applications. This combination of traits helps ensure the long-term viability of various hoses, seals, gaskets, O-rings, and valves placed throughout the machine. Without fluoropolymers, end-users would likely experience much higher rates of fluid leaks, environmental spills, safety issues, component failures, damage to the machine, and premature obsolescence of the machine itself. Currently there are no known technically, or economically, feasible alternatives to these substances.

Climate Change & Ozone Depletion

Various international stakeholders are working to mitigate the impact that humans have on the climate. Like many other sectors, the off-road equipment industry continues to develop new strategies and solutions to reduce its environmental footprint. These efforts may include replacing current refrigerant options with lower GWP alternatives, developing zero-emission powertrains, or working to build new system efficiencies within the equipment to reduce fuel burn. Fluorinated gases will remain a critical substance in these efforts, without which the path to more environmentally friendly technologies will be much more difficult to achieve.

- Refrigerants: Refrigerants and refrigerant systems are already highly regulated for their contribution to atmospheric ozone depletion, and, more recently, their global warming potential. Recently, our organization successfully concluded an application for the use of HFO-1234yf as a refrigerant in off-road equipment through the EPA's Significant New Alternatives Policy (SNAP) program. Commonly used in the automotive sector, HFO-1234yf not only delivers zero ozone depleting potential (ODP), but also provides a greatly reduced global warming potential (GWP) when compared to its immediate predecessor, HFC-134a.

  Unfortunately, many governmental jurisdictions incorrectly identify these fluorinated refrigerants as PFAS chemicals based on the adoption of overly broad regulatory definitions. For this reason, any family wide restriction on PFAS would invariably restrict the use of this substance as a refrigerant in off-road equipment and eliminate the associated environmental gains.

- Alternative Power: Regulatory bodies have a decades long history of looking at on-road and off-road engines to address air quality criteria pollutant concerns. With a growing focus on climate change, policymakers are also looking at engines to help address concerns over GHG emissions. Manufacturers will need to develop new low carbon powertrain technology solutions to achieve the criteria pollutant and GHG reduction levels set by regulators. Within the off-road sector, manufacturers are researching new alternative power technologies, such as lithium-ion batteries, hydrogen fuel cells, and alternative fuels to provide low carbon solutions to their customers and markets they serve. Once again, PFAS provide the functional characteristics required to help foster the maturity and adoption of these new technologies across the market. Without access to certain PFAS, none of these technologies will remain viable in the future.

Waste Streams

Certain PFAS provide advantageous properties that ensure the long-term functionality of off-road equipment. Preserving the useful life of hoses, seals, gaskets, coatings, and electrical components ensures the machine continues to operate for an extended period under severe conditions. Without the use of certain PFAS, machinery in the field will prematurely fail requiring an accelerated need for new parts and components, thus increasing the generation of waste.

Additionally, future broad-based prohibitions or restrictions of PFAS could jeopardize the off-road industry sector's general recycling and remanufacturing efforts. The off-road sector invests a lot of time and money to ensure their equipment is responsibly recycled, remanufactured, and resold into secondary markets. These efforts reduce the amount of wasted materials the industry produces, prevents equipment from going to landfills, and avoids the premature obsolescence of our products. Any restriction of materials needs to protect against endangering these recycling efforts, and the associated unintended environmental consequences.

Safety Concerns

Safety concerns are perhaps the most important issue the off-road industry attempts to mitigate in their design processes. Heavy equipment, operating in hazardous environments, and under severe stress with various workers on the job site provides ample safety challenges for equipment manufacturers to consider. Under these conditions, machine operators look for reliable and durable equipment with the appropriate safety standards designed into the machine. Several PFAS play a key role in ensuring the products continue to operate safely:

- Fluoropolymers in seals and hoses ensure hydraulic systems maintain pressure. Sudden pressure losses due to hydraulic hose failures can cause loads to drop suddenly on a jobsite, significantly increasing potential harm to workers.
- Heavy equipment operates at very high temperatures, requiring unique chemical solutions to mitigate any potential fire issues. Due to the pressure and temperature stability some PFAS chemistries are used to decrease the potential for fire, thereby protecting worker safety.

<u>Undesirable Alternatives</u>

Any transition to a PFAS alternative must avoid regrettable substitutions. Materials must satisfy national and international legal and regulatory requirements. Furthermore, they must not present an even greater risk to the environment, human health, or present new safety risks to the work site and operator.

Off-road equipment manufacturers require thorough testing and validation of new materials prior to their integration into a final product design. Substance specifications vary based on their intended purpose within the larger machine. Due to the nature of the work, manufacturers often require highly durable and robust materials that can operate consistently under very extreme conditions. Replacing proven materials with alternative substances can, under the right circumstances, produce desirable environmental outcomes. However, transitioning away from irreplaceable or highly specified materials can often lead to higher environmental and human health risks, as well as suboptimal product performance outcomes.

For example, FKM materials provide high chemical, temperature and pressure resistance in gaskets, seals, and hoses. This material performs so well, that it is widely considered to be irreplaceable for the continued operation of most modern equipment. Its closest alternative, ethylene propylene diene monomer (EPDM), also known as synthetic rubber, does not perform well in the high pressure and temperature environments found in modern equipment. More troubling, synthetic rubber utilizes N-methylpyrrolidone (NMP) during its synthesis, which is a regulated Substance of Concern (SoC) in a variety of regulatory jurisdictions.

It is important to ensure that OEMs receive enough time and support when transitioning away from regulated substances. Companies struggle with making informed and responsible decisions when faced with short implementation timeframes, discordant regulatory requirements, and overprescribed rulemakings. Policymakers need to provide appropriate exemptions, time, resources, and public-private collaboration necessary to ensure manufacturer stakeholders can identify and adopt desirable alternatives for their SoC**.**

With this in mind, AEM recommends that MPCA make sure that, when establishing criteria for PFAS alternatives, the new material must meet the safety, durability, quality, and performance requirements of the original PFAS materials, and must satisfy the need to avoid regrettable substitutions.

5. **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?**

Off-Road Equipment Challenges and Assumption to Finding Alternatives for PFAS

For most PFAS use cases, there are no currently known technical alternatives available for use in off-road equipment that does not compromise the safety, durability, or reliability of the finished product. AEM members produce equipment designed to consensus safety standards and subject to third party certifications, customer requirements, and regulatory testing obligations. Changes to materials and formulations which affect fit, form, function, performance, or safety must undergo extensive testing to ensure any new designs meet internal quality benchmarks, design specifications, and regulatory requirements.

Due to the challenges inherent to the off-road industry, it is extremely difficult to estimate the time needed to identify, test, and qualify alternative chemical substances for each end use. The estimates from AEM and their member companies are based on the following assumptions:

- A suitable and viable technical alternative material exists (although as described above, there are no known current technical alternatives for most PFAS use cases).
- Manufacturers do not encounter dead ends during their material assessments, and suitable characteristics are identified the first-time test are completed.
- Supply chain issues throughout the world do not hamper shipping and transportation timelines.
- The total number of PFAS substances used in off-road equipment is a manageable size (roughly 10-20 chemicals at a time). Manufacturers will try to conduct simultaneous redesign work wherever possible, but they cannot implement changes across all product lines simultaneously as test cells, qualified staff, and other resources are all limited. The higher the number of PFAS substances used in the components and systems of the end-product, the longer the timeline will be.

Any transition away from PFAS requires significant time and resources to simply identify and qualify any PFAS-free material for use in the off-road equipment sector. AEM's member companies estimate that this effort would require a complete re-direction of all engineering resources within each member company to accomplish this task alone. Global engineering resources are extremely limited, with almost all companies facing severe staffing and human resource challenges. As such, off-road equipment manufacturers will need significant additional resources and time to address the qualification requirements for PFAS-free components, due to the fact that any individual company is highly unlikely to have the resources on hand to accomplish this task. This type of activity will impact all other R&D projects and other internal development programs. It is likely that all these activities would pause in order to focus enough resource on PFAS qualification activities. If no exemption were granted, it is highly likely that all product sales, manufacturing activities, and service actions in the state of Minnesota would stop until suitable alternatives are identified, tested, designed, and qualified.

Off-Road Equipment PFAS Replacement Timeline

Off-road equipment operates in some of the most demanding and severe environments over a product life cycle measured in decades. The equipment are highly complex pieces of machinery requiring each manufacturer to undertake component and system level qualifications to ensure the necessary performance characteristics are met.

Working under these design requirements, and the assumptions listed in the previous section, AEM member companies estimate that replacing a manageable number of PFAS substances at one time would take at least 15 years for new equipment and 30 years for replacement parts and components. This estimate assumes the timeline starts at the date at which an alternative has been identified to ensure the OEM can maintain the systems in the machine which safeguard the operator, maintenance personnel, the worksite, and the environment.

These product re-design and validation assumptions have precedence in other chemical management and environmental rulemakings. In their recently published, *Decabromodiphenyl ether and Phenol, Isopropylated Phosphate (3:1); Revision to the Regulation of Persistent, bioaccumulative, and toxic Chemicals Under the Toxic Substances Control act (TSCA)*[5] proposed rule, EPA granted the off-road equipment industry, along with other similar industries, a 15 year transition period for new equipment and 30 year transition period for replacement parts for a single chemical substance; Phenol, Isopropylated Phosphate (3:1) (PIP 3:1). Furthermore, during engine emission rulemakings[6], which focus only on the engine and aftertreatment system redesigns, regulators like EPA, California Air Resource Board (CARB), and the EU Commission provide a 7-13 year transition (depending on the power category) to produce new certified engines. While these two rules are different from the requirements promulgated in Amara's Law (HF2310), the reality is that these two other rules are simpler to comply with and grant the off-road equipment industry extended timelines to implement the design changes needed to meet the requirements of the law.

Criteria for Establishing Timelines for Unavoidable Use Determinations:

The off-road equipment industry provides a useful case study in adopting a cautious approach to establish unavoidable use determination timelines. Off-road machines are large, highly complex products, with specific design requirements, and extremely long supply chains, making large scale design changes impossible to implement in short periods of time. If a suitable alternative exists, it is unlikely that all industries require the same timeline to transition their products away from the use of PFAS. Assuming this is true, it is important to establish certain criteria for determining a timeline.

Speaking on behalf of off-road equipment, MCPA should grant a current unavoidable use determination when there are no PFAS alternatives that are technically suitable, economically feasible, commercially available, legally compliant, and safe. We understand that overtime these conditions may change and will require careful consideration on behalf of industry stakeholders to determine what an appropriate timeline looks like. That said, AEM strongly believes that the any PFAS alternative must satisfy these listed criteria prior to ending a current unavoidable use determination:

- Technically suitable: The PFAS alternative meets or exceeds the technical properties associated with the PFAS equivalent. This ensures that any replacement material provides the safety, quality, durability, and performance characteristics needed for the machine to operate successfully. If the new substance does not meet these technical requirements, the machine is likely to experience elevated safety risks, performance failures, premature obsolescence, and increased waste.

[5] https://www.federalregister.gov/documents/2023/11/24/2023-25714/decabromodiphenyl-ether-and-phenol-isopropylated-phosphate-31-revision-to-the-regulation-of
[6] https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-control-emissions-air-pollution-nonroad

- Economically Feasible: The PFAS alternative is reasonably priced. If the new alternative is too expensive, the increase in price will threaten the long-term viability of the entire construction, agricultural, mining, utility, and forestry industry.
- Commercially Available: The PFAS alternative is available for purchase at scale. When developing new substances, chemical manufacturers and material processors require time to commercialize these products and distribute enough material for use throughout the global supply chain. OEMs, in turn, require their own time to test and validate new materials prior to adoption.
- Legally Compliant: The PFAS alternative is legally compliant with domestic and international law. Many components in off-road equipment are regulated under other regulatory frameworks. For instance, emissions-related components cannot be altered without notifying and, in many cases, re-certifying the engine with EPA, CARB, the EU, and other regulators. This process takes a substantial amount of time and resources to complete.
- Safe: The PFAS alternative is safe for handling, storage, manufacturing, and use. If the new material does not meet this requirement, it should not be used in the marketplace. This requires extra time and resources to prove.

Off-road equipment manufacturers produce machines to meet a host of different requirements. These include safety, regulatory, environmental, and customer requirements. Validating new components, parts, and systems takes time and cannot be accelerated without sacrificing important features. To achieve a successful outcome and with safe and durable results, a change of this magnitude should be validated and substantiated on an industry level. Other industries operate under similar types of demands. Therefore, it is crucial to keep these criteria in mind when establishing unavoidable use determination timelines.

6. How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

The off-road equipment industry manufactures safe equipment using consensus safety standards with decades of experience using components and materials that satisfy well-tried safety principles. Companies in these sectors will innovate and differentiate themselves on performance, efficiency, functionality, and a host of other features, but prefer to move together when it comes to safety. Therefore, to maximize worker safety and avoid largescale market disruptions, it is important that current unavoidable use determinations apply to the industry as a whole and consider industry wide acceptance and approval of potential PFAS alternatives, rather than on a company-by-company basis. This process will mitigate safety risks on the workplace and guarantee a smoother transition when viable PFAS alternatives are identified.

7. In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

AEM represents off-road equipment manufacturers and suppliers with more than 1,000 member companies and over 200 product lines in the construction, agriculture, mining, forestry, and utility industries. Off-road equipment encompasses a large variety of products and product types. While many of these products use similar components, parts and systems, their intended function and use cases may differ substantially between equipment types; requiring a more complete definition to fully encompass the off-road sector. Generally, off-road equipment includes the following types of machines:

- Mobile off-road equipment,
- Large scale fixed installation,
- Large scale stationary industrial tools,
- Alternative power applications, and
- Attachments and implements.

The definitions of each of these categories are as follows:

- <u>Off-road mobile machine:</u> any mobile machine, item of transportable industrial equipment, or vehicle with or without bodywork or wheels which:
  - Is not intended for carrying passengers or goods on the road,
  - Includes machinery installed on the chassis of vehicles intended for the transport of passengers or goods on the roads,
  - Installed with a combustion engine – either an internal spark ignition (SI) engine, or a compression ignition diesel engine,

- <u>Large Scale Fixed installations:</u> cover a combination of several types of machines which include, but are not limited to, tower cranes, light towers, crushers, and screeners:

  - A combination of several types of apparatus and, where applicable, other devices;
  - Assembled, installed and de-installed by professionals;
  - With the intention to be used permanently in a pre-defined and dedicated location;
  - And it has to be large-scale.

- <u>Large scale stationary industrial tools:</u> include, but are not limited to, cranes and blow-out preventers.

  - An assembly of machines, equipment and/or components, functioning together for a specific application;
  - Permanently installed and de-installed by professionals at a given place;
  - Used and maintained by professionals in an industrial manufacturing facility or R&D facility;
  - And it has to be large-scale.

- <u>Alternative power applications:</u> Products intended to power off-road equipment, such as batteries, battery packs, and recharge equipment.

- <u>Attachments & implements associated with the above equipment</u> (i.e., towed mowers, sprayers, buckets, forks)

<u>PFAS Use Cases in Off-Road Equipment</u>

The off-road equipment industry, defined by its diverse end-use applications, harsh working environments, and extremely long product lifecycles, demands unique material solutions to meet the safety, environmental and performance requirements of the marketplace. Future regulatory, customer, and societal pressures will continue to push this sector to develop and adopt new technologies to tackle global policy concerns, especially issues around climate change, engine emissions, circular economy concepts, enhanced recycling, energy usage, and sustainable supply chain issues. This complex mixture of impending market conditions requires industry access to distinctive material chemistries to accomplish these goals. Due to their highly specialized and unique properties, PFAS chemicals help provide a critical building block for OEMs to meet these objectives. While some industries may find alternatives to specific PFAS applications with sufficient research and development, there are many critical uses which cannot be replaced. Broad restrictions on PFAS will damage product innovation and could render future technology development goals impossible to achieve.

PFAS Essential Use Cases

Manufacturers design their products to operate for decades under extremely harsh, demanding and arduous work environments. Equipment materials, parts, and components need to meet rigorous design and testing requirements to ensure critical product functions continue to operate safely and effectively on the jobsite. With their many useful chemical and physical traits, PFAS provide crucial characteristics necessary to meet various equipment design challenges.

- Seals: All off-road machines use fluids to ensure the equipment continues to perform their intended functions. Fluid applications include hydraulic fluid, oil, fuel, refrigerants, coolant, among others. Sealing technology, such as O-rings and gaskets, prevents fluid leaks and ensures water, dirt, dust, and debris stays out of the equipment.

  Properly designed seals must meet various design characteristics to ensure they operate in a reliable, continuous, and efficient manner. The mechanical functions inside a off-road vehicle exposes parts and components to various stressors:

  - Pressure - various systems, such as the hydraulic and engine systems, experience extreme pressure environments up to 500 bar.
  - Temperature - the engine compartment and exhaust system operate at temperatures as high as 800 °C.
  - Chemical - seals interact with various fluids, requiring a high degree of chemical and corrosion resistance to ensure the continued operation of exposed parts.
  - Mechanical – machines possess a high degree of mechanical wear and tear, sealing parts must survive the shear forces due to the mechanical movement of the equipment.

  PFAS are the only chemical family known to provide the combination of thermal stability, chemical resistance, low frictional characteristics, and sealing capabilities required to operate in this harsh machine environment. Several PFAS chemicals, known broadly as fluoropolymers, which include Polytetrafluoroethylene (PTFE), Fluoroelastomer (Viton), and Polyvinylidene fluoride (PVDF) possess many of these crucial chemical traits and have no known substitutes, making them irreplaceable for the heavy equipment off-road industry.
  Replacing PFAS with inappropriate material substitutes would compromise the functionality of corresponding parts and components, ensuring increasing failure rates, fluid leaks, safety issues, and shorter vehicle lifetimes.

- Hoses: Similar to seals, hoses are required to transport fluids from one location to another, prevent fluid leaks, and maintain the cleanliness of the equipment's components and systems. Many hoses in the off-road industry use fluoropolymers to safeguard the durability of the machine by protecting its components from various internal pressure, temperature, and chemical stressors.

  Under these conditions fluoropolymer lined hoses, especially those with PTFE, provide a necessary level of protection to ensure the durability and long-term reliability of the component. There are no known viable alternatives for PTFE used in hoses. Alternatives, such as rubber hoses, provide less durability, as well as decreased flexibility and strength over time. Inappropriate alternatives will result in increasing fluid leaks, damage to the machine, loss of fluid power, and increasing safety risks for the operator.

- PTFE Tape: Over the operational lifetime of a machine, leaks will inevitably occur. Operators looking to fix fluid leaks from seals and hoses require the appropriate materials to withstand the normal operating conditions found inside off-road equipment. PTFE tape provides this level of assurance.

- Hydraulic Fluid: Hydraulic fluid enables the transfer of power from the engine to end-use hydraulic systems. The vast majority of off-road equipment rely on hydraulic systems to carry, push, dig or lift heavy loads. Without this important technology, much of the work performed today would require radically different, and less efficient, technology solutions. Prominent examples of machines and systems that use hydraulic power include excavators, cranes, forklifts, lifts, dozers, graders, loaders, shovels, trenchers, and concrete pumping systems, among others.

  Hydraulic fluids must possess a variety of crucial properties to protect the longevity of the hydraulic system and its components. In turn, the durability of these systems helps ensure that the machine continues to operate in a safe and efficient manner. Pin hole leaks, sudden drops in pressure, or contamination of the fluid can all cause serious safety issues for the operator or maintenance team. To avoid these types of safety concerns, hydraulic fluid producers utilize certain PFAS based chemicals to provide the corrosion, chemical, temperature and wear resistance needed for the system to operate smoothly.

- Refrigerants: Temperature management is a crucial product design requirement in the off-road sector. Many machines have enclosed operator cabins near large diesel engine exhaust systems, with few options for ventilation due to environmental concerns. Ensuring equipment operators remain comfortable while working is an important safety and comfort feature needed in modern machines.

  Ideal refrigerants need to possess off-corrosive and off-toxic characteristics with a low global warming potential (GWP), zero ozone depleting potential (ODP) and a low boiling point. Most widely adopted refrigerants, such as hydrofluorocarbons (HFCs), hydrofluoro-olefins (HFOs), and hydrochlorofluoroolefins (HCFO's) are used extensively in the automotive, aerospace, and off-road sectors. These substances break down quickly in the atmosphere into substances that naturally occur in the environment. Unlike most PFAS chemicals of concern, which may last thousands of years without breaking down, most modern refrigerants have an atmospheric lifetime measured in days, months and in some cases years.

  Due to the inconsistencies in defining what is, and what is not, a PFAS chemical, refrigerants sometimes find themselves included with this larger group. Refrigerants, such as HFC-134a and HFO-1234yf, may find themselves in scope of certain PFAS regulatory requirements despite possessing none of the chemical attributes or risk profiles which make PFAS a concern to policymakers. An accurate assessment of these substances using scientifically accurate definitions would help exclude them from the broader definition of a PFAS seen in recent legislative and regulatory actions.

- Paints: Coatings protect off-road equipment from chemical, weather, or water erosion. Well-designed coatings can help extend the useful life, and maintenance requirements, for off-road products, and are highly valued by OEM's and their customers. Many coating providers use PFAS in their paints to improve the flow, spread, and glossiness of the coating, as well as to decrease bubbling and peeling. They are also used in specialty paints to give stain-resistant, graffiti-proof, and water-repellent properties.

- Alternative Power: Policymakers have long sought to reduce the emissions of criteria pollutants and decarbonize the off-road sector. OEMs and engine manufacturers are looking at many new alternative power sources and technology solutions to meet their ESG goals. While the industry will continue to innovate and experiment in this space, it is clear that PFAS chemistries will play a crucial role in many of these future developments. Two of the most widely discussed technology solutions, batteries, and hydrogen fuel cells, use PFAS to fulfill crucial functionality.

    - Batteries utilize chemical binders to hold the internal active materials together to maintain a strong contact between the electrodes and the current collectors. Battery manufacturers use Polyvinylidene Fluoride (PVDF) as a binder in lithium-ion batteries due to its electrochemical and thermal stability, as well as its acceptable binding properties for the cathode. Additionally, certain fluorinated compounds are also used to coat the anodes to prevent unwanted reactions with the electrolyte. Due to their long lasting and chemical stable properties, the fluorinated compounds help extend the useful life of the battery.

      Under standard industry practices, batteries are manufactured in clean-room conditions, preventing the release of any PVDF into the surrounding environment. These closed conditions make it impossible for any PFAS materials to escape. Furthermore, battery recycling operations recover the PVDF through hydrometallurgical treatment processes. The collected PVDF is further broken down and captured by gas scrubbers, preventing any further release.

    - Hydrogen fuel cells use a proton exchange membrane (PEM) to separate the anode and the cathode. The PEM uses fluoropolymers to separate the protons from the electrons at the membrane surface, allowing only the protons to permeate to the cathode. In this technology, the fluoropolymers provide crucial properties that enable the fuel cell to produce electricity. The fluoropolymers used in the fuel cell PEM have no known alternative replacement.

Other examples: fire retardants, electrical insulation (Equipment), personal protection equipment including gloves/shielding/aprons (e.g. Nitrile, Viton)

Based on the critical benefit of the off-road equipment industry to society, the complex nature of these machines and their supply chains, as well as the fact that PFAS provides crucial safety functions and has no known alternatives, AEM recommends MPCA grant off-road equipment a current unavoidable use determination.

8. Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria.

AEM supports the criteria outlined in this comment when considering current unavoidable use determinations as well as the criteria needed to establish realistic timelines for these classifications. Assuming these criteria are adopted and used by MPCA when making their determinations, AEM supports making some initial current unavoidable use determinations as part of this rulemaking.

AEM appreciates your consideration of these comments.

Please feel free to contact me at Jmalcore@aem.org if you have any questions or require any further information.

Best Regards,

Jason Malcore
Senior Director, Safety & Product Leadership
Association of Equipment Manufacturers (AEM)

RECEIVED
By: OAH on 3/1/2024
Amy Neal Attachment

EMERSON

March 1, 2024

By E-Mail

Katrina Kessler
Commissioner
Minnesota Pollution Control Agency
520 Lafeyette Road North
St. Paul, Minnesota 55155-4194

Subject: Request for Comments on Planned New Rules Governing Currently Unavoidable Use (CUU) Determinations for Products Containing per-and Polyfluoroalkyl Substances (PFAS)

Dear Ms. Kessler:

Emerson Electric Co. appreciates the opportunity to respond to the State of Minnesota's Pollution Control Agency's (MPCAs) request for comments on criteria and processes by which CUU determinations will be made. We commend MPCA for giving industry the opportunity to participate in this important process.

Emerson Electric Co., headquartered in St. Louis, Missouri, is a global technology and engineering company with significant operations in Minnesota, including more than 2,900 staff and 15 sites, and is fully committed to making industrial products that are safe for end-users and the environment, consistent with MPCA's objectives.

Pursuant to the request for comments guide, answers to most questions are provided herein, highlighting considerations that we believe are essential to the CUU process. Please note that our comments represent the perspective of a downstream user of fluoropolymers in high-performance Industrial Automation Monitoring and Control (IAMC) products.[1]

1. **Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?**

[1] ***The statements, responses, commentary, and estimations made in this request are based on Emerson's good faith effort, research and knowledge Emerson is aware of at this time this request is submitted to Minnesota. Emerson intends to continue to research and acquire knowledge regarding PFAS and may at a future time have updated information and analysis regarding the subject matters in this request. However, Emerson does not undertake to update any such statements, responses, commentary, and estimations submitted in this request to reflect later developments. Emerson has issued these statements, responses, commentary, and estimations in this request to solely address this request for industry comments. Emerson's statements, responses, commentary, and estimations in this request should not be read, construed, or applied as to speaking to matters beyond what Minnesota has requested under this comment request. Emerson encourages industry to continue to find and/or develop PFAS alternatives. Emerson reserves all its rights and interests under this Minnesota law. Nothing in this submission shall be viewed as waiving any of its rights.***

Yes, with the caveat that MPCA should be open to re-evaluating the criteria based on potential technological progress and innovations on which society may be reliant on in the decades to come.

The MPCA could consider leveraging the extensive work and stakeholder input completed for the European (EU) Commission by WSP. The EU Commission contracted with WSP to support the development of the "essential use concept" to satisfy the requirements defined in the Chemical Strategy for Sustainability (CSS) under the EU Green Deal. Below is relevant information extracted from WSP's report:

Criteria # 1: Necessary for health or safety if one or more are met:

- Preventing, monitoring or treating illness and similar health conditions.
    - Provide healthcare (including monitoring and diagnosing), such as uses for and in medical devices, test and measurement equipment, and for producing medicines.
    - Ensure hygiene and cleaning in hospitals where disinfection is required.
    - Prevent transmission of and control diseases.
- Sustaining basic physical conditions for human life and health.
    - Secure sufficient clean water, food and air.
    - Secure heat and shelter
- Managing health crises and emergencies
    - Mitigate the effect of disease outbreaks.
    - Ensure the functioning of emergency and ambulance services.
- Ensuring personal safety
    - Ensure the functioning of personal safety equipment.
    - Ensure lubrication in vehicle brakes, fire resistance in products, or corrosion protection.
- Ensuring public safety
    - Ensure safety of infrastructure, such as road, rail and air safety and building safety.
    - Ensure the functioning of emergency services to prevent danger to the public.
    - Customs control

Criteria # 2: Critical for the functioning of society if one or more are met:

- Providing resources or services critical to society
    - Enable installation, maintenance and transmission of infrastructure and services critical to society, such as energy supply and transport, water treatment and water supply, waste treatment, digital communication and healthcare infrastructure.
- Managing societal risks and impacts from natural crises and disasters
    - Repair damage to infrastructure from natural disasters such as floods, fires, earthquakes.
- Protecting and restoring the natural environment
    - Reduce greenhouse gas emissions, such as use for renewable energy technologies.
    - Reduce air pollutants, such as use in scrubber technologies and similar uses.
    - Protect ecosystems and biodiversity, such as use for control of invasive species.
    - Analyze and monitor pollutants
    - Remediate pollutants in the environment.
- Performing scientific research and development
    - Perform laboratory analysis, measurement and testing.
    - Perform laboratory experiments.
- Protecting cultural heritage

- o Conservation of cultural heritage.

2. **Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?**

An assortment of analysis should be included in this alternative contemplation. Below are some preliminary concepts that Minnesota could consider in its drafting phases. A factor analysis process, along with the preliminary concepts below, for industry to weigh when making these future product determinations may be a practical solution to help MPCA ponder this open question.

1. The alternative material should **be safer**, perform **comparable to PFAS,** and be considered a **drop-in replacement** (i.e. no redesign of the product is required to accommodate performance deficiencies or vulnerabilities).
2. The alternative material should be at a **comparable cost** to the existing PFAS material.
3. The alternative material should be **commercially available at-scale** and from multiple suppliers.

MPCA could consider convening a roundtable of companies to discuss additional concepts for quantifying a reasonable cost threshold.

3. **Should unique considerations be made for small businesses with regards to economic feasibility?**

Not Applicable

4. **What criteria should be used to determine the safety of potential PFAS alternatives?**

Industry requests additional time to provide meaningful comments on this question and request this question comment be extended.

5. **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided? Should significant changes in available information about alternatives trigger a re-evaluation?**

Despite the substantial financial opportunity to replace PFAS, Emerson is not aware of companies offering new materials as a drop-in replacement and capturing the prosperous market, which is a strong indication that, in many cases, especially in industrial applications, that no alternatives exist. Consequently, the time period for a granted CUU should be set at **greater than 15 years for industrial applications**. This timeframe would allow for identification of alternatives and verification and validation testing, which can be upwards of 10 years in highly regulated industrial environments such as those called for in nuclear applications. This estimate assumes that a suitable alternative will be identified within the first few years of the CUU time period.

Industry needs timeframes that are predictable and can be managed without disruption to fulfillment of orders and critical product development projects. With the changing technological landscape, re-evaluations seems reasonable.

6. **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be**

determined to be currently unavoidable? What information should be submitted in support of such requests?

6a. How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA?
For the initial CUU determination, MPCA could issue a formal request for CUU proposals, with detailed instructions and examples, for release to the public with a response timeline of up to six (6) months.

For future requests, an online submission form could be created to streamline requests for new or a renewal of a CUU. An official procedure that defines the requirements, review process, frequency of CUU considerations, and response time should be developed.

6b. Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable?
No comment.

6c. What information should be submitted in support of such requests?
Consider harmonizing with the State of Maine's CUU Request for Proposal (RFP) with further consideration given to item number 1, per the following:

1. Provide a brief description of the type of product including, if applicable, the Global Product Classification (GPC) brick category and code, or if GPC is not applicable than the Harmonized Tariff System (HTS) code.

   Alternative Consideration: Given the complexity and number of products used in the marketplace that would require evaluation, MPCA could consider convening a task force, including industry representatives, to develop alternative ways to identify products.

2. Describe the intended use of the product and explain how it is essential for health, safety or the functioning of society.
3. Describe how the specific use of PFAS in the product is essential to the function of the product. If this use of PFAS is required by federal or state law or regulation, provide citations to that requirement.
4. Describe whether there are alternatives for this specific use of PFAS which are reasonably available.
5. Provide contact information for the submission.

7. In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

Emerson is anticipating requesting a CUU designation for 24 Industrial Automation Monitoring and Control (IAMC) products. This submission was developed with the assumption that MPCA's submission requirements align with the State of Maine's published CUU Request for Proposal (RFP). Below are potentially future analysis based on what we understand today and what Minnesota has published in the context of the rule.

IAMC products are the control systems and associated instrumentation, including the devices and controls used to automate industrial processes. The scope of equipment consists of interdependent, high-performance electromechanical products that measure a variety of parameters such as temperature, humidity, pressure, corrosion, and density as well as process control products such as valves, actuators, flow measurement devices and regulators, as outlined in Table 1 below:

TABLE 1. IAMC PRODUCTS

1. Pressure, Flow, Level and Temperature Measurement (4)	9. Distributed Control Systems (1)
2. Corrosion, Erosion & Heat Trace Monitoring (3)	10. Hygienic & Sanitary Measurement (1)
3. Energy Monitoring & Management (1)	11. Vibration Sensors & Welding Machines (2)
4. Industrial Test & Measurement Instruments (1)	12. Electrical Power Distribution & Control (1)
5. Density & Viscosity Measurement (2)	13. Valves (1)
6. Liquid, Flame & Gas Detection (3)	14. Regulators (1)
7. Machinery Monitoring, Protection & Maintenance (1)	15. Actuators (1)
8. Marine Measurement & Analysis (1)	

In 2022, IAMC products generated revenues of ~$200 billion globally. However, IAMC products are used as a critical component in a wide range of downstream uses where the socio-economic footprint is several times larger. The fluoropolymers used in IAMC products are discrete solid plastic parts that meet the OECD's definition of a polymer of low concern (link) and are contained within enclosures throughout the long life of the product emitting negligible emissions.

IAMC's fluoropolymer-containing products are key to fulfilling many critical-to-society applications:

The comprehensive scope of uses and products are difficult to list, but key examples and additional details are provided below, with additional details provided in Table 3.

- Chlorine production - drinking water and food processing disinfectant
- Semiconductor manufacturing
- Critical chemical processing – feedstocks, pharmaceuticals, pulp & paper, etc.
- Medical procedures - Invasive cyogenic tumor removal
- Pressure vessel – relief valves are required in all pressure vessels by law
  - 46 CFR § 54.15-10 - Safety and relief valves
- Control of sustainable energy applications – wind, H2, solar, mobility, etc.
- Other examples of uses include critical infrastructure sectors, as defined by the United States government, forest products, rail and other mass transportation, and construction operations.

The operating profile of these uses, and to which IAMC products are exposed, are defined by the industrial sectors that leverage the technology. These applications often involve exposure to multiple extreme environmental conditions simultaneously. The IAMC environmental parameters often include the following:

- Hazardous environments are prevalent and include fire, explosion, and toxic chemical threats. These environments often mandate equipment certifications, namely UL/IEC 60079.
- Broad chemical exposure is common due to the massive number of chemicals processed every day. These chemicals span the entire pH range and are processed at different temperatures and pressures. Example harsh chemicals include sulfuric acid, hydrofluoric acid and chlorine.
- Low temperatures near -76°F. Beyond this for cryogenic processing, IAMC products can be exposed to temperatures down to -328°F.
- High temperatures near 500°F.
- High pressures near 2,200 PSI to accelerate and influence reaction rates and to increase volume-time efficiencies. Pressures up to
- 14,500 PSI bar exist in some chemical processes. These environments often mandate equipment certifications, specifically ASME Boiler Pressure Vessel Code (BPVC).

IAMC products frequently operate in harsh environments where only fluoropolymers can deliver the performance needed for safe and efficient operations.

TABLE 2. THESE EXAMPLES ILLUSTRATE THE ESSENTIALITY OF IAMC PRODUCTS, THEIR CONTRIBUTION TO HEALTH, SAFETY, AND THE FUNCTIONING OF SOCIETY, AND THE ESSENTIALITY OF PFAS AS AN ENABLING MATERIAL.

APPLICATION	IAMC INTENDED USE	ESSENTIALITY FOR HEALTH, SAFETY AND/OR THE FUNCTIONING OF SOCIETY (SECTION 2.0)	ESSENTIALITY OF PFAS (SECTION 3.0)
Water treatment & Provision of Safe Food Supply	**Chlorine production** 1. Measurement equipment and valves are used for containment and control of the chlorine production process. 2. Solenoid valves for control of potable water and clean-in-place systems.	Chlorine is the most common type of drinking water disinfectant. It is able to reduce the chance of pathogen regrowth in water storage tanks or distribution systems and oxidizes iron, manganese, taste and odor compounds, remove color in the water, destroy hydrogen sulphide, and aid other water treatment processes, such as sedimentation and filtration. Chlorine is also used to clean and sterilize food processing equipment to prevent bacteria growth.	PTFE & PFA liners in measurement equipment and valves for the production of chlorine. Highly concentrated chlorine is corrosive and highly toxic to people and the environment. PTFE & PFA liners can withstand the corrosive environment, are lightweight and have a relatively low carbon footprint associated with their manufacturing processes. Exotic metals that might withstand the corrosive environment are not viable due to the high weight and increased CO2 associated with their manufacturing processes.
Semiconductors	**Semiconductor manufacturing** 1. Pressure regulators are used to control the pressure of media used in etching and chemical vapor deposition processes. 2. Industrial test & measurement instrumentation to detect organic impurities in air during µ-Processor manufacturing.	The rapid vertical and horizontal expansion in chips applications means the market for semiconductors is expected to multiply in Maine and around the globe.	Use in semiconductors and microchips manufacturing ensuring that highly corrosive chemicals do not contaminate ultra-clean fabrication environment. Pressure regulators utilize PTFE and PCTFE in valve seats to control the pressure of media used in etching and chemical vapor deposition processes for semiconductor manufacturing, providing high purity and compatibility with the processed gases to prevent a reaction with the media. PCTFE also delivers an ideal compressive modulus and creep resistance for maintaining sealability.
Chemical Feedstocks, Pharmaceuticals, Petroleum, Hydrogen, Pulp & Paper	**Critical chemical processing** 1. Measurement equipment and valves for containment and control during chemical production.	Chemical feedstocks are the essential building blocks for items such as building materials, appliances, clothing, pharmaceuticals & personal care items, and everyday items such as laundry detergent and toothpaste.	Control and isolation valves utilize PTFE valve packing in the production of pharmaceuticals, chemicals, hydrogen processing, etc. ▪ PTFE valve packing is better at sealing gases than graphite, is inert and delivers performance at extreme temperatures, -200°C to +260°C ▪ PTFE waveguides are used in non-contact, radar level measurement applications for safe storage of harsh chemicals. ▪ PTFE and PFA liners are used in flow meters to control process conditions. Liners protect metal from corrosive media.
Medical	**Invasive tumor removal procedures** 1. Solenoid valves for control of cryogenic fluids	Tumor removal procedures can be very painful and dangerous, often requiring the use of a cryogenic fluids and accompanying equipment.	Solenoid valves use PTFE, FKM & FFKM in o-rings at cryogenic temperatures (-328°F)
Pressure Vessels	**Pressure vessel** 1. Relief valves to prevent pressure vessel rupture. 2. Welding machinery for automated and consistent fabrication.	Across all pressure vessels – from a heat exchanger to a three-story pressurizer in a nuclear reactor – a relief valve is required by law for safety. Pressure vessels include boilers, chemical tanks and reactors, etc.	Industrial relief valves use PTFE, FKM & FFKM in valve seats at high temperatures (300°F) and high pressures (1,500 PSI). Alternative materials do not provide adequate properties for reliable seals on these devices.
Sustainable energy/ mobility: Batteries/Solar/ Wind/Hydrogen	**Sustainable energy applications** 1. Distributed Control Systems for automation, monitoring & control of processes.	The proliferation of sustainable energy applications are key enablers of decarbonization initiatives across the globe. Automation of these processes, including data collection, is a highly complex but necessary activity to maintaining an efficient and safe manufacturing operation.	Fluoropolymers such as PTFE are utilized in most decarbonization activities such as H2 production and storage, mobility, wind and solar. Fluoropolymers are used as protective films in solar, coatings, for offshore wind turbines, and membranes for transportation activities involving H2 and battery manufacturing.

No Suitable Alternatives Exist Today that can Deliver the Necessary Performance for challenging IAMC operating environments:
The challenging IAMC end uses demand the use of high performance and high reliability materials like fluoropolymers, which are vital as an engineering material class, not because of one particular characteristic, but because of the multiple properties any of them simultaneously possesses. Fluoropolymers' most commonly leveraged properties include:

- Broad chemical resistance to virtually all chemicals
- High and Low temperature performance down to -328°F/ up to 500°F
- High pressures near 2,200 PSI nominally and 14,500 PSI for certain chemical processes
- Intrinsic flame resistance with a limiting O_2 index
- Low friction and Excellent electrical properties

GPC and HTS codes for the proposed 24 CUUs are provided in Appendix A.

8. **Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?**

Yes, CUUs deemed critical to safety, health and critical to the functioning of society should be provided as soon as possible to give industry time to plan next steps, if any.

9. **Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.**

Emerson respectfully submits the following considerations:

- Permit a category of products to be exempted as a CUU. For example, medical devices or Industrial Automation Monitoring & Control (IAMC) products can be categorized as a single CUU.
- Exempt all CUUs from reporting requirements.
- Provide an exemption for fluoropolymers in industrial applications that meet the criteria for critical for health, safety and functioning of society.
- Focus efforts on the beginning and end of life phases by demanding responsible manufacturing by the chemical producers and investing in safe end-of-life emission control strategies. Industrial downstream users deploy fluoropolymers that satisfy the OECD's polymer of low concern criteria (link).

We appreciate the opportunity to provide this information and invite you to reach out for additional information or discussion regarding these comments. We look forward to your response and any potential follow-up.

Contact Details:

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Appendix A: GPC & HTS Codes

NO.	IAMC PRODUCTS	APPLICABLE GPC	GPC DESCRIPTION	GPC NOTES	APPLICABLE HTS	HTS DESCRIPTION	HTS NOTES
	All IAMC Products	78050000-10005661	Circuit Assemblies/ Integrated Circuits	Applies to all IAMC products	8532	Electrical capacitors, fixed, variable or adjustable (pre-set); parts thereof:	Applies to all IAMC products
		78050000-10005662	Discrete Components		8533	Electrical resistors (including rheostats and potentiometers), other than heating resistors; parts thereof:	
		78050000-10005667	Elecronic Circuit Accessories		8534	Printed circuits	
		65000000-10001142	Computers Other		8536	Electrical apparatus for switching or protecting electrical circuits, or for making connections to or in electrical circuits (for example, switches, relays, fuses, surge suppressors, plugs, sockets, lamp-holders and other connectors, junction boxes), for a voltage not exceeding 1,000 V; connectors for optical fibers, optical fiber bundles or cables:	
					8541	Semiconductor devices (for example, diodes, transistors, semiconductor-based transducers); photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light-emitting diodes (LED), whether or not assembled with other light-emitting diodes (LED); mounted piezo-electric crystals; parts thereof:	
					8542	Electronic integrated circuits; parts thereof:	
					8544	Insulated (including enameled or anodized) wire, cable (including coaxial cable) and other insulated electric conductors, whether or not fitted with connectors; optical fiber cables, made up of individually sheathed fibers, whether or not assembled with electric conductors or fitted with connectors:	
					8548	Electrical parts of machinery or apparatus, not specified or included elsewhere in this chapter	
					8543	Electronic integrated circuits; parts thereof:	
					8504	Electrical transformers, static converters (for example, rectifiers) and inductors; parts thereof:	
					8506	Primary cells and primary batteries; parts thereof:	
					3926	Other articles of plastics and articles of other materials of headings 3901 to 3914:	
					8412	Other engines and motors, and parts thereof:	

NO.	IAMC PRODUCTS	APPLICABLE GPC	GPC DESCRIPTION	GPC NOTES	APPLICABLE HTS	HTS DESCRIPTION	HTS NOTES
1	Pressure Transmitter	58000000-99999999	GPC code has been requested		9026	Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases (for example, flow meters, level gauges, manometers, heat meters), excluding instruments and apparatus of heading 9014, 9015, 9028 or 9032; parts and accessories thereof:	
2	Flow Meter	58000000-99999999	GPC code has been requested		9026	Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases (for example, flow meters, level gauges, manometers, heat meters), excluding instruments and apparatus of heading 9014, 9015, 9028 or 903	
3	Level	58000000-99999999	GPC code has been requested		9026	Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases (for example, flow meters, level gauges, manometers, heat meters), excluding instruments and apparatus of heading 9014, 9015, 9028 or 903	
4	Temperature	58000000-99999999	GPC code has been requested		9026	Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases (for example, flow meters, level gauges, manometers, heat meters), excluding instruments and apparatus of heading 9014, 9015, 9028 or 903	
					9025	Hydrometers and similar floating instruments, thermometers, pyrometers, barometers, hygrometers and psychrometers, recording or not, and any combination of these instruments; parts and accessories thereof:	
5	Corrosion Monitoring	58000000-99999999	GPC code has been requested		9031	Measuring or checking instruments, appliances and machines, not specified or included elsewhere in this chapter; profile projectors; parts and accessories thereof:	
6	Erosion Monitoring	58000000-99999999	GPC code has been requested		9031	Measuring or checking instruments, appliances and machines, not specified or included elsewhere in this chapter; profile projectors; parts and accessories thereof:	
7	Heat Trace Monitoring	58000000-99999999	GPC code has been requested		9031	Measuring or checking instruments, appliances and machines, not specified or included elsewhere in this chapter; profile projectors; parts and accessories thereof:	
8	Energy Monitoring & Management	58000000-99999999	GPC code has been requested		9031	Measuring or checking instruments, appliances and machines, not specified or included elsewhere in this chapter; profile projectors; parts and accessories thereof:	

NO.	IAMC PRODUCTS	APPLICABLE GPC	GPC DESCRIPTION	GPC NOTES	APPLICABLE HTS	HTS DESCRIPTION	HTS NOTES
9	Industrial Test & Measurement Instruments	58000000-99999999	GPC code has been requested		9030	Oscilloscopes, spectrum analyzers and other instruments and apparatus for measuring or checking electrical quantities, excluding meters of heading 9028; instruments and apparatus for measuring or detecting alpha, beta, gamma, X-ray, cosmic or other ionizing radiations; parts and accessories thereof::	
		65000000-10001170	CompunterNetworking Equipment Other				
		65000000-10001169	Network Switches				
		65000000-10001168	Network Routers				
		65000000-10001167	Network Interface Cards				
		65000000-10001165	Network Access Points				
		65000000-10001147	Servers				
		65000000-10001142	Computers Other				
		78000000-10005757	Audio Visual Cables				
		78000000-10005754	Computer Cables				
		78040400-10005540	Electrical Wiring				
					8523	Discs, tapes, solid-state non-volatile storage devices, "smart cards" and other media for the recording of sound or of other phenomena, whether or not recorded, including matrices and masters for the production of discs, but excluding products of Chapter 37:	
					8471	Automatic data processing machines and units thereof; magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data, not elsewhere specified or included:	
10	Density Measurement	58000000-99999999	GPC code has been requested		9026	Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases (for example, flow meters, level gauges, manometers, heat meters), excluding instruments and apparatus of heading 9014, 9015, 9028 or 903	
					9027	Instruments and apparatus for physical or chemical analysis (for example, polarimeters, refractometers, spectrometers, gas or smoke analysis apparatus); instruments and apparatus for measuring or checking viscosity, porosity, expansion, surface tension or the like; instruments and apparatus for measuring or checking quantities of heat, sound or light (including exposure meters); microtomes; parts and accessories thereof:	

NO.	IAMC PRODUCTS	APPLICABLE GPC	GPC DESCRIPTION	GPC NOTES	APPLICABLE HTS	HTS DESCRIPTION	HTS NOTES
11	Viscosity Measurement	58000000-99999999	GPC code has been requested		9026	Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases (for example, flow meters, level gauges, manometers, heat meters), excluding instruments and apparatus of heading 9014, 9015, 9028 or 903	
					9027	Instruments and apparatus for physical or chemical analysis (for example, polarimeters, refractometers, spectrometers, gas or smoke analysis apparatus); instruments and apparatus for measuring or checking viscosity, porosity, expansion, surface tension or the like; instruments and apparatus for measuring or checking quantities of heat, sound or light (including exposure meters); microtomes; parts and accessories thereof:	
12	Liquid Detection	58000000-99999999	GPC code has been requested		9026	Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases (for example, flow meters, level gauges, manometers, heat meters), excluding instruments and apparatus of heading 9014, 9015, 9028 or 903	
					9027	Instruments and apparatus for physical or chemical analysis (for example, polarimeters, refractometers, spectrometers, gas or smoke analysis apparatus); instruments and apparatus for measuring or checking viscosity, porosity, expansion, surface tension or the like; instruments and apparatus for measuring or checking quantities of heat, sound or light (including exposure meters); microtomes; parts and accessories thereof:	
13	Flame Detection	58000000-99999999	GPC code has been requested		9026	Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases (for example, flow meters, level gauges, manometers, heat meters), excluding instruments and apparatus of heading 9014, 9015, 9028 or 903	
					9027	Instruments and apparatus for physical or chemical analysis (for example, polarimeters, refractometers, spectrometers, gas or smoke analysis apparatus); instruments and apparatus for measuring or checking viscosity, porosity, expansion, surface tension or the like; instruments and apparatus for measuring or checking quantities of heat, sound or light (including exposure meters); microtomes; parts and accessories thereof:	
14	Gas Detection	58000000-99999999	GPC code has been requested		9027	Instruments and apparatus for physical or chemical analysis (for example, polarimeters, refractometers, spectrometers, gas or smoke analysis apparatus); instruments and apparatus for measuring or checking viscosity, porosity, expansion, surface tension or the like; instruments and apparatus for measuring or checking quantities of heat, sound or light (including exposure meters); microtomes; parts and accessories thereof:	

NO.	IAMC PRODUCTS	APPLICABLE GPC	GPC DESCRIPTION	GPC NOTES	APPLICABLE HTS	HTS DESCRIPTION	HTS NOTES
15	**Machinery Monitoring, Protection & Maintenance**	58000000-99999999	GPC code has been requested		9027	Instruments and apparatus for physical or chemical analysis (for example, polarimeters, refractometers, spectrometers, gas or smoke analysis apparatus); instruments and apparatus for measuring or checking viscosity, porosity, expansion, surface tension or the like; instruments and apparatus for measuring or checking quantities of heat, sound or light (including exposure meters); microtomes; parts and accessories thereof:	
		91000000-10005387	Environmental/Fire/Chemical Safety Products Variety Packs				
16	**Marine Measurment & Analsysis**	58000000-99999999	GPC code has been requested		9027	Instruments and apparatus for physical or chemical analysis (for example, polarimeters, refractometers, spectrometers, gas or smoke analysis apparatus); instruments and apparatus for measuring or checking viscosity, porosity, expansion, surface tension or the like; instruments and apparatus for measuring or checking quantities of heat, sound or light (including exposure meters); microtomes; parts and accessories thereof:	
17	**Distributied Control Systems**	58000000-99999999	GPC code has been requested		8537	Boards, panels, consoles, desks, cabinets and other bases, equipped with two or more apparatus of heading 8535 or 8536, for electric control or the distribution of electricity, including those incorporating instruments or apparatus of chapter 90, and num	
		65000000-10001170	CompunterNetworking Equipment Other				
		65000000-10001169	Network Switches				
		65000000-10001168	Network Routers				
		65000000-10001167	Network Interface Cards				
		65000000-10001165	Network Access Points				
		65000000-10001147	Servers				
		65000000-10001142	Computers Other				
		78000000-10005757	Audio Visual Cables				
		78000000-10005754	Computer Cables				
		78040400-10005540	Electrical Wiring				

NO.	IAMC PRODUCTS	APPLICABLE GPC	GPC DESCRIPTION	GPC NOTES	APPLICABLE HTS	HTS DESCRIPTION	HTS NOTES
18	Hygienic & Sanitary Measurement	58000000-99999999	GPC code has been requested		9027	Instruments and apparatus for physical or chemical analysis (for example, polarimeters, refractometers, spectrometers, gas or smoke analysis apparatus); instruments and apparatus for measuring or checking viscosity, porosity, expansion, surface tension or the like; instruments and apparatus for measuring or checking quantities of heat, sound or light (including exposure meters); microtomes; parts and accessories thereof:	
19	Vibration Sensors	58000000-99999999	GPC code has been requested		9027	Instruments and apparatus for physical or chemical analysis (for example, polarimeters, refractometers, spectrometers, gas or smoke analysis apparatus); instruments and apparatus for measuring or checking viscosity, porosity, expansion, surface tension or the like; instruments and apparatus for measuring or checking quantities of heat, sound or light (including exposure meters); microtomes; parts and accessories thereof:	
20	Welding Machines	58000000-99999999	GPC code has been requested		8515	Electric (including electrically heated gas), laser or other light or photon beam, ultrasonic, electron beam, magnetic pulse or plasma arc soldering, brazing or welding machines and apparatus, whether or not capable of cutting; electric machines and appa	
21	Electricial Power Distribution & Control	58000000-99999999	GPC code has been requested		8537	Boards, panels, consoles, desks, cabinets and other bases, equipped with two or more apparatus of heading 8535 or 8536, for electric control or the distribution of electricity, including those incorporating instruments or apparatus of chapter 90, and num	
		78020000-78021100	Batteries/Chargers		8507	Electric storage batteries, including separators therefor, whether or not rectangular (including square); parts thereof:	
		78020000-78020500	Electrical Connection				
		78020000-78020600	Electrical Distribution				
		78020000-78021200	Electrical Generation				
22	Valves	58000000-99999999	GPC code has been requested		8481	Taps, cocks, valves and similar appliances, for pipes, boiler shells, tanks, vats or the like, including pressure-reducing valves and thermostatically controlled valves; parts thereof:	
					9032	Automatic regulating or controlling instruments and apparatus; parts and accessories thereof:	
23	Regulators	58000000-99999999	GPC code has been requested		8481	Taps, cocks, valves and similar appliances, for pipes, boiler shells, tanks, vats or the like, including pressure-reducing valves and thermostatically controlled valves; parts thereof:	
					9032	Automatic regulating or controlling instruments and apparatus; parts and accessories thereof:	

NO.	IAMC PRODUCTS	APPLICABLE GPC	GPC DESCRIPTION	GPC NOTES	APPLICABLE HTS	HTS DESCRIPTION	HTS NOTES
24	Actuators	58000000-99999999	GPC code has been requested		8481	Taps, cocks, valves and similar appliances, for pipes, boiler shells, tanks, vats or the like, including pressure-reducing valves and thermostatically controlled valves; parts thereof:	
					9032	Automatic regulating or controlling instruments and apparatus; parts and accessories thereof:	
					8412	Other engines and motors, and parts thereof:	
					8537	Boards, panels, consoles, desks, cabinets and other bases, equipped with two or more apparatus of heading 8535 or 8536, for electric control or the distribution of electricity, including those incorporating instruments or apparatus of chapter 90, and num	
					8471	Automatic data processing machines and units thereof; magnetic or optical readers, machines for transcribing data onto data media in coded form and machines for processing such data, not elsewhere specified or included:	

RECEIVED
By: OAH on 3/1/2024

PERFORMANCE
FLUOROPOLYMER
PARTNERSHIP

March 1, 2024

Katrina Kessler
Commissioner
Minnesota Pollution Control Agency

Re: Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837[1]

Submitted via https://minnesotaoah.granicusideas.com/

On behalf of the American Chemistry Council's Performance Fluoropolymer Partnership,[2] thank you for the opportunity to submit comments on planned new rules governing currently unavoidable use (CUU) determinations about products containing per- and polyfluoroalkyl substances (PFAS). The Partnership's members are some of the world's leading manufacturers, processors, and users of fluoropolymers, including fluoroelastomers, and polymeric perfluoropolyethers. The Partnership's mission is to promote the responsible production, use, and management of fluoropolymers, while also advocating for a sound science- and risk-based approach to regulation. We hope the Minnesota Pollution Control Agency (hereafter "MPCA") will find our comments useful in crafting proposed regulations. First, we provide general comments on the proposed regulation, followed by responses to the specific questions raised in the request for comments.

General Comments

When determining whether the use of a PFAS in a product or product component is a CUU, MPCA should recognize that not only is it regulating current uses, but it is also making important decisions about the economic viability of substances critical to future innovations that promise to deliver tremendous societal benefits in a range of fields from healthcare to mitigating the negative effects of climate change. Only by applying a risk-based approach to determining whether a particular substance is unavoidable can MPCA balance the economic and social needs of Minnesotans with the goal of protecting the state's citizens and environment from potentially harmful PFAS.

By using criteria for identifying polymers of low concern to human health or the environment,[3,4] MPCA can avoid using its resources to analyze the essentiality of fluoropolymers in particular uses and instead focus on other PFAS substances that may present a higher risk. Fluoropolymers are large, stable molecules that have been demonstrated to meet multiple criteria developed within chemical regulatory frameworks around the world to identify

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[1] https://www.pca.state.mn.us/sites/default/files/c-pfas-rule3-01.pdf

[2] https://fluoropolymerpartnership.com/

[3] Organisation for Economic Co-operation and Development. 2009. Data analysis of the identification of correlations between polymer characteristics and potential for health or ecotoxicological concern. Document ENV/JM/MONO(2009)1. Paris (FR).

[4] BIO by Deloitte. (2014). Technical assistance related to the review of REACH with regard to the registration requirements on polymers – Final report prepared for the European Commission (DG ENV), in collaboration with PIEP.

polymers of low concern.[5,6] As demonstrated in the references provided, fluoropolymers are insoluble substances and therefore do not present concerns about mobility in the environment, in contrast to certain highly water soluble PFAS substances. In addition, fluoropolymers are neither bioavailable nor bioaccumulative, are not long-chain non-polymer PFAS, such as PFOA and PFOS, and do not transform into non-polymer PFAS in the environment.

Because of their unmatched combination of properties, fluoropolymers are used in thousands of products and product components (see responses to questions 7 and 8). Because of their favorable health and environmental safety profiles, as well as their irreplaceability in a wide range of products and applications that are essential to the daily lives of Minnesota's residents and businesses, fluoropolymers and uses of fluoropolymers should be designated as CUUs. Determination of CUUs across the entirety of Minnesota's economy will be exponentially more complex and burdensome if fluoropolymers are not excluded.

We strongly recommend that MPCA consider four other factors where CUU determinations are concerned:

1. Affirmative CUU determinations should extend to the entire supply chain necessary for the substance in the use. A CUU cannot exist in the economy if the manufacturers and processors involved in bringing the CUU to market do not have adequate regulatory certainty.

2. The 2032 ban may not allow sufficient time for manufacturers acting in good faith to adequately test and document the performance of fluoropolymers versus potential substitutes at scale. While such information is being generated, certain uses could be banned, which could lead to shortages or disruptions of supplies critical to the health, safety, and functioning of society. Implementing regulations should have a mechanism for extensions for manufacturers acting in good faith to generate information to support a CUU determination. Therefore, MPCA should create a continuous process for CUU applications and determinations.

3. Similarly, advances in technology and/or the emergence of new societal threats and challenges may result in new CUUs of fluoropolymers being recognized after 2032. MPCA should ensure that the regulatory process under development will allow those "new" CUU applications to be designated as such and allowed in commerce in Minnesota after January 1, 2032.

4. In order to avoid opinion-based criteria, MPCA should employ methods such as risk assessment, life cycle assessment, and socio-economic analysis and include

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[5] Henry, B.J., Carlin, J.P., Hammerschmidt, J.A., Buck, R.C., Buxton, L.W., Fiedler, H., Seed, J. and Hernandez, O. (2018), A critical review of the application of polymer of low concern and regulatory criteria to fluoropolymers. Integr Environ Assess Manag, 14: 316-334, https://doi.org/10.1002/ieam.4035.

[6] Korzeniowski, S.H., Buck, R.C., Newkold, R.M., El kassmi, A., Laganis, E., Matsuoka, Y., Dinelli, B., Beauchet, S., Adamsky, F., Weilandt, K., Soni, V.K., Kapoor, D., Gunasekar, P., Malvasi, M., Brinati, G. and Musio, S. (2022), A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers. Integr Environ Assess Manag, https://doi.org/10.1002/ieam.4646.

transparent stakeholder engagement in their process. MPCA should obtain broad stakeholder and expert input and carefully consider the uses under consideration.

More specific comments on MPCA's nine questions appear below.

1. Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Yes, criteria should be defined for "essential for health, safety and functioning of society." An "essential" assessment should only be initiated when there is deemed to be a risk to human health or the environment from the use of an intentionally added PFAS in a product. Products that do not present an unacceptable risk to human health or the environment should be presumed to be "essential for health, safety and functioning of society." On this point, we reiterate that fluoropolymers have been demonstrated to satisfy criteria for identifying polymers of low concern. If there is no concern about risk during the use of an intentionally added fluoropolymer, MPCA and stakeholder time and resources should not be wasted on an essentiality analysis. Neither should residents of Minnesota be denied access to a myriad of products important to their daily lives simply because those products contain fluoropolymers.

When considering the essentiality of a substance in a use, MPCA can look to the Maine Department of Environmental Protection's (DEP) most recent regulatory proposal,[7] which says:

> ***"Essential for Health, Safety or the Functioning of Society"*** *means products or product components that if unavailable would result in a significant increase in negative healthcare outcomes, an inability to mitigate significant risks to human health or the environment, or significantly interrupt the daily functions on which society relies. Products or product components that are Essential for Health, Safety or the Functioning of Society include those that are required by federal or state laws and regulations.*
>
> *Essential for the Functioning of Society includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, and construction.*

More generally, the concept of "essential" must be interpreted broadly in order to be workable. Under a narrow interpretation of "essential" it may be argued that products such as cell phones, laptop computers, or automobiles are not "essential to the functioning of society" since society can continue to function without these conveniences. This narrow and inappropriate interpretation fails to properly account for the fact that these types of products are highly beneficial and are an essential feature of our society. Similarly, under a narrow interpretation of "essential" it could be argued that products such as refrigeration units are not "essential to health" since people can live healthy lives without refrigeration. However, this narrow interpretation ignores the critical role that refrigeration plays in supporting good health by preventing food spoilage and preserving pharmaceuticals. These are a few examples of the types of products that, if they became unavailable, would likely cause massive social and

[7] Maine Department of Environmental Protection. PFAS in Products: Currently Unavoidable Uses. https://www.maine.gov/dep/spills/topics/pfas/PFAS-products/cuu.html

economic dislocation. To avoid this type of disruption we strongly urge MPCA to adopt a broader interpretation of "essential".

Three recent federal efforts provide examples of how to evaluate the concept of "essential." First, the Cybersecurity and Infrastructure Security Agency (CISA) has identified 16 critical infrastructure sectors "whose assets, systems, and networks, whether physical or virtual, are considered so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, or national public health or safety."[8] Those sectors are:

- Chemicals
- Commercial facilities
- Communications
- Critical manufacturing
- Dams
- Defense industrial base
- Emergency services
- Energy
- Financial services
- Food and agriculture
- Government facilities
- Healthcare and public health
- Information technology
- Nuclear reactors, materials, and waste
- Transportation systems
- Water and wastewater systems

While not inclusive of all uses that would meet the criteria for "essential", the CISA's list demonstrates the need for broad interpretation to mitigate against potential unforeseen adverse impacts to critical end uses and the people who rely on them.

Secondly, a new report from a committee of the National Science and Technology Council identifies critical and emerging technologies (CETs) and advises federal departments and agencies to use the list to "inform future efforts that promote U.S. technological leadership; cooperate with allies and partners to advance and maintain shared technological advantages; develop, design, govern, and use CETs that yield tangible benefits for society and are aligned with democratic values; and develop U.S. Government measures that respond to threats against U.S. security."[9] The CETs identified in the report are:

- Advanced computing
- Advanced engineering materials
- Advanced gas turbine engine technologies
- Advanced and networked sensing and signature management
- Advanced manufacturing
- Artificial intelligence
- Biotechnologies
- Clean energy generation and storage
- Data privacy, data security, and cybersecurity technologies
- Directed energy
- Highly automated, autonomous, and uncrewed systems, and robotics
- Human-machine interfaces
- Hypersonics

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[8] https://www.cisa.gov/topics/critical-infrastructure-security-and-resilience/critical-infrastructure-sectors.
[9] National Science and Technology Council, Fast Track Action Subcommittee on Critical and Emerging Technologies. *Critical and Emerging Technologies List Update*. February 2024. https://www.whitehouse.gov/wp-content/uploads/2024/02/Critical-and-Emerging-Technologies-List-2024-Update.pdf.

- Integrated communication and networking technologies
- Positioning, navigation, and timing technologies
- Quantum information and enabling technologies
- Semiconductors and microelectronics
- Space technologies and systems

The report identifies multiple sub-sectors in each of the CETs.

Finally, the Department of Defense (DoD) recently released a report highlighting the criticality of certain PFAS chemistries across a broad swath of applications of strategic and national importance.[10] Based on an extensive survey of known uses of PFAS chemistries, DoD concluded as follows:

> *PFAS are critical to DoD mission success and readiness and to many national sectors of critical infrastructure, including information technology, critical manufacturing, health care, renewable energy, and transportation. DoD relies on an innovative, diverse U.S. industrial economy. Most of the structurally defined PFAS are critical to the national security of the United States, not because they are used exclusively in military applications (although a few are) but because of the civil-military commonality and the potentially broad civilian impact.*

DOD went on to warn that:

> *Emerging environmental regulations focused on PFAS are broad, unpredictable, lack the specificity of individual PFAS risk relative to their use, and in certain cases will have unintended impacts on market dynamics and the supply chain, resulting in the loss of access to mission critical uses of PFAS. These market responses will impact many sectors of U.S. critical infrastructure, including but not limited to the defense industrial base.*

The DoD report specifically mentions the importance of fluoropolymers for energy storage and battery technologies, microelectronics, semiconductors, resins for specialty materials, specialty filters and membranes, munitions, and tactical and protective textiles. In addition, the report notes the importance of fluoropolymers in lines, hoses, o-rings, seals, gaskets, tapes, cables, and connectors in civil and military aircraft, space systems, vehicles, weapon systems, utility systems, and other applications, where "[a]lternatives are not as resistant to embrittlement and break-down and have a much shorter useful life, leading to more frequent part replacement, which is not feasible for space or satellite uses."

In developing regulations interpreting the concept of "essential" MPCA should heed DOD's warning and ensure that the term is interpreted broadly enough to encompass uses of PFAS—fluoropolymers in particular--that are critical to national infrastructure and supply chains. MPCA should also consider whether a PFAS is required to meet a specific performance standard or legal requirement. Some examples include meeting air or water emission controls, occupational safety requirements, product purity/contamination regulations, or in-life product performance and safety standards like performance specifications for the multiple components

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[10] Report on Department of Defense's Per- and Polyfluoroalkyl Substances Task Force Activities, September 2022. https://media.defense.gov/2022/Oct/13/2003095518/-1/-1/1/REPORT-ON-DEPARTMENT-OF-DEFENSE'S-PER-AND-POLYFLUOROALKYL-SUBSTANCES-TASK-FORCE-ACTIVITIES.PDF

of automobiles, airplanes, and electronic devices of all types. Similarly, MPCA should acknowledge that in most instances, the durability and reliability of an "essential" product is itself an essential function, and, therefore, materials such as fluoropolymers that help to assure the reliable functioning of an essential item are themselves essential.

2. Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Yes, the cost of PFAS alternatives should be considered in the definition of "reasonably available." However, the evaluation of the cost of an incumbent material or product relative to potential alternatives involves much more than just comparing the relative unit costs of materials. There are costs associated with testing and qualifying potential alternatives, redesign of production lines, added laboratory expenses, and costs related to training workers, among others. Potential human and environmental risks must be considered as well.

Furthermore, evaluating "availability" should account for the extent to which an alternative is already proven in a particular application and whether existing supply chains for the potential alternative can support increased demand. This includes demonstrating, using objective, quantifiable data, that a proposed alternative performs a required function at least as well as the incumbent substance. It also requires a determination that the proposed alternative will not substantially increase the cost of the product at issue. In other words, an alternative cannot be considered "reasonably available" if: (i) it does not perform a required function as well as the PFAS substance; (ii) it is not available at scale; or (iii) implementation of the alternative will appreciably increase the cost of the product. At a minimum, if those criteria are not met, an alternative cannot be considered "reasonably available".

Fluoropolymers are generally more expensive than other alternatives and are therefore used when potential alternatives cannot meet specific performance requirements. Fluoropolymers are used to improve the functionality, reliability, and durability of products. In many cases, not only do the materials used to make the products undergo rigorous testing and qualification, but the article or assembled product must also meet performance specifications that are not possible without fluoropolymers. Thus, where questions of "essential for health, safety, or the functioning of society" are concerned, MPCA should also investigate performance and reliability.

Therefore, consideration of "cost" must consider a suite of factors beyond the cost of the fluoropolymer and a potential alternative on the open market, and MPCA should not assume that the adoption of an alternative will be cost neutral in terms of the manufacturing process. For product (or product component) users, there may also be substantial costs to replace or repair the product more frequently because of relatively less durability. There may also be societal costs due to reduced product performance or safety.

Finally, MPCA should consider what effect the adoption of an alternative might have on the price of the final good and whether such a price increase would affect the ability of disadvantaged communities in Minnesota to access or maintain important products like mobile phones, computers, automobiles, household appliances, and others. For some, even minor cost increases can be significant, and regulators should take this fact into account.

3. Should unique considerations be made for small businesses with regards to economic feasibility?

Small businesses will be disproportionately affected by costs associated with testing and qualifying potential alternatives, the costs of redesigning products or production processes, and the replacement of any equipment (plus associated training costs). The significant effort required to determine which materials or products a business is using and whether the market is offering alternatives to them has a cost of its own. Such costs may represent an even larger burden on small enterprises that lack the resources to perform the research. MPCA should consider some form of relief for small businesses.

4. What criteria should be used to determine the safety of potential PFAS alternatives?

An alternative should not be considered “reasonably available” unless it is demonstrated, through scientific data, to present less risk under intended conditions of use than the incumbent substance. As a threshold matter, this would require MPCA to determine that the product containing the incumbent substance presents an appreciable risk to human health or the environment. Furthermore, any comparison of potential risks must include an assessment of the risks associated with any increased potential for product or product component failure, including the waste that would be associated with product replacement or repair.

MPCA should articulate clearly and transparently the criteria or information that will be used for comparative evaluations of potential risk and adopt a weight of evidence approach to assessing risk. In addition to the hazard and exposure profiles of incumbent PFAS and potential alternatives, MPCA should also consider impacts such as water use, consumption of raw materials, emissions, energy efficiency, reliability/safety during use, and useful life. The use of landfill capacity or other end of life disposal options should be considered in the cost of replacement.

5. How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

Affirmative CUU determinations should last until demonstrably safer and more sustainable alternatives are discovered and can reasonably be implemented at scale in the economy. Significant changes in available information should trigger a re-evaluation. Re-evaluation should apply not only to the use with an affirmative CUU determination, but to any alternative that was identified as the basis for denying a CUU determination. In other words, if new information about the safety or performance of an alternative becomes available, the denied CUU determination should be re-opened.

In no case should re-evaluations take place more frequently than 10 years. MPCA should consult with potentially affected industries to determine if a longer re-evaluation period may be necessary to evaluate alternatives or otherwise provide information for the re-evaluation process.

For any CUU petition that is declined (including CUUs that were granted and then subsequently declined on re-evaluation), MPCA must give manufacturers adequate time to transition to the alternative. We cannot provide a specific timeframe, as the time required to test and qualify an alternative may be quite different for different product or product component applications.

6. **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?**

MPCA will need to establish a process by which manufacturers and users (or their representatives) can request a CUU determination from MPCA. The process should be flexible enough to accommodate multiple uses of a substance instead of going use by use. The latter would pose a huge time burden on both MPCA and stakeholders.

A manufacturer that makes a timely submission of a request for a CUU determination should not be penalized if MPCA is unable to process the request by the statutory deadline of January 1, 2032, for identifying CUUs. In such cases, the manufacturer should be exempt from the ban until MPCA makes a final determination that the use is not a CUU. The converse process creates even more challenges in terms of allowing adequate time to respond to a request to a “not a CUU” request. At a minimum, the information requirements for either request should be identical. No party in the process should have a relatively higher or lower bar for substantiating its request. If a stakeholder argues against the establishment of a CUU designation, the manufacturers or users of those products should be given a clear and meaningful opportunity to rebut.

Any process around the granting or re-evaluation of a CUU must protect trade secrets. As noted in our November 28, 2023, comments on the Planned New Rules Governing Reporting by Manufacturers Upon Submission of Required Information about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor’s ID Number R-4828:

> *Some types of proprietary information the Agency will request derive independent economic value and are the subject of efforts to maintain its secrecy. Such information may also be recognized as confidential by federal or other state agencies, and trade secrets that are inadvertently disclosed may compromise national security and infrastructure. Therefore, in the proposed rule, the Agency must provide clear instructions regarding the specific steps that must be taken to officially assert and/or substantiate a trade secrets claim for information submitted that qualifies as a trade secret under Minnesota law, including the timeline by which such claims must be made relative to the reporting deadlines.*
>
> *The Agency also should define in regulation a process whereby a manufacturer is to be notified if its trade secret is subject to a public records request or is inadvertently disclosed by the Agency or any organization with which the Agency collaborates or contracts in the administration of the reporting program, including other states and any organization that designs, operates, or otherwise administers the reporting platform. The*

Agency should not enter into data sharing agreements with any organization, including but not limited to other states, if the Agency cannot assure that those organizations possess equivalently protective policies for trade secrets submitted to Minnesota. As we have previously noted in comments to the State of Maine, we are particularly concerned about how commercially valuable trade secret information will be managed by the Interstate Chemicals Clearinghouse (IC2) of which the Agency is a member.

7. In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

We would like to take this opportunity to draw MPCA's attention to a recent report from the Fluoropolymers Product Group of Plastics Europe. The report, *Socioeconomic Impact Assessment for Fluoropolymers,* contains extensive information about the uses of and alternatives for specific fluoropolymers in multiple sectors, including:

- Transport, including automotive and aerospace
- Chemical processing
- Construction materials
- Energy, including batteries and hydrogen
- Petroleum and mining
- Electronics and semiconductors
- Water and wastewater treatment
- High performance lubricants
- Medical devices and pharmaceuticals
- Architectural and professional textiles
- Metal plating and manufacturing of metal products
- Industrial coatings

The report is publicly available.[11] The information in the report about fluoropolymer uses and alternatives is relevant to the United States (as opposed to the economic information).

In addition, we have produced a white paper on the use of fluoropolymer resins in architectural and infrastructure applications.[12] The report compares fluoropolymer resins against potential substitutes in five end-use applications: building facades and protection; roofing and roofing structures; bridges and walkways; water towers; and solar panels. The white paper provides compelling evidence of the unmatched performance of fluoropolymer-based products in elements of the critical infrastructure.

[11] https://fluoropolymers.eu/wp-content/uploads/2023/09/FPG-Socioeconomic-Impact-Assessment-fluoropolymers-EU-PFAS-restriction-proposal-for-publication-Sept-2023.pdf

[12] https://fluoropolymerpartnership.com/wp-content/uploads/2023/12/PFP-White-Paper-on-Fluoropolymers-in-Infrastructure-and-Construction.pdf

8. Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

Yes, MPCA should make some initial CUU determinations as part of the rulemaking process using the proposed criteria. As noted previously, an "essential" assessment should only be initiated based on an assessment of risk to human health or the environment from the use of an intentionally added PFAS in a product. To start, MPCA could determine that products in which the use of a fluoropolymer enhances health, safety, and functioning of society should be granted CUU status or otherwise exempted from the requirements under the PFAS in products statute. Fluoropolymers have been shown to meet criteria for identifying polymers of low concern for human health and the environment. MPCA can maximize the use of its resources and can avoid the disruption of many product supply chains by giving fluoropolymers affirmative CUU determinations.

A non-exhaustive list of fluoropolymer uses that support significant societal benefits are provided as a starting point:

- Medical applications, pharmaceutical precursors, medical devices, and equipment that is deemed necessary to protect society from disease or otherwise reduce morbidity and mortality;
- Military and national defense uses (see the CSIA and DoD report referenced under question 1);
- Safety and critical functioning of chemical manufacturing processes and the storage of hazardous, corrosive, or explosive substances.
- Multiple systems that rely on fluoropolymers to enhance the safety of trains, airplanes, automobiles, heavy motorized equipment, ocean-going vessels, and other passenger and cargo transport vehicles;
- Navigation and communication systems that rely on fluoropolymers' unique combination of optical, thermal and dielectric properties;
- Semiconductor manufacturing that relies on high-performing fluoropolymers and fluoroelastomers to achieve and maintain the required levels of purity and clean manufacturing;
- Lubrication systems and sealing systems operating under harsh conditions;
- Water purification and treatment systems that utilize fluoropolymer membranes, resins, or filtration media;
- Analytical standards, testing equipment, and monitoring systems required for health, environmental, and safety measurements, detection, signaling, and monitoring;
- Exploration, conservation, research, and harvesting in all segments of the energy industry (e.g., hydrogen, solar, wind, oil, hydroelectric, and gas);
- Protective coatings used in construction, original equipment manufacturing, and factory applications;
- Fluoropolymers used in research and development in the uses described above or for uses that receive affirmative CUU determinations; and

- A product for which federal law governs the presence of a fluoropolymer in the product in a manner that preempts state authority.

9. Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

Some CUU determinations will require MPCA to determine whether reasonably available alternatives exist. The bases for such determinations must be consistent, fair, transparent, and well-defined. MPCA should propose objective criteria for determining when alternatives are or are not “reasonably available,” taking into consideration factors such as performance, safety, total cost of ownership, and reduced potential for risk to human health or the environment when compared to products or product components made with alternatives to fluoropolymers.

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Thank you for the opportunity to provide these comments. Please contact me if you or your colleagues have any questions.

Jay West
Executive Director
Performance Fluoropolymer Partnership

Stacy Tatman Attachment RECEIVED
By: OAH on 3/1/2024

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March 1, 2024

Katrina Kessler, Commissioner
Office of Administrative Hearings (OAH)
c/o Rulemaking *eComments* website
https://minnesotaoah.granicusideas.com/
Minnesota Pollution Control Agency (MPCA)
520 Lafeyette Road North
St. Paul, Minnesota 55155-4194

Attention: Resource Management and Assistance Division

Re: MPCA Request for Comments on Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

Dear Commissioner Kessler:

The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) appreciates the opportunity to submit comments to the Minnesota Pollution Control Agency (MPCA) for its planned new rules governing currently unavoidable use (CUU) determinations for products containing Per-and polyfluoroalkyl substances (PFAS).

Regulatory bodies should adopt basic principles to provide stability and certainty to the regulated community. Adopting the basic principles outlined in these comments will help MPCA meet its PFAS management goals, while supporting industry in preparing to meet these new challenges.

In the following proposal, we will provide responses to MPCA's request for information on various points that will help the agency develop regulations that will protect human health and the environment as well as jobs, businesses, and products that are essential to societal well-being. We ask that MPCA consider these comments carefully to prevent AHRI members' essential products from being banned from distribution in Minnesota commencing January 1, 2032.

Background on AHRI

AHRI represents more than 330 manufacturers of heating, ventilation, air conditioning, refrigeration, and water heating (HVACR-WH) equipment. It is an internationally recognized advocate for the HVACR-WH industry and certifies the performance of many of the products manufactured by its members. In North America, the annual economic activity resulting from the HVACR-WH industry is more than $211 billion. In the United States alone, AHRI member companies, along with distributors, contractors, and technicians employ more than 704,000 people. In Minnesota, the HVACR-WH industry supports more than 16,000 jobs.[1] AHRI and its members are committed to reasonable PFAS management that supports human health and the environment while protecting the jobs and the products that are essential to our society's well-being.

Introduction

AHRI supports MPCA's efforts to reduce harm to human health and the environment. We recognize there is precedent among controlling agencies at the international, federal, and state level for providing "critical use" or "currently unavoidable use" exemptions as these entities recognize the unique challenges associated with the PFAS family of over 12,000 unique chemicals.[2]

For the regulated community, even simple chemical substitutions can take years and cost millions of dollars. The chemical substitution process requires identifying chemicals in a complex, global supply chain, trying to find an alternative (if one is available), and then initiating the complicated, time-consuming, and expensive process of product redesign. Product redesigns include research, development, testing, and implementation which is a lengthy process process of several years as this equipment is subject to mandatory testing (e.g., for energy efficiency, safety, earthquake, and in some cases, food safety etc.) for even a single chemical change. Please see Appendix III for the assessed schedule for the steps and timing to replace phenyl isopropylated phosphate (PIP) (3:1).

For these reasons, we urge MPCA to consider not only human health and the environment but also business continuity and survival when proposing new burdensome or potentially unachievable mandates. This is especially true for vulnerable small businesses who have labor and financial constraints which cannot support the proposed compliance timelines and mandates. Government and industry must work together to develop deliberate, effective, thoughtful, and reasonable approaches to PFAS management.

[1] https://images.magnetmail.net/images/clients/AHRI/attach/AHRI_EconContribution.pdf.
[2] https://comptox.epa.gov/dashboard/chemical-lists/pfasmaster (Last accessed on Feb. 13, 2024).

Specific Comments in Response to MPCA's Request

1) Should criteria be defined for "essential for health, safety, or the functioning of society?" If so, what should those criteria be?

Response: Yes, criteria should be defined for "essential for health, safety, or the functioning of society" as well as other key terms and concepts which are detailed here. MPCA should also provide guidance and examples whenever possible. Please consider our responses here:

A. "Essential," "Essential for health, safety, or the functioning of society," and "Reasonably available alternatives"

Under MN Section 21, Subsection 116.943, Subdivision 1(j), "'Currently unavoidable use' means a use of PFAS that the commissioner has determined by rule under this section to be essential for health, safety, or the functioning of society and for which alternatives are not reasonably available." Therefore, it is critical for the regulated community to have a clear understanding of these terms.

To lessen the burden on the regulated community, AHRI asks MPCA to harmonize with other enacted laws and regulations as much as possible. For example, MPCA could consider using the definition found in Maine's Section 1614 of Title 38, which defines "Essential for Health, Safety or the Functioning of Society" to mean:

> products or product components that if unavailable would result in a significant increase in negative healthcare outcomes, an inability to mitigate significant risks to human health or the environment, or significantly interrupt the daily functions on which society relies. Products or product components that are Essential for Health, Safety or the Functioning of Society include those that are required by federal or state laws and regulations. Essential for the Functioning of Society includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, and construction.[3]

Again, for harmonization, AHRI asks MPCA to consider using the definition found in Maine's Section 1614 of Title 38, which defines "reasonably available" to mean "a PFAS alternative which is readily available in sufficient quantity and at a comparable cost to the PFAS it is intended to replace and performs as well as or better than PFAS in a specific application of PFAS in a product or product component."[4]

B. "Product Categories"

Once the MPCA has established the criteria for CUUs, AHRI recommends establishing Product Categories to lessen the burden on the regulated community. AHRI proposes that MPCA establish a category for "HVACR-WH" which includes heating (including space

[3] Maine Title 38, Section 1614, Enacted October 25, 2023.
[4] Maine Title 38, Section 1614, Enacted October 25, 2023.

heating), ventilation, air conditioning, refrigeration (including transport), refrigerants, and water heating equipment and their components and parts including replacement parts, materials, and manufacturing and servicing needs. Please see our response to "Question 7" for additional information.

C. “PFAS Definition”

Under MN Section 21, Subsection 116.943, Subdivision 1(p), PFAS are defined as “’Perfluoroalkyl and polyfluoroalkyl substances’ or ‘PFAS’ means a class of fluorinated organic chemicals containing at least one fully fluorinated carbon atom.” However, no definitive list of chemicals is provided. This makes it difficult if not impossible for product manufacturers (who are not chemicals experts and who often have complex, international, multi-tiered supply chains) to identify which of these substances are used in their products.

The grouping of thousands of PFAS creates regulations that are too complex to comply with or to enforce and thus not reasonable, practical, or achievable. Targeted PFAS should be identified by its unique Chemical Abstract Service Registry Numbers (CASRN). CASRN are unique numerical identifiers assigned by the Chemical Abstracts Service (CAS) to every chemical substance described in the open scientific literature from 1957 through the present. At present, the EPA has compiled a list of over 12,000 PFAS.[5]

In today’s multi-tiered global supply chains, CASRN are the accepted nomenclature for identifying chemicals, and an essential accepted method of communication for chemical disclosure information. Without the CASRN to pinpoint the chemical in question, it would be difficult (if not impossible) to comply with any impending regulatory action.

Despite not providing the clarifying CASRN in the statute, however, in MN Section 21, Subsection 116.943, Subdivision 4(a) “Testing required and certificate of compliance” provides that the commissioner can “direct the manufacturer of the product to, within 30 days, provide the commissioner with testing results that demonstrate the amount of each of the PFAS, identified by its *chemical abstracts service registry number* [emphasis added], in the product…” This statement indicates that MPCA is aware of how difficult it would be to identify chemicals without its CASRN yet expects the regulated community to do so. AHRI requests that MPCA provide a list of targeted PFAS along with their associated CASRN.

Furthermore, it should be noted that currently there are no common methods of testing for PFAS in products.

D. “Intentionally added”

Under MN Section 21, Subsection 116.943, Subdivision 1(l), “‘Intentionally added’ means PFAS deliberately added during the manufacture of a product where the continued

[5] https://comptox.epa.gov/dashboard/chemical_lists/pfasmaster. (Last accessed on Feb. 13, 2024).

presence of PFAS are desired in the final product or one of the product's components to perform a specific function."

AHRI recommends that MPCA clarify to what level a substance is considered "intentionally added" and provide *de minimis* exemptions for articles containing less than 0.1% (by weight) of PFAS. (Please see "AHRI urges MPCA to Grant Certain Exemptions" below for more information pertaining to the *de minimis* concept.)

The intentionally added concept is separate from the concept of concentration in the product. A substance is intentionally added if it serves a technical function in the final product or component. Depending on how Minnesota determines concentrations, it is likely that having a *de minimis* threshold will not exempt many intentionally added PFAS, but rather will further exempt PFAS that are already considered unintentionally added.

E. <u>"Substantially Equivalent" and "Additional Time"</u>

MN Section 21, Subsection 116.943, Subdivision 3(a) states that "[t]he commissioner may waive all or part of the information requirement under subdivision 2 if the commissioner determines that substantially equivalent information is already publicly available" and 3(d) states that "[t]he commissioner may extend the deadline for submission by a manufacturer of the information required under subdivision 2 if the commissioner determines that more time is needed by the manufacturer to comply with the submission requirement." AHRI asks that MPCA provide clarification and guidance as to what will be considered "substantially equivalent" information and what criteria the commissioner will use to determine if "more time is needed."

F. <u>AHRI urges MPCA to Grant Certain Exemptions.</u>

In addition to an exemption to a ban on PFAS, the heating, cooling, water heating, and refrigeration equipment industry asks that policy makers provide additional relief through three additional exemptions. AHRI asks to receive *de minimis* exemptions for articles containing less than 0.1% (by weight) of PFAS, replacement parts exemptions, and large-scale manufacturing equipment exemptions.

a. <u>MPCA Must Grant *De Minimis* Exemptions</u>

Due to the complexities of the international, multi-tiered supply chain, determining a presence below the threshold of 0.1 % by weight is nearly impossible. Manufacturers must rely on the accuracy of reporting from every supplier throughout the entire supply chain on trace amounts of a chemical, even those that are present unintentionally. There is little, if any, evidence to suggest that the presence of trace amounts of a chemical in an article can contribute to *exposure*, which must be considered in any risk determination. Furthermore, there has been much scientific debate over whether it is actually possible to achieve 100% confidence in any formulation.

Lastly, and possibly most importantly, international and federal law has precedent for providing *de minimis* exemptions.[6] The *de minimis* exemption allows covered facilities to disregard certain minimal concentrations (0.1% or below) of chemicals in certain situations. Although this exemption is limited, it shows that the Agency understands the difficulties associated with tracking and managing chemicals below this threshold. Therefore, we urge MPCA to extend that relief to this application as well. We urge other regulatory bodies to follow this precedent. Not having a *de minimis* exemption puts an unreasonable burden on manufacturers and therefore, should be provided to allow permanent regulatory relief.

b. MPCA Must Grant Replacement Parts Exemptions

Another exemption the MPCA should provide relates to replacement parts. Many manufacturers are required to maintain replacement parts for years to ensure that consumers' products can continue to remain operational and meet warranty demands. It is not economically feasible for manufacturers to redesign and produce replacement parts years after they were originally made, because many of these parts are no longer being actively manufactured. So that companies can meet legal and consumer requirements, we request that MPCA provide a fifteen-year exemption for all replacement parts.

c. MPCA Must Grant Large-Scale Manufacturing Equipment Exemptions

MPCA should also exempt large-scale manufacturing equipment. This is equipment that exists at manufacturing facilities that does not enter into commerce, is often legacy equipment, and provides essential functions for which there is no known replacement. Existing equipment should not need to meet new compliance requirements. Accordingly, replacement parts for such equipment should also be exempted.

AHRI asks MPCA to consider these terms and ideas and to provide additional opportunities for stakeholders to work cooperatively with the agency to develop rulemakings that achieve goals to protect human health and the environment while protecting the jobs and the products that are essential to our society's well-being.

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available?" What is a "reasonable" cost threshold?

Response: Yes. The standards for reasonably available alternatives should consider both the *technical and economic* feasibility of alternatives. Here we examine the *economic* feasibility of alternatives; please see the "No Technically Feasible Safer Alternative to PFAS Is Reasonably

[6] 40 CFR §372.38(a), https://ofmpub.epa.gov/apex/guideme_ext/f?p=GUIDEME:GD-TITLE:::title:deminimis. (Last accessed on Feb. 13, 2024).

Available for the Entire HVACR-WH Category of Products" section for information on *technical* feasibility of alternatives.

A. Economic Considerations for *Finding* Feasible Alternatives

TSCA Section 6(g)(1) directs EPA to consider whether a "technically and economically feasible safer alternative is available." In addition to our comments above about the lack of a technically feasible alternative, we also wish to provide MPCA with information on economic feasibility, both in finding an alternative and implementing an alternative. Substantial costs would be incurred to conduct an adequate alternatives analysis. Such costs might include those for performance and reliability testing and additional information gathering to fill data gaps and ensure an informed decision. If no viable alternatives are readily identified, producers must invest in research and development of new chemistries, with subsequent process development and scaling up necessary to evaluate feasible options.

Estimates for conducting evaluations of alternative technologies range from the hundred-thousand-dollar range (with minimal new data acquisition) to several million dollars (if the evaluation requires extensive testing and acquisition of data). The US EPA, for example, is aware of the enormous expenses required to evaluate chemicals. The Agency's *initial* fee for a manufacturer-requested risk evaluation on a single chemical included requires a $1,250,000 up-front payment; full costs are undoubtedly much higher.[7]

Furthermore, if no viable alternatives are readily identified, the next likely step may be to invest in exploring entirely new technologies.

B. Economic Considerations for *Implementing* a Feasible Alternative

The expense imposed on companies – small and medium-sized enterprises as well as large, multinational corporations – affected by a ban on the use of PFAS would be substantial enough to disrupt the market and impact the national economy. Implementation costs include manufacturing infrastructure redesigns, inventory loss, new formulation acquisition costs, product redesign costs, and many other expenses—both foreseeable and unforeseeable.

Even simple chemical substitutions can be very expensive. A great example is the relatively "simple" substitution of a new chemical for methanol in windshield washer fluid in Finland. The ECHA Committee for Socioeconomic Analysis (SEAC) reported this cost as $4 million dollars.[8] More difficult substitutions, such as implementing a new

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[7] https://www.epa.gov/tsca-fees/tsca-fees-table. (Last accessed on Feb. 13, 2024).
[8] https://echa.europa.eu/documents/10162/cc415549-cac9-4784-97dc-2170d0bf8f25. (Last accessed on Feb. 13, 2024).

material or a new fluid across an HVACR product line, can quickly run into the tens of millions of dollars.[9]

Manufacturing facility redesign costs tend to be incredibly costly. Introducing a new chemical into the manufacturing process would result in "retooling" the manufacturing infrastructure as an unavoidable by-product of implementing new technology. These major changes require sufficient capital investment. Employees would need training.

Furthermore, disruptions in production schedules to engage in parts reformulation and conducting testing to meet safety standards would have adverse downstream impacts and possibly broader repercussions across related markets. This process could shut down businesses across our industry in the United States, making our nation more reliant on imports, which would consequently cause sharp cost increases for domestic manufacturers. That in turn could cause decimation of important manufacturing sectors of the nation, including public safety, food and agriculture, transportation, and national defense.

Due to the complex nature of the production process, product reformulations or facility redesigns can be extremely costly and can easily run in the tens of millions of dollars.

MPCA should also consider that costs would be passed on to the consumer or business owner. For instance, how costs could impact an average consumer to replace an HVAC system when typical prices range from $8,000 - 12,000. For a retail food store or restaurant business these costs could range from $40,000 – 150,000. For large, refrigerated warehouse storage facilities the cost easily be up to $1 million or more. For larger supermarkets, this will necessitate retrofits for each refrigeration rack, and each rip-out would require considerable investment – an estimated $1 million per rack – and result in significant downtime and store closures across the state.

3) Should unique considerations be made for small businesses with regards to economic feasibility?

<u>Response</u>: Yes. For all the points made in response to Question 2, small businesses face these same challenges.

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[9] For example, see costs for substituting another chemical for BPA in thermal paper as reported by the ECHA Committee for Socioeconomic Analysis (SEAC), https://echa.europa.eu/documents/10162/7f8d2988-fad4-4343-bef3-4518336db109. (Last accessed on Feb. 13, 2024).

4) What criteria should be used to determine the safety of potential PFAS alternatives?
<u>Response</u>: MPCA should use a scientifically sound, risk-based approach when making determinations of the safety of PFAS alternatives.

A. <u>Best Available Science</u>
Determinations should be based on sound science. Any regulatory action addressing PFAS should be based on sound, peer-reviewed science and a transparent and well-informed record. Agencies should identify sources of uncertainty and the research needed to reduce those uncertainties, and regulations should remain flexible to accommodate emerging science.

B. <u>Risk-Based Approach</u>
Determinations should apply a risk-based approach to consider both hazard and exposure. To best protect human health and the environment, a risk-based approach focuses limited agency resources on the highest priorities based on actual environmental, health, and safety risk of particular chemistries, not just the mere presence of a substance. Please see additional information about this in the "No Technically Feasible Safer Alternative to PFAS Is Available for the Entire HVACRHVACR-WH Category of Products" section.

5) How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided? Should significant changes in available information about alternatives trigger a re-evaluation?

<u>Response</u>: AHRI recommends that MPCA look for guidance on this question from the precedents set at the national and international levels. For example, recent EPA rulings have set a precedent for providing manufacturer exemptions to chemical bans that do not have a time limit (and other regulatory bodies should follow suit).[10] If MPCA determines that any exemptions granted must sunset, they should consider federal guidelines. For example, the EPA is required under TSCA Section 6(g)(3) that the period of exemption must be "reasonable."

The controlling federal statute provides additional clarification. TSCA Section 6(d) states that the Administrator shall, "specify mandatory compliance dates for the *start* [emphasis added] of ban or phase-out requirements under a rule under subsection (a), which shall be as soon as practicable, but not later than 5 years after the date of promulgation of the rule…" and furthermore states the Administrator shall "specify mandatory compliance dates for full implementation of ban or phase-out requirements under a rule under subsection (a), which shall be as soon as practicable; and provide for a *reasonable transition period* [emphasis added]." Therefore, EPA has the authority to provide five years for the start of any ban or required phase-out of any chemical, and further allow for a reasonable amount of time for manufacturers to

[10] 86 Fed. Reg. 894, January 6, 2021, "Phenol, Isopropylated Phosphate (3:1) (PIP 3:1); Regulation of Persistent, Bioaccumulative, and Toxic Chemicals Under TSCA Section 6(h)", https://www.regulations.gov/document/EPA-HQ-OPPT-2019-0080-0588. (Last accessed on Feb. 13, 2024).

transition to alternatives. Therefore, we expect MPCA to provide a similar number of years to allow manufacturers a reasonable time period for addressing this complex issue.

Further, there is global precedent for allowing reasonable phase-out periods for complying with chemical bans. The European Union's "RoHS Directive"[11] allows for several years for manufacturers to eliminate substances that are being restricted. For example, RoHS II Amendments under Directive 2015/863 provided for four to six years to implement restrictions and recently the European Commission stated in their RoHS Review report[12] that the current exemption time periods are too short, stating "[t]he evaluation found that the validity periods for time-limited exemptions and transition periods in case of expiry are too short for EEE, which requires long development, testing and validation time (e.g. for certain medical devices). Both periods are currently limited. Time-limited exemptions cannot exceed a seven-year validity period and where an exemption is revoked, a transition period of at least 12 months but no more than 18 months applies."

Moreover, European authorities routinely have granted "exemptions" to the RoHS thresholds for restricted substances in designated uses. The maximum time allowable under the RoHS Directive for such exemptions extends to seven years for certain categories of products. The European authorities recognize the complexities of the chemical management process and accordingly grant sufficient time for affected entities to implement change. Recently, EPA provided an additional 10 years for processing and distribution in commerce certain PIP (3:1) containing articles and PIP (3:1) used in manufacturing equipment and provided an exclusion for PIP (3:1) used in wire harnesses and circuit boards. MPCA should follow suit to provide sufficient time based on each particular substitution, which some manufacturers estimate could take up to 20 years. This time will allow manufacturers to determine the presence of PFAS throughout its supply chain and manufacturing processes, find a suitable alternative, and begin to implement the alternative. Alternatively, it is reasonable to suggest that MPCA should keep any CUU exemptions in place until a suitable alternative can be found and implemented, the complexities of which are explained below.

A. Determining the Presence of PFAS in the Supply Chain and in the Manufacturing Processes

The modern network between a company and its suppliers to produce and distribute a specific product consists of a global, nonlinear, multi-tiered supply chain. The system is vastly broad and complicated and includes levels starting with the raw materials supplier, moving on to a material formulator, to an article producer, to a component assembler, to an end producer, and to, finally, an original equipment manufacturer. And the network is not linear as portrayed in this simple example and is instead a complicated web of dealers, contractors, and sellers at any one tier in the chain. Further, suppliers can be found in any country throughout the world—often a product crosses many national borders several times before ultimately reaching a US consumer.

[11] Directive 2011/65/EU of The European Parliament and of The Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment. (Last accessed on Feb. 13, 2024).
[12] European Commission, "Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions," December 7, 2023.

To comply with a chemical regulation, AHRI members must first navigate the complexities of the international supply chain to determine the presence of a chemical in their supplier network. Next, they must determine the presence of a chemical in their manufacturing processes. Since MN controlling law does not provide a *de minimis* exemption, this process must be conducted for even trace amounts of a chemical, even for those that are not added intentionally. To do so, there must be reliance on the accuracy of reporting from every supplier throughout the entire supply chain. It can take months (if ever, due to confidential business information (CBI) claims), lack of resources and expertise, and other factors to get responses from suppliers deep within the supply chain.

Manufacturers must devote considerable effort and divert resources from other immediate activities to comply with an unnecessarily and artificially short regulatory timeframe. It is almost impossible to get internal approval to divert time and money towards this endeavor in advance of an actual ban. Businesses cannot proactively begin this process for hundreds or even thousands of chemicals that might someday be banned. And MPCA must recognize that although these comments focus on PFAS, manufacturers are also dealing with PFAS and non-PFAS regulations from international treaties to local ordinances. Small businesses are especially disadvantaged.

Further, a process must be developed to track and manage chemicals throughout the entire supply chain to ensure compliance beyond any regulations' effective date. AHRI is actively working with its members to support their development of materials management processes, and although some AHRI members have robust internal processes, many are still in development.

A conservative estimate is that the process of determining a single chemical's position in the supply chain and developing a tracing program to ensure continued compliance would take at least 24-36 months to achieve. Emerging regulations should allow manufacturers essential time to undertake proper review of their supply chains to adequately ensure compliance.

B. *Finding* a Technically and Economically Feasible Safer Alternative

Because currently there are no reasonably available, known-to-be-suitable, PFAS alternatives for the *entire* HVACR-WH category, manufacturers would need to identify an immediate substitution of alternate formulations for companies to maintain production. But finding a suitable chemical requires significant investment of time and resources, with no guarantee of success within a planned timeline.

To find an alternative chemical, a conservative estimate of time to complete a *preliminary* screen for possible alternatives to PFAS can take months to years, depending on the complexity of the product. A more in-depth alternative analysis including stakeholder surveys to collect additional information on safety, performance, availability, and economic feasibility could take many years.[13]

Based on our experience, an additional one to two years to conduct adequate performance testing is needed before manufacturers can commit to using a particular alternative. This step brings the entire process of finding a suitable alternative to a total timeline of two to three years, if not longer.

C. *Implementing* a Technically and Economically Feasible Safer Alternative

Once an alternative formulation has been identified, additional time is needed for implementation. A conservative estimate of the time needed to implement a *single* alternative to PFAS is three to five years. When products contain multiple PFAS, this timeline increases (especially if the substitution of many PFAS are happening concurrently), as different PFAS perform different functions in products. That is, an alternative for PFAS "A" may not function as an alternative for PFAS "B."

The process requires redesigning and testing new parts that contain PFAS alternatives for compliance with applicable standards – a resource-intensive and time-consuming process. Similar tests and evaluations likely would be needed to eliminate PFAS use in industrial machinery. Sufficient volumes of any alternative formulations would need to be made available in the market to meet demand. Given that PFAS are used in multiple heating, cooling, water heating, and refrigeration equipment industry applications, these activities would disrupt and delay production schedules.

Specific tasks required to phase out existing products and introduce alternatives typically include:

- Procurement of appropriate alternative components
- Compliance assessments
- Quality assessments and certifications
- Safety assessments and certifications
- Supplier coordination
- Manufacturing modifications
- Shipment, import, and distribution
- Replacing existing systems
- Retrofitting equipment
- Investing in new technologies
- Retraining and reskilling workers to adapt to the changes in technology for the manufacturing, installation, maintenance, and servicing of these critical heating and cooling systems

[13] For more information about the complexities of a chemical alternatives analysis, please see the California Department of Toxic Substances Control (DTSC) 302-page guide: https://dtsc.ca.gov/wp-content/uploads/sites/31/2016/01/AA-Guide-Version-1-0_June-2017.pdf. (Last accessed on Feb. 13, 2024).

D. Minnesota Should Create a Safe Harbor for Supplier Chemical Disclosure

Obtaining information from suppliers remains difficult. AHRI members continue to face difficulty in obtaining information on whether chemicals are contained in articles and the many components used in their products.

AHRI's Directory of Certified Product Performance lists over four million products with over nine million new products sold and installed annually in homes and businesses. Members continue parsing through tens of thousands of stock-keeping units (SKUs), each having hundreds of associated components and spare parts, to better understand whether their products will be affected by this regulation. Suppliers, especially small businesses, struggle to provide chemical data information to their OEM customers. Some suppliers will not disclose the chemical makeup of components as the composition due to CBI constraints.

AHRI and its members urge MPCA to consider these points and create an allowance for safe harbor provided best efforts are made to obtain this important information.

6) How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

Response: For harmonization and a lessened burden on the regulated community, MPCA should look to prevailing federal law for guidance. MPCA should use its authority to meet its legal obligations while still providing manufacturers with an ability to obtain compliance without undue encumbrance. For example, under TSCA Section 6(g)(1), EPA has authority to grant an exemption from a risk management rule if the Agency finds that:

> (A) the specific condition of use is a critical or essential use for which no technically and economically feasible safer alternative are available, taking into consideration hazard and exposure;
>
> (B) compliance with the requirement, as applied with respect to the specific condition of use, would significantly disrupt the national economy, national security, or critical infrastructure; or
>
> (C) the specific condition of use of the chemical substance or mixture, as compared to reasonably available alternatives, provides a substantial benefit to health, the environment, or public safety.[14]

When a member of the regulated community can successfully show these criteria are met, EPA has the obligation to use its authority under TSCA Section 6(g) to grant the exemption. We urge MPCA to adopt similar criteria.

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[14] US Toxic Substances Control Act, Section 6(g)(1).

7) In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

Response: AHRI members will likely request a CUU for the heating, ventilation, air conditioning, refrigeration, refrigerants, and water heating equipment (HVACR-WH) category of products, based on the intended use of these products, as well as the criticality for health, safety, and the functioning of society.

A. Brief Description of HVACR-WH Category Typical Product Lines:

"HVACR-WH" includes heating, ventilation, air conditioning, refrigerants, refrigeration, and water heating equipment and their components and parts including replacement parts, materials, and manufacturing and servicing needs. Here are brief descriptions of the types of products that generally comprise each associated product line within the HVACR-WH category. This list is meant to provide examples of product types and individual products and is not meant to be exhaustive (please see Appendix I for more information):

- "Heating"
  - Heating products generally include manufactured items such as: space heaters, room heaters, ventless room heaters, heat pumps, furnaces, boilers, heating elements, burners, boiler equipment and associated parts and accessories, anti-scaling agents, filters, venting, and their associated spare parts, and similar products. These examples are meant to be representative, not exhaustive, of heating products.
- "Ventilation"
  - Ventilation products generally include manufactured items such as: louvers dampers, energy recovery ventilators, air exchangers, air filters, air filtration equipment, residential and commercial air filters, air filter media in general (and their associated manufactured equipment), and similar products. These examples are meant to be representative, not exhaustive, of ventilation products.
- Air Conditioning and Heat Pumps"[15]
  - Air conditioning products generally include manufactured items such as residential, commercial, and industrial products which heat and cool air or fluids, air conditioning machines comprised of motor-driven fans and elements for changing the temperature and humidity (including those machines in which the humidity cannot be separately regulated), cooling towers and similar plants for direct cooling (without a separating wall) by means of recirculated water, evaporative air coolers, thermal energy storage tanks, and similar products. These examples are meant to be representative, not exhaustive, of air conditioning and heat pump products.

[15] https://www.hts-code.com/code/hts_result?code=8415, https://www.hts-code.com/code/hts_result?code=8418&submit=Search.

- "Refrigerants" [16,17,18]
    - Refrigerants products generally include manufactured items such as: single component refrigerants and blends, refrigerants and non-mechanical heat transfer fluids, items defined by ASHRAE34 and approved by the EPA Significant New Alternatives Policy (SNAP) Program used in air conditioning, heat pump, refrigeration or other refrigerant containing equipment, specific refrigerants (for example, R125, R134a, R143a, R227ea, R1234yf, R1234ze(E), and any R400 or R500 series blends containing one or more refrigerants with a fully fluorinated carbon atom), and similar products.. These examples are meant to be representative, not exhaustive, of refrigerants products.
- "Refrigeration Equipment" [19]
    - Refrigeration Equipment products generally include manufactured items such as freezers (commercial, residential, and laboratory/medical), refrigerators, warehouse refrigeration (large storage), coolers, walk-in coolers, walk-in freezers (restaurants, retail food stores), reach-in refrigeration, cold rooms, refrigerated vending machines and icemakers, heat transfer products (including evaporative open towers), and evaporative, adiabatic, and dry coolers and condensers, thermal energy storage units, evaporators and their controls, refrigeration racks, refrigerated cases and merchandizers, prep equipment, condensing units, air cooled condensers, unit coolers, self-contained refrigeration, ice machines, dispensing equipment, blast chillers, mobile/transport refrigeration, refrigeration racks (Low, Medium and High Temp), blast chillers, coolers, and freezers, self-contained cases and merchandizers and similar products. These examples are meant to be representative, not exhaustive, of refrigeration equipment products.
- "Air Conditioning and Refrigeration Equipment Components"
    - Refrigeration Equipment Components generally include manufactured items such as plastic wire insulation, plastic electrical components, contactors, relays, overloads, and molded parts such as fan guards, fans, blowers, compressors, thermal expansion valves, heat exchangers, motors, plastic wire insulation, plastic electrical components, contactors, relays, overloads, and molded parts such as fan guards, fans, and similar components. These examples are meant to be representative, not exhaustive, of air conditioning and refrigeration equipment components.
- "Water Heaters"
    - Water heating products generally include manufactured items such as residential, commercial and industry products which heat water for potable uses, residential and commercial water heating equipment that utilizes gas, oil, or electric (via electric resistance heating elements or a heat pump), storage water heaters, tankless water heaters, heat pump water heaters, and others. Water heater products utilize oil, gas, or electricity to heat potable water for use outside the heater upon

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[16] https://www.hts-code.com/code/hts_result?code=2903&submit=Search
[17] American Society of Heating, Refrigeration and Airconditioning Engineers 34, Designation and Safety Classification of Refrigerants.
[18] https://www.epa.gov/snap.
[19] https://www.hts-code.com/code/hts_result?code=8418&submit=Search.

demand, and similar products. These examples are meant to be representative, not exhaustive, of water heater products.

- "HVACR-WH Monitoring and Controls Equipment"
  - Water heating products generally include manufactured items such as residential, commercial and industry products which heat water for potable uses, residential thermostats, other controllers, leak detectors, and similar products. These examples are meant to be representative, not exhaustive, of HVACR-WH monitoring and controls equipment products.
- "HVACR-WH Parts"
  - Parts generally include manufactured items such as o-rings, gaskets, heat exchangers, cabinets gas burners, air filters, fluid filters, filter driers, compressors, thermal expansion valves, heat exchangers, fans/blowers, motors, and similar products. These examples are meant to be representative, not exhaustive, of HVACR-WH parts.
- "HVACR-WH Replacement Parts"
  - Although HVACR-WH Replacement Parts will generally mirror the list for HVACR-WH Parts, it is important to recognize replacement parts as a separate category as there are precedents at the federal level and other jurisdictions where chemical laws and regulations exempt replacement parts in recognition of the long life of complex durable goods and the need to continue to provide repair and service for products already sold.
  - Replacement Parts generally include manufactured items such as compressors and fans, electric motors, batteries, and parts thereof, original equipment manufacturer (OEM) parts including fans, motors, drive systems, heat exchangers, structural and non-structural framing and panels, compressor parts, filters, valves, seals, gaskets, compressors, thermal expansion valves, heat exchangers, fans and blowers, motors, and similar products. These examples are meant to be representative, not exhaustive, of HVACR-WH replacement parts.
- "HVACR-WH Servicing Needs"
  - Most existing systems use an HFC (or HCFC) refrigerant with equipment lifetimes of up to 25-30 years. This equipment must be serviced and maintained and there are currently no reasonably available alternatives.
  - HVACR Servicing Needs generally include manufactured items such as vacuum pumps, gage manifolds, refrigerant service cylinders, and similar products. These examples are meant to be representative, not exhaustive, of HVACR-WH servicing needs parts.
- "HVACR-WH Manufacturing Processes"
  - Manufacturing Processes generally include processes for equipment, components, parts, and materials such as brazing, soldering, and welding tools, equipment, and supplies; machining, cutting, and grinding tools and others. These examples are meant to be representative, not exhaustive, of HVACR-WH manufacturing processes parts.

B. Intended Use of HVACR-WH Category Products

The HVACR-WH Category products that are manufactured with and through the use of PFAS[20] provide substantial benefits to health and public safety. Heating, cooling, water heating, and refrigeration products serve and support nearly every major sector in the nation, providing life critical products and services for medical facilities and hospitals; government agencies; the US military; law enforcement, first responders, and public safety; food and medicine preservation; energy; public works and infrastructure support services; critical manufacturing; defense industrial base; and conservation. Often, the health, safety, and the functioning of society depends on AHRI member products for which alternatives are not reasonably available. Burdensome regulations could impair our sector's ability to meet these critical needs.

C. HVACR-WH Category Products' Essentialness for Health, Safety, and the Functioning of Society

Many PFAS are integrated into critical components in numerous residential and commercial heating, cooling, water heating, and refrigeration products and systems that contribute not just to provide comfort, but to ensure public health and safety. Other important services include cold chain procedures that ensure the systematic coordination of activities for ensuring essential temperature-control for food preservation and processing and for critical health and life sciences. Services dependent on refrigeration include everything from the prevention of dangerous food spoilage to life-giving medicines, vaccines, proteomics, therapeutics, blood plasma, and other temperature-dependent elements in the life sciences and pharmaceutical sectors. Collectively these constitute a vital part of the economy, at all levels, including for public safety.

"To ensure our economic prosperity and national security,"[21] President Biden's Executive Order 14017, "America's Supply Chains," recognized the need to strengthen and secure critical supply such as the HVACR-WH supply chain which has been recognized as essential. As noted earlier, the HVACR-WH industries provide critical lifesaving ventilation, climate control, and transportation and storage of food and medicines (including vaccines). The United Nations has also declared that access to cooling is a fundamental human right.[22]

Domestic and foreign manufacturing would be substantially disrupted by a ban on use of PFAS in manufacturing facilities, given the current lack of technically feasible alternatives for many applications. In 2018, PFAS materials and products generated $2.1

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[20] PFAS" as it is currently defined by the state of Minnesota: "'Perfluoroalkyl and polyfluoroalkyl substances' or 'PFAS' means a class of fluorinated organic chemicals containing at least one fully fluorinated carbon atom." MN Section 21, Subsection 116.943, Subdivision 1(p); under other, more targeted definitions, these same chemicals may not be considered PFAS.

[21] Amidst Rising Heat Waves, UN says cooling is a Human Right. https://thewire.in/environment/un-cooling-human-right-not-luxury

[22] Amidst Rising Heat Waves, UN says cooling is a Human Right. https://thewire.in/environment/un-cooling-human-right-not-luxury

billion in direct economic activity and supported 13,500 jobs indirectly.[23]

Because PFAS are used ubiquitously throughout the heating, cooling, water heating, and refrigeration equipment supply chain and in its manufacturing processes, and because currently there are no reasonably available, known-to-be-suitable, PFAS alternatives for the *entire* HVACR-WH category, a ban on all PFAS would substantially disrupt provision of these critical societal services as well as the industry's business sustainability and continuity.

As mentioned earlier, the heating, cooling, water heating, and refrigeration industry has a $211 billion impact on the nation's annual economy and in communities across the country, with more than 704,000 American jobs.

In conclusion, a ban on HVACR-WH Category PFAS products and uses would disrupt societal access to lifesaving cooling and heating as well as the entire heating, cooling, water heating, and refrigeration industry and therefore, the national economy at a time when our nation's manufacturers continue to struggle with other supply chain disruptions and economic hardships due to the recent pandemic and current inflation, as well as expending all available resources to respond to new and pending environmental and efficiency regulations. Now is the time for the government to initiate actions to support continued equitable access to heating and cooling and to support businesses and foster economic recovery, rather than impose additional regulation for which it would be impossible for companies to comply.

D. PFAS Are Essential to the Function of HVACR-WH Category Products

In the HVACR-WH Category products sector, common uses for PFAS include: electronics, computer chips, bearings, gaskets, air filters, grommets, washers, PTFE tape used on joints, O-rings, hoses, wiring, wiring insulation, sealant, foams, packaging, cloth, textiles, chrome plating, paints, pigments, coatings, and waxes, among many others (please see Appendix I for more information).

However, it should be noted that we are considering "PFAS" here as it is currently defined by the state of Minnesota: "'Perfluoroalkyl and polyfluoroalkyl substances' or 'PFAS' means a class of fluorinated organic chemicals containing at least one fully fluorinated carbon atom."[24] And under other, more targeted definitions, these same chemicals may not be considered PFAS. AHRI and its members do not support this definition and urge the state of Minnesota and MPCA to adopt a new definition that better reflects a PFAS family representative of high-risk chemicals (please see more information about prioritization in our "MPCA Should Adopt a Risk-Based Chemical Management Approach" section below).

Here are some specific examples of how products in the HVACR-WH category are essential for the well-being of society but this is meant to be illustrative and not

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[23] https://fluoropolymerpartnership.com/fluoropolymer-facts/socioeconomic-importance/.
[24] MN Section 21, Subsection 116.943, Subdivision 1(p).

exhaustive (please also see Appendix I for more information):

i. PTFE in Tape and Paste: This product is used for the proper assembly of pipe fittings. PFAS are used in the manufacture of these materials and trace amounts are potentially left in the products. There are currently no other products on the market that will properly seal pipe fittings The lack of availability of this product would lead to inadequately assembled hot water piping causing risk to the health and safety of the consumer due to increased scalding risk and damage to property from water leakage. These materials are considered Polymers of Low Concern (PLC's).[25]

ii. PTFE in Bearing Material in Compressors: Historically, compressor technologies applied bearings made of aluminum. In general, the performance was poor, leading to limited compressor lifetime and an inadequate ability to support large loads. Recently, bearing technology has evolved with the introduction of PTFE into their composition. Because there is no other technology available to replace PTFE at this time, manufacturers would be forced to return to an aluminum composition. Consequently, compressor lifetime would be reduced, creating a significative impact on sustainability. Additionally, the limited ability to support higher loads would create limitations within heat pumps to achieve desired temperatures, such as sanitary hot water or operation in very low ambient temperatures without a complementary electrical heater.

iii. Fluoropolymer Gaskets and O-rings (PTFE, FKM): These products are used to seal flange fitting and ensure leakless connections. PTFE, a fluoropolymer, and FKM, a fluoroelastomer, are used in the manufacture of these products. PFAS are used in the manufacture of these materials and trace amounts are potentially left in the products. Fluoropolymer gaskets are required to meet the high temperature and chemical resistant requirements of these products. There are currently no replacement products that can adequately meet the required specifications of these gaskets. Replacement with an unsuitable alternative would lead to similar concerns to health and safety as described above. These materials are considered Polymers of Low Concern (PLC's).[26]

iv. HFO Blowing Agent in Foam Insulation: Is used because it has the best performance/cost ratio. HFO is being used as a blowing agent in foam insulation for our industry as a replacement for cyclopentane. HFO can provide a 10 – 15% improvement in performance in K-factor thermal conductivity as compared to cyclopentane.[27] Alternatives would be vacuum insulation panels (VIP),

[25] "A Critical Review of the Application of Polymer of Low Concern and Regulatory Criteria to Fluoropolymers," Barbara J Henry, *et al.* Integrated Environmental Assessment and Management, Volume 14, Number 3, pp. 316–334, January 30, 2018.

[26] "A Critical Review of the Application of Polymer of Low Concern and Regulatory Criteria to Fluoropolymers," Barbara J Henry, *et al.* Integrated Environmental Assessment and Management, Volume 14, Number 3, pp. 316–334, January 30, 2018.

[27] https://pmt.honeywell.com/us/en/about-pmt/newsroom/featured-stories/the-blowing-agent-alternative-enabling-key-improvements-in-the-household-appliance-industry

cyclopentane blowing agent, or thicker insulation. VIP is very difficult to handle without damage and is ~ 2x+ cost. Cyclopentane is highly flammable (HFO is non-flammable) and less effective.[28] Additionally, current HFO equipment cannot support cyclopentane and would need to be retrofitted. Thicker insulation would affect the product fit in current locations for replacement.

Therefore, many complex, high-value products and services are provided from the use of select PFAS, which are essential to the manufacturing or installation processes and in incorporation into articles or products. Because PFAS molecules have unique properties, including very strong chemical bonds, they are employed in a myriad of applications. PFAS are used to make fluoropolymer coatings and products that resist heat, oil, stains, grease, and water. Fluoropolymers withstand high temperatures and resist interference from other substances, which increases reliability, prevents fires, and keeps consumer costs low.

The presence of PFAS in heating, cooling, water heating, and refrigeration product components ensures that the parts perform appropriately and contribute to product safety and reliability. Without some PFAS (or an effective alternative, yet to be identified), many products and processes would not function as intended and would experience a decrease in performance, safety, and longevity. Thus, simply eliminating PFAS from these uses is not an option for this sector.

E. No *Technically* Feasible Safer Alternative to PFAS Is Reasonably Available for the Entire HVACR-WH Category of Products[29]

Currently, there are no reasonably available, known-to-be-suitable, PFAS alternatives for the *entire* HVACR-WH category. Due to the unique characteristics of this class of chemicals, few other substances have been shown to meet the rigorous standards applicable to these applications.

Because PFAS molecules have unique properties, they are employed in a variety of applications. Some PFAS are used to make fluoropolymer coatings and products that resist heat, oil, stains, grease, and water.[30] Fluoropolymers withstand high temperatures and resist interference from other substances, which increases reliability, prevents fires, and keeps consumer costs low. In HVACR-WH equipment, substituting fluoropolymers with lower performing alternatives would result in products that are less safe, require more maintenance, have shorter service lives, and are less efficient.

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[28] https://pmt.honeywell.com/us/en/about-pmt/newsroom/featured-stories/the-blowing-agent-alternative-enabling-key-improvements-in-the-household-appliance-industry.

[29] AHRI acknowledges that there are a few potentially available alternatives for a small number of select products within the broad HVACR category that have been identified, however, the implementation and testing process could take years before the substitution could take place. Also, for the vast majority of products within the HVACR category, no alternatives have yet even been identified.

[30] https://www.cdc.gov/biomonitoring/PFAS_FactSheet.html. (Last accessed on Feb. 13, 2024).

Consideration should also be given to the technical standards that illustrate why fluoropolymers are critical in these HVACR-WH systems and components. Alternative materials are not reasonably available to simultaneously satisfy all required properties, such as low flammability, high service temperature, low dielectric constant, electric arc tracking resistance, mechanical strength and elasticity, and chemical resistance/inertness to even the most aggressive chemicals.

MPCA Should Adopt a Risk-Based Chemical Management Approach

Another point to consider here is that certain chemicals that fall within the scope of the broad structural definition used by Minnesota to define the term PFAS represent a low risk to human health and the environment. For example, most fluoropolymers that meet Minnesota's structural definition meet the Organization for Economic Cooperation and Development's criteria to be polymers of low concern which means that they are "deemed to have insignificant environmental and human health impacts."[31] Current research supports this:

> Per- and polyfluoroalkyl substances (PFAS) are a group of fluorinated substances that are in the focus of researchers and regulators due to widespread presence in the environment and biota, including humans, of perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA). Fluoropolymers, high molecular weight polymers, have unique properties that constitute a distinct class within the PFAS group. Fluoropolymers have thermal, chemical, photochemical, hydrolytic, oxidative, and biological stability. They have negligible residual monomer and oligomer content and low to no leachables. Fluoropolymers are practically insoluble in water and not subject to long-range transport. With a molecular weight well over 100 000 Da, fluoropolymers cannot cross the cell membrane. Fluoropolymers are not bioavailable or bioaccumulative, as evidenced by toxicology studies on polytetrafluoroethylene (PTFE)…[32]

AHRI and its members recommend that MPCA apply a *risk-based approach* to consider both hazard *and* exposure. To best protect human health and the environment, a risk-based approach focuses limited agency resources on the highest priorities based on actual environmental, health, and safety risk of particular chemistries, not just the mere presence of a substance.

The mandate to evaluate both hazard and exposure in any risk assessments is well established in the controlling federal statutory law. As outlined in 15 U.S.C. Section 2605

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[31] "A Critical Review of the Application of Polymer of Low Concern and Regulatory Criteria to Fluoropolymers," Barbara J Henry, et al. Integrated Environmental Assessment and Management, Volume 14, Number 3, pp. 316–334, January 30, 2018; "A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers," Stephen H. Korzeniowski, *et* al. Integrated Environmental Assessment and Management, Volume 19, Issue 2, pp. 326 – 354, June 9, 2022.

[32] "A Critical Review of the Application of Polymer of Low Concern and Regulatory Criteria to Fluoropolymers," Barbara J Henry, *et al.* Integrated Environmental Assessment and Management, Volume 14, Number 3, pp. 316–334, January 30, 2018.

(b)(1)(A), "The process to designate the priority of chemical substances shall include a consideration of the hazard *and exposure* potential of a chemical substance" (emphasis added). Similarly, 15 U.S.C. Section 2605 (b)(4)(D) states a requirement to "Integrate and assess available information on hazards *and exposures* for the conditions of use of the chemical substance" (emphasis added). The requirement is also stated repeatedly throughout the Lautenberg Chemical Safety Act because it is a logical way to approach complex chemical management. We urge MPCA to prioritize high-risk use and grant exemptions for low-risk uses such as those found in the HVACR-WH category.

Comparative Analysis of Substitutes

We urge MPCA to follow the Significant New Alternatives Policy (SNAP) program[33] process of a mandatory, comparative analysis of alternatives to ensure that no regrettable substitutes are deemed acceptable in replacing PFAS chemicals.

Under Section 612 of the Clean Air Act (CAA), SNAP program reviews substitute within a comparative risk framework examining overall risk to human health and the environment of both existing and new substitutes including toxicity, flammability, occupational and consumer health and safety, local air quality, and ecosystem effects. This careful analysis ensures that currently used chemicals, necessary for the efficacy of this equipment are not prohibited unless EPA has determined that there are other available substitutes that pose less overall risk to human health and the environment.

Fluorinated Refrigerants Are Not Persistent and Are Not a Concern to Human Health or the Environment.

A perfect example of low-risk PFAS can be seen in refrigerants. Fluorinated refrigerants do not present a hazard to human health or the environment. This is due both to their inherent properties and the way they are used. Unlike certain fluorinated substances, fluorinated refrigerants are not persistent in the environment. These refrigerants readily break down to a degradation product, trifluoroacetic acid (TFA), which has been shown to pose a low risk of toxicity to human health and the environment.[34] For instance, a study prepared for the Norwegian Environment Agency on fluorinated refrigerants concluded in 2017 that "the consensus amongst academic experts is that TFA will have a negligible effect on the environment."[35] In addition, unlike previous generations of refrigerants, fluorinated refrigerants have low global warming potential (GWP). Finally, due to the use of these refrigerants in closed loop systems, exposure to humans and the environment is low.

Another example can be found in various national legislations which place restrictions on where refrigerant alternatives can be installed. From that perspective, carbon dioxide, for example, may

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[33] EPA Significant New Alternatives Policy (SNAP) program https://www.epa.gov/snap

[34] UNEP EEAP, Environmental Effects of Stratospheric Ozone Depletion, UV Radiation, and Interactions with Climate Change: 2022 Assessment Report, 25 (March 2023) – "[Furthermore,] [t]rifluoroacetic acid has biological properties that differ significantly from the longer chain polyfluoroalkyl substances (PFAS) and inclusion of TFA in this larger group of chemicals for regulation would be inconsistent with the risk assessment of TFA."

[35] Norwegian Environment Agency, Study on Environmental and Health Effects of HFO Refrigerants (2017).

appear to be a good alternative to a fluorinated refrigerant, but carbon dioxide is not always a good alternative in terms of energy efficiency or safety. For larger stores using carbon dioxide for refrigeration applications, the overall energy efficiency can be good, but for small facilities where the need for heat recovery is small, the overall energy efficiency can be insignificant, and the carbon dioxide systems therefore burden the external environment more in the form of a greater need for purchased energy--thus also defeating Minnesota's additional efforts to become a climate leader in the future. Carbon dioxide systems must also operate at extremely high pressures often exceeding 2,000 psig which compared to traditional HVAC systems is ~ 5 times greater and thus requires special design considerations.

8) Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

Response: Yes. AHRI recommends that MPCA make a CUU determination for the HVACR-WH category of products, according to the information we provided in response to Question 7.

Conclusion

The decisions made during this formative period will set the precedent for years and perhaps decades to come. To ensure the smoothest path forward for all affected parties, we need to work together now.

MPCA should continue to engage the regulated community, by convening workshops, by providing comment opportunities (and with sufficient notice), by disseminating information, and by providing timely, regular updates. AHRI proposes that formal government-industry councils be established, similar to those found in other areas of government. This would provide an ongoing opportunity for regulators and regulated parties to confer as issues develop. Government and industry could work together to find reasonable, workable solutions to the challenge of balancing jobs and the economy while ensuring chemicals are managed appropriately for human health and the environment.

Thank you for allowing us to provide our information. Please feel free to contact us directly if you have questions or need additional information.

Sincerely,

Stacy Tatman, MS, JD
AHRI Senior Director, Regulatory Affairs
Email: statman@ahrinet.org

Product Type	GPC Code	HTS Code	Brief Description	Intended Use	Reason PFAS are Essential	PFAS Function	Alternatives	PFAS Used Name	PFAS Used CASRN
Adibatic and Evaporative Condensers			Used to control the boiler and zoning systems in a home to ensure comfortable heating.	Commercial and Industrial Heat Rejection	Safety and comfort of building occupants, Heat Rejection for industrial processes	Electrical insultaion, electronics, grease and lubricants, possibly in some plastics	No known alternative at this time		
Air Conditioners				Residential heating	Safety and comfort of building occupants	Used for electrical insulation in electronics	No known alternative at this time		
Air Conditioning and Heat Pumps		8415 8418	Air conditioning products generally include manufactured items such as residential, commercial and industry products which heat and cool air or fluids, air conditioning machines comprised of motor-driven fans and elements for changing the temperature and humidity (including those machines in which the humidity cannot be separately regulated)						
		8419	Cooling towers and similar plants for direct cooling (without a separating wall) by means of recirculated water						
		8940	Cooling towers and similar plants for direct cooling (without a separating wall) by means of recirculated water						
		847960	Evaporative air coolers						
		84186990	Thermal Energy Storage tanks						
Air Conditioning and Refrigeration Equipment Components			Refrigeration Equipment Components generally include manufactured items such as plastic wire insulation, plastic electrical components, contactors, relays, overloads, and molded parts such as fan guards, fans, blowers, compressors, thermal expansion valves, heat exchangers, motors, plastic wire insulation, plastic electrical components, contactors, relays, overloads, and molded parts such as fan guards, fans, and similar components.						
Air Conditioning Equipment	10004063		Product for heating and cooling		refrigerant, Sealing, insulation, low friction, electronic components		No	Flouropolymer	not known
Air Conditioning Equipment spare parts	10003984		Replacement Parts/accessories		Sealing, insulation, low friction, electronic components		No	Flouropolymer	not known
Air Handlers									
Air Purification Units									
Air Purifiers	10005336		Air Purifiers		Sealing, insulation, low friction, electronic components		No	Flouropolymer	not known
Air Terminals									
Boiler equipment and associated parts and accessories	10002658								
	10002654								
	10002649								
	10007005								

Product Type	GPC Code	HTS Code	Brief Description	Intended Use	Reason PFAS are Essential	PFAS Function	Alternatives	PFAS Used Name	PFAS Used CASRN
	10002660								
Boiler replacement part	10007005		Replacement part		Sealing, insulation, low friction		No	Flouropolymer	not known
Boiler replacement parts	10007005		Many boilers and water heaters use printed circuit boards (PCB) as an integral component for the product and can be replaced to keep a unit functional.	Residential heating	Safety and comfort of building occupants	Sealing, low friction, insulation, fire retardant	No known alternative at this time		
Boiler/furnace	10002658				Sealing, insulation, low friction		No	Flouropolymer	not known
Boilers									
Brass NPT adaptors	10002660		Adapters used as an accessory to make boiler installations easier and quicker.	Residential heating	Safety and comfort of building occupants	Sealing	No known alternative at this time		
Building Controls, Automation, and Accessories									
Chilled Beams									
Chillers									
CO Alarms and Monitors									
Commercial air conditioning and refrigeration				Leadwire Insulation				Polytetrafluoroethylene (PTFE) (Teflon)	9002-84-0
				Tubing in some special applications				Polytetrafluoroethylene (PTFE) (Teflon)	9002-84-1
				Leadwire Insulation on some Thermistors				Polytetrafluoroethylene (PTFE) (Teflon)	9002-84-2
				Leadwire Insulation				Fluorinated ethylene propylene (FEP)	25067-11-2
				Shrink Tubing in some special applications				Fluorinated ethylene propylene (FEP)	25067-11-2
				Tubing in some special applications				Fluorinated ethylene propylene (FEP)	25067-11-3
				Leadwire Insulation on some Thermistors				Fluorinated ethylene propylene (FEP)	25067-11-4
				Leadwire Insulation on some Thermistors				Poly(tetrafluoroethylene-co-perfluoro(propylvinyl ether))（PFA）	26655-00-5
				Leadwire Insulation on some Thermistors				Tetrafluoroethene（TFE）	116-14-3
				Leadwire Insulation on some Thermistors				Ethylene tetrafluoroethylene (ETFE)	25038-71-5
				Shrink Tubing on some Thermistors				Polyvinylidenefluoride (PVDF)	24937-79-9

Product Type	GPC Code	HTS Code	Brief Description	Intended Use	Reason PFAS are Essential	PFAS Function	Alternatives	PFAS Used Name	PFAS Used CASRN
Commercial Air-Cooled Condensers used with chillers									
Commercial Gas Boilers			A device that uses combustion to heat water that provides heating to a commercial building such as a resturant, office, school, or other establishment.	Commercial heating	Safety and comfort of building occupants	Sealing, low friction, insulation, fire retardant	No known alternative at this time		
Commercial Split Systems									
Commericial Oil Boilers			A device that uses combustion to heat water that provides heating to a commercial building such as a resturant, office, school, or other establishment.	Commercial heating	Safety and comfort of building occupants	Sealing, low friction, insulation, fire retardant	No known alternative at this time		
Compressors									
Cooling Towers (Open, Closed, Wet, Hybrid)				Commercial and Industrial Heat Rejection	Safety and comfort of building occupants, Heat Rejection for industrial processes	Electrical insultaion, electronics, grease and lubricants, possibly in some plastics	No known alternative at this time		
Dedicated Outdoor Air Systems									
Dehumidifiers									
Dry Coolers				Commercial and Industrial Heat Rejection in the absence of available water	Safety and comfort of building occupants, Heat Rejection for industrial processes	Electrical insultaion, electronics, grease and lubricants, possibly in some plastics	No known alternative at this time		
Ductless Systems									
Electric Instanatneous Water Heater	10005479		A tankless water heater uses a resistive heating element to heat domestic hot water for home usage such as sinks and showers.	Residential water heating	Safety and comfort of building occupants	Sealing, insulation	No known alternative at this time		
Electric Tank Water Heater	10002658		A tank product that used resistive heating elements to heat water for domestic usage such as sinks and showers.	Residential water heating	Safety and comfort of building occupants	Sealing, insulation	No known alternative at this time		
Evaporator Coils									
Fan Coils									
Furnace	10002658		Furnaces		Sealing, insulation, low friction, electronic components		No	Flouropolymer	not known
Furnace spare parts	10007005		Replacement Parts/accessories		Sealing, insulation, low friction, electronic components		No	Flouropolymer	not known
Gas Furnaces									
Geothermal Heat Pumps									
Heat Pumps									

Product Type	GPC Code	HTS Code	Brief Description	Intended Use	Reason PFAS are Essential	PFAS Function	Alternatives	PFAS Used Name	PFAS Used CASRN
Heating		8514 8416 8417	Heating products generally include manufactured items such as furnaces, boilers, heating elements, burners, and others.						
Heating Equipment Accessories	10002660		Water heaters have many components and parts that are often replaced including large components such as valves or motors and small components like sealants or o-rings.	Residential heating	Safety and comfort of building occupants	Sealing, low friction, insulation, fire retardant	No known alternative at this time		
Humidifiers									
HVACR-WH at large				Leadwire Insulation in special applications				Polytetrafluoroethylene (PTFE) (Teflon)	9002-84-0
				Shrink Tubing in some special applications				Polytetrafluoroethylene (PTFE) (Teflon)	9002-84-1
				Grease in some special bearings for special motor applications.				Perfluoropolyalkyl Ether (Krytox, Braycote 601EF)	60164-51-4
HVACR-WH Servicing Needs			HVACR Servicing Needs generally include manufactured items such as vacuum pumps, gage manifolds, refrigerant service cylinders, and others. Only 2% of retail stores comprise new installations, while the others are existing systems. Most existing systems use an HFC (or HCFC) refrigerant that have lifetimes of up to 25-30 years. This equipment must be serviced and maintained and there are currently no reasonably available alternatives.						
HVACR-WH Manufacturing Processes		8454-8468	Includes processes for equipment, components, parts, and materials such as Brazing, soldering, and welding tools, equipment, and supplies; machining, cutting, and grinding tools						
HVACR-WH Monitoring & Controls Equipment		8414	Parts generally include manufactured items such as compressors, thermal expansion valves, heat exchangers, fans/blowers, motors, and others.						
		4016	O-rings and gaskets						
		8415	Heat exchangers						
		8416	Cabinets gas burners						
		5911	Air filters						
		8421	Fluid filters/filter driers						
HVACR-WH Replacement Parts			Although HVACR-WH Replacement Parts will generally mirror the list for HVACR-WH Parts, it is important to recognize replacement parts as a separate category as there are precedents at the federal level and other jurisdictions where chemical laws and regulations exempt replacement parts in recognition of the long life of complex durable goods and the need to continue to provide repair and service for products already sold						
		8414	Compressors and fans						
		8501-8507	Electric motors, batteries, and parts thereof						

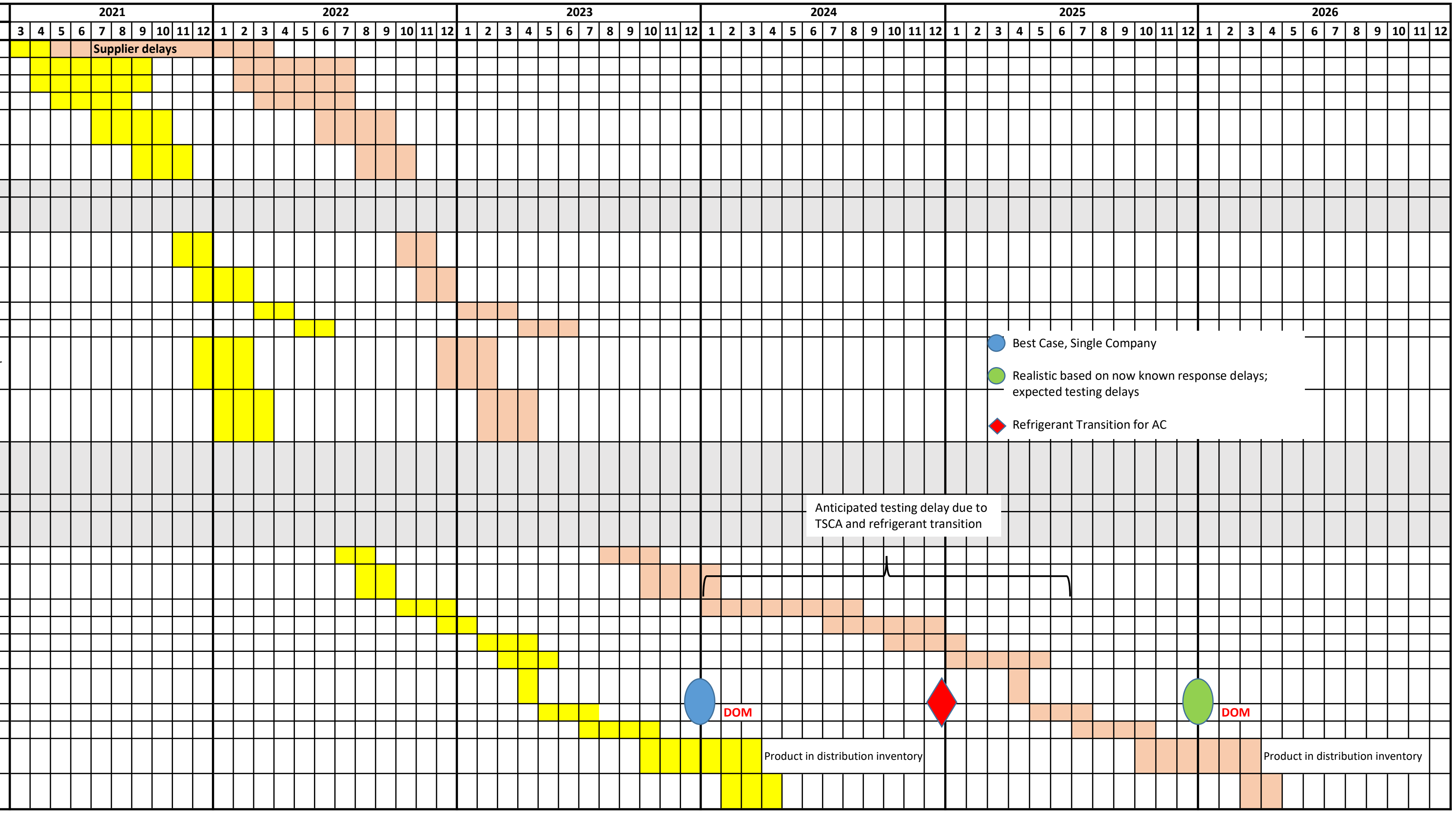
Product Type	GPC Code	HTS Code	Brief Description	Intended Use	Reason PFAS are Essential	PFAS Function	Alternatives	PFAS Used Name	PFAS Used CASRN
			Also, original equipment manufacturer (OEM) parts including fans, motors, drive systems, heat exchangers, structural and non-structural framing and panels, compressor parts, filters, valves, seals, gaskets, compressors, thermal expansion valves, heat exchangers, fans and blowers, motors, and others						
Hyrbid Electric Water Heater (heat pump)	10002658		A tank product that uses resistive heating elements and a heat pump with refrigerants to heat water for domestic usage such as sinks and showers.	Residential water heating	Safety and comfort of building occupants	Sealing, low friction, insulation, fire retardant	No known alternative at this time		
Indirect Hot Water Tanks	10002658		Hot water tanks that use a boiler as its heating source. The product uses a foam insulation and tank to store the hot water	Residential water heating and heating	Safety and comfort of building occupants	Sealing, insulation	No known alternative at this time		
Magnetic Filter	10002649		A filtration system used to maintain water in a boiler system. Without the filter, products are prone to a higher rate of corrosion and less efficient heating	Residential heating	Safety and comfort of building occupants	Sealing	No known alternative at this time		
Oil Furnace									
Packaged Outdoor Units									
Packaged Water-cooled Indoor Units and Heat Pumps									
Panel Radiators	10002654		A radiator that can be mounted to a wall that provides radiant heating in combination with a hydronic heating system such as a gas or oil boiler	Residential heating	Safety and comfort of building occupants	Sealing	No known alternative at this time		
Printed Electronic Control Board Spare Part	10007005		A refrigerant that is commonly used in hybrid electric water heaters	Residential water heating and heating	Safety and comfort of building occupants	Insulation, fire retardant	No known alternative at this time		
Refrigerantion Equipment		8418 8476	Refrigeration Equipment products generally include manufactured items such as freezers (commercial, residential, and laboratory/medical), refrigerators, warehouse refrigeration (large storage), coolers, walk-in coolers, walk-in freezers (restaurants, retail food stores), reach-in refrigeration, cold rooms, refrigerated vending machines and icemakers, heat transfer products (including evaporative open towers), and evaporative, adiabatic, and dry coolers and condensers, thermal energy storage units, evaporators and their controls, refrigeration racks, refrigerated cases and merchandizers, prep equipment, condensing units, air cooled condensers, unit coolers, self-contained refrigeration, ice machines, dispensing equipment, blast chillers, mobile/transport refrigeration, refrigeration racks (Low, Medium and High Temp), blast chillers, coolers, and freezers, self-contained cases and merchandizers and similar products.						
		2903	Single component refrigerants and blends						
		3827	Single component refrigerants and blends						
Refrigerants		2903	Refrigerants and non-mechanical heat transfer fluids[3]: Refrigerants products generally include manufactured items defined by ASHRAE[4] 34 and approved by the EPA Significant New Alternatives Policy (SNAP) Program[5], used in air conditioning, heat pump, refrigeration or other refrigerant containing equipment as defined above, Specific examples include: Refrigerants such as R448A, R449A, R404A, R410A, R454A, R454B, R454C, R455A, R1234ze, R1234yf, and others						

Product Type	GPC Code	HTS Code	Brief Description	Intended Use	Reason PFAS are Essential	PFAS Function	Alternatives	PFAS Used Name	PFAS Used CASRN
			Various fluorinated gases, including hydrofluorocarbons ("HFC"), hydrochlorofluoro-olefins ("HCFO"), hydrofluoroolefins ("HFO") refrigerants and their mixtures ("Blends").						
Replacement parts	10002660				Sealing, insulation, low friction		No	Flouropolymer	not known
Residential Oil Boilers	10002658		A device that uses combustion to heat water that provides heating (often the only source) to the home	Residential heating	Safety and comfort of building occupants	Sealing, low friction, insulation, fire retardant	No known alternative at this time		
Residential Gas Boilers	10002658		A device that uses combustion to heat water that provides heating (often the only source) to the home	Residential heating	Safety and comfort of building occupants	Sealing, low friction, insulation, fire retardant	No known alternative at this time		
Residential Gas Instantaneous Water Heater	10005479		A tankless water heater uses combustion to heat domestic hot water for home usage such as sinks and showers.	Residential water heating	Safety and comfort of building occupants	Sealing, low friction, insulation, fire retardant	No known alternative at this time		
Thermal Energy Storage Equipment				Commercial and Industrial thermal energy storage for energy efficiency or load balancing	Safety and comfort of building occupants, requred for heat rejection in industrial processes	Electrical insultaion, electronics, possibly in some plastics	No known alternative at this time		
Thermostats	10004002		Device for controlling air conditioning equipment		Sealing, insulation, low friction, electronic components		No	Flouropolymer	not known
Thermostats and Outdoor Reset Accessory for Boilers	10004002		Replacement and accesory parts for water heaters and boilers such as pressure relief valves, manifolds, spare parts for plumbing, etc.	Residential heating	Safety and comfort of building occupants	insulation, fire retardant	No known alternative at this time		
Transport Refrigeration									
UV Lights									
Variable Refrigerant Flow Units (VRF)									
Ventilation		8414 8481	Ventilation products generally include manufactured items such as louvers dampers, energy recovery ventilators, air exchangers, and others						
Ventilators									
Venting Kit	10002660		Kit used for concentric venting that includes sealant to ensure a safe path for flue gas.	Residential water heating and heating	Safety and comfort of building occupants	Sealing	No known alternative at this time		
Water heaters	10002658 10005479		Water heating products generally include manufactured items such as residential and commercial water heating equipment that utilizes gas, oil, or electric (via electric resistance heating elements or a heat pump) which heat water for potable uses.						

Product Type	GPC Code	HTS Code	Brief Description	Intended Use	Reason PFAS are Essential	PFAS Function	Alternatives	PFAS Used Name	PFAS Used CASRN
Water heater replacement parts	10007005		Boilers have many components and parts that are often replaced including large components such as valves or motors and small components like sealants or o-rings.	Residential water heating	Safety and comfort of building occupants	Sealing, low friction, insulation, fire retardant	No known alternative at this time		

APPENDIX II

	Process	Comment
1	Identify Current Use	Identify all places where chemical is used
2	Identify Alternatives	Need to identify potenial alternative chemicals
3	Source	Source appropriate supplier(s)
4	Formulation	Formulation chemical
5	Chemical Testing	Testing of chemical (flammability, flexibility, corrosion resistance, etc.)
6	Results analysis	Chemical company, parts supplier and OEM review and adjust as needed
7	Formula Adjustment	reformulate / adjust chemicals
8	Retesting	Testing of chemical (flammability, flexibility, corrosion resistance, etc.) as needed
9	Results analysis	Chemical company, parts supplier and OEM review and adjust as needed
10	Test Parts Development	Manunfacture initial sample parts for testing - confirmation of compound will work
11	Testing	Testing of initial samples
12	Analysis	Review results and feedback for adjustment
13	Chemical manufacturing	Chemical company needs to manufacture enough chemical and depending on company, may be doing so for many customers
14	Drawing Updates	OEM needs to update applicable drawings, possible new models numbers, part numbers, etc to control invnetory
15	Modify manufacturing process	As needed, manufacturing processes, tools, etc may need to be changed or new tooling made to allow use of new alternate chemical
16	Tooling Trial	Initial trial for use of new tool; analyze results
17	Modify/improve tooling as needed	If changes needed tool needs to be retested
18	Retrial/test	Retest and analyze results
19	Sample Parts	Receive sample parts off tooling or other more final samples
20	Parts testing	Testing of parts
21	Product Testing	Install and test in product
22	Parts safety approval	Perform applicable safety approval for parts
23	Product safety approval	Perform applicable safety approval for products
24	Order parts for mass production	Order after approvals
25	Produce products	OEM manufacturing and shipping lead time
26	Ship to distribution	OEM's ship from factories to warehouses, inventory
27	Distribution ship to customers	Ship from OEM warehouse to distributor warehouse
28	Customers sell to end users	Distributor inventory and sells to contractor for install



Andrea Murphy Attachment RECEIVED
By: OAH on 3/1/2024

Panasonic

Panasonic Corporation of North America

Two Riverfront Plaza
Newark, NJ 07102-5490
www.panasonic.com

March 1, 2024

Laura Kessler, Commissioner
Minnesota Pollution Control Agency
520 Lafayette Rd. N.
St. Paul, MN 55155-4194

RE: Request for Comments; PFAS in Products Currently Unavoidable Use Rule; Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837; OAH Docket No. 71-9003-39667

Dear Commissioner Kessler:

Panasonic Corporation of North America (Panasonic) appreciates the opportunity to submit proposals seeking currently unavoidable use (CUU) determinations for our various product categories, including appropriate uses of PFAS in electronics and is fully supportive of the intent behind MN HF 2310 to protect the residents of the State of Minnesota from PFAS exposure. Panasonic is a comprehensive electronics manufacturer involved in development, production, sales, and service activities in a broad array of business areas, such as components for home and commercial electronic equipment, as well as equipment in telecommunications, industrial, automotive, aviation, and housing, and more. Panasonic has operated under its business philosophy, "contributing to the progress and development of society and the well-being of people worldwide through its business". We continue to work diligently to create new values and challenge ourselves to remove present and future barriers, by facing head-on global environmental and social issues.

Over many years Panasonic has voluntarily reduced the hazardous chemicals in the products we manufacture. PFAS, however, are a broad class of chemicals and are embedded in many internal components of electronics, thus being more challenging to identify and replace. PFAS commonly used in electronics has a variety of properties including the ability to resist high temperatures, inert chemical resistance, water, and oil repellency for protection against moisture and corrosion, low coefficient of friction, low dielectric constant and its manufacturability, compressibility, flexibility, high stress crack resistance and flame retardant. PFAS is found in semiconductors, wires and cables, printed circuit boards, etc. Namely, a tiny amount of PFAS is used in internal, mechanical components. PFAS in electronics is not likely exposed to humans, unlike food packaging, floss, or water repellent clothing, nor to the environment, due to proper management of electronics product end-of-life implemented in this country.

Specific knowledge of the presence of PFAS in many products is still under review, given that requirements to track and report its use are relatively new. This makes completing the State's questions regarding CUU quite challenging in the limited timeframe provided. We are still surveying our suppliers (tens of thousands) for the presence of PFAS in the materials, components, and subparts they provide for incorporation into our final products. Without adequate time to complete a full investigation of the use of PFAS, and if restrictions or bans of PFAS-containing-products, without derogations or scope exemptions, there will inevitably be massive, negative nationwide impacts as companies are forced to reassess where they sell or manufacture key products, such as batteries. Therefore, Panasonic respectfully requests the State to consider the following:

- Allow adequate time for a thoughtful and thorough review of current uses of PFAS.
- Rely on national standards and requirements set by the U.S. Environmental Protection Agency (EPA) to avoid a national patchwork of requirements for essential products.
- All CUU of PFAS for the best possible protection of health and safety and the functioning of society.

Specific products that Panasonic is requesting a CUU for include batteries, industrial components (e.g., consumer, business-to-business, automotive, and aviation), and refrigerants.

Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Yes. Panasonic requests that the State aligns with the EPA and other U.S. states, such as the State of Maine, for the CUU. In 2021, the State of Maine became the first state to enact a comprehensive PFAS ban. The Maine Department of Environmental Protection (Maine DEP) is currently undergoing rulemaking around CUU. In their submission requirements, the Maine DEP requested how PFAS is essential for health, safety, or functioning of society. By establishing this definition, manufacturers and suppliers can provide real world examples of how PFAS is essential to human health and the environment. Some specific uses of PFASs would be considered essential because they provide vital functions as established by federal law and are currently without established alternatives.

Maine defines "Essential for Health, Safety or the Functioning of Society,"

> Means products or product components that if unavailable would result in a significant increase in negative healthcare outcomes, an inability to mitigate significant risks to human health or the environment, or *significantly interrupt the daily functions on which society relies*. Products or product components that are

> Essential for Health, Safety or the Functioning of Society include those that are required by federal or state laws and regulations. Essential for the Functioning of Society includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, and construction. (Emphasis added.)

Many of the products Panasonic manufactures are included in this definition. For example, our batteries are used to power medical devices and smoke detectors, which save lives, electric vehicles, which are needed to meet the nation's carbon reduction goals, and night vision goggles, which enhance our nation's security. It would be impossible to list every product with a justification of its use. Therefore, we request that the State of Minnesota allows industry to determine more broad ranges of product categories that are deemed essential for health, safety, or the functioning of society, such as batteries.

Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Yes. Potential PFAS prohibition requirements will result in additional costs to manufacturers, sellers, and distributors of priority consumer products containing PFAS in Minnesota. Thus, costs will increase for consumers. At this time, there are no feasible alternatives for many PFAS uses, therefore a cost threshold cannot be determined.

What criteria should be used to determine the safety of potential PFAS alternatives?

Panasonic recommends taking a risk-based evaluation approach to determine the safety of alternatives. First, let us note that many uses of PFAS are in internal components, not accessible to human touch or ingestion, and, due to end-of-life practices, are not likely to leach into the environment. Therefore, the risk of PFAS to human health and the environment may be negligible, for example, from use in the electronic components and parts or in batteries. The first step in the risk-based approach should be to determine if there is a hazard associated with the use of PFAS in the product category. If that is determined to be significant, then alternatives need to be evaluated for their ability to perform to all safety and use tests and have no adverse effects equal to or worse than the PFAS it is replacing. This approach would follow the Safer Products program designed by the State of Washington Department of Ecology, in which priority chemical classes are first selected, followed by identifying which consumer products contain these chemicals and may harm people and the environment. The Department then determines what regulatory action is taken for each priority chemical class and provides a list of feasible alternatives to all stakeholders. The process for determining alternatives will depend on the product and product use, and may take years, through various testing requirements.

Panasonic recommends that the State should defer to the U.S. Environmental Protection Agency, which currently has a reporting requirement for PFAS and then will determine risk-based restrictions.

How long should PFAS CUU determinations be good for? How should the length of the CUU determination be decided? Should significant changes in available information about alternatives trigger a re-evaluation?

We acknowledge that new information may arise after appropriate research and development is conducted on risks and alternatives. Panasonic suggests a minimum of 10 years before re-evaluation to adequately assess the situation.

To get a sense of what type of and how many products may seek a CUU determination, please share what uses and products you may submit a request for in the future and briefly why. MPCA notes that there will be a future opportunity to present a full argument and supporting information for a possible CUU determination.

Specific products for which Panasonic will likely request a CUU include batteries, industrial components (e.g., consumer, business-to-business, automotive, and aviation), and refrigerants. This includes the components of already prohibited uses, such as ball bearings in massage chairs, which are classified as upholstered furniture.

How should stakeholders request to have a PFAS use considered for CUU determination by MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

As a global manufacturer, we request harmonization with other nations, the U.S. Environmental Protection Agency, and other states that already implemented similar regulations before Minnesota. We cannot manufacture products specifically for sale in a specific state; and any state-specific prohibitions will simply result ceasing sales into Minnesota.

Under the State of Maine's CUU rulemaking, the following information is requested:

1. Provide a brief description of the type of product including, if applicable, the Global Product Classification (GPC) brick category and code, or if GPC is not applicable than the Harmonized Tariff System (HTS) code.
2. Describe the intended use of the product and explain how it is essential for health, safety or the functioning of society.

3. Describe how the specific use of PFAS in the product is essential to the function of the product. If this use of PFAS is required by federal or state law or regulation, provide citations to that requirement.
4. Describe whether there are alternatives for this specific use of PFAS which are reasonably available.

Should MPCA make some initial CUU determinations as part of this rulemaking using the proposed criteria?

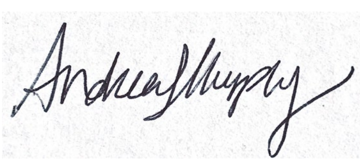
Yes. Many uses of PFAS are CUU. Panasonic would appreciate a determination is made quickly so that our company can focus efforts on surveying our vast supply chains and researching and finding alternatives for uses that have a direct impact on human health or the environment.

Other questions or comments relating to defining CUU criteria and the process MPCA uses to make CUU determinations.

As a global company, Panasonic manufactures and sells products around the world and recommend global alignment with other agencies, such as the European Union, the U.S. EPA, and other U.S. states. It is virtually impossible for a company of our size to manufacture products to individual State standards while maintaining prices that do not negatively impact consumers, affect overall employment, or disrupt the current functioning of society. We are supportive of the risk-based approach that the U.S. EPA is taking regarding PFAS, and alignment with their approach is more feasible.

Thank you for your consideration of these points. If you have further questions or need clarification, my contact information is listed below.

Sincerely,



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RECEIVED
By: OAH on 3/1/2024
Paula Maccabee Attachment

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March 1, 2024

Via Email and OAH portal

Commissioner Katrina Kessler (katrina.kessler@state.mn.us)
Maya Gilchrist (Maya.Gilchrist@state.mn.us)
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, Minnesota 55155-4194

RE: Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS)
OAH Docket No. 71-9003-39667

Dear Commissioner Kessler, Ms. Gilchrist,

WaterLegacy appreciates the opportunity to comment on the above matter, described by the Minnesota Pollution Control Agency (MPCA) as the "PFAS in Products Currently Unavoidable Use Rule." Our comments do not address the full scope of concerns that could be raised regarding PFAS. They highlight the areas with which WaterLegacy is most familiar as a result of our work the past fifteen years and track the sections of the statute to which they correspond. WaterLegacy then provides brief answers to the nine questions in MPCA's December 8, 2023 notice of a comment opportunity. In order to protect water quality and human health, WaterLegacy requests that:

A) MPCA's rulemaking requiring disclosure and prohibition of the use of PFAS must include drilling and mining activities that may use processes and products containing PFAS.

B) MPCA's PFAS rulemaking must require transparency, limit "unavoidable use" exemptions, and fully cover industrial products and applications, including mining.

C) MPCA's PFAS rulemaking must focus on protecting public health from long-term impacts of PFAS not protecting private short-term economic interests.

A. PFAS Rulemaking Must Include Drilling and Mining Processes and Products.

Exploratory drilling for minerals, use of tunnel boring machines, use of surfactants to enhance metal recovery in the ore floatation process, ore leaching, acid mist suppression, use of wetting agents, and use of fluoropolymer in pipes, cables, hoses and conveyor belts are just some of the ways in which the mining industry can introduce PFAS to surface water and groundwater.

(Barfoot *et al*. 2022).[1] Specifically, PFAS may be used in mining for "ore floating" using their property of low surface tension to "[c]reate stable aqueous foams to separate the metal salts from soil." (Gluge *et al*. 2020).[2] PFAS may also be present at mining sites in uses that are ancillary to the mining operation, such as fire suppression and firefighting activities, cleaning of metal surfaces, and use as a foaming agent in drilling fluids, coatings and lubricants. PFAS may end up in effluent or tailings ponds through use in processing as well as in AFFF. *Id*.

Although there have been few efforts to monitor mines as potential sources of PFAS to the environment and little disclosure by the industry, BHP's Mount Whaleback Iron Ore Mine in Western Australia was recently identified as the source of PFAS impacts to groundwater with the potential to threaten a nearby drinking water supply. (Barfoot *et al*., 2022). The Western Australia (WA) Department of Water and Environment Regulation declared the Mount Whaleback mine a dangerous "contaminated site" and ordered BHP to clean it up. (Hunt, 2021).[3] In discussing this finding of PFAS a fire protection company director has cautioned, "There would definitely be residual legacy contamination on a lot of sites, because under WA law all firefighting suppression systems need to be tested annually. . . This means PFAS is being sprayed on the ground, so it makes sense there's ground contamination." *Id*.

Drilling and the use of tunnel boring machines pose risks to health and the environment to the degree that they inject PFAS into groundwater. The media platform for drilling professionals noted that the PFAS contaminant "is found in many of the products, materials and equipment commonly used in the drilling industry." (Rasmussen, 2019).[4] Drilling professionals were advised to review the Manufacturer Safety Data Sheet to ensure that materials used in the field—including PVC casing and sleeve, tubing, grout, bentonite, fuels, oils, and grease—do not contain PFAS substances including the "most commonly found and best studied PFAS" perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS). *Id*.

Chemical formulations for products used in tunnel boring are not publicly available on industry websites. Without specifying the chemical parameters, one company's website promotes the

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[1] Barfoot, K. *et al*., PFAS and the Mining Industry: Understanding the Challenges, Proceedings of Mine Water Solutions 2022, June 14-16, 2022, Vancouver, Canada, Exhibit 1, available at https://www.mineconferences.com/bluepixeldesign/wp-content/uploads/2022/07/47.-Krista-Barfoot-PFAS-and-the-Mining-Industry-Understanding-the-Challenges-Final.pdf.

[2] Gluge, J., *et al*., An overview of the uses of per- and polyfluoroalkyl substances, *Environ. Sci. Processes Impacts*, 2020, 22, 2345, Exhibit 2, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7784712/

[3] Hunt, P. (July 2, 2021), PFAS a toxic problem in "wild west" mining industry, *Australia's Mining Monthly*, Exhibit 3, https://www.miningmonthly.com/life-cycle-end-of-life-management/news/1413112/pfas-toxic-problem-in-%E2%80%98wild-west%E2%80%99-mining-industry

[4] Rasmussen, S. (July 22, 2019), PFAS Adds Complexities to Environmental Drilling Jobs, *The Driller*, Exhibit 4, https://www.thedriller.com/articles/91558-pfas-adds-complexities-to-environmental-drilling-jobs

following: "Specific products and lubricants for rock tunnel boring machines: sealants, protection pastes for the main bearing, greases, hydraulic fluids, ground treatments and additives for backfill grouting" including "tail seal greases, main-bearing sealing paste, main-bearing greases, fire-resistant fluids for tunnel boring, foaming agents for rock tunnel boring, grouting additives."[5] Another company's website for tunnel boring fire suppression claims that its product is an alternative to "PFAS based systems that are starting to face regulatory pressure."[6]

Both websites highlight the need for products to which PFAS have frequently been intentionally added. One explains the need for foaming agents to control dust, stating "because of a much higher rotation speed of the cutting head and much drier spoil than earth pressure tunnel boring machines (EPB), create dust. Dust accumulation on the flanks of the disc cutters is a source of wear for the tools: disc cutters, grippers, cutters, etc. . . . Further, it makes the atmosphere on the tunnel boring machine difficult to breathe."[7] The second underscores the need for fire suppression products if a tunnel boring machine is used:

> A fire in a TBM is a catastrophic event to be avoided at all costs. First and foremost, any fire in a tunnel is deadly. . . Then there is the machine itself. As referenced above, TBMs carry an incredible price tag. . . The fire risk on a TBM is real. They are virtually a self-contained city of high-voltage systems that operate an array of mechanisms that cut and support the tunnel . . . The undeniable fire hazard must be recognized and addressed.[8]

The toxic impacts of PFAS in oil and gas drilling and extraction have been analyzed and documented.[9] However, other than the BHP Mount Whaleback Iron Ore Mine in Western Australia, WaterLegacy could find no example of groundwater monitoring proximate to metallic mining to determine PFAS levels. The use of PFAS in exploratory drilling, tunnel boring, mining processes, or mining products is rarely disclosed. MPCA's March 2022 PFAS Monitoring Plan did not discuss the need to monitor exploratory drilling or mining facility sites.[10]

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[5] Condat Corp., Rock tunnel boring machines, https://www.condatcorp.com/domaine/tunnels-underground-works/rock-tunnel-boring-machines/ last visited Feb. 29, 2024.

[6] StatX, Aerosol Fire Suppression, https://www.statx.com/application/tunneling-equipment/ last visited Feb. 9, 2024.

[7] Condat Corp., Foaming agents for rock tunnel boring, https://www.condatcorp.com/produit/sealant-foam-lubricant-tunnel-boring/foaming-agents-rock-tunnel-boring/ last visited Feb. 29, 2024.

[8] StatX, *supra*.

[9] *See e.g.,* Physicians for Social Responsibility, Fracking with "Forever Chemicals" in Texas, February 2023, https://psr.org/wp-content/uploads/2023/02/fracking-with-forever-chemicals-in-texas.pdf.

[10] MPCA, PFAS Monitoring Plan, March 2022, https://www.pca.state.mn.us/sites/default/files/p-gen1-22b.pdf. However, Cliffs Erie LLC – Hoyt Lakes is listed as a solid waste management

Given Minnesota's existing taconite mines, extensive exploratory drilling efforts underway for nonferrous metals, and numerous proposals for metallic mining, it is critical that MPCA's upcoming "currently unavoidable use" rules for products containing PFAS mindfully and rigorously address drilling and mining products and processes. Many of the suggested rule clarifications and definitions discussed below arise from this concern.

B. MPCA's PFAS Rulemaking Must Require Transparency, Limit "Unavoidable Use" Exemptions, and Address Drilling, Mining and Other Industrial Uses of Products.

MPCA has previously requested comments tracking the provisions of Minn. Stat. § 116.943. WaterLegacy's comments in this section follow the structure of the statute.

1. ***Definitions in Minn. Stat. § 116.943, subd. 1 should be clarified to ensure that the concept of "currently unavoidable use" is appropriately narrow and the scope of products where the PFAS statute applies is broad enough to include mining and other industrial uses.***

    a. Clarification of "currently unavoidable use" in Minn. Stat. § 116.943. Subd. 1(j) is necessary to prevent exceptions from swallowing the rule.

    - In order to avoid indefinite exemptions and remove any incentive to develop safer alternatives, the rule should state that "Currently unavoidable use" means "a specific use of PFAS that the commissioner has determined by rule under this section to be essential for health, safety, or the functioning of society and for which alternatives are not reasonably available within a specified period of time."

    - Any determination that a specific use is currently unavoidable should sunset at the end of the time during which the commissioner has determined that an alternative is not reasonably available. This avoids the need for the commissioner to continually review and update exemptions.

    - The rule should state that there is a rebuttable presumption that use of PFAS is avoidable and that the manufacturer or user bears the burden of proof to demonstrate both that the proposed use is essential and that alternatives are not reasonably available. This clarity will reduce the burden on the agency and reflects the legislative intent.

    - The rule should state that "economic considerations alone" cannot be used to determine that alternatives are not reasonably available. This is consistent with principles and policies in Minnesota's environmental laws.

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facility at which PFAS monitoring may be implemented. MPCA, Facilities included in the PFAS Monitoring Plan, August 2022, https://www.pca.state.mn.us/sites/default/files/p-gen1-22c.pdf.

b. Clarifications of "intentionally added" in Subd. 1(l) and the term "manufacturer" in Subd. 1(n) are necessary to avoid creating a loophole for industrial users that blend, mix or modify products.

- "Intentionally added" should include "blending, mixing, or modifying" as well as the "manufacture" of a product to avoid creating a loophole where an industrial user could blend, mix, or modify a drilling fluid, lubricant, or other product so that it contains PFAS without a disclosure or unavoidable use requirement.

- "Manufacturer" for purposes of this rule should mean the person that creates or produces a product or a person that blends, mixes, or modifies a product so that it intentionally contains PFAS.

c. Clarification of the term "industrial use" in the definition of "product" in subd. 1(q) is necessary to ensure that various mining uses are covered.

- Where the rule refers to the statutory definition including "product components, sold or distributed for personal, residential, commercial, or industrial use," the rule should further clarify that "industrial use" for purposes of this section includes "all components of mining, including drilling, tunnel boring, construction, mining, processing, containment, storage, or disposal of wastes."

- There may be other uses such in construction or transportation that should also be explicitly identified in the definition of "product."

2. ***Terms in Minn. Stat. § 116.943, subd. 2 should be clarified to avoid placing an undue burden of proof on an agency to prove intent or knowledge and to emphasize disclosure.***

a. The rules should clarify that disclosure of PFAS cannot be evaded by claiming lack of intent or knowledge. Disclosure should be required for Subd. 2 "to the extent that such information is known to or reasonably ascertainable by that person." This is the standard that U.S. Environmental Protection Agency has applied for years in its Toxic Substances Control Act Chemical Data Reporting Rule and recently extended its use to the agency's PFAS reporting rule. *See e.g.*, 40 C.F.R. § 711.15; 88 Fed. Reg. 70516. This creates a reasonable person standard rather than requiring the agency to prove specific knowledge or intention and would make implementation more effective.

b. Clarification is needed to ensure that products containing PFAS used for commercial or industrial purposes are not excluded because there is no sale per se in Minnesota. Products may be sold to a national or even international corporation that will foreseeably use the product in Minnesota. To avoid a potential loophole, the rules should clarify that Subd. 2(a), (c), and (d) apply to "a manufacturer of a product sold, offered for sale, or distributed in such a manner so that its use in the state is known or reasonably foreseeable that contains intentionally added PFAS."

c. The rule should clarify that Subd. 2(b) has a limited scope so that with the approval of the commissioner, a manufacturer may supply the information required in paragraph (a) for a category or type of product rather than for each individual product "only if such a limited disclosure is sufficient to inform consumers, commercial users, industrial users and the public of the purpose for and amount of PFAS in a specific product or application."

d. In addition to clarification of statutory language, the MPCA should emphasize public health and welfare in reporting as follows:

- MPCA should require reporting on all products that contain PFAS in the interest of public health and welfare. If manufacturers wish to protect their formulas for products, they should use safer alternatives to PFAS.

- MPCA should make publicly available and readily accessible at no charge information disclosed under Subd. 2 disclosing the purpose and amount of each PFAS.

- When it is known or reasonably ascertainable that a product contains other toxic chemicals that may have synergistic adverse health effects with PFAS, their purpose and amount should also be disclosed in the interest of public health and welfare.

3. ***Terms in Minn. Stat. § 116.943, subd. 3 should be clarified in rule to restrict the commissioner's ability to provide waivers for disclosure.***

a. The rule should clarify the concept in Subd. 3(a) to specify the findings and disclosures that the commissioner must make in order to grant a waiver so that the exception does not overwhelm the rule. For Subd. 3(a)(i) the rule should clarify: "The commissioner may only waive all or part of the information requirement under subdivision 2 if the commissioner determines that substantially equivalent information is already publicly available, describes how it is substantially equivalent, and specifies where and how that information is readily accessible to the public."

b. The rule should also ensure that Subd. 3(a)(ii) is not the loophole that swallows the rule, as follows: "The commissioner may only grant a waiver under this paragraph to a manufacturer or a group of manufacturers for multiple products or a product category if the commissioner has determined for each manufacturer and product that it meets the requirements in sub-paragraph (i)."

c. WaterLegacy lacks experience with the agricultural statutes cited in Subd. 3(b). However, it seems that the language of the second sentence requires clarification to have a substantive meaning. Text with a more definite meaning would read: "For information that is regulated under chapters 18B and 18C, the commissioner and the commissioner of agriculture ~~must jointly determine whether to~~ will make the information publicly available ~~based on~~ unless such disclosure is clearly prohibited under applicable statutes."

4. ***Prohibitions in Minn. Stat. § 116.943, Subd. 5 are the heart of the recently enacted legislation and require clarification and emphasis in MPCA's rulemaking*.**

   a. MPCA rules implementing Subd. 5(b) should refer back to the definitions provided in WaterLegacy's comments on Subd. 1(l) and (q) above so as to include "products" for "industrial use" including all components of mining in the description of prohibited uses.

   b. The rules implementing Subd. 5(b) should refer back to the scope of covered products provided in WaterLegacy's comments on Subd. 2(a)–(d) above so that products containing PFAS sold or distributed so that their use in Minnesota is known or reasonably foreseeable will be addressed.

   c. Prohibitions of use of products with PFAS implementing Subd. 5 should be drafted to ensure compliance with Minnesota's groundwater rules. The rules should contain a provision specifically stating that discharge, injection, or introduction of a product containing intentionally added PFAS into the saturated or unsaturated zone of groundwater is prohibited. Minn. R. 7060.0600, subp. 1 and subp, 2.[11]

C. MPCA's PFAS Rulemaking Must Focus on Protecting Public Health from Long-Term Impacts of PFAS, Not Protecting Private Short-Term Economic Interests.

WaterLegacy appreciates the opportunity to comment at this early stage of the MPCA's development of the "PFAS in Products Currently Unavoidable Use" Rule. However, we are concerned that the nine questions asked in the MPCA's December 8, 2023 notice seem biased in favor of weakening prohibitions on PFAS. Below, please find WaterLegacy's brief responses to these questions.

1. *Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?*

It is not recommended that MPCA define criteria for "essential for health, safety, or the functioning of society." The word "essential" has a plain dictionary meaning. Rulemaking to set

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[11] *See In re Denial of Contested Case Hearing Requests and Issuance of NPDES/SDS Permit No. MN0071013 for the Proposed NorthMet Project*, 993 N.W.2d 627, 663 (Minn. 2023) ("under subpart 2, pollution cannot be discharged to the unsaturated zone in a way that may result in pollution to the underground waters.")

criterial for what is "essential" is likely to undermine the legislative purpose, which is to prohibit PFAS products in the state, not to find ways to allow their continued use.

2. *Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?*

Costs of alternatives should not be considered in the definition, other than to say that economic considerations alone should not determine that an alternative is not reasonably available. The statute does not use the term "cost" except in the context of fees to cover agency expenses.

3. *Should unique considerations be made for small businesses with regards to economic feasibility?*

Unique considerations should not be made for small businesses. Nothing in the statute suggests that MPCA would be authorized to apply such considerations.

4. *What criteria should be used to determine the safety of potential PFAS alternatives?*

MPCA should rely on independent scientific evidence of safety or reduced harm of potential PFAS alternatives and should recognize that standards developed either in the (often political) regulatory process or through industry-sponsored research are likely to be insufficient to determine safety. It is recommended that safety be determined by an independent scientific advisory team working with the Minnesota Department of Health. Such a process should remove the determination of the safety of potential alternatives from the conflict-driven question of whether a "currently unavoidable use" of PFAS should be allowed.

5. *How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?*

The applicant for a currently unavoidable use determination should bear the burden of proving the length of time for which the determination should apply. The rules should also state a maximum length that no determination can exceed. After it sunsets, any further "currently unavoidable use" determination should require a new application.

6. *How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?*

Producers or users seeking a "currently unavoidable use" exception from the PFAS prohibition should be required to make an application to MPCA, subject to notice, comment, and judicial review. That application should require the applicant to demonstrate that the particular use is essential to health, safety, or the functioning of society and that no other ways to accomplish that use without PFAS are reasonably available. A financially interested party (for example, a manufacturer of a competing product that does not contain PFAS) and members of the public should be able to apply for an "avoidable use" category determination. Such a category determination could be based on information that products or processes not containing PFAS are reasonably available to accomplish an essential use or that a particular category of products or processes containing PFAS is not an essential use. Such a determination would not sunset.

7. *In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.*

This question does not apply to WaterLegacy.

8. *Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?*

MPCA should not make any "currently unavoidable use" determinations except through a specific application process. Minn. Stat. § 116.943 gave the MPCA clear authority to expand the categories of products with PFAS that are *prohibited*, but provided no comparable authority for MPCA to search out and prove exceptions to the statute.

9. *Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.*

It is recommended that MPCA prioritize determining and prohibiting categories of products containing PFAS that are *not* essential to health, safety, or the functioning of society and those for which there *are* reasonably available safer alternatives without intentionally added PFAS. This approach and the requirement that industries prove any "currently unavoidable use" exceptions would provide clarity and protect health and the environment as the statute intended.

WaterLegacy requests that MPCA take this PFAS rulemaking opportunity to protect public health and clean water and to increase public transparency regarding products containing chemicals with serious health effects. We also request that MPCA work with the Minnesota Department of Health and the Minnesota Department of Natural Resources to monitor both exploratory drilling and legacy mining sites for PFAS and to ensure that environmental review and proposals for permitting require evaluation and avoidance of the discharge or injection of PFAS into groundwater.

Sincerely yours,

Paula G. Maccabee

Paula G. Maccabee
WaterLegacy Advocacy Director and Counsel

Exhibits 1-4 Attached

WaterLegacy Comments March 1, 2024
OAH Docket No. 71-9003-39667

Minnesota Pollution Control Agency (MPCA)
Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing PFAS

EXHIBIT 1

Barfoot, K. *et al*., PFAS and the Mining Industry: Understanding the Challenges, Proceedings of Mine Water Solutions (2022)

https://www.mineconferences.com/bluepixeldesign/wp-content/uploads/2022/07/47.-Krista-Barfoot-PFAS-and-the-Mining-Industry-Understanding-the-Challenges-Final.pdf

PFAS and the Mining Industry: Understanding the Challenges

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Abstract

Per- and poly-fluorinated alkyl substances (PFAS) are a group of more than 3,000 man-made chemicals including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). This emerging class of contaminants has been the centre of litigation settlements already worth billions of dollars across various US states. Ubiquitous at very low levels in the environment, PFAS have been measured in water supplies across the US. While the focus on PFAS to date has centred around manufacturing facilities and commonly known aqueous film forming foam (AFFF) release sites (airports and military bases), international governments have been starting to consider other types of PFAS impacts associated with a broad range of industries.

Although mining has not yet become a key focus area for concerns related to PFAS impacts, mines are beginning to be identified as sources of PFAS. For example, BHP's Mount Whaleback Iron Ore Mine in Western Australia was recently identified as the source of low level PFAS impacts to groundwater. These impacts have the potential to threaten a nearby drinking water supply, prompting BHP to evaluate PFAS use across its site. The use of PFAS within the mining industry has been long established, including use within industrial processes (e.g., use as surfactants to enhance metal recovery, within the ore flotation process, etc.), as well as use of AFFF for firefighting activities. Consequently, environmental releases of PFAS from mining facilities could occur and require consideration and management.

This paper will provide an overview of the challenges associated with PFAS in the environment, and the implications these challenges may have for the mining industry. It will review PFAS use within the mining industry, site characterization challenges, potentially relevant receptors and exposure pathways, and remedial options, as well as the status of PFAS regulation internationally.

Introduction

Per- and poly-fluorinated alkyl substances (PFAS) are a group of more than 3,000 man-made chemicals including perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS). This emerging class of contaminants has been the centre of litigation settlements worth over $5.5 billion across the US. Ubiquitous at very low levels in the environment, PFAS have been measured in water supplies across the US. A variety of adverse health effects have been associated with PFAS exposure, including liver damage, decreased fertility, thyroid disease, cancer, decreased immunity, and more.

Mines are beginning to be identified as potential sources of PFAS release to the environment. The use of PFAS within the mining industry has been long established, including use within industrial processes (e.g., use as surfactants to enhance metal recovery, within the ore flotation process, etc.), as well as use of aqueous film forming foam (AFFF) for firefighting activities. Consequently, environmental releases of PFAS from mining facilities could occur and require consideration and management. As such, this paper will review PFAS use within the mining industry, site characterization challenges, potentially relevant exposure pathways for receptors, and remedial options, as well as the status of PFAS regulation.

PFAS Use within the Mining Industry

As outlined in Gluge et al. (2020), 1400 individual PFAS substances have been identified for more than 200 uses in 64 different categories, including the mining industry. PFAS substances are widely used due to the many properties that make them invaluable to industry, including:

- the ability to lower the aqueous surface tension
- high hydrophobicity
- high oleophobicity
- high non-flammability
- capacity to dissolve gases
- high stability
- extremely low reactivity
- high dielectric breakdown strength
- good heat conductivity
- low refractive index
- low dielectric constant
- ability to generate strong acids
- operation at a wide temperature range
- low volatility in vacuum
- impenetrability to radiation

In mining, PFAS uses include ore leaching in copper and gold mines, ore floating, separation of uranium from ore/minerals, concentration of vanadium compounds, acid mist supressing agent, wetting agents, hydrocarbon foaming agent, and the use of fluoropolymer in pipes, cables, hoses and conveyor belts (Gluge et al. 2020, Wood 2021).

PFAS may also be present at mining sites for uses that are ancillary to the mining operation, such as PFAS-containing AFFF for fire suppression/firefighting activities, cleaning of metal surfaces, and use as a foaming agent in drilling fluids, paints and coatings, and so on. In the case of AFFF, fire suppression systems often need to be tested annually, and traditionally this has involved discharge of AFFF to the ground surface. As noted by Hunt (2020), mining sites typically have fixed fire suppression/fighting systems that can spray suppressants for long distances from a fixed location, meaning impacts can be widespread.

Site Characterization Challenges

The characterization of PFAS at any Site, including mining sites, should consider PFAS fate and transport in the environment, requirements for adjusted field procedures during sample collection, and implementation of appropriate laboratory quality assurance and quality control (QA/QC) processes.

PFAS Fate and Transport

Fate and transport of PFAS in the environment can be highly variable, given PFAS include many compounds with different physical-chemical characteristics that control their behaviour (ITRC 2021a). Carbon-fluorine chain length, functional group, charge and degree of fluorination all influence PFAS behaviour. When PFAS are discharged or spilled to ground surface, the PFAS can adsorb to soil through either hydrophobic or electrostatic interactions and remain close to the source area. PFAS can also show enhanced retention within the vadose zone, given the tendency of PFAS to accumulate at the air-water interface. Alternately, the charged functional group and associated hydrophilic properties can lead to PFAS leaching into groundwater and mobilizing with groundwater flow. Generally, the degree to which PFAS adsorb to solids or mobilize can be approximated by the chain length; longer carbon-fluorine chains tend to adsorb more strongly to solids versus shorter carbon-fluorine chains. Given the high stability of PFAS, once present in groundwater, large plumes can form that remain present for long periods of time. Transformation of commonly assessed PFAS, such as PFOA and PFOS, under typical environmental conditions is limited; however, PFAS precursors or polyfluorinated compounds may transform into more stable PFAS. Uptake of PFAS by plants and animals has been observed, with some PFAS showing bioaccumulation and biomagnification potential. Site-specific considerations cannot be omitted from assessment planning, as they do impact the fate and transport of PFAS, similar to other contaminants (ITRC 2021a).

PFAS can be found in other media, such as surface water, sediment and air (ITRC 2021a). Similar mechanisms as discussed for soil and groundwater dictate how PFAS behave in these media as well, including solid-liquid partitioning, and transformation or uptake. Given the surfactant-like properties of many PFAS and accumulation at the air-water interface, PFAS have been observed to form a foam at the top of surface water bodies when present at high concentrations. Many PFAS have low vapour pressures that limit movement of PFAS from water to air; however, there are some PFAS, such as fluorotelomer alcohols (FTOHs), that show greater volatility. Atmospheric transportation of PFAS can occur through release of volatile PFAS or PFAS adsorbed to air-borne particulate matter (ITRC 2021a).

Field Sampling Procedures and QA/QC

Although standard environmental sampling best practices should be followed, field sampling programs that include PFAS have additional considerations. PFAS are found in many commercial products, which include some of the equipment and supplies typically used to collect environmental samples, creating the potential for sample contamination. Other materials (such as glass) may adsorb PFAS, which would low-bias the collected data. Both cases should be avoided, and this can be facilitated through review of available reference documents regarding PFAS sampling, which notably include the Michigan Department of Environmental Quality (MDEC) *General PFAS Sampling Guidance* (MDEC 2018) and the Interstate Technology Regulatory Council's (ITRC's) *Sampling Precautions and Laboratory Analytical Methods for Per- and Polyfluoroalkyl Substances (PFAS)* (ITRC 2020).

Precautions outlined in MDEC (2018) and ITRC (2020) include avoiding certain clothing, materials, food packaging, and personal hygiene products that may contain PFAS when sampling. Sampling equipment and supplies should not contain Teflon, polytetrafluoroethylene (PTFE), fluorinated ethylene propylene (FEP), ethylene tetrafluoroethylene (ETFE), LDPE, polyvinylidene fluoride (PVDF), fluoropolymers or anything with "fluoro" in the name. Other materials that should be avoided during sampling include Decon-90, post-it notes, waterproof field paper or books, "blue ice" and any type of cooler pack, waterproof markers, sharpies, permanent markers, binders, spiral/ hard cover notebooks, plastic clipboards, adhesive paper products, food packaging and containers and adhesive tapes. Acceptable materials to use during sampling include materials made from high density polyethylene (HDPE), polypropylene or silicone, decontamination solutions like Alconox/ Liquinox, and field supplies that include loose plain paper, metal clipboards, ball point pens, and ice formed by water.

When executing a PFAS sampling program, PFAS sampling materials should be stored separately from sampling supplies for other parameters. Non-disposable field equipment should be decontaminated between each sample location and prior to use at a site where PFAS is being assessed. Sample collection should begin at the location where impacts are least expected (i.e., lowest anticipated PFAS concentrations) and move towards locations where impacts are most expected (i.e., highest anticipated PFAS concentrations). Eating or drinking on site during sampling should be avoided to minimize the potential for cross-contamination. Hands should be washed prior to returning to the site following any breaks.

In order to confirm that field procedures have been effective in inhibiting sample contamination, field QA/QC blank samples should be obtained, including equipment blanks, trip blanks and field blanks. Equipment blanks are collected using laboratory-provided PFAS-free water that is passed through or over equipment used for sampling activities to assess whether the equipment represents a potential source of PFAS to the sample. Field blanks are PFAS-free water samples that are collected in separate laboratory-provided sample containers while conducting sampling in the field to monitor that field activities are not a potential source of PFAS to the sample. Trip blanks are PFAS-free water samples prepared by the laboratory that are transported during the sampling procedure to monitor that PFAS have not been introduced to the samples through laboratory preparation or transportation. The combination of these field QA/QC blank samples will provide confidence that the collected PFAS data are representative of site conditions.

Laboratory QA/QC

Choosing a certified laboratory to complete PFAS analysis is important to maintaining the accuracy and reliability of the data. The laboratory should provide appropriate containers to collect samples (i.e., unlined and made of polypropylene or HDPE); glass containers and certain plastic bags should be avoided, wherever possible. If high PFAS concentration samples are to be submitted for analysis, these samples should be segregated during sampling and shipment, and flagged to the laboratory to support appropriate preparation for analysis. It is noted that there are only a few multi-laboratory validated and published methods for analysis of PFAS, and those released to date have generally been developed for analysis of water samples (drinking water, groundwater, surface water and wastewater). Draft laboratory methods are available for other media, such as soil, sediment, biosolids and tissue; however, these have not been validated by multiple laboratories (ITRC 2021b). Following PFAS analysis, it is important to review the laboratory certificates of analysis to confirm the reported laboratory QA/QC procedures, such as method blanks, spiked blanks and analysis of duplicates, and compare the results to the provided evaluation criteria. This review of laboratory QA/QC may help indicate whether sample matrix interference or laboratory issues could have impacted the reliability of the reported PFAS concentrations.

Relevant Exposure Pathways

Human and ecological receptors can be exposed to PFAS through various pathways both at a mining site, as well as off-site, due to fate and transport mechanisms (e.g., groundwater migration, wind erosion, deposition). The routes of exposure and the receptors exposed, particularly off-site, can be influenced by the physical location of the mining site. Figure 1 illustrates a potential mining site, the surrounding land use, and the potential routes of exposure and receptors (as indicated by the numbers [#], and explained in the text below). The main expected source of PFAS is the use of AFFF (#1). PFAS may also end up in effluent or tailings ponds through use in processing (#2). These waters are unlikely to be treated for PFAS.

Human Health

The most likely potential exposure routes to PFAS for people at a mining site (e.g., workers) are incidental ingestion of soil (#3), potable water ingestion (should the mining site rely on groundwater or nearby surface water as source water) (#4), and, to a lesser extent, direct contact with PFAS-containing products (e.g., AFFF) (#1) and inhalation of PFAS in dust and air (#5). According to ITRC (2021c), exposure via potable water is generally the dominant exposure pathway in comparison to other pathways (e.g., from food), even if PFAS concentrations in the drinking water source are low. If there is an on-site accessible surface water feature, there may also be exposure via incidental ingestion of sediment and surface water (#2).

Figure 1: Potential mining site and surrounding land use (numbers described in text).

Similar routes of exposure to PFAS would also be present for people living near the mining site, including mining workers living in off-site camps, as well as other residential communities, including Indigenous communities. The dominant exposure pathway of concern off-site would still be ingestion of PFAS-impacted potable water (i.e., groundwater or surface water) (#6); however, other routes of exposure could include direct contact with PFAS-impacted soil (due to off-site migration of soil particulates via wind or mining emissions and deposition onto soils) (#7), consumption of food exposed to PFAS through watering (e.g., livestock) (#8), soil up-take or irrigation (e.g., crops) (#9), exposure to PFAS-impacted surface water and sediment (e.g., incidental ingestion of surface water/sediment, ingestion of aquatic biota) (#10), and, to a lesser extent, inhalation of PFAS in dust and in air (#11).

Ecological Health

The routes of exposure for ecological receptors would be similar both at the mining site and off-site. Plants and soil invertebrates could be exposed to PFAS in soil (#12), although exposure off-site may be limited as impacts would only be transmitted via off-site migration of PFAS through wind (e.g., soil particulate) or mining emissions, followed by deposition onto soils. Aquatic biota could be exposed to PFAS in both surface water and sediment in on-site surface features, if present, and from PFAS migration in mining site groundwater to off-site surface water features (#10). Terrestrial and aquatic mammals and birds could be exposed via impacted surface water (e.g., consumption) (#10) and via food (e.g., plants, invertebrates, mammals, birds and aquatic biota) (#10, 12, 13); however, exposure on-site for mammals and birds may be limited if measures are in place that limit their access to the mining site itself (e.g., fencing).

Remedial Options

Remediation depends on the use of treatment technologies that can exploit a contaminant's chemical and physical properties for the purpose of removing or destroying the contaminant from environmental media. PFAS are a challenge to remediate because they are typically found in the environment as mixtures composed of different PFAS with potentially very different properties. The solubility, surfactant properties, stability, and poor adsorption characteristics of different PFAS tend to complicate remediation, as common technologies are ineffective (e.g., air stripping, soil vapor extraction, biostimulation or bioaugmentation) or have limited effectiveness (e.g., chemical oxidation). There are very few field-demonstrated, cost-effective treatment technologies for PFAS on solids or in water; however, there are proven ex situ technologies that could be applicable to the situations typically encountered at a mining site and these will be reviewed here. ITRC (2021d) provides an excellent summary of other emerging technologies currently under development.

Mines typically use local groundwater for drinking water and historical PFAS use may contaminate the drinking water supply to levels above recommended drinking water criteria. Beyond use of AFFF, treatment of process water at most mining sites largely does not address PFAS, meaning PFAS can be discharged to the environment in treated process water and impact drinking water supplies. As the primary concern at mining sites is drinking water, this review will focus primarily on water treatment technologies.

To date, readily available technologies for drinking water treatment have been limited to sorption and ion exchange, whereas treatment of leachates and process waters has included foam fractionation and coagulation (ITRC 2021d), depending on the composition of the solution. When considering remedial options for mining sites, it is important to note these sites are typically remote and operate under harsh environmental conditions, where power generation can be costly. Consequently, transport of PFAS-impacted treatment media off-site is expensive, sensitive specialized equipment has poor longevity, and onsite disposal of highly soluble and potentially mobile contaminants like PFAS is not practical.

Sorption and Ion Exchange

Sorption and ion exchange are two removal technologies that bind PFAS using Van der Waals and/or weak ionic forces, resulting in the accumulation of PFAS on the sorptive media. Granular activated carbon (GAC) and ion exchange resins (IX) are the most common sorptive media available used for PFAS adsorption. Various types of GAC have been tested with most PFAS and manufacturers having developed models to predict mass loading under a variety of solution conditions. Most testing has focussed on the efficacy of

GAC sorption of long-chain PFAS (Appleman et al. 2013; Ochoa-Herrera and Sierra-Alvarez 2008) and has demonstrated that GAC treatment can achieve effluent concentrations below detection limits for United States Environmental Protection Agency (USEPA) Method 537.1 (Shoemaker and Tettenhorst 2018). Although also effective with other organic contaminants such as petroleum hydrocarbons and chlorinated solvents, co-contaminants can displace PFAS from GAC, reducing treatment. Sorption efficiency is dependent on carbon chain length of the PFAS and the ionic functional group, with shorter chain PFAS and carboxylic acids having lower sorption efficiencies than longer chain and sulfonic acid types (e.g., PFOS adsorbs more effectively than PFOA [McCleaf et al. 2017] and both adsorb more effectively than perfluorobutanesulfonate [PFBS] or perfluorobutanoate [PFBA] [Appleman et al. 2013]).

GAC can be regenerated through solvent (methanol) extraction and the material reused for non-drinking water applications. The solvent extracted PFAS can be distilled to remove the solvent and the concentrated PFAS can be treated through incineration in a kiln at temperatures >1,000° Centigrade (°C).

Ion exchange has been shown to effectively sorb and treat a broad suite of PFAS at field scale to below analytical detection limits for influent concentrations in the range of several 100 micrograms per liter (µg/L) total PFAS (Kothawala et al. 2017; McCleaf et al. 2017; Woodard et al. 2017). Resins can be designed to target certain PFAS more effectively, but generally, like GAC, perfluorosulfonic acids (PFSAs) have a greater affinity than perfluorocarboxylic acids (PFCAs) for similar chain length and longer chains have a greater affinity than shorter chain PFAS. IX are also available as single use and regenerable resins, where the solvent extract can be submitted directly for incineration or distilled and the PFAS residue incinerated. Regenerable resins are better suited for removal of higher concentration PFAS (ITRC 2021d).

IX are highly susceptible to fouling and require pre-treatment for pH, inorganic and organic co-contaminants and major anions and cations. Low concentrations of dissolved organic matter, iron or manganese can significantly influence membrane performance and permeability.

Reverse Osmosis and Nanofitration

Reverse osmosis (RO) and, to a lesser extent, nanofiltration (NF) are commonly used in mining and many industrial water treatment processes to remove ions from water by forcing impacted water through a semipermeable membrane. Both techniques can concentrate PFAS in the permeate, which can then be treated using a second technology (such as foam fractionation or advanced oxidation) and have been shown to be effective at removing longer chain (>C5) perfluoroalkyl acids (PFAAs) (Loi-Brugger et al. 2008; Tang et al. 2006). In order to preserve the RO/NF membranes for removal of PFAS, pre-treatment is required to remove interfering anions and cations, optimize pH and remove organic contaminants that might clog the membranes. The effectiveness of RO/NF at removing PFAS has been evaluated extensively in wastewater and drinking water applications where PFAS was not the target contaminant (Tang et al. 2006; Flores 2013;

Glover et al. 2018; Dickenson 2016; Merino et al. 2016). Tang et al. (2006 and 2007) studied PFAS from various wastewaters using various RO and NF membranes and achieved >99% removal at PFOS concentrations ranging from 0.5 to 1,500 milligrams per liter. Although RO/NF have high treatment efficiencies at high PFAS concentrations and reliably remove the bulk of PFAS from highly impacted waters (e.g., PFAS-AFFF impacted groundwater where concentrations can be in the high μg/L range), they still require a polishing treatment using GAC or IX to reliably achieve regulatory criteria for effluent limits.

Foam Fractionation

As a result of their non-polar tail and polar head, PFAS tend to accumulate at the air-water surface which facilitates removal via foam fractionation by bubbling air or reactive gases (e.g. ozone) through a water column to form foam. The foam, which is composed predominantly of PFAS and other similar co-contaminants, is then skimmed off the water surface. One application used by the Australian Department of Defence, Army Aviation Centre Oakey (AACO) (base near Toowoomba, Queensland) is referred to as surface activation foam fractionation (SAFF) and uses hundreds of columns to progressively strip PFAS off the top of the water columns (ITRC 2021d). Various studies have shown that C6 PFAS and greater can be removed effectively with this technology; however, it is less effective on shorter chain PFAS. The treatment rates that can be achieved with foam fractionation depend on the degree of foaming and contaminant load. At high foaming rates, throughput is reduced significantly, but the technology is very useful for removal of longer chain PFAS from concentrated mixed contaminant streams and RO/NF reject.

Developing Destructive Technologies

There are many destructive technologies in development showing promise for the destruction of short and long chain PFAS using oxidation approaches (ITRC 2021d). Ozonation (in combination with persulfate), activated persulfate, electrochemical oxidation, sonochemical oxidation, supercritical water oxidation, photochemical oxidation (UV-Ox) and other advanced oxidation technologies are in various stages of development. While these technologies are promising, the PFAS concentrations need to be in the range where oxidation is cost effective. At remote sites, like mining sites, where disposal of PFAS can be challenging due to transportation costs, these destructive technologies may be better options for onsite destructive treatment of concentrated waste in combination with a GAC or IX polishing post treatment.

Status of PFAS Regulation

To date, internationally, there appears to be no official guidance or guidelines produced regarding PFAS that are specifically directed to the mining industry; however, many jurisdictions have produced screening values for environmental media that would be potentially applicable to mining sites. Standards and guidelines for surface water, drinking water, groundwater, and soil have been developed for up to 20 PFAS in the jurisdictions of Canada, the United States (US), and internationally. The majority of these standards and guidelines are for PFCAs and PFSAs, with only a few jurisdictions preparing standards and guidelines for select fluorotelomer sulfonic acids (FTSAs) and GenX (a trade name for a group of shorter chain PFAS, e.g., less than six carbons). Some of these values are regulated. Select jurisdictions have also developed criteria for other types of media (e.g., sediment, ambient air, fertilizer, fish tissues, eggs, other food products, etc.); however, these values are often unregulated. Given the primary exposure pathway of concern at mining sites is expected to be ingestion of potable water, this review will focus on standards and guidelines that have been produced for water.

North America

In the US, no federal maximum contaminant level (MCL) has been released by the USEPA for any PFAS; however, the USEPA did define a lifetime health advisory for drinking water concentrations of PFOA and PFOS as 70 nanograms per litre (ng/L) in 2016, which applies to PFOA and PFOS individually and as a sum (USEPA 2019a). The USEPA has also released a screening level of 40 ng/L to determine if PFOA and/or PFOS are present in groundwater and warrant further investigation, but the preliminary remediation goal for contaminated groundwater remains as the USEPA drinking water health advisory (USEPA 2019b). In 2020, the PFAS Action Act was passed by the House of Representatives to classify certain PFAS as hazardous substances, which is expected to lead to enforceable MCLs in future (Library of Congress, 2020).

In the absence of federal MCLs, pressure from citizens and politicians has led some states to develop their own standards (Zemba et al. 2019). Many states have developed their own guidelines and criteria, especially for PFOA and PFOS, at a range of values more conservative than the USEPA (ITRC 2021e). Illinois (2 ng/L PFOA and 14 ng/L PFOS) and California (5.1 ng/L PFOA and 6.5 ng/L PFOS) have some of the most conservative values for drinking water (ITRC 2021e). Hawaii has set criteria for the largest number of PFAS parameters, with groundwater protective concentration levels for 18 PFAS. The range of guidelines and standards available from the States for the six PFAS for which standards and guidance values are most commonly defined are summarized in **Error! Reference source not found.**1. Soil guidelines and standards for the protection of drinking water or groundwater have also been released by 12 States for up to 18 PFAS (ITRC 2021e).

In Canada, Health Canada (HC) has established drinking water guidelines (DWGs) for PFOA and PFOS, as well as drinking water screening values (DWSVs) for nine additional PFAS (HC 2019). The DWGs and DWSVs for the same six PFAS included in Table 1 are detailed in Table 2. The DWGs and DWSVs were defined to protect human exposure from drinking water sources. The DWGs for PFOA and PFOS are presented as Maximum Acceptable Concentrations (MACs) that are based on a study that referenced hepatocellular hypertrophy in rats as a result of exposure to PFOA and PFOS (HC 2018a and 2018b). Health Canada suggested that an additive approach using the ratio of PFOA and PFOS to their respective DWG should also be considered in cases where PFOA and PFOS occur concurrently in drinking

Table 1: Sample PFAS Water Guidelines and Standards (United States) (ITRC 2021e)

PFAS Analyte	Drinking Water (ng/L)	Groundwater (ng/L)	Surface Water (ng/L)
PFOA	2 - 667	2 – 40,000,000	70 – 24,000
PFOS	6.5 - 667	2 – 500,000	6 – 300,000
Perfluorononaote (PFNA)	6 - 70	4.4 – 40,000,000	70 – 1,000
PFBS	345 – 667,000	420 - 400,000	400,000
Perfluorohexanesulfonate (PFHxS)	18 - 140	18 – 500,000	700
Perfluoroheptanoate (PFHpA)	20 - 70	2 – 40,000,000	300

water sources (HC 2018a and 2018b). In 2021, the Canadian Council of Ministers of the Environment (CCME) produced a federal environmental quality guideline for PFOS in groundwater protective of ecological receptors and human health (CCME 2021). The CCME value is also summarized in **Error! Reference source not found.**. None of the federal guidelines developed in Canada are currently regulated. The only Canadian province to produce regulated values is British Columbia (BC) (BC 2019); these values are included in Table 2.

Table 2: Sample PFAS Water Guidelines and Screening Values (Canada)

PFAS Analyte	DWG (MAC, ng/L) (HC 2019)	DWSV (ng/L) (HC 2019)	CCME, Groundwater (ng/L) (CCME 2019)	BC Contaminated Sites Regulation, Drinking Water (ng/L) (BC 2019)
PFOA	200			200
PFOS	600		600	300
PFNA		20		
PFBS		15,000		80,000
PFHxS		600		
PFHpA		200		

International

The Australian government completed a literature review for PFAS toxicity and indicated the evidence of human health impacts directly related to PFAS exposure is limited and does not indicate an increase in overall cancer risk (Zemba et al. 2019); however, this government still released health-based PFAS guidelines for drinking water, residential water, and soil for PFOA, PFOS, and PFHxS (ITRC 2021e).

For other areas known for mining sites, such as South America, Indonesia, Asia, Russia and the Middle East, country-specific regulatory frameworks for PFAS are unknown; however, many of the countries in these regions are part of the Stockholm Convention (Brennan et al. 2021) which has been regulating select PFAS as Persistent Organic Pollutants since 2009.

Conclusion

PFAS can be found at mining sites both due to their use in industrial processes, as well as in AFFF. The assessment, management, and remediation of environmental releases of PFAS from mining facilities needs to consider the unique receptors and exposure pathways associated with these remote sites, as well as the related logistical challenges for assessment and remedial approaches. As a number of jurisdictions are advancing regulation around the use of PFAS and its presence in environmental media, mining facilities will need to consider the potential impacts and liabilities associated with PFAS use at their operations.

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WaterLegacy Comments March 1, 2024
OAH Docket No. 71-9003-39667

Minnesota Pollution Control Agency (MPCA)
Planned New Rules Governing Currently Unavoidable Use
Determinations about Products Containing PFAS

EXHIBIT 2

Gluge, J., *et al*., An overview of the uses of per- and polyfluoroalkyl substances (2020)

Environmental Science Processes & Impacts

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An overview of the uses of per- and polyfluoroalkyl substances (PFAS)†

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Per- and polyfluoroalkyl substances (PFAS) are of concern because of their high persistence (or that of their degradation products) and their impacts on human and environmental health that are known or can be deduced from some well-studied PFAS. Currently, many different PFAS (on the order of several thousands) are used in a wide range of applications, and there is no comprehensive source of information on the many individual substances and their functions in different applications. Here we provide a broad overview of many use categories where PFAS have been employed and for which function; we also specify which PFAS have been used and discuss the magnitude of the uses. Despite being non-exhaustive, our study clearly demonstrates that PFAS are used in almost all industry branches and many consumer products. In total, more than 200 use categories and subcategories are identified for more than 1400 individual PFAS. In addition to well-known categories such as textile impregnation, fire-fighting foam, and electroplating, the identified use categories also include many categories not described in the scientific literature, including PFAS in ammunition, climbing ropes, guitar strings, artificial turf, and soil remediation. We further discuss several use categories that may be prioritised for finding PFAS-free alternatives. Besides the detailed description of use categories, the present study also provides a list of the identified PFAS per use category, including their exact masses for future analytical studies aiming to identify additional PFAS.

Environmental significance

Per- and polyfluoroalkyl substances (PFAS) are a large group of more than 4700 substances that are used in a wide range of technical applications and consumer products. Releases of PFAS to the environment have caused large-scale contamination in many countries. For an effective management of PFAS, an overview of the use areas of PFAS, the functions of PFAS in these uses, and the chemical identity of the PFAS actually used is needed. Here we present a systematic description of more than 200 uses of PFAS and the individual substances associated with each of them (over 1400 PFAS in total). This large list of PFAS and their uses is intended to support the identification of essential and non-essential uses of PFAS.

1 Introduction

Per- and polyfluoroalkyl substances (PFAS) are a class of thousands of substances[1,2] that have been produced since the 1940s and used in a broad range of consumer products and industrial applications.[3] Based on concerns regarding the high persistence of PFAS[4] and the lack of knowledge on properties, uses, and toxicological profiles of many PFAS currently in use, it has been argued that the production and use of PFAS should be limited.[5] However, there are specific uses that make an immediate ban of all PFAS impractical. Some specific uses of PFAS may currently be essential to health, safety or the functioning of today's society for which alternatives so far do not exist. On the other hand, if some uses of PFAS are found to be non-essential, they could be eliminated without having to first find alternatives that provide an adequate function and performance. To determine

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which uses of PFAS are essential and which are not, the concept of "essential use," as defined under the Montreal Protocol, has recently been further developed for PFAS, including illustrative case studies for several major use categories of PFAS.[6]

PFAS are costly to produce (*e.g.* fluorosurfactants are 100–1000 times more expensive than conventional hydrocarbon surfactants per unit volume[7]) and therefore are often used where other substances cannot deliver the required performance,[1] or where PFAS can be used in a much smaller amount and with the same performance as a higher amount of a non-fluorinated chemical. Examples are uses that operate over wide temperature ranges or uses that require extremely stable and non-reactive substances. The C–F bonds in PFAS lead to very stable substances, a feature that also makes the terminal transformation products of PFAS very persistent in the environment. Furthermore, the perfluorocarbon moieties in PFAS are both hydrophobic and oleophobic, making many PFAS effective surfactants or surface protectors.[8] PFAS-based fluorosurfactants can lower the surface tension of water from about 72 mN m^{-1} (ref. 9) to less than 16 mN m^{-1}, which is half of what is attainable by hydrocarbon surfactants.[8,10] Likewise, the surfaces of fluorinated polymers have about half the surface tension compared to hydrocarbon surfaces. For instance, a close-packed, uniformly organized array of trifluoromethyl ($-CF_3$) groups creates a surface with a solid surface tension as low as 6 mN m^{-1}.[11]

Due to these and other desirable properties, PFAS are used in many different applications. A good overview of the range of uses of PFAS as surfactants and repellents is provided in the monograph by Kissa (2001).[3] It lists 39 use categories, mostly derived from patents, and describes the functions of PFAS in these use categories. However, the work by Kissa (2001) was published nearly 20 years ago, focused on fluorosurfactants and repellents, and it is not clear which of these uses are still relevant today. In addition to Kissa (2001),[3] there are a few other monographs and a number of peer-reviewed scientific articles and reports that have looked into the uses of PFAS.[8,12–22] While these articles and reports provide useful information, each of them focuses on the uses of a specific PFAS group (in specific use categories). This is also the case for the reviews from the Persistent Organic Pollutants Review Committee (POPRC), the focuses of which are on perfluorooctanoic acid (PFOA), perfluorooctane sulfonic acid (PFOS), perfluorohexane sulfonic acid (PFHxS), their precursors, and the PFAS that may be or have been introduced as replacements for these PFAS.[23–29] The FluoroCouncil[30] has provided additional information on uses of PFAS. However, the information is rather generic with limited details about specific uses and substances. Hence, a comprehensive overview that summarizes major current uses is missing.

The present paper, together with the Appendix (Table 4) and the ESI,† aims to provide a broad, but not exhaustive, overview of the uses of PFAS and associated individual substances (note that a working definition of PFAS is used here to define the scope of PFAS considered in this study, which is provided in the Methods section below). The paper addresses the following points: (i) in which use categories have PFAS been employed and for which functions? (ii) Which PFAS have been – and are still – used in a certain category? (iii) What is the extent of the uses in certain parts of the world? Within the European Union (EU), there are discussions underway for restricting PFAS to those uses that are essential,[31] and extensive information on many PFAS uses will be needed in this context. The present work also aims to support this process by showing in which specific applications PFAS are used, and in which functions, as a first step toward differentiating essential and non-essential uses of PFAS.

2 Methods

2.1 Which PFAS are addressed?

A first clear definition of PFAS was provided by Buck *et al.* (2011).[1] They defined PFAS as aliphatic substances containing the moiety $-C_nF_{2n+1}$ within their structure, where n is at least 1. The OECD/UNEP Global PFC Group noted that many substances containing other perfluorocarbon moieties (*e.g.* $-C_nF_{2n}-$) were not commonly recognized as PFAS according to Buck *et al.* (2011), *e.g.* perfluorodicarboxylic acids.[2] Considering their structural similarities to commonly recognized PFAS with the $-C_nF_{2n+1}$ moiety, the OECD/UNEP Global PFC Group proposed to also include substances that contain the moiety $-C_nF_{2n}-$ ($n \geq 1$) as PFAS.[2] However, the exact definition is still under discussion. The present study is in line with the OECD proposal in several, but not all, respects. In contrast to the definition by Buck *et al.* (2011), the present study also includes (i) substances where a perfluorocarbon chain is connected with functional groups on both ends, (ii) aromatic substances that have perfluoroalkyl moieties on the side chains, and (iii) fluorinated cycloaliphatic substances.

More specifically, the present study focuses on polymeric PFAS with the $-CF_2-$ moiety and non-polymeric PFAS with the $-CF_2-CF_2-$ moiety. It does not include non-polymeric substances that only contain a $-CF_3$ or $-CF_2-$ moiety, with the exception of perfluoroalkylethers and per- and polyfluoroalkylether-based substances. For these two PFAS groups, substances with a $-CF_2OCF_2-$ or $-CF_2OCFHCF_2-$ moiety are also included.

2.2 Literature sources

The present inventory was started with the risk profiles and risk management evaluations for PFOA, PFOS, PFHxS and their related compounds to obtain an overview of uses of these chemicals.[23–29] Reports and books that address fluorosurfactants and fluoropolymers in general were also included.[3,8,12,16,20,21,32–43] Literature specific to certain use categories was retrieved for more information either on the substances used, or to understand why PFAS are, or were, necessary for a given use. All specific references are cited in the ESI-1.†

In addition, databases, patents, information from PFAS manufacturers and scientific studies that measured PFAS in products were examined. These additional sources are described in more detail in the following subsections. The

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searches were not exhaustive in any of the sources described, and there are still many more reports, scientific studies, patents, safety data sheets and databases with information on the uses of PFAS than the ones cited here or in the ESI-1.†

The information in the Tables in the ESI-1† from these sources was marked according to its original source. Information from patents (cited in a book, article or report) was marked with "P", information on PFAS analytically detected in products with "D", and information on uses or information without additional reference with "U" for "use", or "U*" for "current use" (which is defined as a use with public record(s) of use from the last 4 years, *i.e.* 2017 or later).

2.2.1 Chemical data reporting under the US Toxic Substances Control Act. Manufacturers and importers that produced chemicals in amounts exceeding 25 000 pounds (11.34 metric tons, t, per year) at a site in the United States (US) between 2012 and 2015 were obliged to report to the US Environmental Protection Agency (US EPA) in 2016 (data for 2016 to 2019 will be reported in 2020). The data reported in 2016 included for each reported substance: the name, Chemical Abstracts Service (CAS) registry number and product categories for consumer and commercial uses and sectors, as well as function categories for industrial processing and use. The masses (tonnages) used and exported also had to be reported; however, they are in most cases confidential business information (CBI). The reported data were filtered according to chemical names containing the word "fluoro". Non-polymeric substances that did not contain the $-CF_2CF_2-$ moiety and polymeric substances that did not contain the $-CF_2-$ moiety subsequently were removed. This left 39 entries where a specific PFAS was applied in a consumer or commercial use, and around 120 entries where a specific PFAS was applied in an industrial processing or use. The entries are labelled with "U" for "use" in the Tables in the ESI-1 and ESI-3.†

2.2.2 Data from the SPIN database of Denmark, Finland, Norway and Sweden. The Substances in Preparations in Nordic Countries (SPIN) database contains information on substances from the product registries of Denmark, Finland, Norway and Sweden.[44] There are several cases in which substances do not need to be registered. For example, Denmark, Finland, Norway and Sweden exempt products that come under legislation on foodstuffs and medicinal products from mandatory declaration. Furthermore, the duty to declare products to the product registers does not apply to cosmetic products and there is in principle no requirement to declare solid processed articles to any of the registers. There is also a general exemption from the duty to declare chemicals in Sweden, Finland and Norway, if the quantity produced or imported is less than 0.1 t per year (in Finland no exact amount is given). Of the Nordic countries, only Denmark and Norway require information on all constituents for most products for which declaration is mandatory. In Sweden, substances that are not classified as dangerous and that make up less than 5 per cent of a product may be omitted from the declaration. In Finland, information on the composition of products is registered from the safety data sheets. Complete information on the exact composition is consequently not necessarily given.

The data that we used in the present study were extracted for us from the SPIN database by an employee of the Swedish Chemicals Agency (KEMI) and the data included only non-confidential information. However, there is also a substantial amount of confidential information in the SPIN database. This is visible when the substances are accessed *via* the web interface of the SPIN database.[44] It was also pointed out to us that not all substances have available use data due to confidentiality.

The database includes four large data sets with information on uses. Two of the data sets ("UC62" and "National use categories") contain information on specific use categories, while the other two ("Industrial NACE" and "Industry National") contain information on sectors of uses. In addition to the use categories and sectors of uses, the data sets also contain information on the quantities of a chemical used in a certain use category or sectors of uses if the reported mass exceeds 0.1 t. The available data cover the time period 2000 to 2017. The four data sets were merged and then (as with the TSCA Inventory data) filtered for chemicals containing the word "fluoro". Those non-polymeric substances that did not contain the $-CF_2CF_2-$ moiety and polymeric substances that did not contain the $-CF_2-$ moiety subsequently were removed. This left 950 entries. Entries with available data for 2017 were labelled as "current use" (U*) in the Tables in the ESI-1 and ESI-3,† all other entries with "U" for "use".

2.2.3 Patents. Another important source of information is the patent literature. Patents were searched for *via* SciFinder^{n}[45] (which is the newest version of SciFinder) and Google Patents.[46] The patent search in SciFinder^{n} was mostly conducted *via* keywords and the constraint that the patent must contain a substance with the $-CF_2-CF_2-$ moiety. This can be done in SciFinder^{n} by using the "draw" function. Google Patents was mainly used to search for a full patent text (*via* the patent number) when SciFinder^{n} only provided the abstract of the patent. The advantage of SciFinder^{n} (which belongs to CAS) is that experts manually curate the substances described in the patents and provide CAS numbers. All substances identified in the patent are visible in SciFinder^{n} together with the patent. Through the patents it was possible to determine in which applications PFAS may be used. While it is not possible to determine whether licenses for a patent have been obtained, the status of the patent (*e.g.* active, withdrawn, expired, not yet granted) can be determined. Active patents become expensive for their owners over the years. Representatives from CAS informed us that it is very likely that a patent is still in use if it is still paid for after 10 to 15 years.[47] After 20 years, a patent expires, which means that the invention can be used by others free of cost. Note that many patents cover not just a specific substance, but rather a basic structure to which different functional groups can be attached. The SciFinder^{n} experts assign CAS numbers to those substances whose existence has been proven by the registrants. Such a proof can be

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a physical method or the description in a patent document example or claim. Still, it is not always clear which substances are actually used in practice. Patents were found for many uses, and the patented substances are included in the Table in the ESI-1,† labelled with "P" for "patent".

2.2.4 Information from companies that manufacture or sell PFAS. 3M, Chemours, DuPont, F2 Chemicals, Solvay, and other PFAS manufacturers describe on their webpages which products they make and what these can be used for. Separate factsheets are also available for some of the products, for example, for fluorocarbons from F2 Chemicals,[48] 3M™ Novec™ Engineered Fluids[49–52] or Vertrel™ fluids from Chemours.[53] The difficulty with this information is that it often does not specify which substances are contained in the products. Sometimes the safety data sheets provide information about the composition of the products, but in most cases they do not. Dozens of factsheets and safety data sheets were screened for the present study and the information on the PFAS they contained was extracted. However, it was not feasible, in a reasonable amount of time, to examine all factsheets and safety data sheets of the major PFAS manufacturers. The data included in the Table in the ESI-1† are labelled with "U" for "use".

2.2.5 Studies that measured PFAS in products. There are also numerous individual studies that analysed PFAS in products, for example in apparel,[54,55] building materials,[56] hydraulic fluids and engine oils,[57] impregnation sprays,[58,59] fire-fighting foams,[60–65] food packaging materials,[66,67] or various other consumer products.[33,68–75] These studies are important because they show in which products PFAS exist. However, in most studies only a handful of substances were analysed and even for these substances it is not clear whether they were used intentionally, impurities in the actual substances, or degradation products. The data included in the Tables in the ESI-1† are labelled with "D" for "detected analytically".

2.2.6 Market reports. A variety of non-verified commercial market reports exist for PFAS. Examples are the Fluorotelomer Market Report, Fluorochemicals Market Report or the Perfluoropolyether Market Report from Global Market Insights.[76–78] The information from these reports is not included in this study as these reports do not state their information sources and thus cannot be verified.

2.3 Nomenclature

In the present study, a distinction is made between use categories and subcategories. A use category can, but does not necessarily, have subcategories. An example of a use category for PFAS is sport articles; a subcategory under sport articles is tennis rackets.

A distinction is also made between use, function and property. The "use" is the area in which the substances are employed. This can either be the use category or the subcategory. The "function" is the task that the substances fulfil in the use, and the "properties" indicate why PFAS are able to fulfil this function. An example for a use would be chrome plating. In chrome plating, PFAS have the *function* to prevent the evaporation of hexavalent chromium(VI) vapour, because of the PFAS *properties* that lower the surface tension of the electrolyte solution and since the PFAS used are stable under strongly acidic and oxidizing conditions.[3]

In the present study, the term "individual PFAS" always refers to substances with a CAS number, irrespective of whether they are mixtures, polymers or single substances.

2.4 Classification of use categories

The use categories in the present study were developed and refined throughout the course of the project to have as few well-defined use categories as possible that were not too broad. Initially, the use categories as defined by Kissa (2001)[3] were employed, but they are very specific and thus broader categories were needed to cover the identified uses. Examples of use categories from Kissa (2001) which were assigned to broader categories are "moulding and mould release" (in the present study a subcategory under "production of plastic and rubber"), "oil wells" (in the present study a subcategory with a slightly different name under "oil & gas"), and "cement additives" (in the present study a subcategory under "building and construction"). In the course of the project, more use categories were defined as additional uses were added. The use categories in the present study were finally divided into "industrial branches" and "other use categories" to make a distinction between use categories that define broad industrial branches such as the "semiconductor industry" or the "energy sector", and use categories that are more specific such as "personal care products" or "sealants and adhesives". Note that some of the "other use categories" may be applied to several of the "industry branches". For example, "wire and cable insulations" may be applied in "aerospace", "biotechnology", "building and construction", "chemical industry" and others. A detailed overview of the use categories and their subcategories is provided in the Appendix (Table 4) of this paper.

Overall, the use categories defined in the present study are very similar to the categories of the SPIN database, although some categories of the SPIN database are more specific (and correspond to subcategories in the present study). Some of the categories in the SPIN database could not be assigned to any of the use categories in the present study because they were too general. Examples are "impregnation", "surface treatment", "anti-corrosion materials" or "manufacture of other transport equipment". Although the substances from these categories are not included in the present study, their quantities appear in Fig. 3 under "various".

2.5 What kind of information can be found where in this article?

The present study comes with an Appendix (Table 4) that lists the functions of the PFAS in the use categories and subcategories that we identified. In addition, we indicate which properties of the PFAS are important for the identified function. The Appendix thus contains the main results of the present study in a condensed form and is therefore part of the main paper and not part of the ESI.†

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The ESI† of the present study is divided into three parts. ESI-1† is a comprehensive document with over 250 pages. It is available as a pdf, but can also be provided upon request as an MS Word document. ESI-1† is intended to be used as a reference document and contains a detailed description of all uses that were collected here as well as the PFAS employed in these categories with names, structural formulas and CAS numbers. Before reading sections of the ESI-1,† it is recommended to study the first two pages of the ESI-1,† where some of the specific features of the document are explained.

In addition, there is an MS Excel workbook (ESI-2†) that contains all PFAS that appear in ESI-1.† This workbook has a worksheet for each of the most common PFAS groups such as perfluoroalkyl acids (PFAA), perfluoroalkane sulfonyl fluoride (PASF)-based substances, or fluorotelomer-based substances and, thus, offers a good overview of the described PFAS. A list of what is included in the different worksheets is provided in the first worksheet. ESI-2† is primarily intended as a reference for readers who do not have access to SciFinder^n or other chemical databases or who just want to look up the name or structural formula for a specific CAS number. In addition to name, CAS number, and structural formula, ESI-2† also contains the identified uses of each PFAS. In contrast to ESI-1, ESI-2† assigns the uses to the PFAS (and not the PFAS to the uses).

The third part of the ESI-3† is also an Excel workbook that provides a separate worksheet for each use category. These worksheets list the PFAS from the ESI-1† with the names, CAS numbers, elemental compositions, and exact monoisotopic masses of the substances. Our intention is that the lists can be added to accurate mass spectrometry libraries and thus help to identify unknown PFAS more easily in the future. For this purpose, it would be helpful to connect the CAS numbers in the ESI-3† with *e.g.* the Norman SusDat ID of the NORMAN Substance Database[79] and perhaps to commercial mass spectrometry libraries in the future.

Table 1 Industry branches and other use categories where PFAS were or are employed. The numbers in parentheses indicate the number of subcategories. No parentheses indicate no subcategories

Industry branches	
Aerospace (7)	Mining (3)
Biotechnology (2)	Nuclear industry
Building and construction (5)	Oil & gas industry (7)
Chemical industry (8)	Pharmaceutical industry
Electroless plating	Photographic industry (2)
Electroplating (2)	Production of plastic and rubber (7)
Electronic industry (5)	Semiconductor industry (12)
Energy sector (10)	Textile production (2)
Food production industry	Watchmaking industry
Machinery and equipment	Wood industry (3)
Manufacture of metal products (6)	
Other use categories	
Aerosol propellants	Metallic and ceramic surfaces
Air conditioning	Music instruments (3)
Antifoaming agent	Optical devices (3)
Ammunition	Paper and packaging (2)
Apparel	Particle physics
Automotive (12)	Personal care products
Cleaning compositions (6)	Pesticides (2)
Coatings, paints and varnishes (3)	Pharmaceuticals (2)
Conservation of books and manuscripts	Pipes, pumps, fittings and liners
Cook- and bakingware	Plastic, rubber and resins (4)
Dispersions	Printing (4)
Electronic devices (7)	Refrigerant systems
Fingerprint development	Sealants and adhesives (2)
Fire-fighting foam (5)	Soldering (2)
Flame retardants	Soil remediation
Floor covering including carpets and floor polish (4)	Sport article (7)
Glass (3)	Stone, concrete and tile
Household applications	Textile and upholstery (2)
Laboratory supplies, equipment and instrumentation (4)	Tracing and tagging (5)
Leather (4)	Water and effluent treatment
Lubricants and greases (2)	Wire and cable insulation, gaskets and hoses
Medical utensils (14)	

3 Results

In the present study, more than 200 uses in 64 use categories were identified for more than 1400 individual PFAS. This means that the present study encompasses five times as many uses (counted as use categories plus subcategories) than included in Kissa (2001).[3] This shows that our present study goes much further than simply updating this previous work. The following subsections describe the identified use categories and substances, and show and discuss the most important use categories in terms of quantities used, based on the data of the SPIN database and the Chemical Data Reporting database under the TSCA.

3.1 In which use categories have PFAS been employed and for which function?

The Appendix to the present study sets forth the use categories identified and answers the question of why PFAS were employed for a specific use. The use categories identified in this study are divided into "industry branches" and "other use categories", as listed in Table 1. In total, 87 uses within the 21 industry branches and 123 uses within the 43 other use categories were identified. Among the use categories, medical utensils, the semiconductor industry, and the automotive industries have the largest numbers of subcategories. About 15% of the subcategories were identified by patents, and 5% by studies that measured PFAS in products (see ESI-3†). The remaining categories have been mentioned previously in other publications.

The identified uses include many uses not previously described in the scientific literature on PFAS. Some examples of those uses are PFAS in ammunition (ESI-1 Section 2.4†),

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climbing ropes (ESI-1 Section 2.38†), guitar strings (ESI-1 Section 2.24†), artificial turf (ESI-1 Section 1.17†), and soil remediation (ESI-1 Section 2.37†). Also, additional subcategories of PFAS in already described use categories such as in the semiconductor industry were identified. For example, in addition to the subcategories etching agents, anti-reflective coatings, or photoresists, PFAS may also be employed for wafer thinning (patent US20130201635 from 2013)[45] and as bonding ply in multilayer printed circuit boards (patent WO2003026371 from 2003) in the semiconductor industry.[45] In the energy sector, PFAS are known to be employed in solar collectors and photovoltaic cells, and in lithium-ion, vanadium redox, and zinc batteries. In addition, fluoropolymers are also used to coat the blades of windmills[13] and PFAS can be employed in the continuous separation of carbon dioxide in flue gases (patent CN106914122 from 2017)[45] and as heat transfer fluids in organic Rankine engines.[48] These examples all show that the uses of PFAS are much more extensive than so far reported in the scientific literature.

Altogether, we were able to identify almost 300 functions of PFAS (listed in the Appendix). Examples of those functions are foaming of drilling fluids, heat transfer in refrigerants, and film forming in AFFFs. The properties that led to the use of the PFAS are also identified. These include among others: ability to lower the aqueous surface tension, high hydrophobicity, high oleophobicity, non-flammability, high capacity to dissolve gases, high stability, extremely low reactivity, high dielectric breakdown strength, good heat conductivity, low refractive index, low dielectric constant, ability to generate strong acids, operation at a wide temperature range, low volatility in vacuum, and impenetrability to radiation. In the Appendix (Table 4), these properties are assigned to the specific uses (and functions).

3.2 Which PFAS have been – and are still – used in a certain category?

The ESI-1† to the present study describes or lists those PFAS that have been or are currently employed (or have been patented) for each individual use. In total we have found uses for more than 1400 individual PFAS. About one third of these PFAS are also listed in the OECD list.[2] This shows that many of the PFAS listed in the present study are on the market, and that many more PFAS that are not on the OECD list may be used or are already being used.

Due to the great variety of uses and the large number of PFAS, it is difficult to make generic statements here. Overall, it was found that the number of different PFAS identified for a certain use mostly depends on the properties required for that use. Some properties, or combinations of properties, are only found in specific groups of PFAS. For example, perfluorocarbons seem to be particularly well suited as vehicles for respiratory gas transport due to the high solubility of oxygen therein. Similarly, anionic PFAS (largely those with a sulfonic acid group) are used as additives in brake and hydraulic fluids due to their ability to alter the electrical potential of the metal surface and thus, protect the metal surface from corrosion through electrochemical oxidation. In contrast, there are also properties that are shared by many different groups of PFAS. Many PFAS are very stable and many can reduce the surface tension of aqueous solutions considerably, improving wetting and rinse-off. Therefore, a typical use in which many different types of PFAS have been or are used is in cleaning compositions. The patented, analytically detected and employed PFAS for this use include PFAAs, PASF-based substances, and fluorotelomer-based substances (see ESI-1 Section 2.6.1†). A similar variety of PFAS (87 substances in total) were identified in patents for photographic materials to control surface tension, electrostatic charge, friction, adhesion, and dirt repellency.

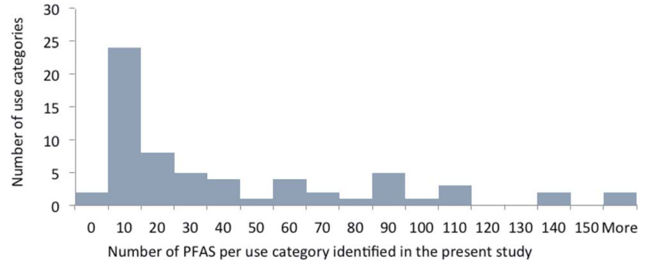

Fig. 1 Use categories grouped according to the number of PFAS identified. The use categories are those mentioned in Table 1 without distinction of subcategories. Identified PFAS included PFAS detected analytically in products, patented and employed PFAS. The data show *e.g.* that 26 use categories contain fewer than 20 PFAS and seven use categories contain more than 100 PFAS.

This array of different PFAS may be surprising, but it shows that some properties of PFAS are shared across many PFAS groups. The large number of patented PFAS for the same use raises the question of whether some of these substances offer better performance than others, or whether it does not really matter which PFAS are employed. The latter would indicate that manufacturers can invent new PFAS quite easily to avoid license fees for patents of other manufacturers.

For the majority of uses, however, far fewer PFAS were identified. Fig. 1 highlights the use categories grouped according to the number of PFAS identified. It should be noted that the number of PFAS reflects the number that we have identified in the present study, and not the number of substances on the market or available for a certain use. For half of the use categories, we have identified more than 20 PFAS, and for seven use categories more than 100 PFAS. The use categories with more than 100 identified PFAS are "photographic industry", "semiconductor industry", "coatings, paints and varnishes", "fire-fighting foams", "medical utensils", "personal care products", and "printing". There are also two categories where no specific substances were identified. These are "ammunition" and "nuclear industry".

The most frequently identified PFAS in our literature search are non-polymeric fluorotelomer-based substances, followed by non-polymeric PASF-based substances and PFAAs. Other identified non-polymeric substances are perfluoroalkyl phosphinic acids (PFPIA)-based substances, perfluoroalkyl carbonyl fluoride (PACF)-based substances,

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cyclic PFAS, aromatic substances with fluorinated side-chains, per- and polyfluoroalkyl ethers, hydrofluoroethers, and other non-polymers. Polymeric substances include fluoropolymers, side-chain fluorinated polymers, and perfluoropolyethers (see also ESI-2†). There is also a variety of substances in the groups themselves, especially among the non-polymeric fluorotelomer-based and PASF-based substances. For many of the substances, only one use (or patent for a use) was identified. For example, one use (or patent) was assigned to 375 fluorotelomer-based substances, two uses (or patents) to 46 fluorotelomer-based substances and three or more uses to 36 fluorotelomer-based substances. The reason why so many PFAS have only one identified use may be that not all the uses were identified for all PFAS. But it also seems that many patents contain "new" PFAS because they work just as well as the established ones.

In contrast to the many PFAS with only one assigned use, some PFAS have many uses. ESI-2† illustrates this point: of the 2400 links between individual PFAS and assigned uses, 16 PFAS have been assigned to 10 or more uses (see Table 2 and Fig. 2). The exact use counts are not important *per se*, because there may be more uses for these PFAS that have not been included in the present study, but they demonstrate that some PFAS are employed more frequently than others. It has to be noted that the three fluoropolymers in Table 2 are quite different from the other PFAS on the list, as they represent possibly dozens or hundreds of technical products with different grades and molecular sizes.

Of the 2400 links between individual PFAS and assigned uses, around 40% were obtained from patents, 26% from studies that detected PFAS in products, and 34% of the links were obtained from publications that reported actual uses.

3.3 What is the extent of the uses in certain areas of the world?

To prioritize PFAS uses in the search for alternatives, it is key to know for which uses PFAS were employed the most. Wang *et al.*[15,17,80] and Boucher *et al.* 2019 (ref. 14) published global emission inventories for C_4–C_{14} PFCAs and C_6–C_{10} PFSAs. For PFSAs and their precursors, the highest amounts were identified for the use in "apparel/carpet/textile", followed by "paper and packaging", "performance" and "after-market/consumers". There is also information on the quantities of individual fluoropolymers used.[40,81] However, a coherent data set with data covering a wide range of uses and at the same time a wide range of PFAS has not been available so far. The following two subsections will show the magnitude of the uses in the Nordic countries and the US based on the data from the SPIN database and the Chemical Data Reporting database under the TSCA, respectively. Data from REACH that would have covered more countries than the data from the SPIN database are not shown, because the tonnage bands in REACH refer to the substances and not to use categories. Accordingly, only in those cases where a substance has only one use would it have been possible to obtain useful information for this study, which would have created a lot of uncertainty in the data.

3.3.1 Data from the SPIN database. Fig. 3 highlights the total, non-confidential amounts of PFAS employed in the different use categories in Sweden, Finland, Norway and Denmark between 2000 and 2017.[44] It should be noted that the data from these Nordic countries may not be representative of other parts of the world. Reasons are that only non-confidential data are included, that substances in foodstuffs, medicinal products, and cosmetics do not have to be declared (see Section 2.2.2) and that there is no fluoropolymer or PFAS production in these

Table 2 PFAS with more than 10 assigned uses. Numbers based on counts of uses and patents, not on detections in products. The structures of these substances are shown in Fig. 2

Substance	CAS number	Assigned uses
Ammonium perfluorooctanoate	3825-26-1	14
Potassium perfluorooctane sulfonate	2795-39-3	15
Potassium *N*-ethyl perfluorooctane sulfonamidoacetate	2991-51-7	22
1-Propanaminium, 3-[[(1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-heptadecafluorooctyl)sulfonyl]amino]-*N*,*N*,*N*-trimethyl-, iodide (1 : 1)	1652-63-7	17
1-Propanaminium, 3-[[(1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,9,9,9-heptadecafluorooctyl)sulfonyl]amino]-*N*,*N*,*N*-trimethyl-, chloride	38006-74-5	21
Oxirane, 2-[[(3,3,4,4,5,5,6,6,7,7,8,8,8-tridecafluorooctyl)oxy]methyl]-	122193-68-4	10
1*H*-Pentafluoroethane	354-33-6	10
Pentane, 1,1,1,2,2,3,4,5,5,5-decafluoro-	138495-42-8	12
Methyl perfluoropropyl ether	375-03-1	14
Methyl perfluorobutyl ether	163702-07-6	17
Methyl perfluoroisobutyl ether	163702-08-7	17
Ethyl perfluorobutyl ether	163702-05-4	13
Poly(oxy-1,2-ethanediyl), α-[2-[ethyl[(1,1,2,2,3,3,4,4,5,5,6,6,7,7,8,8,8-heptadecafluorooctyl)sulfonyl]amino]ethyl]-ω-hydroxy-	29117-08-6	11
Polytetrafluoroethylene (PTFE)	9002-84-0	37
Poly(vinylidene fluoride) (PVDF)	24937-79-9	17
Ethylene tetrafluoroethylene copolymer (ETFE)	25038-71-5	10

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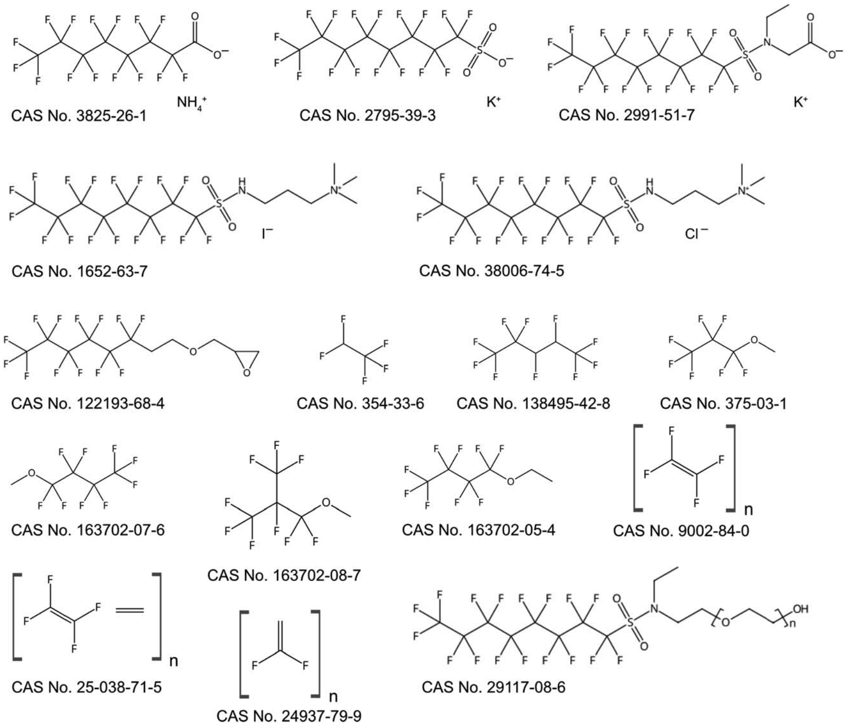

Fig. 2 Structures and CAS numbers of the PFAS with more than 10 assigned uses.

countries. Nevertheless, the data from the SPIN database provide a first indication of which uses of PFAS have been important in the last 20 years in this region.

The data illustrate that a large amount of PFAS was used in the production of plastic and rubber, the electronics industry, and coatings and paints (Fig. 3). The production of plastic and rubber does not include the production of fluoropolymers. Between 2000 and 2017, more than 3000 t of PFAS were used in the three categories previously mentioned. Around 1500 t of PFAS were used in building and construction and in lubricants and greases and around 1200 t of PFAS in the chemical industry, respectively. All other uses were below 1000 t.

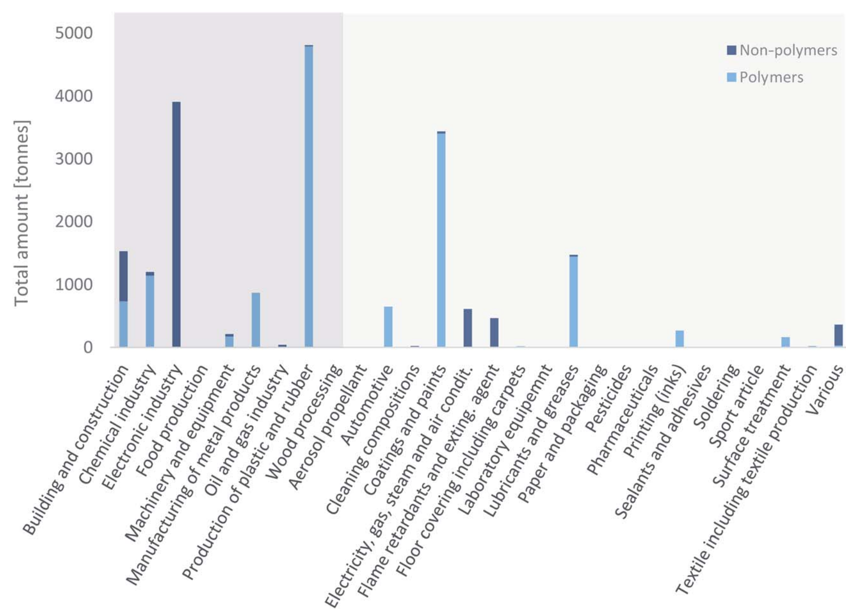

Fig. 3 Amount of PFAS employed in the different use categories in Sweden, Finland, Norway and Denmark from 2000 to 2017, as reported in the SPIN database.[44] Polymers include fluoropolymers and perfluoropolyethers. Side-chain fluorinated polymers have not been used above 0.2 t in any of the uses. Use categories with dark background are industrial branches, use categories with light grey background are other use categories.

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Non-polymers were mainly used in the electronic industry, in buildings and construction, electricity, gas, steam and air conditioning supply, and flame retardants and extinguishing agents. Of the 6300 t of non-polymers used in the Nordic countries between 2000 and 2017, 5650 t (90%) were the hydrofluorocarbon (and greenhouse gas) 1*H*-pentafluoroethane (CAS no. 354-33-6). More than 70% (470 t) of the remaining non-polymeric PFAS were used in flame retardants and extinguishing agents. The SPIN database has a combined category for these two use categories, so it was not possible to distinguish them.

Polymers were mostly used in the production of plastic and rubber, coatings and paints, lubricants and greases, and in the chemical industry. At least 13 700 t of polymers were used in the Nordic countries between 2000 and 2017, and 10 000 t (73%) of this was PTFE. This percentage is a bit higher than the numbers published recently by AGC, which stated that 53% of the 320 000 t of fluoroplastics consumed worldwide in 2018 was PTFE.[81]

3.3.2 Data from the Chemical Data Reporting under the TSCA. Under the TSCA, the Chemical Data Reporting lists under "volume" the amount of a substance in a certain sector and function category or product category. However, more than 80% of the volume entries in the Chemical Data Reporting database are CBI. The certainty of the available information is therefore low, but a general statement is still possible. Table 3 highlights the non-confidential data on used and exported amounts of PFAS for the different uses based on the data reported in 2016.

The amount of used and exported PFAS was largest for functional fluids in "electrical equipment, appliance, and component manufacturing" and functional fluids in "machinery manufacturing". The exact same amounts in the two use categories are no coincidence but come from the declaration that 50% of the total amount was used for "electrical equipment, appliance, and component manufacturing" and 50% for "machinery manufacturing". 1*H*-Pentafluoroethane (CAS no. 354-33-6) accounted for 100% of the total amount in both cases. The high amounts of 1*H*-pentafluoroethane employed as functional fluids in "electrical equipment, appliance, and component manufacturing" confirm the data from the SPIN database indicating that the electronic industry is an important purchaser of this hydrofluorocarbon. The high amounts of "functional fluids" in "machinery manufacturing" could be related to refrigerants, air conditioners or other uses, but due to the broadness of the use category, nothing definite can be concluded. Also, as it was found for Europe, no data were available for amounts of non-polymeric PFAS used as processing aids under fluoropolymer production in the US, which may be expected to be a considerable contributor. The same amounts of "finishing agent" in "paint and coating manufacturing" and "paper manufacturing" are again from the declaration of 50% and 50%.

4 Discussion

4.1 Scope of the present study and uncertainties

4.1.1 Scope and uncertainties related to use categories. The present study covers many past and current uses of PFAS. The inventory is not exhaustive and it also contains uncertainties. One area of uncertainty comes from harmonizing entries to one use category that come from different sources. This is especially relevant for the comparison of amounts used, because the reported amounts from the different databases are related to more or less specific use categories that may be defined differently in different databases. Although not quite as critical, this was also a relevant point for the ESI-1.† Here, information on specific uses of PFAS was assigned to subcategories and information on broader uses to the main use

Table 3 Amounts (used + exported) that were not labelled as CBI for the different uses of PFAS from the Chemical Data Reporting under the TSCA from 2016. The rows with bold text are the uses with high amounts indicated by non-confidential data

Sector and function	Amount [t]
Paint and coating manufacturing – adhesive and sealant chemicals	0.001
Industrial gas manufacturing – air conditioners/refrigerations	138
Computer and electronic product manufacturing – solvents for cleaning and degreasing	1.03
Electrical equipment, appliance, and component manufacturing – functional fluids	**2180**
Fabricated metal product manufacturing – solvents for cleaning and degreasing	0.11
All other chemical product and preparation manufacturing – fire-fighting foam agents	190
Machinery manufacturing – functional fluids	**2180**
Miscellaneous manufacturing – solvents for cleaning and degreasing	0.10
Oil and gas drilling – surface active agents	0.022
Paint and coating manufacturing – adhesives and sealant chemicals	0.31
Paint and coating manufacturing – finishing agents	0.005
Paper manufacturing – finishing agents	0.005
Pesticide, fertilizer, and other agricultural chemical manufacturing – surface active agents	0.07
Miscellaneous manufacturing – plating agents and surface treating chemicals	1.96
Printing ink manufacturing – processing aids, not otherwise listed	0.001
All other basic inorganic chemical manufacturing – refrigerants (heat transfer fluids)	450
Rubber product manufacturing – rubber compounding	0.13
Soap, cleaning compound, and toilet preparation manufacturing – surface active agents	0.12
Textile, apparel and leather manufacturing – finishing agents	0.16

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categories. Still, there were some use categories (especially from the Chemical Data Reporting database under the TSCA) that were so broad that we were not able to assign them to any category in our list. Examples are "surface active agents in all other basic inorganic chemical manufacturing", or "functional fluids in wholesale and retail trade". The PFAS listed under such categories and their quantities were not, therefore, considered in the present study.

Another area of uncertainty originates from unidentified uses. We found, for example, that PFAS are used in climbing ropes.[82] It therefore cannot be excluded that PFAS are also used in climbing harnesses, but no information was found on this. We did not have the capacity to conduct interviews with industry representatives who might have revealed additional information. We were similarly limited when it came to evaluating the copious amount of information about PFAS uses, for example in reports, scientific papers and patents. Therefore, not all PFAS uses might have been identified in the present study.

In the case of patents in particular, a great amount of information is available, but it should be noted that only some of the PFAS included in patents currently are likely to be used on the market. In addition to these uncertainties, some of the use category-specific information in the SPIN database is CBI, meaning that we may have not seen all categories. It would be desirable if such information was no longer confidential in the future, in order to inform consumers, users, and regulators.

Nevertheless, the SPIN database is a very valuable source of information and it would be much easier to compile such inventories of uses if other countries had product registries like the Nordic countries. Without such product registries, the compilation of uses and the substances used remains difficult and lengthy. It would also be advantageous if the uses under REACH were more precisely named. Current categories like "processing aids at industrial sites" or "manufacture of chemicals" are very broad and thus difficult to include.

An important question is whether the majority of the use categories is covered in the present study or whether important use categories are still missing. It is difficult to answer such a question quantitatively, but a qualitative indication is possible when the use categories of the SPIN database are compared to the categories that were identified independently of the SPIN database. Both categories match very well; only three categories had to be added to accommodate data from the SPIN database in the ESI-1† appropriately. These three categories were "machinery and equipment", "manufacture of basic metals" and "manufacture of fabricated metal products". However, with the exception of these three categories, all specific information from the SPIN database could be classified very well into the existing categories of the present study. Overall, we assume that there are no major gaps in the general use categories. However, it is quite possible that subcategories are missing. Among the uses of which we are aware, there may also be some uses where PFAS are no longer employed.

To improve the list of uses in the future, there are several possibilities. Firstly, one could try to get access to product registries of as many countries as possible. Unfortunately, not all product registries are as easily accessible as those of the Nordic countries and many developing countries do not have such a registry. The list could also be extended with information from REACH registration dossiers. These dossiers include information of uses and tonnage bands expected to be used at the time of registration. Interviews with manufacturers of products could also generate more information. However, we know from experiences with past projects that manufacturers often want the interviewers to sign a non-disclosure agreement before the interview, which prevents using the information obtained in publications. The information from such interviews could still provide some indication as to what kind of information to look for in the public domain. The same is true for market reports. They can only provide a clue of what to look for in the public domain (given that they often contain no references). A discouraging factor for researchers who may want to use market reports as data sources is that the companies who generate them often sell them for extortionate sums (*i.e.* several thousand US dollars) and that most of them are not based on thorough research.[83] Another approach could be to use artificial intelligence to systematically search product sales/industry magazines for words or phrases, such as 'fluor'.

4.1.2 Uncertainties related to substances. Uncertainties also exist regarding the substances identified for a particular use. Some of these uncertainties are already discussed in the Methods section: not all registered patents are used on the market, not all substances included in a patent are used in practice, and substances that have been detected analytically in products might be impurities in or degradation products of the actual substances. In addition, we only looked for examples of certain types of PFAS and the lists are by no means complete. Also, the substances included in the present study from the SPIN database are not substances in articles, but substances in preparations. The substances listed in the ESI-1† under U or U* are also those that were intentionally used in the products. However, impurities, reaction products upon mixing the ingredients, and degradation products of the intentionally added PFAS might also be present in products. Industrial blends are rarely pure, but can be only 80% of the registered substance, so 20% can be impurities, reaction by-products, degradation products *etc.*

In addition, industry tends to evolve around consumer needs, cost savings, and external factors such as regulatory oversight, and substances used today may no longer be relevant tomorrow. A better overview of the substances being used could be obtained if manufacturers had to list which substances are contained in a product in the safety data sheets. However, except for a few instances (*e.g.* when uses are authorized for food contact materials in Germany), this is not the case and patents are therefore often the only way to find out what products (might) contain. A better overview of the substances used would also be possible, at least for the US, if substances with tonnages below the reporting threshold of 11.34 t per year were also included in the TSCA Chemical Data Reporting database. In the EU, it would be helpful if the registration dossiers under REACH as well as other legislations were updated regularly with a more detailed breakdown of which-quantities of the substances are used in which applications.

4.1.3 Uncertainties related to quantities. The third part of the present study – identifying the key use categories in terms of

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quantities – also contains various uncertainties. The data from the SPIN database only represent the Nordic countries, and many industry branches have a greater presence in other countries or regions of the world than in the Nordic countries. Additionally, many of the volumes in the SPIN database are CBI. Furthermore, the SPIN database does not include all uses. An example is that foodstuff, and hence food packaging, is not reported to the SPIN database, which possibly could explain why 'packaging', which was significant in the OECD study, did not stand out in the SPIN survey. Similarly, non-polymeric PFAS such as ADONA and the GenX chemicals are used as processing aids during fluoropolymer production. The quantities of these processing aids are not captured in the statistics of the SPIN database since this activity is not ongoing in Scandinavia. However, the significant amounts of fluoropolymers produced in Europe in 2018 of about 51 000 t per year,[81] and globally of about 320 000 t per year suggest that a considerable amount of PFAS is used as processing aids in this use category in addition to what is shown in Fig. 3 under "Chemical industry".

The data from the US are only partly helpful, because a large part of the reported amounts has been claimed as CBI and only substances manufactured or imported at above 11.34 t per year at a single site have been reported. Although in some use categories large quantities of PFAS are employed, it is difficult to compare the amounts, because the unreported amounts due to CBI could be much larger than the non-confidential reported amounts. The extent of the uncertainties in the SPIN database due to the CBI cannot be estimated with the available data, but could be large. It would be helpful if regulatory agencies, such as the US EPA or the national authorities in the Nordic countries, could create a ranking of the PFAS uses (without stating any numbers) based on the entire datasets they have collected.

4.2 Findings of the present study with regard to uses

The present study is a renewed and expanded effort to systematically compile a wide range of known as well as many overlooked uses of PFAS. Besides describing the uses of PFAS, we also endeavoured to explain which functions the PFAS fulfil in these uses (see Table 4 in the Appendix). The descriptions of the functions and properties of the PFAS employed are especially important for determining "non-essential" use categories and identifying alternatives for those uses currently considered "essential".

However, as can be seen from the question marks in the Appendix it was not always possible to determine why PFAS were used or needed in a particular case. In 4% of the cases we could not clarify which function the PFAS fulfil in the use category or subcategory, and in 21% of the cases we could not clarify which property is needed to fulfil the mentioned function. For example, we do not know exactly why PFAS are employed in the ventilation of respiratory airways, in brake-pad additives, and in resilient linoleum. It would be important to engage with product manufacturers to understand what function the PFAS actually have, in order to identify appropriate replacements. Some of the uses might also be judged as "non-essential" and thus could be eliminated or discontinued.

Our study also shows that in several areas where large quantities of PFAS are employed, discussions concerning alternatives are still not underway in the public domain. In general, in recent years the focus in the search for alternatives for PFAS has been on fire-fighting foams,[84,85] paper and packaging,[86,87] and textiles.[88–91] This focus was certainly appropriate, because these are uses where PFAS are in direct contact with the environment (fire-fighting foam) or with humans (food packaging, textiles). However, our results show that PFAS are also used widely in the production of electronics and in machinery manufacturing, and at least in the Nordic countries in the production of plastic and rubber and in paints and coatings. Measuring and/or reporting emissions along the life cycles of these uses, and the search for alternatives in these use categories should therefore also be prioritized. These uses could for instance be included in the activities for which data have to be reported under the European Pollutant Release and Transfer Registry.

It would also be important to look for alternatives in industry branches that use smaller amounts of PFAS or that are not included in the SPIN database or Chemical Data Reporting database, but produce large amounts of wastewater, exhaust gases or solid waste containing PFAS. More information is needed to prioritize the various use categories, but potentially worrisome categories where environmental contamination has been documented are fluoropolymer production,[92–94] the semiconductor industry,[95,96] and metal plating.[97]

Beside the categories mentioned above, there are also uses where humans are in direct contact with PFAS and that have not yet gained much attention regarding alternatives. These include: personal care products and cosmetics (ESI-1 Section 2.28†), pesticides (ESI-1 Section 2.29†), pharmaceuticals (including eye drops) (ESI-1 Section 2.30†), printing inks (ESI-1 Section 2.33†), and sealants and adhesives (ESI-1 Section 2.35†). A search for alternatives would also be important here.

4.3 Findings of the present study with regard to substances

We can ascertain from the SPIN database that two PFAS, 1*H*-pentafluoroethane and PTFE, account for 75% of the quantities used in the Nordic countries. One explanation is that PTFE and 1*H*-pentafluoroethane are not used as additives, but as the main products. For example, entire roof structures or coatings are made out of PTFE.[30] For 1*H*-pentafluoroethane (also known as HFC-125), one of the main uses is as a heat transfer fluid and cooling agent,[44,98] which could explain the large quantities of that substance used.

Other PFAS used as surfactants are utilized in much smaller quantities probably due to their high market price. They may therefore not appear (or at least not in high amounts) in databases such as the SPIN database or the Chemical Data Reporting database, which only report substances (or amounts) above a certain threshold. PFAS used in articles that are manufactured mainly in Asia or other countries outside the EU or the US may also not appear

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in large amounts in the SPIN or Chemical Data Reporting database, simply because the databases do not contain information on PFAS in articles. The PFAS that we have listed as examples in the ESI-1† are mainly those used in Europe or North America. A recent publication[99] lists *e.g.* seventy PFAS from the Inventory of Existing Chemical Substances Produced or Imported in China (IECSC) that are not in the North American and European chemical inventories. These PFAS are also not in our inventory, because no information on their intended use was provided.

Concerning the currently used PFAS, it was thought – due to the voluntary phase out of all PFAS products derived from perfluorooctane sulfonyl fluoride by 3M[100] and the voluntary PFOA Stewardship Program in which eight companies agreed to phase out 95% of uses by 2015 (ref. 101) – that at least ammonium perfluorooctanoate and potassium perfluorooctane sulfonate are no longer in use in the US. However, other companies have not been prevented from taking over the market, and there has been very limited enforcement of the actual phase-out through regulation. A recent article revealed that PFAS that can break down into PFOA and PFOS are still in use in the US.[102] Those uses include coatings for medical devices, apparel, and other industries, and equipment in pharmaceutical companies. PFAS that can break down into PFOA and PFOS are also still used by semiconductor and electronics companies.[102]

4.4 Prioritisation of use categories

Based on the data from the SPIN database, the Chemical Data Reporting under the TSCA and information on the production of wastewater, exhaust gases and solid waste, we propose that the following use categories need to be prioritized for reducing/eliminating the use of PFAS. At the same time, it must be noted that fluoropolymers and hydrofluorocarbons are produced and used in much larger quantities than PFAAs and their precursors. However, PFAAs and their precursors are more critical from a toxicological point of view. Therefore, the proposal for prioritization is made for each of the three PFAS groups individually: PFAAs and precursors, hydrofluorocarbons, and fluoropolymers.

4.4.1 PFAAs and precursors

4.4.1.1 Fire-fighting foams. PFAS-containing fire-fighting foams are used for extinguishing liquid fires such as fires in oil, jet fuel, other non-water-soluble hydrocarbons, alcohols and acetone. Although relatively small quantities of PFAS are used in fire-fighting foams (class B for extinguishing flammable liquid fires), these foams are an important use category because the foams and the chemicals they contain are released directly into the environment. There are numerous reports about PFAS-contaminated sites where fire-fighting foams have been used (especially for training activities) or spilled.[61,63,103,104] Although PFAS-free class B fire-fighting foams have been developed in the meantime, PFAS-containing fire-fighting foams are still widely in use today.[65,105,106] For more information, see ESI-1 Section 2.14† and the Appendix.

4.4.1.2 Chemical industry with a special focus on processing aids in the polymerization of fluoropolymers. Important uses of PFAS in the chemical industry are their uses as processing aids in the polymerization of fluoropolymers, the production of chlorine and sodium hydroxide, and the production of other chemicals including solvents. PFAS that are used as processing aids in the polymerization of fluoropolymers are of special concern. This is because the surrounding environments at numerous sites have been heavily contaminated due to the release of the processing aids from the nearby manufacturing plants,[92–94] and considerable amounts of fluoropolymers are produced in Europe and worldwide. For more information, see ESI-1 Section 1.4.†

4.4.1.3 Surface protection of textile, apparel, leather, carpets, and paper. Considerable quantities of PFAS, especially of side-chain fluorinated polymers, have been used as surface protectors in textile, apparel, leather, carpets, and paper. These are open and dispersive uses where many consumers come into contact with the PFAS-containing products. It has also been reported that there are high emissions to air, dust, and wastewater from a textile manufacturing plant in China.[107] The side-chain fluorinated polymers contain PFAAs as impurities and they may act as important precursors to PFAAs.[108] For more information, see ESI-1 Sections 2.5, 2.16, 2.20, 2.26, and 2.40.†

4.4.2 Hydrofluorocarbons

4.4.2.1 Electronic industry. PFAS have been used in electronic devices themselves *e.g.* in flat panel displays or liquid crystal displays. However, they have also been used for the testing of electronic devices and equipment, as heat transfer fluids/cooling agents, in cleaning solutions, to deposit lubricants and to etch piezoelectric ceramic filters. Based on data from the SPIN database and the Chemical Data Reporting database under the TSCA, the most widely used substance in the electronic industry in the Nordic countries and the US is the hydrofluorocarbon 1*H*-pentafluoroethane. According to the SPIN database it is mainly used as a heat transferring agent and cooling agent. However, 1*H*-pentafluoroethane is not only of concern due to its high persistence but also because it has a global warming potential that is 3500 times that of carbon dioxide. Therefore, 1*H*-pentafluoroethane is one of the substances regulated by the Kigali Amendment of the Montreal Protocol and efforts are being undertaken to reduce the production and consumption of this substance. The search for PFAS-free alternatives is therefore even more important in this use category.

4.4.2.2 Machinery and equipment. The Chemical Data Reporting database under the TSCA lists also high amounts (more than 2000 t per year) of 1*H*-pentafluoroethane that is used as a “functional fluid” in “machinery manufacturing” in the US. This could be related to refrigerants, air conditioners or other uses, but due to the broadness of the use category, nothing specific can be concluded. Given the high amounts reported, there is an urgent need for more information on where and for which function hydrofluorocarbons, and PFAS in general, are

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used in this category. For more information, see ESI-1 Section 1.10† and the Appendix.

4.4.3 Fluoropolymers

4.4.3.1 Production of plastic and rubber. The SPIN database reveals that large amounts of fluoropolymers (more than 4000 t between 2000 and 2017) have been used in the production of plastic and rubber in the Nordic countries between 2000 and 2017. PFAS have been used as mould release agents, foam blowing agents, foam regulators, polymer processing aids, in the etching of plastic, as anti-blocking agents for rubber, and as curatives in the production of plastic and rubber. As polymer processing aids, fluoropolymers can increase the processing efficiency and quality of plastic and rubber.[109] The use of PFAS in the production of plastic and rubber may explain why PFAS are found, for example, in artificial turf.[110] For more information, see ESI-1 Section 2.14† and the Appendix.

4.4.3.2 Coatings, paints and varnishes. The data from the SPIN database show that large amounts of fluoropolymers (more than 3000 t between 2000 and 2017) have been used in coatings and paints in the Nordic countries between 2000 and 2017. Fluoropolymers can be used to impart oil- and water-repellency to the paints or coatings, and fluoropolymers are also used as anti-stick and anticorrosive coatings. For more information, see ESI-1 Section 2.8† and the Appendix.

4.5 Use and implications of the present study

The large number of uses that exist for PFAS, together with the large number of individual substances, makes their regulation and eventual phase-out very challenging. The approach of allowing PFAS only in "essential uses", as suggested for example in the EU strategy paper "Elements for an EU-strategy for PFAS",[5] will not be easy to implement if regulators try to assess all uses individually. An alternative approach could be to deem all PFAS uses as "non-essential" unless producers or users make a convincing case for essentiality, and that authorities set a sunset clause on "essential uses".

The number of use categories for both non-essential and essential cases is critical to estimate the amount of work that would need to be done, for example, to prepare a restriction proposal under REACH (as planned by five European countries[31]). The descriptions in the present study of where and why PFAS are used can be used to provide an overview of the uses and may also facilitate an understanding of what alternatives need to be developed and with which priority.

The information in this study may also help regulators and scientists determine which PFAS to measure in contaminated areas, in humans, in surrounding communities, and in products. To facilitate the identification of PFAS in various matrices, we provide the ESI-3 file,† which contains for each use category the name, CAS number, and exact monoisotopic mass of the substance. The ESI-3 file† also includes information on whether PFAS were identified in a patent, detected analytically in products, or reported as employed substances. Laboratories could use modern analytical methods such as suspect-screening analysis utilising accurate mass spectrometry to identify novel and emerging PFAS listed in our ESI-3.†[60,111] Patented substances may be less likely to be on the market and could be excluded or given a lower priority or weighting in suspect screening workflows. Similar lists (such as the ESI-3†) are provided by the OECD/UNEP Global PFC Group,[2] Zhang *et al.* (2020),[99] the US EPA, the NORMAN Substance Database[79] and others. An overview is provided under https://comptox.epa.gov/dashboard/chemical_lists. However, only a few of these lists also contain information on uses.

The ESI-3† may also be valuable for identifying sources of PFAS in the environment. Some uses may impart characteristic PFAS "fingerprints" (*i.e.* PFAS contamination patterns) to environmental samples that could be used to identify a source, *e.g.* through statistical methods.[112] On the other hand, many environments will be impacted by multiple sources and such fingerprinting methods could be challenging in practice.

5 Conclusions

The present study is the first of its kind to systematically compile a wide range of known as well as poorly documented uses of PFAS. The compilation is not exhaustive, but it still demonstrates that PFAS are used in almost all industry branches and in many consumer products. Some consumer products even have multiple applications of PFAS within the same product. A cell phone for example may contain fluoropolymer-insulated wiring, PFAS in the circuit boards/semiconductors, and a screen coated with a fingerprint-resistant fluoropolymer. The search for alternatives is therefore a challenging and extensive task and is important in all use categories. However, it seems particularly critical to us to replace PFAAs and their precursors in fire-fighting foams, processing aids for the polymerization of fluoropolymers and in the surface protection of textiles, apparel, leather, carpets, and paper. Hydrofluorocarbons seem to be used most in the electronics industry and in machinery and equipment. Replacing them in these categories will therefore be an important but challenging task. A search for alternatives to fluoropolymers will be important in the production of plastic and rubber and in coatings, paints, and varnishes.

A matching database of viable alternatives to PFAS would be a logical progression of the present study. It would also be helpful if environmental protection agencies, for example the US EPA, could create a ranking of PFAS uses (without providing tonnages) based on the data they have collected. A ranking without exact figures would still be better than the current situation, in which very little is known about the quantitatively most important use categories due to CBI. The TSCA reform in the US was unfortunately unsuccessful in reducing industry's excessive use of CBI. On the one hand, CBI may protect a specific industry's business, but on the other hand it also results in less protection for consumers, users, and workers from the chemicals. Even regulators are left in the dark about volumes, use categories, and PFAS used, which limits their ability to assess and prevent harm to humans and the environment.

Conflicts of interest

Jamie DeWitt is serving as a plaintiff's expert witness in several cases related to PFAS.

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Appendix

Table 4 Overview of the uses of PFAS, the function of the PFAS in the uses and the properties of the employed PFAS that make them valuable for this application

Use category/subcategory	Function of PFAS	Properties of the PFAS employed
Industry branch		
Aerospace		
- Phosphate ester-based brake and hydraulic fluids	Corrosion protection	Altering the electrical potential at the metal surface
- Gyroscopes	Flotation fluids in gyroscopes	?
- Wire and cable	High-temperature endurance, fire resistance, and high-stress crack resistance	Non-flammable polymers, stable
- Turbine-engine	Use as lubricant	Corrosion resistant, stable, non-reactive, operate at a wide temperature range
- Turbine-engine	Use as elastomeric seals	Operate at a wide temperature range
- Thermal control and radiator surfaces	Reject waste heat	Survival over a wide operating temperature range, low solar absorbance, high thermal emittance, and freedom from contamination by outgassing
- Coating	Protect underlying polymers from atomic oxygen attack	Non-reactive, very stable
- Propellant system	Elastomers compatible to aggressive fuels and oxidizers	Non-reactive, very stable
- Jet engine/satellite instrumentation	Use as lubricant	Long-term retention of viscosity, low volatility in vacuum and their fluidity at extremely low temperatures
Biotechnology		
- Cell cultivation	Supply of oxygen and other gases to microbial cells	Great capacity to dissolve gases
- Ultrafiltration and microporous membranes	Prevent bacterial growth	?
Building and construction		
- Architectural membranes *e.g.* in roofs	Resistance to weathering, dirt repellent, light	Oleophobic and hydrophobic, low surface tension, beneficial weight-to-surface ratio
- Greenhouse	Transparent to both UV and visible light, resistant to weathering, dirt repellent	Oleophobic and hydrophobic, low surface tension
- Cement additive	Reduce the shrinkage of cement	?
- Cable and wire insulation, gaskets & hoses	High-temperature endurance, fire resistance, and high-stress crack resistance	Non-flammable polymers, stable
Chemical industry		
- Fluoropolymer processing aid	Emulsify the monomers, increase the rate of polymerization, stabilize fluoropolymers	Fluorinated part is able to dissolve monomers, non-fluorinated part is able to dissolve in water
- Production of chlorine and caustic soda (with asbestos diaphragms cells)	Binder for the asbestos-fibre-based diaphragms	?
- Production of chlorine and caustic soda (with fluorinated membranes)	Stable membrane in strong oxidizing conditions and at high temperatures	Stable, non-reactive
- Processing aids in the extrusion of high- and liner low-density polyethylene film	Eliminate melt fracture and other flow-induced imperfections	Low surface tension
- Tantalum, molybdenum, and niobium processing	Cutting or drawing oil	Non-reactive, stable
- Chemical reactions	Inert reaction media (especially for gaseous reactants)	Non-reactive, stable

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Table 4 (*Contd.*)

Use category/subcategory	Function of PFAS	Properties of the PFAS employed
- Polymer curing	Medium for crosslinking of resins, elastomers and adhesives	?
- Ionic liquids	Raw materials for ionic liquids	?
- Solvents	Dissolve other substances	Bipolar character of some of the PFAS
Electroless plating	Disperses the pitch fluoride in the plating solution	Low surface tension
Electroplating (metal plating)		
- Chrome plating	Prevent the evaporation of chromium(VI) vapour	Lower the surface tension of the electrolyte solution, very stable in strongly acidic and oxidizing conditions
- Nickel plating	Non-foaming surfactant	Low surface tension
- Nickel plating	Increase the strength of the nickel electroplate by eliminating pinholes, cracks, and peeling	Low surface tension
- Copper plating	Prevent haze by regulating foam and improving stability	Low surface tension
- Tin plating	Help to produce a plate of uniform thickness	Low surface tension
- Alkaline zinc and zinc alloy plating		
- Deposition of fluoropolymer particles onto steel	Supported by fluorinated surfactants	Cationic and amphoteric fluorinated surfactants impart a positive charge to fluoropolymer particles which facilitates the electroplating of the fluoropolymer
Electronic industry		
- Testing of electronic devices and equipment	Inert fluids for electronics testing	Non-reactive
- Heat transfer fluids	Cooling of electrical equipment	Good heat conductivity
- Solvent systems and cleaning	Form the basis of cleaning solutions	Non-flammable, low surface tension
- Carrier fluid/lubricant deposition	Dissolve and deposit lubricants on a range of substrates during the manufacturing of hard disk drives	?
- Etching of piezoelectric ceramic filters	Etching solution	Acidic
Energy sector		
- Solar collectors and photovoltaic cells	High vapour barrier, high transparency, great weatherability and dirt repellency	Oleophobic and hydrophobic, low surface tension
- Photovoltaic cells	Adhesives with PFAS hold mesh cathode in place	Lower the surface tension of the adhesive
- Wind mill blades	Coating	High weatherability
- Coal-based power plants	Polymeric PFAS filter remove fly ash from the hot smoky discharge	Stable, non-reactive
- Coal-based power plants	Separation of carbon dioxide in flue gases	Lower the surface tension of the aqueous solution
- Lithium batteries	Binder for electrodes	Almost no reactivity with the electrodes and electrolyte
- Lithium batteries	Prevent thermal runaway reaction	Good heat absorption of first layer and good heat conductivity of second layer
- Lithium batteries	Improve the oxygen transport of lithium–air batteries	Great capacity to dissolve gases
- Lithium batteries	Electrolyte solvents for lithium–sulfur batteries	Bipolar character of some of the PFAS
- Ion exchange membrane in vanadium redox batteries	Polymeric PFAS are used as membranes	Resistance to acidic environments and highly oxidizing species
- Zinc batteries	Prevent formation of dendrites, hydrogen evolution and electrode corrosion due to adsorption onto the electrode surface	Low surface tension, non-reactive

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Table 4 (*Contd.*)

Use category/subcategory	Function of PFAS	Properties of the PFAS employed
- Alkaline manganese batteries	MnO_2 cathodes containing carbon black are treated with a fluorinated surfactant	?
- Polymer electrolyte fuel cells	Polymeric PFAS are used as membranes	Ion conductance
- Power transformers	Cooling liquid	Good heat conductivity
- Conversion of heat to mechanical energy	Heat transfer fluids	Good heat conductivity
Food production		
- Wineries and dairies	Final filtration before bottling with polymeric PFAS	Resist degradation
Machinery and equipment	?	?
Manufacture of metal products		
- Manufacture of basic metals	Inhibit the formation of acid mist during the electrowinning of copper	Lower the surface tension of the aqueous solution
- Manufacture of fabricated metal products	?	?
- Pickling of steel wires	Acid-pickling promoter	?
- Treatment of coating of metal surfaces	Promote the flow of metal coatings, prevent cracks in the coating during drying	Lower the surface tension of the coating
- Treatment of coating of metal surfaces	Corrosion inhibitor on steel	Non-reactive
- Etching of aluminium in alkali baths	Improving the efficient life of the alkali baths	?
- Phosphating process for aluminium	Fluoride-containing phosphating solutions help to dissolve the oxide layer of the aluminium	?
- Cleaning of metal surfaces	Disperse scum, speed runoff of acid when metal is removed from the bath, increase the bath life	?
- Water removal from processed parts	Solvent displacement	Low surface tension
Mining		
- Ore leaching in copper and gold mines	Increase wetting of the sulfuric acid or cyanide that leaches the ore	Low surface tension
- Ore leaching in copper and gold mines	Acid mist suppressing agents	Low surface tension
- Ore floating	Create stable aqueous foams to separate the metal salts from soil	Low surface tension
- Separation of uranium contained in sodium carbonate and/or sodium bicarbonate solutions by nitrogen floatation	Improve the separation	?
- Concentration of vanadium compounds	Destruction of the mineral structure, increases the specific surface area and pore channel thus facilitating vanadium leaching	Acidity
Nuclear industry		
- Lubricants for valves and ultracentrifuge bearings in UF6 enrichment plants	PFAS are used as the lubricants	Stable to aggressive gases
Oil & gas industry		
- Drilling fluid	Foaming agent	Low surface tension
- Drilling – insulating material for cable and wire	Polymeric PFAS are used as insulating material	Withstand high temperatures
- Chemical driven oil production	Increase the effective permeability of the formation	Low surface tension
- Chemical driven oil production	Foaming agent for fracturing subterranean formations	Low surface tension
- Chemical driven oil production	Heavy crude oil well polymer blocking remover	?

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Table 4 (*Contd.*)

Use category/subcategory	Function of PFAS	Properties of the PFAS employed
- Chemical driven gas production	Change low-permeability sandstone gas reservoir from strong hydrophilic to weak hydrophilic	Hydrophobic and oleophobic properties
- Chemical driven gas production	Eliminate reservoir capillary forces, dissolve partial solid, dis-assemble clogging, increase efficiency of displacing water with gas	Lower surface tension of the material
- Oil and gas transport	Lining of the pipes is made out of polymeric PFAS	Non-reactive (corrosion resistant)
- Oil and gas transport	Reduce the viscosity of crude oil for pumping from the borehole through crude oil-in-water emulsions	Hydrophobic and oleophobic properties
- Oil and gas storage	Aqueous layer with PFAS prevents evaporation loss	Lower the surface tension of the aqueous solution
- Oil and gas storage	Floating layer of cereal treated with PFAs prevents evaporation loss	Low surface tension
- Oil containment (injection a chemical barrier into water)	Prevents spreading of oils or gasoline on water	?
- Oil and fuel filtration	Polymeric PFAS are used as membranes	Non-reactive (corrosion resistant)
Pharmaceutical industry		
- Reaction vessels, stirrers, and other components	Use of polymeric PFAS instead of stainless steel	?
- Ultrapure water systems	Polymeric PFAS are used as filter	Low surface tension
- Packaging	Polymeric PFAS form moisture barrier film	Hydrophobic
- Manufacture of "microporous" particles	Processing aid	?
Photographic industry		
- Processing solutions	Antifoaming agent	Lower the surface tension of the solution
- Processing solutions	Prevent formation of air bubbles in the solution	Lower the surface tension of the solution
- Photographic materials, such as films and papers	Wetting agents, emulsion additives, stabilizers and antistatic agent	Low surface tension, low dielectric constant
- Photographic materials, such as films and papers	Prevent spot formation and control edge uniformity in multilayer coatings	Low surface tension
- Paper and plates	Anti-reflective agents	Low refractive index
Production of plastic and rubber		
- Separation of mould and moulded material	Mould release agent	Hydrophobic and oleophobic properties
- Separation of mould and moulded material	Reduce imperfections in the moulded surface	Low surface tension
- Foam blowing	Foam blowing agent	Low surface tension
- Polyol foams	Foam regulator	10.5.3.1.1.1.1 lower the surface tension of the foam
- Polymer processing aid	Increase processing efficiency and quality of polymeric compounds	Lower the surface tension of the polymeric products
- Etching of plastic	Wetting agent	Low surface tension
- Production of rubber	Antiblocking agent	Low surface tension
- Fluoroelastomer formulation	Additive in curatives	?
Semiconductor industry		
- Photoresist (itself)	Photoresist matrix, changes solubility when exposed to light	?
- Photoresist (photosensitizer)	Increase the photosensitivity of the photoresist	?
- Photoresist (photo-acid generator)	Generate strong acids by light irradiation	Able to generate strong acids
- Photoresist (quencher)	Controlling the diffusion of the acid to unexposed region	?
- Antireflective coating	Provide low reflectivity	Low refractive index

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Table 4 (*Contd.*)

Use category/subcategory	Function of PFAS	Properties of the PFAS employed
- Developer	Facilitate the control of the development process	?
- Rinsing solution	Rinsing the photoresist to remove the developer	Low surface tension
- Etching	Wetting agent	Low surface tension
- Etching	Reduce the reflection of the etching solution	Low refractive index
- Etching	Etching agent in dry etching	Strong acids
- Cleaning of silicon wafers	Etch cleaning	Strong acids
- Cleaning of integrated circuit modules	Remove cured epoxy resins	?
- Cleaning vapour deposition chamber	Remove dielectric film build up	Generation of reactive oxygen species
- Wafer thinning	Non-stick coating composition on carrier wafer	Low surface tension
- Vacuum pumps	Working fluid	Stable, non-reactive
- Technical equipment in contact with process chemical or reactive plasma	Polymeric PFAS are used in inert moulds, pipes and elastomers	Stable, non-reactive
- Multilayer circuit board	Bonding ply composition	Low dielectric constant, low dissipation factor
Textile production		
- Dyeing and bleaching of textiles	Wetting agent	Low surface tension
- Dyeing process using sulphur dyes	Antifoaming agent	Low surface tension
- Dye transfer material	Release agent	Low surface tension
- Textile treatment baths	Antifoaming agent	Low surface tension
- Fibre finishes	Emulsifying agent	Hydrophobic and oleophobic properties
Watchmaking industry		
- Lubricants	Form an oil layer and reduced wear	Non-reactive (do not oxidize, resistant to corrosion)
- Drying as production step after aqueous cleaning	Solvents in solvent displacement drying	Low surface tension
Wood industry		
- Drum filtration during bleaching	The used coarse fabric is made out of polymeric PFAS	Stable
- Coating for wood substrate	Clear coating is made out of polymeric PFAS	Stable, non-reactive
- Wood particleboard	Part of adhesive resin	Low surface tension
Other use areas		
Aerosol propellant	Aerosol propellant	Non-flammable, stable, non-reactive
Air conditioning	Working fluid	Non-flammable, stable, non-reactive
Antifoaming agent	Prevent foaming	Low surface tension
Ammunition	Make the final product rubbery and reduce the likelihood of an unplanned explosion due to shock; enable long-term storage without degradation of the polymer	Long-term stability without degradation
Apparel		
- Breathable membranes	Polymeric PFAS are used as membranes	High permeability to water vapour, but resist passage of liquid water

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Table 4 (*Contd.*)

Use category/subcategory	Function of PFAS	Properties of the PFAS employed
- Long-lasting durable water repellent finish	Provide water and oil repellence, stain resistance and soil release	Lower surface tension of the fabric, hydrophobic and oleophobic properties
Automotive		
- Car body	Weather resistance paint, no-wax brilliant top coat	Low surface tension
- Automotive waxes	Aid spreading, improve the resistance of the polish to water and oil	Lower the surface tension of the wax, oleophobic
- Windshield wiper fluid	Prevent icing of the wind shield	?
- Car body	Light, stable	Beneficial weight-to-surface ratio, stable
- Engine and steering system	Polymeric PFAS are used as sealants and bearings	Operate at a wide temperature range, non-reactive
- Engine oil coolers	Heat transfer fluid	Good heat conductivity
- Cylinder head coatings and hoses	Increase the fuel efficiency	?
- Cylinder head coatings and hoses	Reduce the fugitive gasoline vapour emissions	Low surface tension
- Electronics	Cables and wires	High-temperature endurance, fire resistance
- Fuel lines, steel hydraulic brake tubes	Corrosion protection	Non-reactive, stable
- Interior	Dirt repellent in carpets and seats	Low surface tension, oleophobic
- Brake pad additives	?	?
Cleaning compositions		
- Cleaning compositions for hard surfaces	Enhance wettability	Lower the surface tension of the cleaning product
- Carpet and upholstery cleaners	Provide stain resistance and repel soil	Low surface tension, oleophobic
- Cleaning compositions for adhesives	?	?
- Dry cleaning fluids	Stabilizer, improve the removal of hydrophilic soil	Hydrophobic and oleophobic, low surface tension
- Cleaning of reverse osmosis membranes	Remove calcium sulphate	?
Coatings, paints and varnishes		
- Paints	Emulsifier for the binder, dispersant for the pigments, wetting agent	Hydrophobic and oleophobic, low surface tension
- Paints	Enhance the protective properties of anticorrosive paints	Non-reactive
- Paints	Antifouling on ships	?
- Paints and coatings	Anti-crater, improved surface appearance, better flow and levelling, reduced foaming, decreased block, open-time extension, oil- and water repellency, dirt pickup resistance	Low surface tension, oleophobic
- Paints and coatings	Form second coat on a first coat	Low surface tension
- Coatings	Antistick and anticorrosive coatings	Low surface tension, non-reactive
- Coatings	Highly durable and weatherable	Stable, non-reactive
Conservation of books and manuscripts	Preserve historical manuscripts	Permeability to water vapour, but resist passage of liquid water
Cook- and bakingware	Prevent food from sticking to the pan/baking ware	Low surface tension, non-reactive, stable at high temperatures
Dispersions	Disperse solutions	Low surface tension
Electronical devices		
- Printed circuit boards	Use fibre-reinforced fluoropolymer layer	Low dielectric constant
- Capacitors	Separation of high voltage components (dielectric fluid)	High dielectric breakdown strength, non-flammable

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Table 4 (*Contd.*)

Use category/subcategory	Function of PFAS	Properties of the PFAS employed
- Acoustical equipment	Provide an electrical signal in response to mechanical or thermal signals	Piezoelectric and pyroelectric properties
- Liquid crystal displays (LCDs)	Provide the liquid crystal with a dipole moment	Dipoles
- Liquid crystal displays (LCDs)	Polymeric PFAS provide moisture sensitive coating for displays	Hydrophobic
- Light management films in flat panel display	Reduced static electricity build-up and dust attraction during fabrication	Low dielectric constant
- Razors	Polymeric PFFAs is used on the razor	?
- Electroluminescent lamps	Polymeric PFAS is used as coating	?
Fingerprint development	Solvent	?
Fire-fighting foam		
- Fluoroprotein (FP) foams	Fuel repellents	Low surface tension
- Film-forming fluoroprotein (FFFP) foam	Film formers, foam stabilizers	Lower the surface tension of water
- Alcohol-resistant film forming fluoroprotein (AR-FFFP) foam	Film formers, foam stabilizers	Lower the surface tension of water
- Aqueous film-forming foams (AFFF)	Film formers	Lower the surface tension of water
- Alcohol-resistant aqueous film forming foam (AR-AFFF)	Foam stabilizers	Low surface tension
Flame retardants		
- Polycarbonate resin	Flame retardants	Non-flammable
- Other plastic	Flame retardants	Non-flammable
Floor covering including carpets and floor polish	Improve wetting and levelling	Low surface tension
- Soil-release finishes for carpets	Provide water and oil repellence, stain resistance and soil release	Low surface tension, hydrophobic and oleophobic
- Aftermarket carpet protection	Provide water and oil repellence, stain resistance and soil release	Low surface tension, hydrophobic and oleophobic
- Resilient linoleum	?	?
- Laminated floor covering	?	?
- Floor polish	Improve levelling and wetting	Low surface tension
Glass		
- Surface treatment	Make glass surfaces hydrophobic and oleophobic	Hydrophobic and oleophobic
- Surface treatment	Prevents misting of glass	Hydrophobic
- Surface treatment	Dirt-repellent	Low surface tension
- Surface treatment	Fire-or weather resistant	Non-flammable, stable
- Etching and polishing	Increase the speed of etching, improve wetting	Low surface tension
- Drying as production step in glass finishing	Solvents in solvent displacement drying	Low surface tension
Household applications		
- Threads and joints	Polymeric PFAS is used for sealing	?
Laboratory supplies, equipment and instrumentation		
- Consumable materials (vials, caps, tape)	Made out of polymeric PFAS	?
- Personal protective equipment (gloves)	?	?
- Particle filters	Minimize the sorption of compounds to the filter itself	Low surface tension
- Solvents	Dissolve other substances	Hydrophobic and oleophobic

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Table 4 (*Contd.*)

Use category/subcategory	Function of PFAS	Properties of the PFAS employed
- LC instruments	Polymeric PFAS are used in the solvent degasser	Non-reactive ?
- LC columns	Some columns are based on polymeric PFAS	?
- Reverse phase LC-solvents	can contain PFAS	?
- Seals and membranes in UPLCs, autoclaves and ovens	are made out of polymeric PFAS	Work over a wide temperature range
- Oils and greases in pumps	Form a thick oil layer and reduced wear	Non-reactive, non-flammable
- Sterilization of an insulated vessel	Sterilization medium	?
- Electro plotting	Protein-sequencing membranes are made out of polymeric PFAS	?
- Analysing the phosphoamino content in proteins	Protein-sequencing membranes are made out of polymeric PFAS	?
Leather		
- Manufacturing of genuine leather	Improve the efficiency of hydrating, pickling, degreasing and tanning	?
- Repellent treatment (genuine leather)	Provide water and oil repellence, stain resistance and soil release	Hydrophobic and oleophobic, low surface tension
- Manufacturing of synthetic leather	Polymer melt additives that impart oil and water repellency to the finished fibres	Hydrophobic and oleophobic
- Shoe brighteners	Improve the levelling of shoe brighteners	Low surface tension
- Impregnation spray	Provide water and oil repellence, stain resistance and soil release	Low surface tension
Lubricants and greases	Form a thick oil layer and reduced wear	Non-reactive, non-flammable, operate also at high temperatures, do not form sludge or varnish
Medical utensils		
- Electronic devices that rely on high frequency signals (defibrillators, pacemakers, cardiac resynchronization therapy (CRT), positron-emission tomography (PET) and magnetic resonance imaging (MRI) devices)	High dielectric insulators	High dielectric breakdown strength
- Video endoscope	Use in charge-coupled device colour filters	?
- Microbubble-based ultrasound contrast agents	Fluorinated gas inner core, which provides osmotic stabilization and contributes to interfacial tension reduction	Low solubility in aqueous media (dissolve more slowly)
- X-ray imaging	Contrast enhancement agents	Radio-opaque
- Magnetic resonance imaging	Contrast agent	Lack of a 19F endogenous background signal *in vivo* and high magnetic resonance sensitivity of 19F atoms
- Proton and 19F NMR imaging	Contrast agents	Lack of fluorine in organs and tissue
- Computed tomography and sonography	Contrast agents	Lack of fluorine in organs and tissue
- Radio-opaque materials	Polymeric PFAS has been used	Radio-opaque
- Surgical drapes and gowns	Improve water-, oil- and dirt-resistance	Hydrophobic and oleophobic, low surface tension
- X-ray films	Wetting agents, emulsion additives, stabilizers and antistatic agent	Low surface tension, low dielectric constant
- Dispersant	Facilitate the dispersion of cell aggregates	Low surface tension
- Contact lenses	Raw material	
- Retinal detachment surgery and proliferative vitreoretinal	Endotamponade gases	High specific gravity, low surface tension, and low viscosity
- Retinal detachment surgery and proliferative vitreoretinal	Intraoperative tool during vitreoretinal surgery	High specific gravity, low surface tension, and low viscosity
- Eye drops	Delivery agent	Unique combination of apolarity and amphiphility
- Filters, tubing, O-rings, seals and gaskets in dialysis machines	Made out of polymeric PFAS	Low surface tension

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Table 4 (*Contd.*)

Use category/subcategory	Function of PFAS	Properties of the PFAS employed
- Dialysis membranes	Made out of polymeric PFAS	Low surface tension
- Catheter, stents, and needles	Provide low-friction and clot-resistant coatings	Low surface tension
- Surgical patches and vascular catheter	Use of polymeric PFAS	?
- Blood transfer and artificial blood	Oxygen carrier	Great capacity to dissolve gases
- Organ perfusion	Oxygen carrier	Great capacity to dissolve gases
- Percutaneous transluminal coronary angioplasty	Oxygen carrier	Great capacity to dissolve gases
- Toothpaste	Enhances fluorapatite formation and inhibits caries	Low surface tension
- Dental floss	Allows the narrow ribbon to slip easily between close-pressed teeth	Low surface tension
- UV-hardened dental restorative materials	Improve the wetting of the set materials	Low surface tension
- Ventilation of respiratory airway	?	?
- Anaesthesia	Polymeric PFAS is used to dry or humidify breath	Hydrophobic
- Artificial heart pump	Blood compatible and durable	Non-reactive, stable
- Wound care	Cleaning burn residues	Dissolve hydrocarbon
Metallic and ceramic surfaces	Generates easily removable sludge	Hydrophobic and oleophobic
Music instruments		
- Guitar strings	Prevent loss of vibration due to residue build up	?
- Piano keys	Contain polymeric PFAS	?
- Piano	Eliminate squeaks in piano key	?
Optical devices		
- Glass fibre optics	Able to include rare earth in glass fibre optics	?
- Optical lenses	Provide optical lenses with low refractive index and high transparency	Low refractive index
Paper and packaging		
- Paper and cardboard	Provide water- and oil repellency	Hydrophobic and oleophobic
- Manufacturing of paper	Release agent for paper-coating compositions	Low surface tension
Particle physics		
- Particle accelerators	Part of the detection assemblies	Non-reactive, stable, high ionization charge density
Personal care products		
- Cosmetics	Emulsifiers, lubricants, or oleophobic agents	Hydrophobic, low surface tension
- Cosmetics	Make creams *etc.* penetrate the skin more easily	
- Cosmetics	Make the skin brighter	
- Cosmetics	Make the skin absorb more oxygen	Great capacity to dissolve gases
- Cosmetics	Make the makeup more durable and weather resistant	Hydrophobic and oleophobic, stable, non-reactive
- Hair-conditioning formulations	Enhance wet combing and render hair oleophobic	
Pesticides		
- Insecticide against the common housefly and carmine mite	Suffocation of the insect by the adsorbed fluorinated surfactant	?
- Insecticide against ants and cockroaches	?	?

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Table 4 (*Contd.*)

Use category/subcategory	Function of PFAS	Properties of the PFAS employed
- Formulation additives	Anti-foaming agent	Low surface tension
- Formulation additives	Dispersant, facilitate the spreading of plant protection agents on insects and plant leaves	Low surface tension
- Formulation additives	Dispersant, increase uptake by insects and plants	Low surface tension
- Formulation additive	Wetting agent for leaves	Low surface tension
Pharmaceuticals		
- Active ingredient (fulvestrant)	Estrogen antagonists, inhibits the growth stimulus that the estrogen exert on cells	?
- Active ingredient	Pharmaceutical combination of dabigatran and proton pump inhibitors	?
- Formulation additives	Dispersant in self-propelling aerosol pharmaceuticals	Low surface tension
- Formulation additives	Solvent	Hydrophobic and oleophobic
Pipes, pumps, fittings and liners		
- Pipes, pipe plugs, seal glands, pump parts, fasteners, fittings and liners	Polymeric PFAS are used for these applications	Stable, non-reactive, low surface tension, hydrophobic and oleophobic
- Working fluid for pumps in the electronics industry	Stable to reactive gases and aluminium chloride	Extremely stable, non-reactive
Plastic and rubber		
- Plastic	Polymeric PFAS micropowder as additive ?	?
- Thermoplastic	Plasticizer	?
- Bonding of rubber to steel	Allow adhesiveness bonding	Low surface tension
- Rubber and plastic	Antistatic agent	Low dielectric constant
- Resin	Improve weatherability and elasticity	Non-reactive, stable
- Polycarbonate resins	Flame retardant for polycarbonate resins	Non-flammable
Printing (inks)		
- Toner and printer ink	Enhance ink flow and levelling, improve wetting, aid pigment dispersion	Low surface tension
- Toner and printer ink	Impart water resistance to water-based inks	Hydrophobic
- Ink-yet recording heads	Make them ink repellent	Low surface tension
- Recording and printing paper	?	?
- Lithographic printing plates	?	?
Refrigerant systems		
- Refrigerant fluid system	Heat transfer fluid	Good heat conductivity
- Refrigerant compressor	Lubricants	Non-flammable
Sealants and adhesives		
- Sealants	Can be made out of polymeric PFAS	Operate at a wide temperature range, non-reactive, stable
- Silicone rubber seals	Prevents soiling	Low surface tension, hydrophobic and oleophobic
- Adhesives	Improve levelling, spreading, and the penetration of the adhesive into the pore structure of the substrates	Low surface tension
- Adhesives	Antistatic agent	Low dielectric constant
Soldering		
- Vapour phase fluids in vapour phase soldering	Heat transfer medium	Good heat conductivity
- Fluxing agent in solder paste	Low-foaming noncorrosive wetting agent	Non-reactive, stable, low surface tension

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Table 4 (*Contd.*)

Use category/subcategory	Function of PFAS	Properties of the PFAS employed
Soil remediation		
- Vapour barrier material on top of contaminated soil	Evaporation retarder	?
- Surfactants to mobilize pollutants	Surfactants to mobilize soil-bound contaminants in remediation	Stable, non-degradable (during photodegradation)
Sport article		
- Ski wax	Highly water repellent	Low surface tension, hydrophobic
- (Sailing) boat equipment	Weather protection of textiles; anti-fouling protection of ship hulls	Non-reactive, stable, hydrophobic and oleophobic
- Tennis rackets	Used in coatings for tennis rackets	?
- Bicycle	Lubricants	Hydrophobic
- Climbing ropes	Provide water repellence, stain resistance and soil release	Low surface tension, hydrophobic
- Fishing lines	No water absorption, invisible in water, high knot strength	Hydrophobic
- Golf gloves	Antifouling protection for the natural sheep leather of the glove	?
Stone, concrete and tile	Impart oil and water repellency to the surface; delay oxidation and ageing of surface	Low surface tension, hydrophobic and oleophobic
Textile and upholstery		
- Surface treatment	Provide water and oil repellence, stain resistance and soil release	Low surface tension, hydrophobic and oleophobic
- Waving yarn	Facilitate waving	?
Tracing and tagging		
- Tracking air–borne pollutants	Tracer in air	Non-radioactive, chemically and thermally stable, do not occur naturally, have very low atmospheric background concentrations
- Testing ventilation systems	Tracer in air	〃
- Mapping gas and petroleum reservoirs	Tracer in gas or petroleum	〃
- Leak detection in cables, pipelines, landfill waste and underground storage tanks	Tracer in leaking material	〃
- Tracking of marked items	Tracer in the marked item	〃
Water and effluent treatment		
- Filter membranes	Polymeric PFAS minimize the sorption of compounds to the filter itself	Low surface tension
Wire and cable	Provide high-temperature endurance, fire resistance, and high-stress crack resistance	Non-flammable, operate at a wide temperature range

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WaterLegacy Comments March 1, 2024
OAH Docket No. 71-9003-39667

Minnesota Pollution Control Agency (MPCA)
Planned New Rules Governing Currently Unavoidable Use
Determinations about Products Containing PFAS

EXHIBIT 3

Hunt, P., PFAS a toxic problem in “wild west” mining industry (2021)

AUSTRALIA'S MINING MONTHLY

https://www.miningmonthly.com/life-cycle-end-of-life-management/news/1413112/pfas-toxic-problem-in-%E2%80%98wild-west%E2%80%99-mining-industry

PFAS a toxic problem in 'wild west' mining industry

WESTERN Australia has no plan to phase out highly toxic chemicals found on mine sites and oil and gas projects and cannot quantify the level of contamination across the state.

PFAS foam being sprayed.

Asset Management > Life-cycle-end-of-life-management

Comments

Paul Hunt

Deputy Editor: Energy & Commodities

Per-and-poly-fluoroalkyl substances (PFAS) such as perfluorooctane sulfonate, perfluorooctanoic acid and perfluorohexane sulfonate have been used since the 1970s as firefighting foam across mining and oil and gas operations.

PFAS is used in both pre-engineered suppression systems such as haul trucks and mobile plants, as well as fixed suppression systems - installed tanks onsite filled with foam concentrate that is then mixed with water and sprayed on fires from a distance.

The toxic chemicals cause a range of health issues to people exposed, including cancers, liver and kidney failure, immunological problems, and pregnancy complications.

PFAS does not break down and accumulates over time in soils, surface and ground water.

Earlier this year mining giant BHP made headlines after PFAS contamination was **found in groundwater** at its Whaleback iron ore project in Newman, WA, close to public drinking water.

The WA Department of Water and Environment Regulation (DWER) declared the Mount Whaleback mine a dangerous "contaminated site" and ordered BHP to clean it up.

The incident sparked concern that PFAS could be an underestimated health and environmental disaster waiting to happen in WA.

After three months of inquiries, *Australia's Mining Monthly* can reveal the WA government has no inventory on the quantity of PFAS in the state.

AMM contacted the WA Department of Water and Environmental Regulation, Department of Mines, Industry Regulation and Safety, individual ministers, and peak body the Chamber of Minerals and Energy WA.

None of the organisations, departments, or ministers could provide any data on how abundant PFAS was on WA mine sites or resources operations.

CMEWA told *AMM* that the issue was a government one, and it was not responsible for gathering this data.

Speaking under anonymity, several sources also told *AMM* no formal meetings between industry and the government had taken place on how to manage PFAS contamination since the BHP incident. This is contrary to a report by the *Australian Financial Review* claiming meetings were taking place.

Furthermore, the government has no plan on how to phase out the harmful substance from resources operations and is instead waiting on the federal government to come up with a solution.

This is despite multiple other states moving quickly to ban PFAS.

Queensland banned PFAS in 2016 with a three-year phase-out period, while South Australia banned it in 2020. New South Wales more recently moved into its own staged process of banning it.

While WA has not moved to ban PFAS itself, the government has "strongly recommended" PFAS be replaced across mines and oil and gas operations with PFAS-free solutions.

DWER told *AMM* it was helping contribute to a national approach to PFAS and said laws had been introduced in recent years to "ensure contaminated sites are identified, investigated and, where necessary, cleaned up".

It could not say how many mine sites or oil and gas operations in the state were still using PFAS.

Fire and safety experts told *AMM* the government needed to join other states in banning PFAS in the short term.

Sicada Fire and Safety chief Robin Sellar said WA was known in the industry as the "wild west" and PFAS was most likely prominent across the "majority of resources operations" in the state.

In Queensland Sicada was a pioneer in removing PFAS from the mining industry. It watered down the toxic chemical and then disposed of it at a local high-temperature incineration facility.

There are only three incineration facilities in Australia with the capacity to destroy PFAS. All are located on the east coast.

Fellow leading fire protection company Wormald agreed with Sicada, that PFAS was "most likely prominent across WA and the Northern Territory".

Wormald technical director Justin Morris told *AMM* that PFAS would still be used in firefighting systems in WA.

"It definitely would be prevalent across mines, but how much is out there we just don't know," Morris said.

He noted contamination would also be highly likely due to testing requirements.

"There would definitely be residual legacy contamination on a lot of sites, because under WA law, all firefighting suppression systems need to be tested annually," Morris said.

"This means PFAS is being sprayed on the ground, so it makes sense there's ground contamination."

One of the key problems facing WA's mining industry is how to dispose of PFAS from fixed fire suppression systems.

Fixed suppression systems are generally large units on an oil platform, LNG plant, or mine site that can spray suppressants for long distances from a fixed location.

However, most of fixed systems in WA contain PFAS.

To extract the PFAS, clean the entire system, and replace equipment where necessary, could mean entire operations would have to be shut down.

Such a shutdown would cost large mining companies millions of dollars in lost time, never mind the cost of replacing PFAS chemicals and then incinerating them.

Morris said the cost of shutdowns and replacing the firefighting foam was a major inhibitor for industry to voluntarily remove PFAS from their sites.

"On a large fixed system at a mine site or oil and gas project, it is a significant cost," he said.

"It's cost of removal, downtime, and then disposal and incineration of PFAS.

"Maintenance and shutdowns can take anywhere from between a few days and weeks or longer, but it's different with every project."

Another problem facing WA is the fact that none of the operating incinerator facilities are located in the state.

While Queensland has two and NSW has one, WA has never built a purpose-built chemical incineration facility.

This would mean PFAS waste from mine sites and oil and gas operations would need to be transported across the country for disposal, and with states quickly banning the use and import of the chemicals, that could be problematic.

"There's the cost of transport, there's the risk of a spill, and then of course barriers in transporting the waste across state lines as well," Morris explained.

"This is a challenge. But building a new waste facility in Western Australia could be an option ... it would bring costs down for disposal for sure."

In the meantime, experts agree that without state government policy, miners and oil and gas companies would be unlikely to voluntarily undertake the extensive and expensive process of PFAS removal.

"Looking at other states that have successfully removed PFAS, it has taken state government leadership and policies before anything happened," Morris said.

Both Sicada and Wormald offer PFAS disposal services.

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WaterLegacy Comments March 1, 2024
OAH Docket No. 71-9003-39667

Minnesota Pollution Control Agency (MPCA)
Planned New Rules Governing Currently Unavoidable Use
Determinations about Products Containing PFAS

EXHIBIT 4

S. Rasmussen, PFAS Adds Complexities to Environmental Drilling Jobs (2019)

PFAS Adds Complexities to Environmental Drilling Jobs

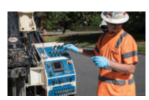
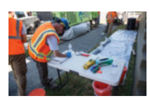
By Stephen Rasmussen

PFAS contamination is often high at sites that manufactured the substance or in areas like military bases where it was used in fire suppression foam.

Source: Holt Services Inc. photos

Before a company gets in the field, it should in

https://www.thedriller.com/articles/91558-pfas-adds-complexities-to-environmental-drilling-jobs

July 22, 2019

In January 2018, the documentary "The Devil We Know" debuted. The film is about toxic chemicals being dumped in a West Virginia town's water supply and the residents' fight with DuPont Corporation to try to hold it accountable for the contamination. But this story isn't new. It starts in 1938 with the invention of man-made chemicals designed for non-stick cookware. Companies found more ways to use these chemicals over the years to produce food packaging, stain and water repellents, and foam fire suppressants. PFOA — a toxic chemical in Teflon — is so widespread, the documentary claims it is in the blood of 99 percent of Americans.

PFAS contamination is often tied to sites that store or use flammable and combustible materials, and thus use fire suppression foams containing PFAS for firefighting missions. Foams are a better suppressant for these highly combustible fires because the foam can cool the fire, separate the flame and ignition source from the surface, suppress the vapors and prevent reignition.[1] The foams are great for putting out the fires. However, they're also permeating our groundwater supplies and finding other pathways to our most precious resource. This, in turn, adversely affects the food we eat. Thankfully, awareness of PFAS chemicals and their harmful effects is on the rise and new steps have been taken to reduce exposure and combat their presence in our natural environment.

Over the past few years, Holt Services Inc. has had the opportunity to work on several projects investigating and/or remediating the threat of per- and polyfluoroalkyl substances (PFAS) to the environment. Although PFAS is not necessarily a new chemical, its widespread presence and harmful effects on the environment have become alarming issues. Studies have shown that large doses of PFAS-related chemicals can cause reproductive, developmental, liver, kidney and immunological effects in laboratory animals.[2]

Environmental and engineering consulting firms continue to make headway in the identification, containment and treatment of PFAS contamination. I policies have also been introduced to help deal with and protect against human exposure, and with the ongoing threat to the environment.

Privacy - Terms

Under the direction of these consulting firms, Holt Services is working to combat the PFAS problem. Holt provides the most technologically advanced drill rigs in the environmental market, along with drill crews who have decades of experience working with and handling harmful contaminants. Having managers with PFAS experience is a vital piece in the success of a drilling project in which the contaminant you are trying to identify and remediate is found in many of the products, materials and equipment commonly used in the drilling industry.

Here are some things to think about before you get into the field.

Inspect the Manufacturer's Specification Sheet

A lot of commonly used groundwater pumps and tooling have grips, fittings, seals and other components made up of plastic materials that can contain or could have been manufactured and exposed to PFAS chemicals.[3]

Common Level D personal protective equipment (PPE) should also be inspected. This includes:

- Safety vests
- Steel-toed boots
- Hard hats
- Gloves
- Rain gear

PFAS is used in a lot of different manufacturing processes and is commonly found in stain and water repellants often used in PPE.[4]
Ensure there is no direct exposure with samples to prevent cross contamination.

Check the MSDS

Review the MSDSs to ensure the well materials used in the field do not contain PFAS substances. The most commonly found and best studied PFAS are perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS).

Some materials you'll want to look at include:

- PVC casing and sleeve
- Tubing
- Grout
- Bentonite
- Cement and concrete
- Fuels
- Oils
- Grease

Water Supply

PFAS chemicals do not readily breakdown in the environment and are water soluble. As a result, there are very low levels of PFAS in many areas of the environment. Contamination levels may be higher near facilities that manufactured, disposed of or used PFAS. Since water is often used to decontaminate equipment and assist with drilling activities, your water supply should be tested for PFAS.

Storage

Take care when storing materials and equipment that will be used in sample collection. Avoid storing materials and equipment in areas where there is a possibility of contact with materials containing PFAS.

Environmental contractors can do their part in the complex fight against PFAS and PFOA substances. A thorough check of equipment and supplies used on the jobsite can help contractors ensure the best samples and help reduce exposure to their crews and beyond.

Sources:

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4. https://toxicfreefuture.org/science/chemicals-of-concern/pfas-nonstick-nightmare/

KEYWORDS: environmental drilling PFAS soil sampling well drilling

RECEIVED
By: OAH on 3/1/2024
Anthony Price Attachment

February 15, 2024

Ms. Katrina Kessler
Commissioner
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, Minnesota 55155

RE: Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing PFAS

Dear Commissioner Kessler,

Whirlpool Corporation appreciates the opportunity to comment on the Agency's approach to determining currently unavoidable uses of per- and polyfluoroalkyl substances (PFAS) in products. We support the **Minnesota Pollution Control Agency's (MPCA**) effort to narrowly regulate PFAS within appliances by excluding substances with no established persistent and bioaccumulation characteristics.

Additionally, we share key considerations supporting criteria for evaluating currently unavoidable uses essential for the health, safety, or functioning of society. Finally, we strongly support MPCA in establishing and releasing to the public initial currently unavoidable use determinations for hydrochlorofluoro-olefins (HCFO) substances such as SOLSTICE (LBA 290379) which have undergone federal authorizations and programs for specific uses[1].

Should criteria be defined for "essential for health, safety, or functioning of society"? If so, what should those criteria be?

Whirlpool Corporation supports MPCA in developing additional guidance on definitions for "essential for health, safety or functioning of society." A chief objective should include assessing alternatives to materials that are considered PFAS, and whether the alternatives

[1] Federal authorizations and programs includes the SNAP program, Section 5 of the Toxic Substance Control Act, and other federal programs deeming PFAS or products containing them acceptable for intended use by federal agencies

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would have negative impacts on products' energy efficiency, greenhouse gas emissions, safety[2], and end-of-life cycle management.

Many chemicals are approved for their respective end-use applications by federal agencies such as the United States Environmental Protection Agency (EPA) under Section 612 of the Clean Air Act (CAA), as well as specific Toxic Substances Control Act (TSCA) significant new use rules and various Section 5(e) Consent Orders. Further, these substances also are already subject to CAA and TSCA reporting requirements. Thus, we seek MPCA to clarify whether information submitted and reported at the federal level would suffice reporting requirements in Minnesota.

What criteria should be used to determine the safety of potential PFAS alternatives?

Whirlpool Corporation recommends that MPCA utilize established federal laws and regulations to make necessary determinations. For example, the Significant New Alternatives Policy (SNAP) program and Section 5 of the Toxic Substances Control Act have determined certain substances as acceptable uses.

Specifically, we support MPCA in considering the following factors when making safety determinations of potential PFAS alternatives:

- **Benefits**: Whether alternatives provide benefits to public health, protect the environment, and or are critical to the function of society.

- **Safety:** Whether alternatives present safety risks, including flammability, during production, use, or end-of-life management.

- **Economical feasibility of alternatives**: Whether PFAS alternatives can be technically and economically feasible for the same purpose, including whether their implementation is possible without significant changes in manufacturing processes.

Fluoropolymers such as SOLSTICE (LBA 290379) remain critical substances for home appliance manufacturers in the United States and ensure they can meet the needs of customers while protecting the environment.

[2] Considerations surrounding safety includes alternatives' flammability potential. This includes the use of alternatives being used during the product's manufacturing process and end-of-lifecycle management.

3

In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

Whirlpool Corporation encourages MPCA to exempt products that are regulated at the federal level. We do intend to submit a currently unavoidable use request for hydroclorofluoro-olefins (HCFO), given the minimal risk to human health and low global warming potential.

Below, we briefly highlight the importance that HCFOs play in manufacturing appliances and maintaining safety and efficiency.

Hydrochlorofluoro-olefins (HCFOs)

HTS Code - SOLSTICE LBA 290379

Per existing law, HCFOs will be banned by the effective compliance date. HCFOs are utilized in refrigeration products as foam-blowing agents used for insulating walls and doors of household refrigerators and freezers.

HCFOs are one of a few climate-friendly alternatives that have ultra-low global warming potential. Not only do HCFOs have lower global warming potential compared to their predecessors but they also reduce the potential impact of ozone depletion which makes them less harmful to human health and the environment.

With the rise of state action banning hydrofluorocarbons (HFCs), EPA has encouraged the transition of low global warming potential alternatives such as HCFOs through the environmental review and approval via the SNAP program. As a direct result, federal action of phase-out of chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and HFCs have excluded foam blowing agents and refrigerants given the low risk and potential to harm human health and the environment[3].

[3] U.S. Environmental Protection Agency. *Overview of SNAP*. https://19january2017snapshot.epa.gov/snap/overview-snap_.html

Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

We highly encourage MPCA to determine initial currently unavoidable use determinations of HCFOs as part of the rulemaking using the proposed criteria. Failure to release initial currently unavoidable use determinations, based on the proposed criteria, will have a significant impact on consumers and households throughout the state of Minnesota.

Timely action on an unavoidable use determination for HCFOs is critical. Transitioning to an alternative, such as cyclopentane, presents unique challenges that would require significant manufacturing investments and product redesigns across four of our manufacturing facilities in North America.

Thank you for your consideration. Should you have any questions regarding our comments, please let us know.

Sincerely,

Anthony Price
Manager, Government Relations
anthony_d_price@whirlpool.com

RECEIVED
By: OAH on 3/1/2024

Hazardous Waste Management Program

201 S. Jackson Street, Suite 5600, Seattle, WA 98104
www.kingcountyhazwastewa.gov

February 29, 2024

Minnesota Pollution Control Agency
Resource Management and Assistance Division
520 Lafayette Road North
St. Paul, MN 55155-4194

RE: Comments on Minnesota Pollution Control Agency's PFAS in Products Currently Unavoidable Use Rule (Revisor's ID Number R-4837)

To Whom It May Concern:

We want to express our gratitude for the opportunity to share our thoughts on the proposed PFAS in Products Currently Unavoidable Use Rule (Revisor's ID Number R-4837). The Hazardous Waste Management Program in Washington state is committed to ensuring public health and environmental quality in King County.

The Hazardous Waste Management Program in Washington state, authorized by the Washington State Department of Ecology, focuses on protecting public health and the environment in King County. With 2.3 million residents, King County is among the most populous in the United States. The program, which includes 42 local jurisdictions, aims to reduce threats from hazardous materials in consumer products, emphasizing the need to restrict PFAS (per- and polyfluoroalkyl substances) within commerce when not essential. The program provides the following comments on the Minnesota Pollution Control Agency's rulemaking, seeking workable policy solutions to achieve its goals and emphasizing the importance of both minimizing exposure to hazardous materials and reducing hazardous waste generation.

1) Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

We recommend that MPCA determine that a use of PFAS in a product category is a currently unavoidable use (CUU) only if all the following criteria are met[1]:

(1) The function provided by PFAS in the product is necessary for the product to work.
(2) There are no safer alternatives to PFAS that are reasonably available.
(3) The use of PFAS in the product is critical for health, safety, or the functioning of society.

[1] For example, see California's proposed bill SB-903 bill (2023-2034): [Bill Text - SB-903 Environmental health: product safety: perfluoroalkyl and polyfluoroalkyl substances. (ca.gov)]

For many uses of PFAS, the criterion associated with whether a use is "essential for health, safety, or the functioning of society" will be more difficult to adjudicate compared to the other two criteria. In those cases, it is critical that MPCA be able to first determine whether PFAS are necessary for the product to work and whether there are safer and reasonably available alternatives, since, if either of these criteria are met, the use would not be consistent with any reasonable definition of an unavoidable use.

As Balan et al. (2023)[2] have recently written, it is possible to operationalize the above CUU criteria while avoiding unnecessary assessments—thereby maximizing efficiency—by asking the following three questions: (1) is the function of the PFAS necessary for the product?; (2) is use of the PFAS the safest feasible option?; and (3) is use of the PFAS justified because such use in the product is necessary for health, safety, or the functioning of society? If a response to any question is no, then the use of PFAS should not be considered a currently unavoidable use and the use can be substituted, discontinued, or denied approval. Therefore, MPCA could start with the question that is most easily answered no for any given use and possibly avoid the need for further assessment.

If an assessment of whether a use is "essential for health, safety, or the functioning of society" is required, we expect that decisions will necessarily be based on the specific context and information provided by the requestor. In any case, manufacturers petitioning for CUU status should be obligated to provide tangible and measurable public health, environmental, or societal benefits within their petitioning, and those benefits should be weighed against the long-term societal costs of continued use of PFAS.

Another important principle for CUU determinations is that individual PFAS chemicals or industries should not be deemed "essential," such that all uses of certain PFAS or within certain industries are designated as CUU; each specific use within a product should be assessed independently.

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

We believe that it is reasonable to consider costs when determining safer, feasible, and available alternatives to PFAS. Cost considerations are well-recognized within the practice of alternatives assessment—for example, there is an entire module on cost and availability within the Interstate Chemical Clearinghouse (IC2) Alternatives Assessment Guide.[3] We further encourage MPCA to review criteria for feasible and available developed by the Washington Department of Ecology for implementing our state's Safer Products for Washington law.[4]

However, we believe that MPCA should not be explicitly required to show that costs are comparable when determining if alternatives are "reasonably available". It can be difficult for

[2] See Balan et al. (2023). Optimizing chemicals management in the United States and Canada through the essential-use approach. Environmental Science & Technology, 57(4), 1568-1575. https://doi.org/10.1021/acs.est.2c05932

[3] Alternatives Assessment Guide - Interstate Chemicals Clearinghouse (IC2) (theic2.org)

[4] See Appendix D in Regulatory Determinations Report to the Legislature: Safer Products for Washington Cycle 1 Implementation Phase 3.

agencies to obtain enough high-quality cost information to rigorously document that costs are comparable, so a requirement to do so would prevent the identification of safer alternatives. We further recommend that MPCA not define a specific cost threshold (e.g., a specific dollar amount or percentage cost difference) that would be a determinative factor in assessing whether an alternative is reasonably available. Such a threshold would not allow for consideration of potentially important context associated with individual use cases. For example, identical costs differences could have dramatically different impacts across different firms, industries, or customers. Additionally, markets can rapidly change due to factors such as technological advances or regulations. We note that the Washington Department of Ecology criteria mentioned above explicitly states that cost considerations will be evaluated on a "case-by-case basis—relying on existing alternatives assessments and frameworks and with stakeholder feedback."

Further, MPCA should work to develop these rules such that cost and economic considerations are not weaponized by manufacturers to avoid transitioning away from non-essential uses of PFAS. In particular, MPCA should balance consideration of manufacturers' costs with other society-level costs, such as remediation costs for removing PFAS from the environment, costs for disposing and handling PFAS-contaminated waste, or medical and healthcare costs associated with adverse human health impacts of PFAS exposure.[5]

3) Should unique considerations be made for small businesses with regards to economic feasibility?

No response.

4) What criteria should be used to determine the safety of potential PFAS alternatives?

We urge MPCA to adopt criteria for determining safer alternatives that are consistent with state-of-the-art research, policy, and practice from the field of alternatives assessment. Most importantly, it is critical that MPCA recognize that ***safer alternatives to PFAS can be either alternative chemicals or alternative products, materials, or processes that eliminate the need for PFAS or alternative chemicals.*** For example, a safer alternative to a non-stick pan coating doesn't have to be a different nonstick coating; instead, it could be a process change to cook differently using oil or fat. We hope the MPCA will consider adopting the following definition, used in a recently proposed bill from CA[6]:

> *"Safer alternative" means an alternative that, in comparison with another product or product manufacturing process, has reduced potentially adverse impacts or potential exposures associated with PFAS. Alternatives include materials, processes, designs, products, or chemicals that achieve the desired result. For example, a safer alternative to stain resistant sprays for avoiding stains could be the use of detergents or the use of fibers that are inherently stain resistant.*

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[5] The True Cost of PFAS and the Benefits of Acting Now (pubs.acs.org)

[6] See California's proposed bill SB-903 bill (2023-2034): Bill Text - SB-903 Environmental health: product safety: perfluoroalkyl and polyfluoroalkyl substances. (ca.gov)

In our own state, the Washington Department of Ecology has developed an adaptable, hazard-based criteria for identifying safer chemical alternatives, which is used to implement our state's Safer Products for Washington law.[7] Our state's law also considers alternative products and processes when determining safer alternatives to priority chemicals. We encourage MPCA to review these criteria to see if they are adaptable for the PFAS in Products Currently Unavoidable Use Rule.[8]

5) How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

For this law to have its intended impact of phasing out unnecessary uses of PFAS, it is imperative that currently unavoidable use (CUU) determinations be time limited. In principle, CUU determinations should not last so long that they reduce the incentive for users to identify safer alternative chemicals or processes. Any petition for renewal of CUU status by a manufacturer should require evidence of significant effort to develop alternatives, for example, peer reviewed studies or funding of third-party research with no financial conflict of interest.[9]

We also strongly believe that changes in information about available alternatives should allow for MPCA to re-evaluate a CUU determination. Additionally, MPCA should institute a public petitioning mechanism that allows external stakeholders to request a re-evaluation of CUU determinations. This could improve opportunities for timely decision making since other local, state, and federal government agencies; non-governmental organizations; and companies may have the deepest and most up-to-date knowledge of advances in research and development in PFAS alternatives.

6) How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

As mentioned in our response to question 5, we recommend MPCA develop a public petitioning mechanism to allow stakeholders the opportunity to bring forward timely information within a formal request to have MPCA re-evaluate CUU determinations on an ad hoc basis.

One type of information that MPCA should consider highly credible evidence that a use of PFAS is avoidable is if another government entity has already enacted a ban on the sale or use of a PFAS within a product or product category. If certain PFAS uses have already been banned in

[7] Safer Products for Washington - Washington State Department of Ecology

[8] See Appendix C in: Regulatory Determinations Report to the Legislature: Safer Products for Washington Cycle 1 Implementation Phase 3

[9] For example, see California's proposed bill SB-903 bill (2023-2034): Bill Text - SB-903 Environmental health: product safety: perfluoroalkyl and polyfluoroalkyl substances. (ca.gov)

another state, the United States, or other countries and if the ban is in effect, then that demonstrates that the use of PFAS is not a currently unavoidable use.[10]

7) In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

No response.

8) Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

We do not believe that MPCA should make any CUU determinations prior to rulemaking. It should be the responsibility of a manufacturer to petition for a CUU determination.

On the other hand, it is appropriate for MPCA to proactively identify product categories in which PFAS uses are avoidable. One straightforward approach for MPCA to accomplish this is by considering actions from other government entities (e.g., other U.S. states) to ban the sale or use of PFAS in a product or product category. If certain PFAS uses have already been banned in another state, the United States, or other countries and if the ban is in effect, then that demonstrates that the use of PFAS is not a CUU.

Here is a list of PFAS uses and product categories for which other states have already enacted bans, and should therefore not be considered a CUU:

- PFAS in textiles/apparel has been banned in California[11] and New York[12]; a ban in Washington is also forthcoming[13]
- PFAS in pesticides have been banned in Maine[14]
- PFAS in oil and gas products (e.g., hydraulic fracturing fluids) has been banned in Colorado[15]

Note that in some cases, restrictions for the use of PFAS in products or product categories in other states have been based on rigorous identification of safer alternatives—for example, see the recent report from the Washington Department of Ecology which identifies safer, feasible, and available alternatives to PFAS in apparel and cleaning products.[16] Further, we encourage MPCA

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[10] For example, see California's proposed bill SB-903 bill (2023-2034): Bill Text - SB-903 Environmental health: product safety: perfluoroalkyl and polyfluoroalkyl substances. (ca.gov)
[11] California AB-1817 Product safety: textile articles: perfluoroalkyl and polyfluoroalkyl substances (PFAS). (ca.gov)
[12] NY State Senate Bill 2023-S1322 (nysenate.gov)
[13] WAC 173-337 - Washington State Department of Ecology
[14] Maine H.P. 1501 An Act To Require the Registration of Adjuvants in the State and To Regulate the Distribution of Pesticides with Perfluoroalkyl and Polyfluoroalkyl Substances (mainelegislature.org)
[15] Colorado House Bill 2022-1345_signed.pdf (colorado.gov)
[16] Draft Regulatory Determinations Report to the Legislature: Safer Products for Washington Cycle 1.5 Implementation Phase 3

to review Tables 8 and 9 of the European Chemicals Agency (ECHA) Annex XV Restriction Report proposing restrictions for PFAS.[17] These tables summarize ECHA's findings on the existence of technically and economically feasible alternatives to PFAS and indicate several additional product categories for which PFAS is avoidable, including paints and other construction-related products.

9) Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

We urge MPCA to use the broadest reasonable scope of a product category in making a CUU determination. We also want to make sure you're aware of the following sources of information on PFAS uses and potential alternatives.

- ZeroPM's database of PFAS alternatives[18]
- Consumer Product Safety Commission's PFAS source characterization database (and accompanying white paper and other relevant resources)[19]
- 3M's database of their PFAS containing products[20]

The Hazardous Waste Management Program thanks you for this opportunity to comment. If you have questions regarding the comments above, please contact Dr. Trevor Peckham, Environmental Scientist, at tpeckham@kingcounty.gov.

Respectfully,

Maythia Airhart, Director
King County Hazardous Waste Management Program

[17] ECHA Annex XV Restriction Report PFAS (europa.eu)
[18] ZeroPM Alternative Assessment Database (zeropm.eu)
[19] See Per-and Polyfluoroalkyl Substances (PFAS) section at: CPSC Chemicals Research Resources (CPSC.gov)
[20] PFAS & Their Uses (pfas.3m.com)

RECEIVED
By: OAH on 3/1/2024
Abbey Linsk Attachment

American Chemistry Council

March 1, 2024

Katrina Kessler
Commissioner
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, Minnesota, 55155-4194

RE: Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

Submitted via https://minnesotaoah.granicusideas.com/

Dear Commissioner. Kessler,

The American Chemistry Council (ACC) represents over 190 companies engaged in the business of chemistry—an innovative, $639 billion enterprise that is helping solve the biggest challenges facing our nation and the world. The business of chemistry drives innovations that enable a more sustainable future, creates approximately 555,000 manufacturing and high-tech jobs—plus over four million related jobs—that support families and communities, and enhances safety through the products of chemistry and investment in research.

Per- and polyfluoroalkyl substances (PFAS), or Fluorotechnology, are a diverse universe of chemistries that helps make possible the products that power our lives – the cellphones, tablets and telecommunications we use every day to connect with our friends and family; the aircraft that power the U.S. military; alternative energy sources critical to sustainability goals; and medical devices that help keep us healthy. However, all PFAS are not the same. Individual chemistries have their own unique properties and uses, as well as environmental and health profiles.

As ACC communicated throughout the legislative process, we do not support the concept of unavoidable uses and believe this misguided policy will likely lead to significant unintended consequences for Minnesota.

The Minnesota Pollution Control Agency (MPCA) should be aware that as it initiates a regulation on the Currently Unavoidable Use (CUU) of PFAS, it could impact thousands of products and establish requirements for hundreds of companies to file for exemptions to continue to sell basic products across Minnesota. Without substantial modifications, under the CUU rulemaking, the following industries may need to file many exemptions to continue to operate and sell or distribute products in Minnesota:

- Electronics
- Medical
- Refrigeration
- HVAC
- Renewable Energy
- Optical and Data Transmission
- Automotive
- Aerospace
- Semiconductors
- Agriculture and Food
- Paint and Coatings
- Batteries and Battery Storage
- Industrial Equipment
- Specialty Films
- Others

ACC urges MPCA to recognize the full societal and economical weight of regulating a product or product component. ACC strongly recommends that MPCA consider the following additional factors where CUU determinations are concerned:

- **Overall Product Design, Safety, Performance, and Sustainability Factors** – Effective evaluation of uses should include the multiple factors that are important for overall product design and performance, including critical attributes related to efficacy and sustainability. Absent a robust and holistic assessment process, this new program will likely foster regrettable substitution and detract from some of the underlying objectives of the program. Moreover, there are a host of sustainability issues to consider in the context of overall electronic product design and performance, including energy efficiency, durability, light, weighting, and material selection, among other factors. Failure to consider these factors could ultimately impact product safety, performance, sustainability, and innovation. Active engagement with the actual end-users for the use will be important for this.

- **Consideration of Existing Product Codes and Standards** – Evaluation of uses should consider existing product codes and standards. There are numerous existing codes and standards that help inform and guide overall product design and performance. In addition, it is important to recognize that these are often viewed as minimum requirements for many Original Equipment Manufacturers (OEM) and that overall performance and safety can often go beyond these standards for specific applications. Changes in product design may affect the ability to meet certain standards and/or require product redesign, re-sourcing, re-testing and recertification.

- **Robust Assessment of Alternatives** – The assessment of alternatives is critical for this new program and is also needed to help avoid regrettable substitution. Key considerations for the assessment of alternatives include:

    - The safety and efficacy of alternatives.

    - The ability of the alternative to provide equivalent functional performance. This includes whether an alternative can meet relevant product and performance standards.

    - The regulatory environment for the identified alternatives as well as broader circularity and safety considerations relevant for product design related to the available alternative.

    - The technical and economic feasibility of deploying alternative technology. "Feasibility" under the National Academy of Sciences (NAS) Alternatives Assessment Framework[i] includes an analysis of both technical feasibility and economic feasibility. The process for evaluating potential alternatives should include both technical and economic feasibility. Technical feasibility requires a demonstration that a substitute chemistry or formulation provides equivalent or better performance for the relevant performance criteria for a particular product. In any given class of chemistry, different individual chemistries may be used or marketed for different applications with different levels of necessary performance. For example, marine paint, outdoor paint for a bridge, outdoor paint for a building, and interior paint for a kitchen, may have performance requirements that differ significantly.

    - The availability of the alternative including a.) what is the approximate cost and availability of other materials that may be required for use of the potential alternatives including required product design changes, b.) what will be the approximate costs and supply chain implications for redesigning the product, including product testing and recertification, and c.) how long would it take the relevant company/industry to transition.

  - **Alignment with Federal and International Regulations** – No state, federal, or international regulatory authority has yet to implement such a massive restriction on fluoro technology as the one considered in Minnesota. This would make the state an outlier, potentially decreasing products available for purchase in the state and potentially impacting broader product safety, innovation, and sustainability. If not implemented carefully, the current law may also run counter to federal and international health and safety standards.

  - **Consideration of Relevant, Existing Safety Assessments and Regulatory Determinations** – In many cases there are existing assessments and regulatory determinations that govern the use of specific chemistries. This includes instances where specific PFAS substances have been identified as a preferred alternative. Consideration of such information will be important as part of MPCA's assessment.

- **Consideration of Impact on Minnesota's Overall Priorities and Objectives** – MPCA should assess the product or uses for its relevance and contribution to overall Minnesota priorities and objectives including overall socio-economic considerations.

- **Global Supply-Chain Considerations** – Affirmative CUU determinations should extend to the entire supply chain necessary for the substance in use. A CUU cannot exist in the economy if the manufacturers and processors involved in bringing the CUU to market do not have adequate regulatory certainty. Product manufacturers operate in a global regulatory environment and must consider a broad range of product safety and design factors. This includes complex considerations related to product certification, performance, use and end of life, and even chemical registration and use. In addition, many manufacturers rely on a global supply chain for components and subcomponents. Any CUU evaluation should take these important global considerations into account. Products are designed for worldwide compliance and this needs to be considered.

- **Timelines for Any Potential Transitions** – The 2032 timeline may not allow sufficient time for manufacturers acting in good faith to adequately test and document the performance of PFAS versus potential substitutes at scale. While such information is being generated, certain uses could be banned, which could lead to shortages or disruptions of supplies critical to the health, safety, and functioning of society. Implementing regulations should have a mechanism for extensions for manufacturers acting in good faith to generate information to support a CUU determination. Therefore, MPCA should create a continuous process for CUU applications and determinations.

- **Product Innovation and New Technologies** – Similarly, advances in technology and/or the emergence of new societal threats and challenges may result in new CUUs being recognized after 2032. MPCA should ensure that the regulatory process under development will allow those "new" CUU applications to be designated as such and allowed in commerce in Minnesota after January 1, 2032. Failure to consider this will undermine product innovation and new technologies. The most recent examples of this include recent technological developments related to EV batteries, alternative energy sources, etc.

- **Utilization of Established, Science-Based Frameworks** – In order to support fact-based decision-making, MPCA should employ established methods and framework for risk assessment, life cycle assessment, alternatives analysis and socio-economic analysis and include transparent stakeholder engagement in their process. MPCA should obtain broad stakeholder and expert input and carefully consider the uses under consideration.

- **Protecting Confidential Business Information (CBI) and Intellectual Property** – CBI and proprietary technologies are important considerations. Absent appropriate CBI protection, many downstream users will be reluctant to file CUUs for consideration in a timely manner. Clear, tested process for handling CBI should be established. The MPCA should ensure that all confidential business information (CBI) submitted is afforded the protection this includes: 1) established process and procedures for protecting this information, 2) ensuring that any of contractors that review the information do so under a separate confidentiality agreement; 3) notifying the submitter if MPCA believes any information submitted as CBI does not meet required criteria for protection.

- **Ongoing Process for Engaging Downstream Users and Submission of CUUs** – There is imperfect information in the supply chain and that many downstream users are not aware of the Minnesota law or process to implement the law. MPCA should not assume that all downstream users are aware of this regulatory process or that that they realize their products rely on PFAS technology. To help address this MPCA should establish a regular ongoing process for the submission of uses. This is particularly true for complex supply chains where end-users will not be aware of where PFAS technology may be used, and which rely on subcomponents manufactured by others.

In addition to the critical points raised above, ACC provides comment on the following questions outlined by MPCA:

1) Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

ACC recommends criteria should be defined for "essential for health, safety and functioning of society." An "essential" assessment should only be initiated when there is deemed to be a risk to human health or the environment from the use of an intentionally added PFAS in a product. Products that do not present an unacceptable risk to human health or the environment should be presumed to be "essential for health, safety and functioning of society." On this point, we reiterate that certain PFAS and certain PFAS subcategories do not present a risk. For example, fluoropolymers have been demonstrated to meet criteria for identifying polymers of low concern. If there is no concern about risk during the use of an intentionally added fluoropolymer, MPCA and stakeholder time and resources should not be wasted on an essentiality analysis. Neither should residents of Minnesota be denied access to a myriad of products important to their daily lives simply because those products contain polymers of low concern.

More generally, the concept of "essential" must be interpreted broadly to be workable. Under a narrow interpretation of "essential" it may be argued that products such as cell phones, laptop computers, or automobiles are not "essential to the functioning of society" since some would contend that society can continue to function without these conveniences. This narrow and inappropriate interpretation fails to properly account for the fact that these types of products are highly beneficial and are an essential feature of our society. Similarly, under a narrow interpretation of "essential" it could be argued that products such as refrigeration units are not "essential to health" since people can live healthy lives without refrigeration. However, this narrow interpretation ignores the critical role that refrigeration plays in supporting good health by preventing food spoilage and preserving pharmaceuticals. These are just a few examples of the types of products that, if they became unavailable, would cause massive social and economic dislocation. To avoid this type of disruption and unintended consequences, we strongly urge MPCA to adopt a broad interpretation of "essential".

The consideration of essential should also consider the critical end uses that PFAS technology enable including consideration on how uses enable product longevity, energy efficiency, sustainability and other important societal considerations.

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Yes, MPCA should consider cost when identifying alternatives, and this should include a comprehensive assessment of costs.

In terms of cost, MPCA should not assume that the adoption of an alternative will be cost neutral in terms of the manufacturing process. Critical cost considerations, including retooling production facilities, changes in production yield, workforce training, and disposal costs should be factored in to alternatives. MPCA should also consider the substantial cost associated with replacing products more frequently due to relatively less durability. There will also be broader supply chain costs and impacts to consider.

As noted in our comments, the availability/economic feasibility analysis must consider costs other than price as part of the availability analysis. A substitute chemistry may require process or equipment changes; labor force changes; raw material sourcing changes; and so forth that impact the total cost of the substitution well beyond what an equivalent or similar price is for purchase of the chemical would be.

Evaluation of cost and availability should consider whether any potential substitution will be available at scale during the time for transition. If an entire industry were to switch on a short timescale from one chemical to another, this would create significant scale-up pressures on existing manufacturers and relevant supply chains. This is even more relevant for complex products which have multiple components and require product testing to confirm they meet designated safety and performance standards. In these cases, products must be carefully redesigned, reengineered, and recertified. Such product redesign and recertification processes for complex sectors may take several years so the lead time for these changes needs to be factored into the assessment. We note a recent supply chain challenge regarding the chemical PIP (3:1). Subject to a risk management action under the Toxic Substance Control Act (TSCA), the agency moved earlier this year to a restriction with a phase-out schedule that could not be met by global supply chains. PIP (3:1) was present in manufactured durable goods, like washing machines, and electronics that have multi-year sell inventory and sell-through schedules. The risk of global supply chain disruption from discontinuation of the availability of a commercially important chemical without adequate due diligence with respect to the availability of alternatives can have real, and significant consequences as this example illustrates.

Finally, as noted elsewhere in these comments, MPCA should utilize established frameworks and methodologies to evaluate cost-benefit considerations for a particular use.

ACC understands Minnesota has diverse citizenship with wide ranges of incomes. For some, even minor cost increases can be significant. MPCA should consider what effect the adoption of an alternative might have on the price and availability of the final good and whether such a price increase would affect disadvantaged communities access to important products, including technology like cell phones, computers, and automobiles.

3) Should unique considerations be made for small businesses with regards to economic feasibility?

The Minnesota State Legislature did not to provide small business considerations in crafting this new law. Without provisions that cater to small business, they will be disproportionately burdened with costs associated with reporting requirements, testing products, and qualifying alternatives. MPCA should consider critical supply chains supported by small businesses and the impacts associated with this rulemaking. As noted elsewhere, some of these unique considerations should also apply to related suppliers and global supply chains.

4) What criteria should be used to determine the safety of potential PFAS alternatives?

Any potential alternative should undergo a thorough safety assessment to help avoid regrettable substitution. Such analysis should be conducted on a life-cycle basis. Mere consideration of the hazard characteristics of a chemical is not sufficient and may result in regrettable substitution so a more comprehensive environmental health and safety analysis is required. ACC urges MPCA to compare the use of the alternative with the current product or product component. MPCA should also consider sustainability impacts in criteria, including water use, consumption of raw materials, emissions reduction, energy efficiency, reliability during use, and avoiding the use of landfill capacity. MPCA should include an evaluation for increased product or product component failure. Most importantly, criteria developed for testing alternative products should seek to have a reduced potential for risk to human health and the environment.

MPCA should take hazard, exposure, and risk into account in its alternatives assessment process. The Organisation for Economic Co-operation and Development (OECD) Alternatives Assessment framework[ii] defines "safer alternative" to mean "a chemical, product, or technology that is preferable, in terms of both hazard and potential for exposure to humans and the environment, than the existing option. Evaluating comparative hazard and exposure is an element of the process." In this framework, the OECD notes the "process of determining whether a chemical, product, or technology is "safer" consists of three key steps: comparative hazard assessment, comparative exposure assessment, and integration of hazard and exposure information." To avoid such regrettable outcomes, both the OECD and NAS alternative assessment frameworks recommend the use of comparative exposure assessment.

The alternatives assessment framework also considers broader sustainability factors and evaluates performance, technical feasibility, and economic feasibility before a conclusion may be reached regarding a preferred alternative. A hazard-only approach is not a best practice for alternative assessment.

As noted in our comments, there are established frameworks that can help inform MPCA's analysis of alternatives.

ACC urges MPCA to articulate the criteria that will be used for comparative evaluations of potential risk in the final rule and to seek additional public comment on these criteria.

5) **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?**

Unavoidable use determinations should last until demonstrably safer and more sustainable alternatives are discovered and can reasonably be implemented at scale in the economy. Significant changes in available information should trigger a re-evaluation. Re-evaluation should apply not only to the use of a substance with a CUU, as well as any alternative that was identified as the basis for denying at CUU.

In no case should re-evaluations take place more frequently than 10 years. ACC recommends MPCA consult with potentially affected industries to determine if a longer re-evaluation period may be necessary to evaluate alternatives or otherwise provide information for the re-evaluation process.

For any CUU that is declined (including CUUs that were granted and then subsequently declined on reevaluation), manufacturers must be provided adequate time to transition to the alternative. ACC urges MPCA to consider that the time needed to test and qualify an alternative may differ for various product or product component applications.

6) **How should stakeholders requests to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be**

determined to be currently unavoidable? What information should be submitted in support of such requests?

MPCA will need to establish a process that manufacturers and users (or their representatives) can request a CUU determination. The process should be flexible to accommodate multiple uses of a product or product component rather than applying use by use to synthesize the process and avoid an unnecessary time burden for MPCA and stakeholders. Requests for CUU determinations should be permitted to be submitted by individual product manufacturers or collectively by trade associations or similar organizations. When a CUU is approved by MPCA, it should apply to all manufacturers involved with that particular use, regardless of which entity submitted the request for a CUU determination.

A manufacturer that makes a timely submission of a request for a CUU determination should not be penalized if MPCA is unable to process the request by the statutory deadline of January 1, 2026, for identifying CUUs. In such cases, the manufacturer should be exempt from the ban until MPCA makes a final determination that the use is not a CUU.

ACC urges MPCA to consider the challenges in time and workload associated with accepting stakeholder requests that identify PFAS uses that are not currently unavoidable. This converse reporting option risks slowing down reviews for alternative uses and delays getting the safest products to consumers. Should MPCA move forward with the converse idea, ACC notes the information requirements for either request should be identical. No party in the process should have a relatively higher or lower bar for substantiating its request.

ACC also reiterates that any process surrounding granting or re-evaluation of a CUU must protect confidential business information.

7) **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.**

PFAS are a diverse form of chemistry that contribute to the functions of society – from transportation sources and medical devices to food packaging and basic construction materials, PFAS are woven throughout our daily lives. ACC urges MPCA to thoroughly and thoughtfully consider all product and product component applications submitted as part of this rulemaking process.

There will likely be thousands of submissions for evaluation. While many of these will likely be able to be grouped according to general industrial and commercial sectors, there will be multiple applications and uses within each sector. For an example of magnitude, the broad sector of electronic equipment which relies heavily on fluoro technology, accounts for more than a hundred pages of the U.S. International Trade Commission's Harmonized Tariff Schedule codes.

To help inform MPCA's inquiry, one information source is the recent comment period for the EU PFAS Regulations. In that process over 5000 stakeholders provided initial input including specific background on critical uses with examples of the many thousands of products that would be impacted available here.

Additional information on key uses of fluoro technology and its scope are available here, and the recently completed Department of Defense Report also outlines the numerous critical sues within this specific sector.

8) **Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?**

ACC supports MPCA proposing initial CUU determinations as part of the rulemaking process. This will help create greater market certainty and ensure more of the products Minnesotans rely on for daily life can remain accessible.

9) **Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.**

Some CUU determinations will require MPCA to determine whether reasonably available alternatives exist. These comments outline important considerations that need to be part of such analysis. The basis for such determinations must be consistent, fair, transparent, and well-defined. MPCA should propose objective criteria for determining when alternatives are or are not "reasonably available," taking into consideration factors such as performance, safety, total cost of ownership, and reduced potential for risk to human health or the environment when compared to products or product components made with alternatives. See the above comments regarding other key considerations for evaluating uses.

ACC strongly supports the use of sound scientific principles during any rulemaking that impacts chemistry in commerce, and we stand ready to work with the MPCA during this process. Thank you for the opportunity to provide comments during this pre-rulemaking comment period. Should you have any questions or concerns, please reach out to Abbey Linsk by email at abbey_linsk@americanchemistry.com.

Sincerely,

____

Robert J. Simon, Vice President, Chemical Products and Technology
American Chemistry Council

[i] https://nap.nationalacademies.org/catalog/18872/a-framework-to-guide-selection-of-chemical-alternatives
[ii] https://www.oecd.org/chemicalsafety/risk-management/guidance-on-key-considerations-for-the-identification-and-selection-of-safer-chemical-alternatives.pdf

RECEIVED
By: OAH on 3/1/2024

AmericanCoatings ASSOCIATION℠

March 1, 2024

Katrina Kessler, Commissioner
Minnesota Pollution Control Agency
520 Lafayette Road North,
St. Paul, Minnesota 55155-4194

Re: MN PFAS in Products, Currently Unavoidable Use Rule
Submitted to the Office of Administrative Hearings online at:
https://minnesotaoah.granicusideas.com/
Submitted prior to 4:30 p.m. Eastern

Dear Commissioner Kessler:

The American Coatings Association ("ACA")[1] appreciates the opportunity to provide comment regarding currently unavoidable uses under Minnesota's PFAS in Products Currently Unavoidable Use Rule. The Association's membership represents 90% of the U.S. paint and coatings industry, including downstream users of chemicals who manufacture end-use formulated products such as paint, coatings, sealants and adhesives. ACA appreciates the significant challenges the agency faces in implementing Maine's PFAS in Products Law, and we appreciate DEP's willingness to engage with stakeholders during this process. ACA is commenting in response to DEP's request for information towards developing criteria for "currently unavoidable use."

Minnesota's Products Containing PFAS Statute (Ch. 60, Art. 3, Sec. 21 [Minnesota Statutes Ch. 116.943]) defines, "currently unavoidable use" as:

> "Currently unavoidable use" means a use of PFAS that the commissioner has determined by rule under this section to be *essential for health, safety, or the functioning of society* and for which *alternatives are not reasonably available.*

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[1] ACA is a voluntary, non-profit trade association working to advance the needs of the paint and coatings industry and the professionals who work in it. The organization represents paint and coatings manufacturers, raw materials suppliers, distributors, and technical professionals. ACA serves as an advocate and ally for members on legislative, regulatory and judicial issues, and provides forums for the advancement and promotion of the industry through educational and professional development services. ACA's membership represents over 90 percent of the total domestic production of paints and coatings in the country.

MPCA seeks comment regarding the two elements of "currently unavoidable use," as it effects: 1) essentiality of PFAS; and 2) reasonably available alternatives.

ACA welcomes the opportunity to provide comment on this matter. As a general observation, use or manufacture of paint, coatings, sealants or adhesives is not the cause of PFAS contamination in the State of Minnesota. As described below, these products provide essential benefits by facilitating functionality of critical infrastructure, water delivery systems, specialized industrial uses, buildings, equipment, medical devices, etc. PFAS contamination in the state is caused by mishandling of PFAS, including improper disposal at manufacturing sites and discharges of PFAS-containing firefighting foam, often occurring decades ago. PFAS, however, can be used safely in our products without the effects associated with mishandling of PFAS.

ACA and its members respectfully submit the following comment addressing "currently unavoidable use" criteria:

I. Criteria for essentiality of PFAS

ACA suggests that Minnesota harmonize approach to currently unavoidable use of PFAS with Maine, where currently unavoidable uses are products determined to *be essential for health, safety or the functioning of society*. Maine DEP further describes "essential for health, safety and functioning of society" as:

> Essential for the Functioning of Society includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, and construction.[2]

Federal agencies have also recognized products used in construction as essential to the functioning of society. During the COVID-19 pandemic, the U.S. Department of Homeland Security, Cybersecurity & Infrastructure Security Agency, worked with other agencies to issue a definitive federal list of essential workers by industry sector. The federal government deemed manufacture of building materials as an essential industry, recognizing "painting and coating" as an essential function within this industry sector. Agencies recognized manufacture and commercial operations related to all building materials as essential, with "paintings and coatings" as one example. Building sector products also typically include sealants and adhesives.[3]

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[2] See Maine Department of Environmental Protection request for proposals on currently unavoidable uses in products, available online at: https://www.maine.gov/dep/spills/topics/pfas/PFAS-products/cuu.html

[3] DOH, CISA, with other federal agencies, *Ensuring Essential Critical Infrastructure Workers Have the Ability to Work Safely*, p. 21-22, v. 4.1 (Aug. 5, 2021), designating all building materials and workers facilitating manufacture and commercial operations of building materials, including but not limited to "painting and coatings" as essential. Available online at: https://www.cisa.gov/sites/default/files/publications/essential_critical_infrastructure_workforce-guidance_v4.1_508.pdf

When considering essentiality, MPCA should also consider the benefits of specialized industrial uses of PFAS. Specialty industrial coatings containing fluoropolymers are critical to manufacturing and machinery, national defense, energy infrastructure, mass transport and transportation infrastructure. Specialized industrial coatings applications typically do not cause contamination under normal use. Additional information is included in Section III below, in response to MPCA's Question No. 7 from its Request for Comment, requesting information about products.

II. Criteria for Reasonably Available Alternatives

MPCA has requested comment about criteria for reasonably available alternatives and whether criteria should include consideration of costs. ACA suggests that reasonably available alternatives must meet criteria for 1) environmental and health effects associated with substitution; 2) reasonable costs of substitution; and 3) technical feasibility of alternatives, including performance characteristics and availability of supply.

MPCA must consider environmental and health effects of each potential substitute with characteristics of the individual PFAS chemistry being phased out. Since PFAS encompasses thousands of fluorinated chemistries with varying toxicological profiles, substitution comes with a high risk of replacing a benign fluorinated chemical with a substitute of potentially unknown or greater hazard. Product manufacturers should be allowed to submit relevant information to MPCA regarding factors. MPCA must make a case-by-case determination.

MPCA must also consider cost of substitution. ACA and its members anticipate significant costs associated with developing viable substitutes in coatings used across a variety of demanding conditions, such as pipelines, defense equipment and infrastructure, bridges, buildings, etc. In many instances, "drop-in" substitutes are not available for high-performance coatings that rely on fluorinated chemistries for performance characteristics. As such, costs will be associated with R&D and product development. Efficacy of substitution must also be factored into a cost analysis. A less effective coating results in greater costs over time from more frequent coating. An OECD market study considering non-PFAS coatings for construction and critical infrastructure concludes that coatings without PFAS are not as durable, requiring more frequent repainting, increasing costs.[4]

ACA does not recommend establishing a single threshold cut-off for unreasonable cost increases vs. reasonable cost increases. ACA recommends MPCA make a case-by-case determination based on overall potential costs considered with changes to performance and any health and environmental effects of substitution.

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[4] See *Alternatives in Coatings, Paints and Varnishes (CPVs) (Report on the Commercial Availability and Current Uses,* available online at: https://www.oecd.org/chemicalsafety/portal-perfluorinated-chemicals/per-and-polyfluoroalkyl-substances-alternatives-in-coatings-paints-varnishes.pdf).

MPCA's consideration of technical feasibility of alternatives, including performance and availability of supply, is critical to implementation of the law. When dealing with other (non-PFAS) chemical ingredients, ACA members have faced situations where state regulators identify an alternative raw material that is not readily available on the market and/or does not perform in the same manner. In effect, where a regulation intended to phase out a potentially hazardous chemical, state implementation would have functioned as a broad product ban affecting critical industry sectors.

III. ACA responses to questions posed by MPCA

In developing the currently unavoidable use rule, the MPCA would appreciate comments on the following questions. ACA's responses are included below:

1) Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

   ACA Response: ACA encourages recognizing the essentiality of certain product categories by referencing critical industries recognized by federal agencies and the definition of essentiality in the State of Maine, while also considering specialized industrial coatings. See Section I above.

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

   ACA Response: Consideration of costs, technical feasibility and environmental and health effects of substitution are critical considerations when determining if a substitute is "reasonably available." Cost thresholds must be determined on a case-by-case basis. Please see Section II above for additional discussion.

3) Should unique considerations be made for small businesses with regards to economic feasibility?

   ACA Response: Yes, small businesses often do not have the compliance resources, including resources to identify alternatives, reformulate products and to manufacture using a more expensive raw material, assuming one is available. ACA recommends incorporating small business considerations into assessment of availability of substitutes.

4) What criteria should be used to determine the safety of potential PFAS alternatives?

   MPCA must consider both hazard characteristics and risk profile of alternatives as compared to the PFAS chemistry currently in use. When considering PFAS, EPA has typically referenced its PBT (persistent, bioaccumulative and toxic) criteria. MPCA can also consider hazards as identified in OSHA's Hazard Communication System at 29 CFR 1910.1200. A substitute can also affect risk associated with coating application. In cases where a substitute renders a coating less effective, a substitute can cause additional risk due to increased usage from more frequent application, possibly in greater quantities. This can result in greater exposure to paint applicators and disposal of waste materials.

Another consideration is the impact on safety caused by substitution in a coating or other construction product that has a proven track record of high performance, enhancing durability and preventing corrosion of critical infrastructure, buildings, industrial parts, machinery, pipelines, water delivery systems, medical devices, etc. Substitution can detract from safety of a product or infrastructure due to increased corrosion or other changes to product functionality. In challenging outdoor environments like those encountered in Minnesota, this consideration is particularly critical. Another example is the critical function of intumescent coatings applied to buildings and other infrastructure designed to delay or stop fires from spreading. These coatings perform a critical safety function by allowing additional time for emergency personnel to respond. When considering the safety function of paints, coatings, sealants and adhesives, MPCA should further note that these products are not associated with PFAS contamination in the State.

5. How long should PFAS currently unavoidable use designations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

   ACA Response: This will vary depending on the essentiality of the type of PFAS being substituted. In the coatings industry, certain high-performance, specialty coatings have no available substitute, and substitution would cause environmental effects. In other uses, coatings manufacturers may be able to reformulate within 10 years.

   Reformulation may include identification of substitutes and/or developing replacement technologies requiring overall product reformulation. Industry is currently working towards this end, but this is a time-consuming process requiring research and development, efficacy testing that includes evaluation of government and other client specifications, evaluation of environmental and health effects and risk mitigation strategies and time for EPA's approval process. EPA's TSCA (*Toxic Substances Control Act*) review process alone can take several years, often resulting in indefinite delays. ACA would welcome the opportunity to discuss identification of new technologies and the process for phasing out PFAS in more detail with MPCA.

6. How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

   ACA Response: Currently unavoidable use determinations should be made in consultation with product manufacturers. ACA recommends an application process where a product manufacturer would address criteria for essentiality and reasonably available alternatives. ACA further recommends MPCA allow meetings with MPCA staff and the product manufacturer to discuss and clarify application and considerations. ACA further recommends providing a written determination explaining MPCA's decision and application of currently unavoidable use criteria. The stakeholder process should be limited to the product manufacturer, since the product manufacturer is best leveraged to describe technical specifications related to the product, potential environmental and/or health impacts, current risk mitigation strategies during product use, etc.

Opening the process to general stakeholders is likely to flood MPCA with generic information related to uses and hazards of PFAS already known to the agency or readily accessible in the public domain and/or information that is not narrowly tailored to the chemical or specific use at issue. This could include information based on inappropriate surrogate substances, speculative data and/or data incorporating modeling methods based on inappropriate assumptions.

Considering the potential for error, any open stakeholder process should be accompanied by a subsequent opportunity for a chemical supplier, manufacturer and end-use product manufacturer to address concerns and provide additional data. This would also provide a more complete record for later review by MPCA or other judicial bodies. To that end, MPCA's decision process should include both an administrative and judicial appeals process.

7. In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

ACA Response: ACA encourages a general exemption for paint, coatings, sealants and adhesives manufactured with fluoropolymers. Fluoropolymer resins perform an important role in specialty industrial coatings that are critical to manufacturing and machinery, national defense, energy infrastructure, mass transport and transportation infrastructure.

Adhesives and sealants that incorporate trace amounts of PFAS are used in specialized applications including construction adhesives for residential waterproofing, high performance industrial gaskets sealants, mold release agents in manufacturing and specialized high performance silicone sealants. Use of these products is not associated with contamination in the State of Minnesota. They are also critical to preventing deterioration on a variety of substrates in a challenging environments such as Minnesota.

Fluoropolymer binders are essential for providing the kind of durability, safety, and sustainability that permit long lifespan protective coatings for critical infrastructure such as bridges, buildings, and other structures, required to meet performance standards and specifications. Fluoropolymers are recognized by several regulators as being chemically stable, non-toxic, non-bioavailable, non-water soluble and non-mobile. While noting that MPCA is not seeking complete information at this time, ACA will provide additional references and information when MPCA has defined criteria and is prepared to consider products for a currently unavoidable use designation.

Briefly, we note one reference from the Department of Defense, *Report of Per and Polyfluoroalkyl Substance Uses* (Aug. 2023)[5], providing additional information at p. 13:

> Fluoropolymers are used in resins for specialty high-temperature or weather-/UV-resistant composites due to their temperature-, pressure-, wear-, and chemical-resistance properties. Fluoropolymers are also used in high cleanable, high weathering and chemical resistant coatings for military assets. Many aircraft topcoats contain fluoropolymer resins due to their UV and chemical resistance properties. PFAS are not actually in the coatings themselves but are used in fluoropolymer resin manufacturing. Moving to alternatives in under 10 years may require a return to previous methods of parts construction which produced shorter life and higher weight composites with lower performance characteristics.

ACA would also seek a general exemption for paint, coatings, sealants and adhesives incorporating solvents with a single fluorinated carbon atom. Such solvents are used to manufacture low-VOC emitting paints, and they are not associated with contamination.

8. Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

   ACA Response: ACA supports early decision-making for unavoidable use. However, ACA does not support a determination prior to finalizing criteria. At the proposal stage, criteria is subject to changes that could result in an unfair advantage to companies, if MPCA makes a determination based on proposed, rather than final criteria. ACA encourages MPCA to consider unavoidable use determinations while finalizing criteria to ensure consistent application and a rapid determination of unavoidable use shortly after final publication of criteria.

9) Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination

   ACA Response: See Sections I & II above.

IV. Conclusion

ACA encourages developing a clear and consistent understanding of risk posed by PFAS in products. To that end, ACA encourages MPCA to harmonize its approach to construction products with existing designations developed by Maine and federal agencies, while further developing detailed criteria to evaluate availability of alternatives and the effects of

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[5] *Report of Per and Polyfluoroalkyl Substance Uses*, p. 13 (Aug. 2023), available online at: [Report on Critical Per- and Polyfluoroalkyl Substance Uses (osd.mil)]

substitution. MPCA should also further consider essentiality of specialized industrial applications used in critical machinery, pipelines, water delivery systems, etc. ACA has submitted similar comment to the State of Maine.

ACA also encourages MPCA to develop a process so companies can apply for a “currently avoidable use” designation on a rolling basis, past the reporting deadline. This flexibility will allow companies to complete analysis of its products, use of PFAS substances and potential for substitution.

ACA appreciates the opportunity to submit this comment. Please let me know if I can provide any additional information.

Sincerely,

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RECEIVED
By: OAH on 3/1/2024
Daniel Moyer
Attachment 1

Consumer Technology Association™ ITI

March 1, 2024

Katrina Kessler
Commissioner
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, Minnesota 55155

Re: Consumer Technology Association and Information Technology Industry Council Comments on Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing PFAS

Dear Commissioner Kessler:

On behalf of the Consumer Technology Association (CTA)[1] and the Information Technology Industry Council (ITI),[2] we respectfully submit these comments on the Minnesota Pollution Control Agency's (MPCA) planned new rules governing currently unavoidable use (CUU) determinations about products containing per-and polyfluoroalkyl substances (PFAS).

Minnesota Statutes Section 116.943[3] restricts the sale of products containing intentionally added PFAS beginning January 1, 2032, unless MPCA determines by rule that that use of PFAS is a currently unavoidable use. Certain uses of PFAS in electrical and electronic devices are essential to the health, safety, and functioning of society and do not have available alternatives. We respectfully ask that MPCA through its rulemaking ensure that the essential commercial uses of PFAS in electric and electronic products are maintained.

CTA previously submitted comments[4] on a separate MPCA rulemaking (the Reporting Rule) to implement Section 116.943, subdivision 2, which requires reporting on intentionally added PFAS in products by January 1, 2026. We reiterate our request in those comments that the MPCA grant a reporting deadline extension for the electronics sector and provide clarity on the substance of reporting.

Our comments below are organized around the questions MPCA solicited feedback on regarding CUU determinations rulemaking:

[1] CTA is North America's largest technology trade association. Our members are the world's leading innovators – from startups to global brands – helping support more than 18 million American jobs.
[2] The Information Technology Industry Council (ITI) is the premier advocacy and policy organization for the world's leading innovation companies. ITI navigates the constantly changing relationships between policymakers, companies, and non-governmental organizations to promote creative policy solutions that advance the development and deployment of technology and the spread of digitization around the world.
[3] https://www.revisor.mn.gov/statutes/cite/116.943
[4] https://www.pca.state.mn.us/sites/default/files/c-pfas-rule1-02.pdf

1. Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?

Criteria should be clearly defined for "essential for health, safety, or the functioning of society." This criteria should not rely on narrow, ambiguous, or subjective definitions that could lead to arbitrary or potentially harmful outcomes. The MPCA CUU rule should establish criteria for each of the three terms within "health, safety, and the functioning of society." Industry will rely heavily on these definitions, so it is essential to have regulatory certainty on the meaning of these terms.

We encourage MPCA to engage with the Maine Department of Environmental Protection in their development of definitions and criteria. We hope to avoid different standards in different states resulting in a costly patchwork. In their rulemaking last year, Maine DEP proposed the following definition[5]:

> "Essential for Health, Safety or the Functioning of Society" means products or product components that if unavailable would result in a significant increase in negative healthcare outcomes, an inability to mitigate significant risks to human health or the environment, or significantly interrupt the daily functions on which society relies. Products or product components that are Essential for Health, Safety or the Functioning of Society include those that are required by federal or state laws and regulations. Essential for the Functioning of Society includes but is not limited to climate mitigation, critical infrastructure, delivery of medicine, lifesaving equipment, public transport, and construction."

While we support harmonization across states, CTA did have some concerns with this definition. In CTA's comments to DEP, we said[6]:

> The last sentence of this definition lists out a series of examples for what is considered essential for the health, safety, or the functioning of society. We are concerned that this list unnecessarily limits the definition, reducing DEP's future flexibility in granting exemptions for necessary products. We note that there are numerous other vital categories such as communication, food production, social interaction, recreation, education, law enforcement, research and development, energy production, and countless others that are not included within this list of examples. We ask that DEP not limit its future determinations on this issue and make clear that this term can be interpreted to encompass a wider range of potential needs.

Additionally, CUU determinations should not be only determined on a finished-products level but should be established based on the specific use of PFAS instead. Limiting CUU determinations to finished products would likely result in Minnesota prematurely deciding that some products have currently unavoidable uses while missing others. Any CUU determination should not only apply to the end product itself, but to each of the products and processes in the supply chain that are necessary to produce that product. Without this, a determination could be worthless or at least undermined given that it is not possible to produce the end product without these upstream products and processes.

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5 https://www.maine.gov/tools/whatsnew/attach.php?id=10415809&an=2

6 https://www.maine.gov/dep/ftp/temp/PFAS-in-Products/comments%20on%20public%20notice%2002-14-2023/CTA_Comment%20on%20Chapter%2090_%20Products%20Containing%20PFAS.pdf

The European Union has invested significant technical resources in defining the essential use concept and associated criteria to help phase out PFAS chemicals. We recommend MPCA also consider the results of this effort in defining criteria for determining "essential for health, safety, and the functioning of society."

2. Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

Costs must be considered in the definition of whether an alternative is "reasonably available." Cost is a reflection of an alternative's actual commercial availability. The cost threshold cannot be set with an arbitrary threshold but instead should be defined with flexibility.

MPCA should conduct economic analyses to determine whether alternatives are reasonably available. A significant increase in cost and waste is anticipated due to the R&D involved in manufacturing products using alternatives, accompanied by a lower production in products in general. This would significantly impact certain businesses, and at this time there is no guarantee that alternatives are available for all PFAS uses in the tech sector. Products with PFAS alternatives should also be able to obtain the same quality certifications, satisfy customer standards, and evaluations.

For an alternative to be "reasonably available," it should not result in a decrease in availability, performance, life expectancy, or durability of the product or the supply chain production activities associated with that product. A reasonably available alternative should not result in a significant increase in manufacturing, design, testing, capital investment, or other costs for the product or for the supply chain production activities associated with that product. The definition for "reasonably available" alternative should also factor in that an alternative should not result in increased risks to human health or the environment compared to intentionally added PFAS.

Products such as complex electric and electronic products do not exist in a vacuum; instead, these products sit in various stages of supply chains and the evaluation of an alternative must include how the alternative may affect other parts of the chain. The evaluation of costs should consider not only the cost of the particular alternative, but the cost of the whole project of designing and implementing that alternative. This includes an evaluation of redesign and replacement costs, how the costs of identified alternatives would vary by product category, and the changes that may be required to processes, equipment, labor forces, and raw material sourcing.

The risks of alternatives must be assessed from a life-cycle approach and avoid regrettable substitutions. Regrettable substitution occurs not only from "an alternative that may actually pose similar or higher chemical risks, but also the substitution by alternatives that may be unsustainable from a lifecycle (or footprint) perspective, taking into account energy consumption, sourcing resource efficiency or may lead to loss of performance and/or decreased life expectancy of the product." This is in line with Organisation for Economic Co-Operation and Development (OECD) guidance: Substitution planning involves an evaluation of safer alternatives from a comparative hazard and exposure perspective, as well as "a broader set of environmental, social, and economic factors . . . includ[ing] 'upstream' and 'downstream' chemical or product impacts, resource depletion, circularity, energy use, climate change potential, environmental justice considerations, and worker and community health and well-being." [7] The MPCA should heed OECD's direction in crafting the CUU Rule.

4. What criteria should be used to determine the safety of potential PFAS alternatives?
Determining the safety of potential PFAS alternatives is not part of the statutory requirements of a CUU determination. However, we believe that safety determinations may come into play in the evaluation of whether a PFAS use has a reasonably available alternative. In Question 2 above, we suggest that MPCA should not consider a PFAS alternative as "reasonably available" if it would lead to an increased risk to health or safety. Safety must be assessed under a risk-based framework and lifecycle approach. MPCA would also have to conduct thorough assessments of the risk associated with the PFAS an alternative would be replacing in order to properly compare the relative safety of an alternative.

5. How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided? Should significant changes in available information about alternatives trigger a re-evaluation?
MPCA should clearly state how long CUU determinations are effective when it creates its CUU rule. Given that the estimates for finding and implementing PFAS alternatives for many uses in the electronics sector may range from 5-12 years,[8] we recommend that MPCA grant CUU determinations for the electronics sector for 12 years. At minimum, all products given a CUU determination should be for at least 5 years with a possibility of renewals. MPCA will likely receive requests for CUU determinations for thousands of products and it would be a large and ongoing expense for MPCA to continually run, and for manufacturers to navigate, such a technical and time-consuming exercise.

6. How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?
Since Maine has a similar law and its Department of Environmental Protection is already undergoing a similar CUU determination process, we encourage MPCA to coordinate with the Maine DEP to align definitions of CUU and to create an approach that allows manufacturers to submit CUU requests that can apply to multiple jurisdictions. We also ask that MPCA grant CUU determinations for products which have been granted CUU determinations in other states.

[7] OECD, Guidance on Key Considerations for the Identification and Selection of Safer Chemical Alternatives (2021), https://www.oecd.org/chemicalsafety/risk-management/guidance-on-key-considerations-for-the-identification-and-selection-of-safer-chemical-alternatives.pdf

[8] Attachment titled "DIGITALEUROPE - uPFAS use-specific derogation requests electronics_September 2023"

The MPCA should encourage the option for CUU determination requests to be submitted by groups of manufacturers or trade groups with comparable use cases of specific PFAS or categories of PFAS. This will allow manufacturers to pool resources in requesting determinations, and it will ease the reviewing burden on the MPCA by preventing the submittal of duplicative requests. Requesting determinations as a group is also consistent with a recent request for proposals on CUU determinations announced by Maine DEP.

As part of the determination process, the MPCA must adopt a well-defined CBI framework for any information that manufacturers must include in their requests in order to protect valuable intellectual property that may otherwise be jeopardized. The electronics sector treats the chemical composition of materials, as well as production and sales volume data, as proprietary information that is carefully protected and of significant commercial value. Any CUU Rule must therefore contain explicit language explaining how manufacturers may provide CBI as part of their requests in a generic/sanitized manner, how MPCA will evaluate CBI claims, and how such CBI will be stored and ultimately protected from unlawful disclosure to third parties.

MPCA should be cognizant of the fact that upstream suppliers may be reluctant to provide manufacturers with specific information about PFAS used in products and components. Upstream suppliers may claim that the use of PFAS are essential but not provide additional details due to confidentiality concerns. Therefore, supplier statements should be allowed to be submitted to substantiate a manufacturer's request. If MPCA insists on obtaining data from upstream suppliers, it should set up a system that would allow suppliers to provide information directly to MPCA, though we recognize this could create procedural hurdles as well.

Stakeholders should not be able to request that a PFAS use not be determined to be currently unavoidable. Especially given CBI considerations, such requests are unlikely to have a direct understanding of the product at issue. Requests that a PFAS use not be determined to be currently unavoidable would be unnecessary anyway, since non-manufacturer stakeholders would have an opportunity to submit public comments on any proposed MPCA rulemaking designating a use as currently unavoidable.

The MPCA should be required to timely respond to requests before the compliance deadline of January 1, 2032. If the agency fails to timely respond to a request, that should function as an automatic determination for as long as the MPCA is late. This is critical to prevent a situation where a manufacturer is forced make a product unavailable to Minnesotans because the MPCA was delayed in making a determination. It is also consistent with exemption protocols under other chemical regulatory regimes, such as RoHS Article 5 where an existing exemption to the directive's restrictions remains valid until a decision on a renewed exemption application is made by the European Commission. The CUU Rule should employ a similar logic to account for potential delays in determination decisions.

7. In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present

your full argument and supporting information for a possible currently unavoidable uses determination.
To streamline requests from manufacturers in the electronics industry, MPCA should grant a CUU determination for all PFAS uses in components of electric and electronic products. MPCA should expect a very large number of requests, many of which will be from manufacturers of products which contain electric and electronic components. As an example, the European Chemicals Agency (ECHA) received over 5,600 comments on its PFAS restriction proposal under REACH, many of which were from stakeholders in our industry.[9]

Electric and electronic products are essential for health, safety, and the functioning of society for countless reasons. These products make modern life possible, and they include but are not limited to computers, phones, tablets, printers, and the equipment used to support such devices such as cables, cords, batteries, and data enter equipment. Alternatives for intentionally added PFAS are not reasonably available for many internal components of electric and electronic products. It is anticipated to take many years just to identify PFAS in these components, let alone implement alternatives. This identification process will involve significant costs since a single electric or electronic product can have thousands of internal components which are sourced from numerous suppliers around the world.

While a CUU determination for components of electric and electronic products is justified as explained above, the determination should at the very least cover the PFAS uses with requested derogations in DigitalEurope's comments[10] to ECHA concerning the PFAS restriction proposal under REACH. These uses include:

- Printer related uses (e.g., printheads, sealing materials, valves and pumps in inkjet printers, uses of PFAS in factories where inks are manufactured, electrophotographic printers, paper guiding parts);
- Lithium-ion batteries (e.g., cathode and separator binder material for lithium-ion battery cells);
- Coating materials (e.g., coating and paint for enhanced abrasion resistance in electrical and electronic equipment, coating in connectors, optical isolation layers for display applications);
- Anti-dripping agents (to help prevent propagation of flames in case of fire);
- Cables and connectors (e.g., DC cable insulation, coaxial cables and discrete cable insulations and jackets, connector jackets);
- Capacitors;
- Grease and lubricants (e.g., grease/lubricants on mechanical parts in electrical and electronic equipment, lubricants in connectors);
- Cooling in data centers;
- Mechanical applications for electric and electronic equipment (e.g., to meet tribology requirements such as for friction, wear, and lubrication);
- Ingress protection vents for communication devices; and

[9] *See* ECHA, *ECHA receives more than 5 600 comments on PFAS restriction proposal* (Sept. 26, 2023), https://echa.europa.eu/nl/-/echa-receives-5-600-comments-on-pfas-restriction-proposal
[10] Attachment titled "DIGITALEUROPE - uPFAS use-specific derogation requests electronics_September 2023"

- Mobile telecommunication network infrastructure equipment.

To describe how PFAS are used for the functioning of electronics and what alternatives are reasonably available, we are attaching and has listed below notable resources and submissions created by other electronics trade associations from the past year.[11][12][13][14] These documents outline critical uses for PFAS in the electronics sector – essential functions in semiconductors, batteries, capacitors, coatings, and many other electronic components. These documents also outline where there is a lack of proven, available alternatives for many of these uses. While viable alternatives may someday become available for the electronics industry, it may take several years for them to be found, tested, and implemented.

Comments to ECHA on the proposal to restrict per- and polyfluoroalkyl substances (PFAS) in the European Economic Area.[15]

- Submission 4060 from Information Technology Industry Council (ITI) on information technology
- Submission 4349 from the Japanese Electric Wire & Cable Makers' Association (JCMA) on wire and cable
- Submission 4394 from Infineon Technologies AG on electronics and semiconductors
- Submission 4489 from W.G. Gore and Associates GmbH on wire and cable
- Submission 4543 from Japanese Electronics and Information Technology Industries Association (JEITA) on information technology and detailed information on the feasibility of alternatives
- Submission 5927 from DIGITAL EUROPE on spare parts for electronics equipment
- Submission 5991 from an anonymous source on electronics connectors
- Submission 6006 from Rogers VB on PCB and PCB laminates
- Submission 6253 from an anonymous source on information technology
- Submission 6301 from W.L. Gore and Associates GmbH on aerospace and defense
- Submission 6362 from the Test and Measurement Coalition on industrial monitoring and control instruments
- Submission 8621 from IPC on electronics industry applications, internal components, and the availability of alternatives
- Submission 8680 from RECHARGE
- Submission 8884 from Claigan Environmental and the environmental-related comments
- Submission 8780 from DIGITAL EUROPE on electronics industry applications

[11] Attachment titled "DIGITALEUROPE - uPFAS use-specific derogation requests electronics_September 2023"
[12] White paper from the Semiconductor Industry Association on "PFAS-Containing Materials Used in Semiconductor Manufacturing Assembly Test Packaging and Substrate Processes" https://www.semiconductors.org/wp-content/uploads/2023/06/Assembly-Test-Packaging-Substrate-White-Paper1.pdf
[13] A joint statement by several battery trade associations on uses of fluoropolymers in the battery sector. https://rechargebatteries.org/wp-content/uploads/2023/10/FINAL-Joint-statement-on-importance-of-fluoropolymers-wider-initiative.pdf
[14] IPC Response to European Chemical Agency on the Proposed Restriction of PFAS https://emails.ipc.org/links/IPC-Response-PFAS-RestrictionProposal-FINAL22092023.pdf
[15] https://echa.europa.eu/restrictions-under-consideration/-/substance-rev/72301/term

In addition to the materials referenced above, CTA would also like to specifically direct MPCA's attention to the JP4EE Input to Submission Requirements on CUUs which are submitted to Maine DEP this week. They have a thorough examination of this issue regarding the electronics sector.

Additionally, PFAS are currently undergoing regulatory review by several agencies at the federal government. The U.S. Department of Defense recently released a report that identifies several ongoing critical PFAS uses and also states that due to the difficulty of identifying PFAS in supply chains "the information presented represents a fraction of the mission critical PFAS uses due to a lack of knowledge of the complete chemical composition" in equipment.[16]

CTA and ITI have also engaged with the U.S. Environmental Protection Agency (EPA) during the TSCA Section 8(a)(7) Reporting and Recordkeeping Requirements for Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS Reporting Rule) by submitting several rounds of comments.[17][18] Additionally, we submitted comments to the U.S. Consumer Product Safety Commission (CPSC) for their "Notice of availability and request for information on Per- and Polyfluoroalkyl Substances (PFAS) in Consumer Products."[19]

8. Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

We strongly recommend MPCA make some initial determinations as to what uses of PFAS constitute "currently unavoidable use." In our response to Question 7 above, we outline how electric and electronic products have uses for PFAS which do not currently have available alternatives. The electronics sector should be granted a broad CUU determination.

The investigation into the use of PFAS and preparation needed to submit for the reporting portion of the law is anticipated to take a significant amount of time and resources. If initial determinations can be made, that would alleviate some of the burden on the industry to find alternatives that may not exist and allow the industry to focus on complying with the reporting and prohibition requirements where there are feasible alternatives.

9. Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.

When MPCA is considering whether an alternative to PFAS is available, we encourage them to examine the work conducted by the Washington State Department of Ecology under their

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[16] Report on Critical PFAS Uses, U.S. Department of Defense (August 2023), https://www.acq.osd.mil/eie/eer/ecc/pfas/docs/reports/Report-on-Critical-PFAS-Substance-Uses.pdf

[17] CTA, ITI and IPC comments to EPA on TSCA Section 8(a)(7) Reporting and Recordkeeping Requirements for Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS Reporting Rule) (Comment ID: EPA-HQ-OPPT-2020-0549-0087) https://www.regulations.gov/comment/EPA-HQ-OPPT-2020-0549-0087

[18] CTA Comments on EPA SBAR Panel: TSCA Section 8(a)(7) Rule: Reporting and Recordkeeping Requirements for Perfluoroalkyl and Polyfluoroalkyl Substances. https://www.regulations.gov/comment/EPA-HQ-OPPT-2020-0549-0155

[19] CTA Comments to the CPSC Notice of Availability and Request for Information PFAS (Comment ID: CPSC-2023-0033-0049). https://www.regulations.gov/comment/CPSC-2023-0033-0049

Safer Products program. They have created a methodology for determining whether an alternative is feasible and available.[20]

Conclusion

Thank you for the opportunity to submit these comments on MPCA's planned rules governing CUU determinations. We appreciate MPCA's continued engagement with stakeholders and please do not hesitate to contact us at dmoyer@cta.tech if you have any questions regarding our comments.

Sincerely,

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[20] See slides 16-17 https://www.ezview.wa.gov/Portals/_1962/Documents/saferproducts/August_31_2021_Webinar_Presentation.pdf

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Daniel Moyer Attachment 2

DIGITALEUROPE

European Chemicals Agency consultation:

Per- and polyfluoroalkyl substances (PFAS) restriction proposal

– DIGITALEUROPE use-specific derogation requests –

Submitted: 22 September 2023

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EU Transparency Register: 64270747023-20

Table of Contents

Introduction

Shared goal of a safe transition toward PFAS-free electronics

The digital industry has been, and continues to be, committed to improving the environmental performance and safety of all products placed on the market.

DIGITALEUROPE members support moving towards PFAS-free electronics and are actively investigating the uses of PFAS and the availability of alternatives in an effort to substitute PFAS wherever possible in a timely fashion.

It will however take time for the digital and electronics industries to replace PFAS in their products and processes in a safe, responsible manner. There are considerable challenges related to full implementation of PFAS substitution plans in this sector, such as accurately cataloguing PFAS uses across thousands of component articles, identifying and developing non-PFAS alternatives that can meet the safety and performance needs for each application, and the time needed for material qualification, component and full product re-design, testing and certification. In many cases, there are currently no technically viable alternatives known, and they will need to be developed, qualified and made commercially available.

DIGITALEUROPE contributions to the public consultation

In our first contribution[1] to this public consultation, DIGITALEUROPE has highlighted the need for derogations for:

- **Spare parts for repair of finished consumer electronic equipment already placed on the market,**
- **Spare parts for repair of finished professional business-to-business electronic equipment already placed on the market,**
- **Re-supply of articles already placed on the market (pre-owned products)**

In our second contribution[2] DIGITALEUROPE has explained the need for a **general five-year derogation for electronics (in addition to the generally applicable 18-month transition period called for in the proposal)** for electronics suppliers and manufacturers to gather complete, accurate data and to complete the redesign, testing, certification, and production.

For a number of uses of PFAS in electronics, very specific information is already available on why PFAS is used, which substances are used and the feasibility of several alternatives. In the current document an overview is presented of those specific uses for which, in our view, time-limited derogations are required.

Depending on the availability of alternatives and their maturity, a longer (13.5-year) or shorter (6.5-year) derogation is requested. For several uses we request a 6.5-year derogation (5 years on top of the 18-month transition period), these derogations will not be needed if a general 6.5-year derogation is granted for all electronic equipment (as requested in our second contribution).

[1] RCOM 5927, submitted on 28 June 2023
[2] Submitted concurrently with this document

Detailed information is provided to allow the ECHA scientific committees to evaluate these derogation requests. If for any reason more information is needed, we invite the committees to contact us.

Contributions from other sector associations

As also highlighted in our previous contribution to the public consultation, although the total amount (annual tonnage) of PFAS in electronics is very small, the number of different uses is very large. The current document does not intend to provide a complete overview of all derogations that are required in order to secure the availability of electronic devices. Electronic devices contain many components that can have long supply chains. PFAS can be required by other actors in the supply chain. If these uses are critical for their applications, they are also critical for the entire electronics industry. For example, the entire electronics sector depends fundamentally on the availability of cutting-edge semiconductor technology. The semiconductor manufacturing sector generally sits upstream in DIGITALEUROPE members' supply chains. Our understanding is that PFAS uses are irreplaceable for a number of semiconductor manufacturing-related applications, and that PFAS may be used in (or residues found on) semiconductors as well. We therefore strongly support the detailed assessments and derogation substantiations that we understand will be submitted to ECHA by our partners in the semiconductor value chain[3]. Other sector associations have also submitted derogation requests for other uses. We want to emphasize the need to also provide these derogations.

Impact of the restriction proposal and proportionality

Economic study

If the universal PFAS restriction as proposed by the dossier submitters in the Annex XV report would enter into force unchanged, the impact on the electronics industry would be devastating. There are many uses of PFAS in electronics and as REACH requires each individual article in a complex product to comply, the entire product cannot be sold if only one single element of PFAS cannot be replaced in the product.

A recent study by Ricardo Energy & Environment, commissioned by the European Chemical Industry Council (Cefic), estimated the final economic impact of the PFAS restriction on various sectors.[4] A significant number of DIGITALEUROPE members contributed data to the study. The results clearly demonstrate that the PFAS restriction, should it enter into force in its currently proposed form, would have a devastating impact on the economic performance of the electronics industry in Europe. The annual overall turnover losses for computers, small and large printers, electronic and optical products are estimated at 78% against a 2021 baseline. For electronic components, an 84% turnover loss is estimated.[5] This strongly underlines the need for the derogations requested by DIGITALEUROPE in our contributions.

[3] See semiconductor PFAS Consortium of the Semiconductor Industry Association, https://www.semiconductors.org/pfas/.

[4] Ricardo Energy & Environment (2023): Economic analysis of the impacts of a REACH restriction on the manufacture, placing on the market and use of per- and polyfluoroalkyl substances, Report for The European Chemicals Industry Council (Cefic). See Cefic contribution to this public consultation

[5] ibid p. 57-58

Emissions

According to the Annex XV report the emissions to the environment from electronics are less than 1% of all PFAS emissions. Most uses in electronics concern fluoropolymers. Since fluoropolymers do not evaporate, are not water-soluble and are solid, the emission during the use-phase is negligible. Most fluoropolymers are not classified as hazardous according to the EU CLP regulation.

Not granting the derogations that are required to manufacture and sell electronic products would be disproportionate to the low risk of emissions for the environment.

Overview of DIGITALEUROPE use-specific derogation requests

Table 1 presents an overview of all use-specific derogation requests covered in this submission.

Table 1 Overview of DIGITALEUROPE derogation requests

Requested derogation	Requested derogation duration (in addition to the 18-month transition period)
Printer-related uses	
Printheads	12 years
Sealing materials, valves and pumps in inkjet printers	12 years
Factories for ink and printer components	12 years
Electrophotographic printers	12 years
Paper guiding parts	Until 2035
PFAS material in Lithium-ion batteries	
Cathode binder material for Lithium-ion battery cells	12 years
Separator binder materials in Lithium-ion battery cells	5 years
Coating materials	
Anti-fingerprint coating	5 years
Coating and paint for enhanced abrasion resistance in EEE	5 years
Coating in connectors	5 years
Optical isolation layers for display applications	5 years
Anti-dripping agents	12 years
Cables/Connectors	12 years
Capacitors	12 years
Grease & Lubricants	
Grease/lubricants on mechanical parts in EEE	12 years
Lubricant in connectors	12 years
Cooling in data centres	Unlimited
Mechanical Applications	5 years
Ingress Protection Vents for Communication Devices	12 years
Mobile Telecommunication network infrastructure equipment	12 years

1. Printer related uses

In printing equipment and in the manufacturing of inks and toners, PFAS can currently not be replaced in the following applications:

- Print heads
- Sealing materials, valves and pumps in inkjet printers
- Factories for ink and printer components
- Electrophotographic printers
- Paper guiding parts

1.1 Printheads

General summary of the application category

The parts of the nozzle plate of the printhead used in inkjet printers and printing presses produce printed materials at high speed and quality, providing users with printed materials that can be used for documents, photographs, and commercial applications. Taking advantage of the features of digital printing, it contributes to shortening the delivery time and reducing waste such as trial printing, and it continues to develop while mutually complementing conventional analogue printing.

Inkjet printers use PFAS in the parts of the printhead's nozzle plate for ejecting ink for the purpose of developing functions described below.

With the current technology, there is no substitute that can maintain the same quality as PFAS. If PFAS materials cannot be used, a complete redesign of the printing process in the printer is required since the functionality of the printhead is at the heart of the printer. But even after a redesign, the quality of the product will be much worse than current. As a result, there is a risk that the product life will shorten and the environmental impact will increase due to the increase of waste.

There is no substitute at present, so new material development will be necessary, and if the quality equivalent to PFAS cannot be achieved, not only the print head material may need to be changed, but also the unit configuration of the printer body and the control mechanism may need to be redesigned. Because of the required development of new materials and printers including a long-term evaluation, a sufficient exemption period (approximately 12 years) must be set.

The key functionalities provided by PFAS for the relevant use

To provide such an objective at a low cost and with a simple mechanism, PFAS is used in the parts of the print head nozzle plate.

In particular, technological advances in the latest print heads include a decrease in the volume of ink droplets. This serves two purposes. One is to reduce the graininess of the image, which stands out when the droplet size is large. In order to produce high-quality images as required for photography and commercial applications, low graininess is required.

The second purpose is to minimize user costs and the environmental impact of operating inkjet printers. The use of ink can be significantly reduced by efficiently coating the recording media with small ink droplets in high density. This can help reduce the cost of using ink and the CO_2 emissions associated with transportation. And while commercial high-speed printing machines require drying of the ink by evaporation of moisture, the energy required for drying can be significantly reduced to minimize environmental impacts by lowering the droplet volume.

In order to form a print with a minimum amount of ink and with good image quality, the ink needs to land precisely on the medium at a defined location. To make such small droplets of ink to fly stably, it is important that the surface of the nozzle plate is clean and that the nozzle plate does not deform (swell) over a long period of use.

If the surface of the nozzle plate is contaminated, for example, by ink sticking to it, there is a risk that the flight will be bent when ink is ejected from the nozzle plate or that no ink will be jetted at all from that nozzle. Also, even if the nozzle plate swells, the flight angle may change. This results in a bad image quality.

Especially in recent years, the volume of droplets has become smaller. Very small ink droplets are susceptible to contamination of the nozzle plate surface, and the surface must be kept extremely stable.

For this reason, water repellent PFAS materials are used as nozzle plate surface coating to prevent contamination of the nozzle plate surface. PFAS material in the nozzle plate is applied to prevent deformation (swelling) of the nozzles that form the ink channel. Without the use of PFAS materials it is not possible to make the small droplets fly stably in the right direction.

Critical requirements of the nozzle plate coating are- (1) low surface energy & low ink adhesion enables ink to not wet, easy to clean off, no residue left by jetted drop, maintain drool pressure, (2) chemical inertness towards ink, (3) high temp & pressure stability to enable adhesive bonding steps (~ 24 bar, 270 oC) during PH fabrication, (4) ability to be drilled cleanly by lasers yielding crisp & well defined nozzle edges, & (5) Manufacturable (coating on nozzle plate substrate) with tight tolerances.

Information on (lack of) alternatives and supporting arguments

Detailed information on the lack of alternatives can be found in the confidential appendix. It can be concluded that there are no viable alternatives to the use of PFAS for water repellence of the printhead nozzle plate.

Information on required timing on replacement

As mentioned above, there are currently no candidates for alternative materials, and it is necessary to advance the development of materials that achieve PFAS equivalent performance without increasing user cost or environmental impact during operation.

Building on previous research findings, we will continue the investigation for alternative materials. Because it is very difficult to reach the target simply by substituting materials alone, we believe that it is necessary to review the structure and mechanism of inkjet printers/printers, such as the maintenance mechanism of the print head, as well as to simultaneously develop inks to accommodate these changes.

Thus, adding to the scope not only the development of alternative non-PFAS materials but also a redesign of the printing system, we believe that a minimum of 12 years is necessary, approximately 7 years for the development of materials and systems and 5 years for the confirmation of mass production of materials and the evaluation of their deployment in various products.

In case the development of such alternative materials does not go well, we believe that other methods need to be studied in parallel. These studies need to be initiated from scratch, and similarly, a period of about 12 years may be required.

Information on cost of substitution

The costs of substitution are more than 100,000 euro per kg substituted PFAS.

See confidential appendix for more details.

Substance name and tonnage

Perfluoropolyether and combinations of perfluoropolyether with other polymers are used. See confidential appendix for more specific details.

Information on emissions to the environment

Printheads can either be manufactured in the EU or manufactured outside the EU and imported with the printer itself or supplied as spare parts for replacement.

During coating of the nozzle plate, the solution evaporates into a chamber that is exhausted by the building's air handling system. The oven is also vented to the building air handling system. Small amounts of evaporated fluorinated solvent are currently not captured. Unused coating solution is disposed off as hazmat chemical waste.

The print heads are loaded into the printer and consumed. PFAS is a component hat is integrated in/coated on the printhead's nozzle plate, so there is little risk of it being released outside the printer.

Cartridges that have reached the end of their life or run out of ink are collected or disposed of as waste.

Measures to minimise release into the environment

The Electrical and Electronic Waste (WEEE) Directive requires the collection and safe recycling of end-of-life electronic products. When considering recycling, it is important to ensure long-term durability. Alternative materials will not be as durable as PFAS, and it is expected to be difficult to reuse usable parts of recovered print heads.

With the collection of cartridges/printheads and the very low concentration of PFAS in the printhead the emissions to the environment are considered to be very low.

As described above, the use of PFAS in printers is unlikely to significantly increase environmental pollution. The ban on PFAS used in print heads risks generating more waste due to the shorter life time of printers and printer parts.

Proposed derogation

No alternative is available or known. New substances have to be developed. An exemption for a period of 12 years is needed.

The following text is proposed for the exemption:

Paragraph 1 and 2 shall not apply to fluorinated compounds, fluorinated resins and perfluoropolyethers which are PFAS for use in inkjet printer print heads until 13.5 years after EIF

1.2 Sealing materials, valves and pumps in inkjet printers

General summary of the application category

In all inkjet printers the parts that are in direct contact with ink must be resistant to that ink. In small home office printers, the ink system is small and only a few parts in the ink reservoir and in the print head are in direct contact with ink. In larger printers there are more parts with ink contact, for example tubes, pumps, valves etc. PFAS is typically used for parts that must be flexible as well as ink-resistant. Examples of these parts are:

- O-rings: a non-leaking connection between different components of the ink system is of high importance. No ink may leak out of the printer during its lifetime. Proper sealing is provided by flexible rubbers
- Tubing: in small printers, the ink supply is mounted on the printhead. In large printers the ink supply is in a fixed location separated from the moving printhead. Because of the printhead movement, flexible tubing is required
- Pumps and valves: interior parts of pumps and valves are intended to move and must also provide a good sealing to prevent leaking.

These flexible parts are made of plastics or rubbers. Many plastics and rubbers show an interaction with ink. Over time they can become brittle, beak up or dissolve, ultimately leading to breakdown of the printer or even leaking of ink from the printer. Rubbers may swell due to interaction with ink. Swelling leads to deformation of the rubber and can ultimately result in leaking of ink from the printer. Leaking will damage the property of customers with stains that cannot be cleaned again. It can also lead to safety issues because of exposure of customers to hazardous materials. This must be avoided at all times.

Often PFAS plastics and rubbers have to be chosen because of their resistance to ink and other liquids. These other liquids that are handled in a printer include primers, coolants and varnishes.

Alternatives

In general there are two groups of materials that are flexible and resistant to ink during printer life time: polyethylenes and PFAS. Very often a fluorinated substance is the material of choice.

For tubing an inner layer of polyethylene can be used as an alternative. It is expected that it is possible to change the printer design and replace PFAS tubing with a PFAS-free alternative in new printers before the end of the transition period.

For O-rings a rubber material is required. Non-PFAS rubbers include for example EPDM, silicones and NBR. Non-PFAS rubbers have insufficient resistance against important ink ingredients.

One category of inks is the UV-curable ink. It contains acrylates and photo-initiators. After initiation with UV light, a polymerization reaction starts. The acrylates are the monomers and join together in the polymer network resulting in a dry and very robust in layer on the paper or other substrate.

Most rubbers are not resistant to acrylates (acrylic acid esters). Information on the chemical compatibility of different types of rubbers and plastics is widely available on the internet. See footnote[6] for examples. It can be seen that there is some resistance with polyethylene and

[6] https://dutchwatertech.net/en/kenniscentrum/chemical-resistance-epdm/

polyamide and good resistance against acrylates for fluoroplastics. Non-fluorinated rubbers are not compatible with acrylates. Although a single rubber might be resistant to a single acrylate, they are not compatible with the acrylate mixture in UV curable inkjet inks. FKM rubber (a fluorinated rubber) is not even resistant to all acrylates.

Our actual experience in practice confirms the information that non-fluorinated rubbers cannot be used in combination with UV curable inks: either the rubber is deteriorated by the ink or components of the rubber dissolve in the ink and make it unusable. Even standard FKM rubbers are affected by the ink. The more fluorinated FFKM or special grades of (F)FKM like peroxide cured (F)FKM or PTFE coated FKM are the only suitable rubber materials for UV curable inks.

The other main category of inkjet inks, besides UV curable ink, is the aqueous ink. On the paper, this ink is not cured by polymerization but dried by evaporation of water and other solvents. Sometimes the printer jets a primer liquid in combination with these inks. In general the ingredients in these ink are “milder” than those in UV curable inks and more rubber materials are compatible with these inks. However there still are some ink and primer formulations for which only fluorinated rubbers can be used safely. An example can be seen in the confidential appendix.

The test results in the appendix are in line with other tests that have been performed. The non-PFAS EPDM rubbers are suitable for use in combination with several aqueous inkjet systems, but not with all. For some applications in aqueous inkjet only special grades FKM rubbers and FFKM rubbers can be used safely.

Pumps and valves also contain some polymer material. Two metal parts cannot move along each other and at the same time provide a sealing that does not allow the liquid to pass. A polymeric gasket, seal or seat is always used. In diaphragm pumps the diaphragm is made of a flexible material, a polymer. As for O-rings, for UV curable inks and for some aqueous systems only fluorinated rubbers are inert to the ink and can be used in pumps and valves. If a plastic material is used, polyethylene has insufficient mechanical strength to withstand the frequent movement. This makes fluoropolymers like PTFE the only suitable material.

Similar to the situation of O-rings, not all inkjet printers will require PFAS materials for all pumps and valves. In some cases EPDM rubbers can be used or a gear pump can be used instead of a diaphragm pump. Although it leads to a significant increase in cost price, it leaves out the diaphragm. Nevertheless, gear pumps are not compatible with UV curable ink. They break down quickly.

Stop using UV curable inks and move to aqueous inks is also not an option. Both ink systems have their own application range. UV inks provide a better robustness, water resistance and adhesion to non-paper media. For printing books and paper document aqueous ink can be used. For outdoor applications and several non-paper application UV ink cannot be replaced by aqueous ink.

Currently there are no other materials known that can serve as replacement for the PFAS materials in O-rings, valves and pumps. New materials will have to be developed and no quick solution is foreseen. A derogation for 12 years is required with the possibility to extend if no suitable materials have been developed after 12 years.

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https://www.kendrion.com/fileadmin/user_upload/Downloads/Datasheets_Operating_instructions/Valves_Fluid_Control/Chemical-resistance-valve-technology-Kendrion-EN.pdf
https://www.fernco.com.au/wp-content/uploads/2022/07/Fernco-Rubber-Chemical-Resistance-Chart-V002JUL22-LR.pdf

Substances and amounts

The substances involved are PTFE, PVDF, FKM and FFKM.

For annual volumes, see appendix.

Emissions

Emissions to the environment are not expected during the lifetime of the article. The are no volatile PFAS components, there is no emission. Only in the waste phase the materials will be discarded. The printers are treated as electronic waste and will be handled and disposed of according to all locally applicable regulations.

Proposed derogation

No alternative is available or known. New substances have to be developed. An exemption for a period of 12 years is needed.

The following text is proposed for the exemption:

By way of derogation, paragraphs 1 and 2 shall not apply to fluoropolymers for use in sealing materials, valves and pumps in inkjet printers until 13.5 years after EIF.

1.3 Factories for ink and printer components

General summary of the application category

Just like in any other chemical factory, there are several uses of PFAS in the factories where inks are manufactured. Those parts of the equipment that come into contact with ink, its ingredients or other chemicals must be resistant to these chemicals. If there is an interaction between the material and the chemical, the material will start swelling, deforming, degrading or dissolving. The result is that the product gets contaminated with the equipment material and even worse, the equipment will start leaking.

For rigid materials, stainless steel is a suitable material. For flexible and moving parts plastics or rubbers must be used. As already described in the section about the use of PFAS in inkjet printers there are only a few materials that are resistant to all inks. For an ink factory the situation is more critical because ingredients are processed in their pure form (instead of only diluted in the ink) and sometimes at elevated temperatures. Only fluorinated materials are resistant against all ink ingredients.

PFAS therefore have to be used for example in:

- Valves (PTFE ball valve seats allow opening and closing of the valve while ensuring non-leaking when it is closed)
- O-rings (used for closure and sealing of lids, connectors etc)
- Diaphragm pumps (the diaphragm is moving and must be flexible)
- Gaskets (rotating parts like the axis of pumps and stirrers)

- Flexible tubing (rigid piping is not possible when equipment parts are moving)

Printers contain several components that require special manufacturing processes. These components include printheads, photoconductor drums or belts, fixation rollers etc. The manufacturing process includes chemical processing using solvents and other liquids. When certain solvents are used and especially at elevated temperatures the only flexible materials resistant to these chemicals are fluoropolymers.

Alternatives

Because of the required flexibility and sealing properties, only plastics and rubbers can be used. These plastics and rubbers must be able to resist the chemicals they are in contact with.

The type of plastic and rubber that can be used depends on the chemical and on the temperature of use. When the medium is water, non-PFAS rubbers can be used for sealing. Examples of non-PFAS materials are: EPDM rubber and silicone rubbers.

As explained in the section about ink handling components in printers, for several applications only fluorinated materials are not affected by ink and ink components. Currently no alternative is known. PFAS materials that are used for this application include

- PTFE (9002-84-0)
- PVDF (24937-79-9)
- FKM
- FFKM

Currently there are no alternatives known. The suppliers of the process equipment and parts do not have suitable PFAS-free parts available. If an alternative has to be developed, first the material has to be developed, then the manufacturer of the equipment has to design equipment using the new materials. When new equipment parts are to be used in existing equipment it usually does not fit in the same way as the old part. To some extend the piping and the connections have to be changed. Considering that there are several thousands of parts with PFAS in a factory (a first count in our ink factory resulted in over 2000 parts; probably still incomplete), it is a significant effort to replace a PFAS-containing part by a future PFAS-free part once the old part fails. So even after PFAS-free equipment parts would become available it will take time to make the factory suitable for using them. Therefore a 12 years exemption is requested, with the possibility to extend the exemption if no alternatives are available yet after 12 years.

Amount

The articles can either be fully made of PFAS or have a PFAS coating. The total PFAS usage in a typical manufacturing site is not exactly known but is estimated to be around 100 kg or a few hundred kg per year. The number of toner and ink manufacturing sites in the EU is limited. The total usage in toner an ink manufacturing is not expected to exceed one or a few tons per year.

Emissions

Since the materials involved are all polymers with high molecular weights, there is no evaporation or emission to the air. When the equipment parts are end of life, they are discarded as waste metal.

Consequences when no exemption is granted

When no exemption is granted there is no more manufacturing of ink and printer components possible in the EU. It will have to move to non-EU countries. This will have a huge impact on the EU economy and will lead to extremely high costs for printer companies to build new factories outside the EU.

Proposed derogation

No alternative is available or known. New substances have to be developed. An exemption for a period of 12 years is needed, with the possibility to extend this exemption if no alternative materials have been found after 12 years.

The following text is proposed for the exemption:

By way of derogation, paragraphs 1 and 2 shall not apply to fluoropolymers for use in factories for ink and printer components until 13.5 years after EIF.

1.4 Electrophotographic printers

General summary of the application category

In electrophotographic printers and copiers, PFAS materials are used in parts that come into contact with toner or are at the core of the printing process and are subjected to high stress such as high temperature or high voltage. These are for example the charge roller, photoconductor (or photoreceptor) drum, intermediate transfer belt (ITB), fuser parts. See the figures below for the location of these parts in the printer. More explanation about the function of a printer can be found in several open sources on the internet.

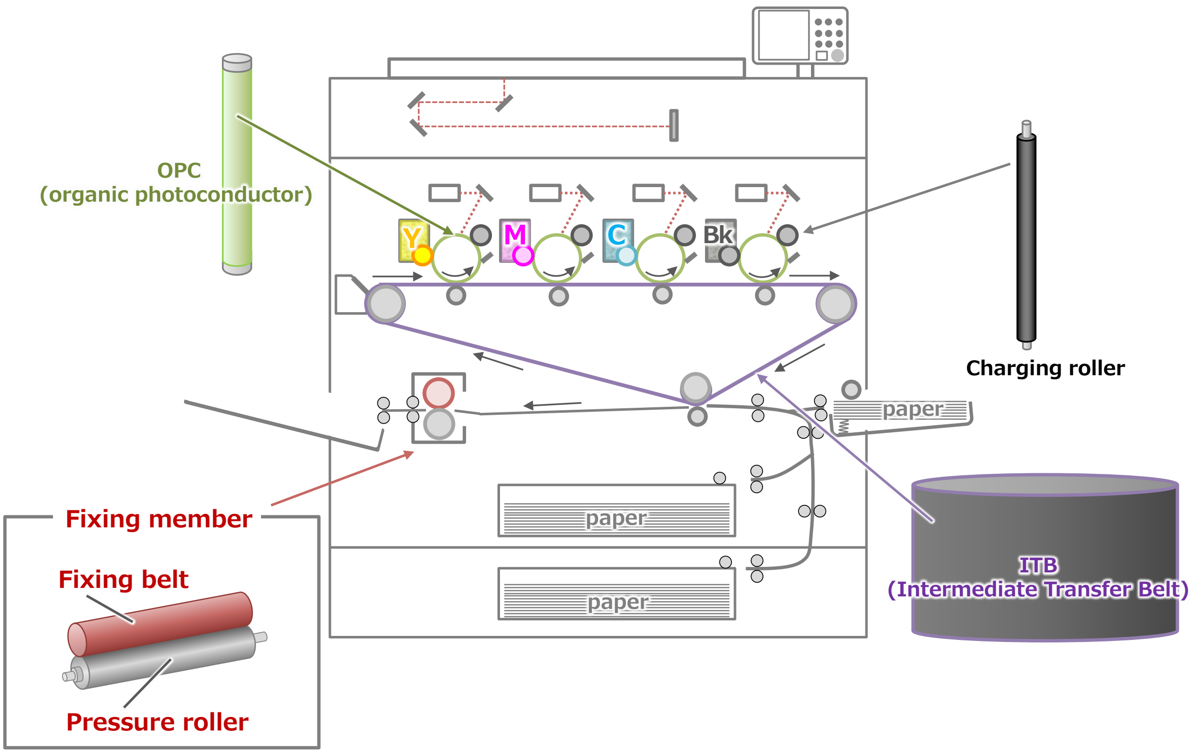

Figure 2 Electrophotographic printer (1)

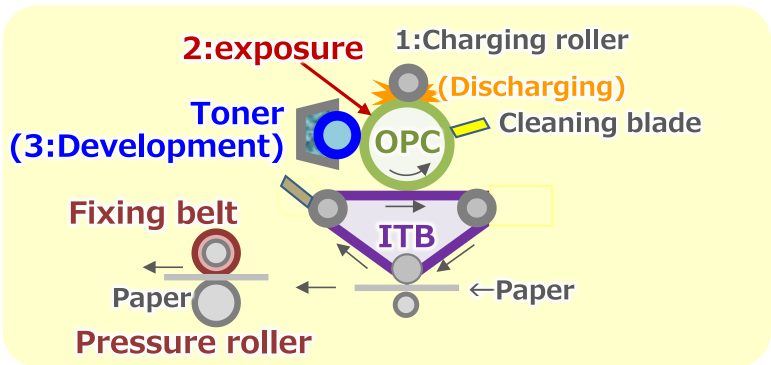

Figure 1 Electrophotographic printer (2)

With the current technology, there is no substitute alternative that can maintain the same quality as PFAS materials, and if PFAS materials become unavailable, the image output becomes impossible in the electrophotographic device. As a result, there is a risk that the product is no longer usable as a printer.

For the charge roller, the photoconductor drum and the ITB the available non-PFAS alternatives have not yet achieved sufficient performance. However, with technological progress the challenges could be overcome in the future. For the fuser parts the alternative components have no prospect of becoming functioning alternatives.

Technical function

The charge roller, photoreceptor drum, intermediate transfer belt (ITB), and fuser parts used in electrophotographic products need to have a good releasability with toner. Toner consists of small particles and in order to avoid contamination of the printing system, it must be possible to release these particles again from the roller, drum, ITB and fuser parts. To improve the releasability with the toner, a PFAS compound is contained as an additive/filler in the surface layer. This PFAS compound also reduces the required torque and reduces the physical wear of the component. It is inert to the solvents used in component manufacturing.

Charge roller, drum and ITB

In the charge roller, photoreceptor drum and ITB, the surface in contact with the toner uses electrostatic force to move the toner. In other words, the toner and parts slide against each other while constantly being exposed to high voltage electrical energy and friction energy. These components must continue to exhibit releasability under severe conditions. Fluoropolymers, which are PFAS, are chemically stable and durable, and can exhibit release properties for long periods even under these harsh conditions. In addition, the latest electrophotographic products tend to use smaller toner for better image quality. This is to reduce the graininess of the image and to reduce the amount of toner used. On the other hand, the smaller the particle size of the toner, the less the release property of the toner, and therefore, the more waste toner remains. Fluoropolymers can reduce the amount of waste toner in the first place, so that they can meet the ever-increasing demand for reducing toner waste. In addition, PFAS compounds in the charge roller, photoconductor drum and ITB also have a friction-reducing effect, which can reduce the amount of wear on these components and reduce the frequency of replacement, thereby contributing to waste reduction. Depending on the customer's usage, it is quite possible that a component that can last from six months to the life of the machine using fluoropolymers, etc. will only last for a few days or months without PFAS.

Fuser parts

The fusing process is a process in which the toner is instantly melted and the melted toner is soaked into the paper fibres to fix the toner on the paper. At this time, the fuser contacts the toner and applies heat (up to approx. 240 °C) and pressure (up to approx. 0.6GPa) to bring the toner into contact with the paper. The toner containing resin or wax melts and penetrates into the paper fibres. At this time, the toner should remain on the surface of the paper but not on the surface of the fixing member. For this reason, it is necessary to have a material that maintains the releasability to the resin under high temperature and high pressure, and whose performance can be obtained stably over a long period of time. In addition, materials are limited in the sliding part with the heater, which is another key part in the fixing process. In the sliding portion between the heater and the fuser belt, the material and grease must be a material that remains highly slidable even at high temperatures up to approx. 270 °C. The fluoropolymers and fluoropolyethers currently in use are chemically stable and have excellent heat resistance, as well as excellent releasability and slidability, and their performance is stable over a long period of time.

Fuser parts: Rollers in high-speed printers

In high-speed printers that have monthly print volumes of several hundreds of thousands up to millions of prints per months, contamination of the fuser system can be a significant problem. Small amounts of additives from the paper can be transferred to the fuser belt during the fusing of the toner. Because of the large printing volume, these small amounts can build up to significant quantities over time. The presence of substances that originate from the paper cannot be influenced by the printer manufacturer. However, in these high-volume printers cleaners are included that clean the fuser belt. Unfortunately, not all substances can be cleaned for 100%. Some substances can migrate to the rollers in the fuser unit (e.g. the pressure roller or one of the rollers inside the fuser belt). When these substances accumulate, they can cause swelling of the outer layer of the rollers, which is made of rubber. This swelling is not evenly distributed along the roller. One part of the roller will get a larger diameter then another part of the roller. This will result in serious printing problems. Examples of these problems are: a cleaner that does not function on the complete width of the belt anymore, speed differences across the fuser belt or temperature differences across the fuser belt. This results in print quality problems or severe pollution of the printer to the extent that the printer will fail.

To prevent the build-up of contamination in the rollers, the outer layer of the rollers is covered with fluoropolymers. Fluoropolymers are resistant to most other chemicals. In this application they are inert to swelling due to contaminants. Fluoropolymers are also resistant to the temperatures of up to 175 °C in these systems. And fluoropolymers are strong enough to withstand the mechanical forces in the system.

Alternatives

No alternative drop-in raw material is known. Requirements for alternatives are constrained by current product portfolio and subsystems. Any change may require customized changes in other materials/subsystems to enable.

For the charge roller, photoconductor drum and intermediate transfer belt (ITB) alternative materials have been investigated. The performance is not sufficient yet, but with further progress in research the challenges could be overcome.

Alternate fillers explored in the past include particle fillers (SiO_2, TiO_2, TiO_2 core with Si shell, hydrophobic silica), which required customized surface treatments to reduce electronic effects. Silica could be a potential option for both photosensitive and non-photosensitive layer applications. The addition of plasticizers or high molecular weight monomers to reduce surface energy and improve cleaning were explored and may enable removal of PFAS, however, reduced part life is likely, and the effect on the electronic performance is unknown. If the same quality as PFAS materials cannot be achieved, it may be necessary not only to change the materials of the above components but also to redesign the unit configuration and control mechanism of the whole electrophotographic machine.

For the fuser parts, there is no expectation that the technical problems with the available alternatives will be overcome. The development of alternatives will have to start from scratch again, as there are currently no alternatives that can play the full role of PFAS. In addition, even when the properties required by the material quality are not achieved, the fundamental principle of fusing cannot be changed, so that the lack of properties cannot be compensated by redesigning the machine. So far, no replacement is in sight.

See the confidential appendix for more details.

Information on required timing on replacement

There are currently no candidates for alternative materials, and the development of materials that can achieve comparable performance needs to start from scratch.

In the past, the implementation of an alternate PFOA-Free PTFE filler in a photoconductor to comply with regulations took 3 years to source material, qualify in manufacturing process, and validate performance across the product portfolio. In this case it was only a relatively small change while the main material (PTFE) remained the same. The development of a totally new material will require longer time.

In addition to the search for alternative PFAS materials to achieve equivalent release and lubricity, it will take approximately seven years to develop the required electrical, optical, and durability fittings for each component. It would also take five years to evaluate the production process to produce each component with alternative materials for PFAS, the start-up of the production equipment and its deployment to various products, including current products. As a result, we believe a total of 12 years is at least necessary.

Also, if the development of alternative materials does not go well, it may be necessary to develop materials that have tried an entirely different approach, such as inorganic surface materials, or other means that do not rely on material properties. In that case, it will be necessary to develop manufacturing equipment, and there is a possibility that even 12 will not be enough.

References regarding industry approach and complexity of replacement:

The extract below from The History and Development of Organic Photoconductors for Electrophotography by David S. Weiss[7] shows the complexity of replacing the filler, with competitors employing their own proprietary methods.
"Ricoh has described an approach where the OCL is filled with semiconductor oxide particles, Al2O3 for example, to increase its hardness. The filler content had to be optimized to permit some wear of the layer, and additives such as antioxidants had to be used to prevent increased conductivity leading to image spread. Silsesquioxane sol–gel OCLs have been commercialized by Eastman Kodak. The sol–gel is a solution coated onto the OPC where drying and partial curing occurs. The overcoated OPC was subsequently thermally cured to optimize the crosslinked structure for hardness, brittleness, and conductivity. The latter was accomplished by the addition of LiI but this caused image spreading at high humidity due to increased conductivity. This was minimized with formulation optimization. More recently hole transport functionalities have been incorporated into the sol–gel such that the OCL will function as a second CTL. Witt and co-workers (Sensient Imaging Technologies and AEG Elektrophotografie) have described a sol–gel OPC overcoat. The overcoat (1–2 µm) has little effect on the dark and photodischarge characteristics of the OPC and significantly improved the OPC wear characteristics. One technical obstacle is that the sol–gel formulation crosslinks with time, so in dip-coating applications the pot life is limited."

US20140051018A1 - Canon patent reference
JP2016184059A - Konica patent reference
JP6123225B2 - Ricoh patent reference

Costs

Information on the costs can be found in the confidential appendix

[7] Weiss, David. (2016). The History and Development of Organic Photoconductors for Electrophotography. Journal of Imaging Science and Technology. 60. 10.2352/J.ImagingSci.Technol.2016.60.3.030505

Substances and amounts

The substances are all fluoropolymers. See attached confidential appendix for details on substances and volumes.

Emissions

These components are manufactured both in the EU and outside the EU and are included in the electrophotographic printer. They are also replaced by service personnel as consumables and service parts.

Despite the fact that copiers and printers use about 0.0001% to 0.1% PFAS by weight (depending on the type of printer), they play an almost crucial role, especially when it comes to fuser parts. Therefore, if the use of PFAS is effectively prohibited, the entire copier must be discarded despite the use of PFAS of at most 0.1%.

According to International Data Corporation (IDC) estimates, about 17 million copiers and printers that use electrophotography and inkjet are shipped to Europe annually. These are estimated to be approximately 500,000 tons by weight. If the number of copiers and printers already on the market is estimated to be about 5 times the annual sales, the number in operation would be 85 million. It is estimated that if all of these were discarded, 2.5 million tons of waste would be generated when the regulations were implemented. The impact on the environment is enormous.

In copiers and printers, parts including PFAS do not come into contact with people. The aforementioned fuser parts, photoreceptor drums, ITBs, and charge rollers are not touched by people during the service life of the copier, except by the service technician who replaces them. There are no volatile PFAS components, there is no emission.

In addition, because the fluoropolymers are chemically stable, it is almost impossible for them to react chemically with the human body when touched. Contact with human bodies and the environment is limited after disposal, but as mentioned above, the WEEE directive is followed and the risk of contamination is minimized. It is unlikely that PFAS caused by copiers and printers will spread into the environment and become a source of pollution that threatens the human body.

Proposed derogation

No alternative is available or known. An exemption for a period of 12 years is needed.

The following text is proposed for the exemption:

paragraphs 1 and 2 shall not apply to fluoropolymers and perfluoropolyethers for the use in drums, rollers and belts in electrophotographic printers until 13.5 years after entry into force

1.5 Paper guiding parts

General summary of the application category

In high speed printers the paper is transported through the printer by many different parts. Because of the high speeds there can be high friction forces between the paper and the printer parts. In some cases this can lead to contamination of these parts with toner and ink. When the contamination builds up during use of the printer, it will damage the prints and eventually lead to paper jams. This is often solved by using low friction and non-stick PTFE parts or PTFE coatings on parts.

Technical function

Paper guiding rollers

"Continuous feed printers" do not print on cut sheet papers, but on large rolls of paper that are cut into sheets after printing. These are high speed production printers. Monthly production print volumes reach several millions of pages per month. The inkjet printing process on a continuous paper feed includes a paper transport system with a series of rollers to pass the paper through the first print station (with sub functions inkjet print heads, drying, cooling), a turning unit and the second print station for two sided printing. These printers are well-balanced systems and are the result of over a decade of research, development and step-wise product improvements. In this printer some paper transport rollers are coated with PTFE.

The printing process includes following main functions:

- jet ink droplets on paper side 1 by drop on demand printheads
- dry ink on paper to achieve sufficient robustness of the printout
- cool down paper to allow further processing
- turn over paper side
- jet ink droplets on paper side 2
- dry ink to achieve sufficient robustness of the printout
- cool down paper to allow further processing

See confidential appendix for a more details.

Technological innovations to improve colour gamut and resolution have been driving factors for successful marketing of new inkjet production printing systems. In order to achieve these targets new ink recipes have been developed.

Ink composition is constrained by many factors like environmental requirements (water based inks), print quality, incl. e.g. colour gamut and good ink adsorption on a wide range of papers, stable jetting properties of the picolitre-size droplets, long storage stability. Also drying properties are taken into account but need to be balanced with all other key aspects. Due to these limitations ink has not yet reached full robustness after the fixation unit. Robustness of the print will come with time, but when the paper is still in the printer, immediately after drying, the ink tends to stick to contact surfaces. This results in problems with ink pollution on the transport rollers. To prevent ink pollution and deterioration of print quality an anti-adhesive coating based on PTFE is used for the rollers after the drying unit.

Paper heating and guiding plates

In high speed cutsheet printers, metal plates are used to guide the paper and/or to heat the paper. The warm paper will move along these plates. Pollution of these plates with toner must be avoided. Also pollution from pre-printed logos and images on the paper must be prevented. Since these printers print high monthly volumes, small amounts of toner pollution on the plates can quickly build up to larger amounts. This larger toner pollution on the plates will damage (scratch) the prints or can lead to paper jams. The pollution can be avoided by using a PTFE coating on the plates.

Other paper guiding parts

There are other small components involved in the transport of the paper through the printer. For those parts that come into contact with the printed paper and have high friction with the paper, toner or ink contamination will build-up leading to damaged prints and paper jams. Also in these cases including PTFE in these parts lowers the friction, provides non-stick properties and solves the contamination problem

Alternatives

No alternatives are known at this moments. If the PTFE is left out and standard materials are used, there is a build-up of contamination that will eventually lead to damaged prints and paper jams. Cleaning these parts is time consuming and not always possible. The build-up of contamination can be even within a few hours of printing. Leaving out the PTFE is not an option. Alternative low-friction and non-stick materials have been investigated but have not been successful so far.

See confidential appendix for more details on materials that have been tested.

Costs and timing of replacement

The feasibility of alternative coating materials without PFAS is unclear at this moment. The known candidates have been tested and failed. There are no other candidate materials known.

Technological innovation could allow other solutions in future. However, the risk of not finding a suitable solution without PFAS is estimated high, besides the fact that industrialization of a technological innovation requires high additional efforts and long lead times.

The costs of alternatives materials cannot be estimated because an alternative material is not known. However, an estimation can be given of the resources required to implement a new material in printers. As an example, the costs for a change in the coating of the paper guiding rollers in continuous feed printers is given.

Developing an alternative coating will require more than 5 years due to the required improvement iterations and lifetime testing. In a first step material candidates need to be identified, samples have to be prepared by the supplier and evaluated with respect to anti-adhesive properties and potential side effects on paper transport stability. Each iteration would take at least 6 months. Lifetime testing would start under laboratory conditions within R&D. After successful completion a customer staging is needed with min. 1 year duration. Including preparation of serial production and manufacturing ramp up 3-5 years lead time are estimated for market introduction. However, since all known candidate materials have been tested and were not suitable, there is a high risk that no solution compliant to the PFAS restrictions can be found. In that case we have to wait for new materials to enter the market. In that case it can easily take more than 10 years before an alternative is implemented in our printers.

An alternative approach could be based on a complete redesign of the printing process including a change of the ink or toner recipe together with modification of printing, drying and cooling process. A modification of these process means that the fundamental design of the printer has to be changed. This will take at least five years and will require at least 50 man years. Given the uncertainty of the feasibility it is also possible that the investment of man years will be twice as much. The total development costs are between 12 and 25 million euro for the coating of the paper guiding rollers in a single printer type only. For the paper guiding plates and other parts similar numbers apply. A redesign of would also have costs in the same order of magnitude for a single printer type/model series.

Substances and amounts

See confidential appendix.

Emissions

Since the materials involved are all polymers with high molecular weights, there is no evaporation or emission to the air. When the equipment parts are end of life, they are discarded as waste metal. Due to abrasion there will be some wear of PFAS containing components. It is estimated that less than 50% of the PFAS material will be released into the environment in this way.

Required exemptions

Changing the PFAS material has an uncertain lead time because there are no PFAS-free candidates yet. New materials have to be invented. An exemption for 12 years would be required.

A fundamental redesign of the printing processes, eliminating the need for PFAS would cost millions of euros. When taking into account the current annual emission of PFAS use for ten years, a full redesign of the printing system only for this purpose would cost more than 50,000 euro per kg avoided PFAS emission. This is not proportionate if this redesign is done only for avoiding PFAS. However, it is expected that a new generation of printers will be developed and ready to place on the market ultimately in 2035. The substitution of PFAS can be included in the development of this next generation.

An exemption for the use of PTFE as coating on paper guiding parts in printers is required until 2035.

Proposed derogation

paragraphs 1 and 2 shall not apply to fluoropolymers for the use paper guiding parts in printers until 1-1-2035.

2. PFAS material in Lithium-ion batteries

2.1. Cathode and separator binder material for Lithium-ion battery cells

Name of PFAS substance(s) Polyvinylidene fluoride (PVDF), Polytetrafluoroethylene (PTFE), Ethylene tetrafluoroethylene (ETFE) and Fluorinated ethylene propylene (FEP)

CAS Number(s) 24937-79-9, 9002-84-0, 25038-71-5, 25067-11-2.

General summary on the application category

All Lithium-ion battery cells use PVDF or PTFE as the binder material for all types of positive electrodes (cathode). They are also widely used in separators. These PFAS binder materials help to improve energy density, durability, reliability, and usable lifetime of the battery. It also prevents them from self-discharging when idle.

Product durability/useful life is a key focus of policy efforts as part of the Circular Electronics Initiative and has been a key feature in the review of Ecodesign Regulation 617/2013 (Lot 3) - Computers and Computer Services. The durability of batteries potentially limits the lifetime of the device it is powering, if battery replacement is economically not feasible, or technically not possible. This may lead to early disposal of devices. Prolonging life is particularly important for lithium-ion batteries (LIB), not only do LIB contain a high amount of critical materials such as cobalt, they also involve substantial environmental impacts during their manufacturing (Source, JRC, 2018, https://publications.jrc.ec.europa.eu/repository/handle/JRC105156).

For the cathode, many other binder materials have been evaluated as replacements for PVDF and PTFE, however all other materials have been found to oxidize at the high voltage at the positive electrode (RCOM Ref. 3925, Supplier Survey 2023). In practice, this would mean that batteries in electronics would need to be replaced very frequently, leading to a corresponding growth in e-waste, battery waste, and demand in critical raw materials. Restricted high-voltage operation also means low run time for any portable devices, which would not meet consumers' daily use requirement.

Although the PFAS binder comprises only a small portion of the composite electrode (typically 2–5% of the mass of the electrode), the binder plays an important role in battery performance. The PFAS binder:

- Helps to disperse the active material and the conductive additive in the solvent during the fabrication process, enabling a homogeneous distribution of the slurry.
- Holds the active material and the conductive additive together and connects them to the current collector, ensuring the mechanical integrity of the solid electrode without significantly impacting electronic or ionic conductivity.
- Acts as an interface between the composite electrode and the electrolyte. In this role, the PFAS binder protects the composite electrode from corrosion and the electrolyte from depletion while facilitating ion transport across this interface.
- Tailors the viscosity of the slurry to allow a smooth coating onto the current collector during electrode manufacturing.

PVDF and PTFE have several unique properties that enable them to fulfil these critical roles[8]:

- Mechanical properties, including stiffness, toughness and hardness as well as good adhesion to the active material, the conductive additive, and the current collector. The positive electrode binder must be able to withstand the forces that result from the expansion and contraction of active materials during charge/discharge cycles.
- Thermal properties, particularly thermal stability, are also important, both for the high temperatures commonly used for curing and drying during electrode fabrication and also for operation of the battery at various temperatures.
- Good dispersive capabilities are important to help distribute the slurry evenly over the current collector during fabrication,
- Chemical and electrochemical stability are essential properties to enable the binder to function for long periods and over numerous cycles without degradation of the battery. The positive electrode binder must not react with any other components or intermediates formed during operation. In particular, the positive electrode binder must remain stable at the high and low voltage potentials experienced by the cathode. This stability guarantees its safe use in the electrochemical environment of the lithium cell.

Many academic-level and lab-scale investigations are currently looking at replacing PVDF as the cathode binder material but remain at this stage small scale research - there is still a significant gap before these can be tested, proven, produced, deployed, and sourced at the large mass production scale needed to replace PVDF.

For the separator (which is an indispensable part of batteries which separates the negative electrode from the positive electrode to prevent internal short circuits, whilst not participating in electrochemical reactions), PVDF is used because it offers excellent adhesion in liquid electrolyte which in turn ensures interface stability resulting in better performance (lower impedance and degradation) and durability. Further, the polarity of the C-F bond in the PVDF is high. While PMMA has been trialed to replace PFAS as the separator binder coating, there are issues with accelerated decay in the later stage of cycling and degradation of the negative electrode interface under high-rate charging.

A PFAS restriction without derogations for batteries will seriously limit the Green Deal and prevent Europe from achieving a net zero economy by 2050. The European Green Deal is one of the world’s most ambitious climate policies to usher the European Union and its Member States into a net zero economy by 2050 by decoupling economic growth from fossil fuel dependency. The Green Deal relies on batteries to achieve objectives for low-emission mobility, decarbonized energy generation and digitalization.

Batteries have been identified by the European Commission as a strategic value chain. The Commission states: ""Batteries are thus an important source of energy and one of the key enablers for sustainable development, green mobility, clean energy, and climate neutrality".[9]

The annual tonnage and emissions (at sub-sector level) and type of PFAS associated with the relevant use

Refer to RCOM Ref. 3925 (RECHARGE submission) - Section 4 PFAS consumption in tonnes and emissions during battery life cycle.

[8] RCOM Ref. 3925
[9] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL:ST_5469_2023_INIT&from=EN

The key functionalities provided by PFAS for the relevant use[10]

1. Mechanical properties, including stiffness, toughness and hardness as well as good adhesion to the active material, the conductive additive, and the current collector.
2. Thermal properties, particularly thermal stability.
3. Good dispersive capabilities are important to help distribute the slurry evenly over the current collector during fabrication
4. Chemical and electrochemical stability enable the binder to function for long periods and over numerous cycles without degradation of the battery at the high and low voltage potentials experienced by the cathode.

For which uses of PFAS is there no alternative?

Outlook: No alternative has yet been identified.

R&D activity: refer to details in RCOM Ref. 3925 (RECHARGE submission):

For Lithium-ion rechargeable batteries, PVDF was previously also used as the binder material for the negative electrode as well as for the positive electrode. For graphite negative electrodes (anodes), companies have successfully substituted PVDF with water-based CMC/SBR binder materials. CMC/SBR is now the most common commercially used binder material for the graphite negative electrodes due to its good cell performance, lower cost and reduced environmental impact[11].

For cathodes, no alternatives are available. The European Commission has recently funded the GIGAGREEN research project on dry alternatives and water-based binder systems for the positive electrode which propose to utilise a range of polymers including CMC/SBR, poly(acrylic acid), sodium alginate, polyurethanes and catechol-bearing polymers[12]. Whilst these initial research studies have indicated that these aqueous binder systems may have good adhesion properties, further research and development is required to investigate whether these alternatives have adequate chemical, mechanical, and electrical properties[13]. There are significant concerns about whether water-based CMC/SBR technology will have the necessary rheology and stability to match with today's positive electrode active materials such as LCO, NMC, NCA, LNMO, LFP. There are also specific concerns about the use of water in the slurry production and the electrode coating, drying and calendaring processes, particularly if the water is not completely removed before the battery is assembled.

The German Government has funded the DigiBatt Pro 4.0[14] research project which also includes development of water-based binder systems for positive electrodes. As part of this research project, positive electrodes of around 100 metres in a lab scale with roughly 1/100 to 1/50 the scale of mass production have been produced using a nickel rich NCM cathode active material, $LiNi_{0.83}Co_{0.12}Mn_{0.05}O_2$. The cells could be successfully charged and discharged

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[10] Source: RCOM Ref. 3925 (RECHARGE submission)

[11] Hawley, W. B., & Li, J. (2019). Electrode manufacturing for Lithium-ion batteries—Analysis of current and next generation processing. *Journal of Energy Storage*, *25*(C), 100862–. https://doi.org/10.1016/j.est.2019.100862

[12] Funding & tenders, Towards the sustainable giga-factory: developing green cell manufacturing processes (GIGAGREEN). (n.d.). https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/how-to-participate/org-details/999999999/project/101069707/program/43108390/details

[13] Cholewinski, A., Si, P., Uceda, M., Pope, M., & Zhao, B. (2021). Polymer Binders: Characterization and Development toward Aqueous Electrode Fabrication for Sustainability. *Polymers*, *13*(4), 631–. https://doi.org/10.3390/polym13040631

[14] "*DigiBattPro 4.0 - BW*" - Digitized Battery Production 4.0 - Fraunhofer IPA. (n.d.). Fraunhofer Institute for Manufacturing Engineering and Automation IPA. https://www.ipa.fraunhofer.de/en/reference_projects/digibattpro.html

1,000 times at 25°C before they fall below 80% of initial capacity[15]. Whilst this research project appears to show promising results for very high nickel content batteries, correspondence with the project partners highlights that:

- Positive electrodes manufactured using water-based binder materials show increasing impedance/resistance with increasing numbers of charging and discharging cycles,
- The stability of the charging and discharging cycles is substantially lower than state-of-the-art positive electrodes using PVDF binder materials,
- The rapid increase in pH alkalinity of the water-based binder materials results in a very short shelf life for the mixed slurries, this would be very challenging for an industrial process as the mixture would go out of specification very quickly.

Further investigation of this research project confirms it focused on a very specific high nickel NCM cathode active material at a moderate cell voltage of 4.2V. There is no evidence that this water-based binder material could be developed to meet the performance targets for positive electrodes with LCO chemistries operated at higher voltages, which is what many electronic devices use today.

It is also important to note that this research project focused on a very specific cylindrical 21700 cell form factor used in certain automotive and power tool applications[16]. Performance in this specific form factor is not directly transferrable to other cell form factors used in other applications. There are many unknowns which would need to be investigated before this technology could be adopted in other chemistries and other form factors, including:

- cycle life and calendar life and impedance growth under wide range of temperatures
- swelling, fast charge cycling is unknown,
- electrode processibility for multilayer pouch cells and uniformity of coating is unknown,
- correspondence with the project partners highlighted that the positive electrodes manufactured using water-based binder materials show higher cell resistance and faster growth in resistance with increasing numbers of charging and discharging cycles with the high nickel NCM cathode active material. This trend is anticipated to become worse when industry moves to cathode active material operating at higher voltage, higher energy and higher power.

Several other research laboratories have reported developments in water-based binder systems for positive electrodes using other polymer materials in limited applications on the lab scale with simple coin cell batteries, but none of these efforts have successfully been scaled up to perform for industry relevant chemistries, cell configurations and production volumes. For example, Lawrence Berkeley National Laboratory reports they have tested polyacrylic acid (PAA) with the cross-linking agent polyethylenimine (PEI) as the binder for sulfur cathodes for LiS coin cells operating between 1.5v and 2.8v for 100-200 cycles[17]. No information is provided on performance in larger cells or industry-scale applications. Furthermore, industry

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[15] Radloff, S., Scurtu, R.-G., Hölzle, M., & Wohlfahrt-Mehrens, M. (2021). Applying Established Water-Based Binders to Aqueous Processing of $LiNi_{0.83}Co_{0.12}Mn_{0.05}O_2$ Positive Electrodes. *Journal of the Electrochemical Society*, *168*(10). https://doi.org/10.1149/1945-7111/ac2861

[16] Radloff, S., Carbonari, G., Scurtu, R.-G., Hölzle, M., & Wohlfahrt-Mehrens, M. (2023). Fluorine-free water-based Ni-rich positive electrodes and their performance in pouch- and 21700-type cells. *Journal of Power Sources*, *553*, 232253–. https://doi.org/10.1016/j.jpowsour.2022.232253

[17] Liu, Z., He, X., Fang, C., Camacho-Forero, L. E., Zhao, Y., Fu, Y., Feng, J., Kostecki, R., Balbuena, P. B., Zhang, J., Lei, J., & Liu, G. (2020). Reversible Crosslinked Polymer Binder for Recyclable Lithium Sulfur Batteries with High Performance. *Advanced Functional Materials*, 30(36), 2003605–n/a. https://doi.org/10.1002/adfm.202003605

relevant chemistries such as LCO and NMC have high pH when dispersing in water and this may not be compatible with the binding function of this PAA/PEI binder.

New research papers and grant applications are regularly being proposed to develop alternatives to PVDF as the cathode binder and/or NMP as the solvent. We investigate all these research papers in detail and include comments on all research papers published up to August 2023 in this dossier. However, some research papers may be published after the public consultation closes in September 2023 and where we are not able to comment on them in this dossier.

Furthermore, replacing the PVDF cathode binder likely requires the development of new cathode active material and Aluminium current collectors that are compatible with a new binder and solvent system. Water is known to cause poor cycle life and increased impedance growth in Lithium-ion cells. A new grade of active cathode powder may need to be developed to increase particle surface protection against water.

Replacing the PVDF cathode binder with new binder and solvent also requires development of a compatible electrode and cell manufacturing process and equipment. The necessary process and equipment change at mass production scale is unknown at this point and will be different for different companies depending on which alternative technology they pursue. The performance of mass production line produced PVDF free battery may have significant performance gaps compared with current batteries. Addressing these performance gaps may require a significant number of iterations of materials improvement, production process change and cell performance testing.

Replacing the PVDF cathode binder with new binder and solvent also requires development of a compatible electrode and cell manufacturing process and equipment. The necessary process and equipment change at mass production scale is unknown at this point and will be different for different companies depending on which alternative technology they pursue. The performance of mass production line produced PVDF free battery may have significant performance gaps compared with current batteries. Addressing these performance gaps may require a significant number of iterations of materials improvement, production process change and cell performance testing.

Given the above, we estimate that efforts to develop and commercialise high performance non-PFAS cathode binder, Al foil, active materials and corresponding cell manufacturing processes would take at least 10 years, followed by 5 years to commercialise the new technologies.

PFAS is also used as a binder material on the separator of Lithium-ion battery cells. The separator is an indispensable part of batteries which separates the negative electrode from the positive electrode to prevent internal short circuits, whilst not participating in electrochemical reactions. At present, the most commonly used commercial separators are polyolefin separators, such as polypropylene (PP), polyethylene (PE) and multi-layer composite separators (PP-PE-PP). The layer materials are processed to make them porous by including tiny pores or voids at 35-45% porosity. The typical pore size is 200 nm - 1µm which is large enough for the lithium ions to move smoothly through the separator.

Commercial tri-layer PP/PE/PP separators take advantage of the difference in the melting point of PP (165°C) and PE (135°C), using PE as the shutdown layer and PP to protect structural integrity. When the cell temperature rises near the melting point of the PE layer, the PE layer will melt at a temperature of 135°C and close the pores in the separator to stop the current flow while the PP layer, which has higher melting temperature than PE, remains solid. However, such protection is only effective below the melting point of PP.

To provide better thermal and mechanical stability, commercially available ceramic coated separators have been developed. Ceramic particles, such as alumina, silica, or zirconia can be mixed with polymeric binders and slurry-coated onto the polyolefin separators. In comparison to PP layers, ceramic coatings offer a better electrolyte wettability, which translates into better Li-ion transport through the separator and therefore a better performance of the battery. Although ceramic coatings have proven effective in improving the thermal stability of separators, the effectiveness of the protection is still limited by the thermal stability of the polymeric binder used.

Some companies use PVDF as the binder material for the ceramic coating to provide good adhesion to the electrolyte/composite electrode, as well as providing good adhesion of the ceramic coating to the separator. Other companies have developed non-PFAS binders which also provide good levels of adhesion to the separator and the electrolyte/composite electrode. PMMA is considered as a potential alternative material for PVDF separator binder, but there are issues with accelerated decay in the later stage of cycling and degradation at the negative electrode interface under high rate charging. Some organizations are researching the use of binder-free, thin-film ceramic-coated separators which may be able to provide improved safety for Lithium-ion batteries. Additional time is required for battery manufacturers to study and qualify non-PFAS alternative solutions to ensure performance and safety and to commercialize the technology broadly.

In addition, contrary to what is stated in Annex E (page 416) of the PFAS Annex XV dossier, solid state batteries are not potential non-PFAS alternatives to Lithium-ion batteries. This is because solid state batteries do use PFAS, specifically PVDF and PTFE in the binder within the active material, in solid electrolytes and in gel polymer electrolytes.[18]

Substitution:

Substitution is estimated to take at least 15 years, and possibly longer. This will first depend on the battery industry to develop a suitable potential alternative material. As detailed in RCOM Ref. 3925 (RECHARGE submission), the estimated time to develop and commercialize high performance non-PFAS cathode binder, Al foil, active materials and corresponding cell manufacturing processes would take at least 10 years, followed by 5 years to commercialize the new technologies.

Proposed derogations

Paragraph 2(c) shall apply from (**13.5 years** after entry into force) to PFAS used in **cathode binder materials in Lithium-ion battery cells**. **The European Commission shall review this derogation by 3 years before its expiry to assess whether alternatives are now available or whether further renewal is needed and to publish amendments to the Regulation.**

Paragraph 2(c) shall apply from (**6.5 years** after entry into force) to PFAS used in **separator binder materials in Lithium-ion battery cells.**

[18] Source: RCOM Ref. 3925 (RECHARGE submission)

2.2. Lithium-ion batteries: Socio-economic impacts

The European Green Deal is one of the world's most ambitious climate policies to usher the European Union into the net zero economy by 2050. The Green Deal relies on batteries to achieve objectives for low-emission mobility, decarbonised energy generation and digitalisation. **A PFAS restriction without a derogation for batteries, and without a review clause, will limit the Green Deal and prevent Europe from achieving a net zero economy by 2050.**

Batteries have been identified by the European Commission as a strategic value chain. The Commission states:

'*Batteries are thus an important source of energy and one of the key enablers for sustainable development, green mobility, clean energy, and climate neutrality*'[19].

More than EUR 20 billion has been devoted to the EU battery value chain via the European Commission framework on Important Projects of Common European Interest (IPCEI), the European Investment Bank and research funding in the last few years. Dozens of billions more are available via the European Union InvestEU fund and the European Commission Recovery and Resilience Facility. Over half of all lithium batteries on the EU market in 2022 were produced in Europe, with the continent projected to become the world's second biggest battery cell manufacturer by the end of the decade[20]. As a direct effect, this will require 800 000 workers by 2025[21]. The installation and maintenance of batteries as well as end of life recycling could potentially create between 3-4 million jobs by 2025[22].

- Europe is on track to produce 6.7 million battery electric cars (BEV) by 2032, or just over half of all the cars produced, which is in line with the recently agreed -55% CO2 target for carmakers for 2030 that is expected to result in a 50-60% share of BEV sales[23].
- Half of the lithium battery cells used in electric vehicles and energy storage systems in the EU were already made in the bloc in 2022, notably in Poland, Hungary, and to a lesser extent in Germany and Sweden. Transport & Environment analysis of the battery cell capacity announcements to date shows that Europe can be self-sufficient in battery cells, i.e. produce 100% of our lithium battery cell demand from 2027[24].

[19] REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC. https://data.consilium.europa.eu/doc/document/PE-2-2023-INIT/en/pdf

[20] A European Response to the US Inflation Reduction Act, T&E report January 2023, *https://www.transportenvironment.org/discover/a-european-response-to-us-inflation-reduction-act/*

[21] Commission Staff Working Document. Accompanying the document, Report from the Commission to the European Parliament and the Council. Progress on competitiveness of clean energy technologies. 1-Macroeconomic. SWD (2021) 307 final. October 2021. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD:2021:307:FIN#footnote114

[22] Entwicklung und Umsetzung eines Monitoringsystems zur Analyse der Akteursstruktur bei Freiflächen-Photovoltaik und der Windenergie an Land, https://www.umweltbundesamt.de/sites/default/files/medien/5750/publikationen/2021-06-28_cc_49-2021_monitoringsystem_akteursstruktur_wind_pv.pdf

[23] *Commitments but no plans, T&E 2021 report, https://www.transportenvironment.org/wp-content/uploads/2021/08/202106_EV_Report-Final-1.pdf*

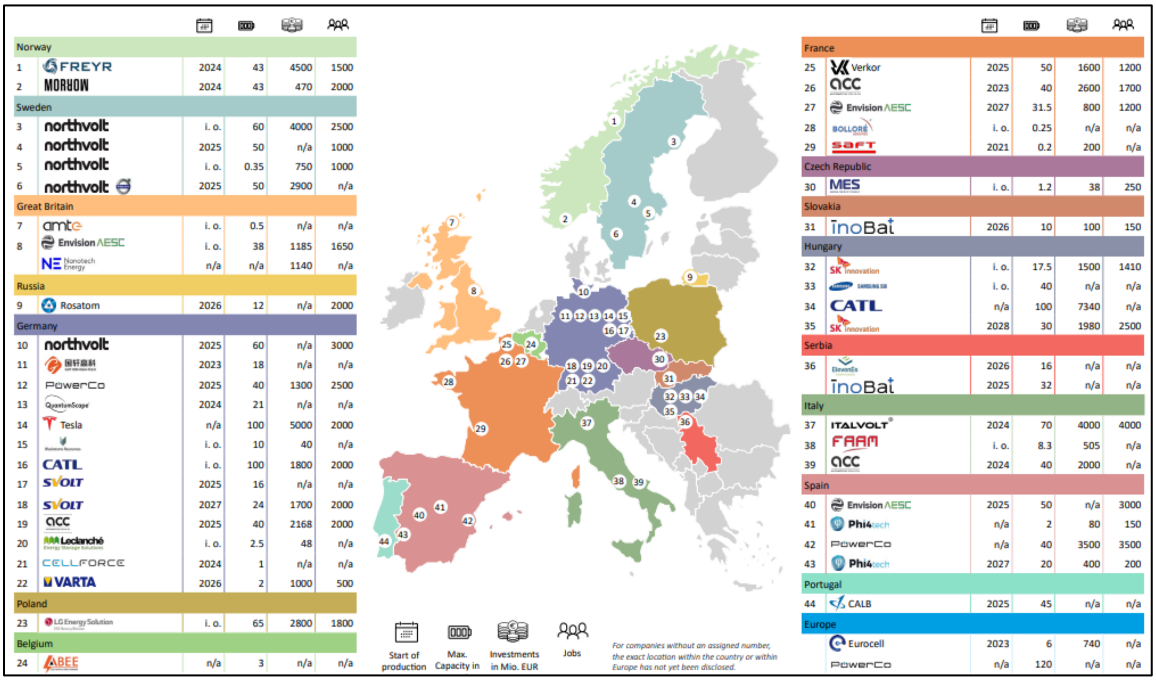
[24] A European Response to the US Inflation Reduction Act, T&E report January 2023, *https://www.transportenvironment.org/discover/a-european-response-to-us-inflation-reduction-act/*

- Europe has secured much investment: the continent is projected to produce up to a third of lithium-ion batteries globally by 2030 (from just a few % today)[25].

However, this investment will likely not proceed if the derogations are limited to 13.5 years only. A company is not likely to invest in building a battery cell production factory with the knowledge that they will have to close the factory in 13.5 years.

Even if this derogation is granted with a review clause, this may still not provide sufficient certainty for companies to invest in Europe because there is risk that the derogation may not be renewed and therefore prevent any further competition. This uncertainty is already diverting some investment from Europe and putting a high risk on the current investment in Europe, which could jeopardise the current set up of the European value chain. For this reason, the European Battery Association RECHARGE will propose an alternative approach to manage the PFAS emissions risk in a different way.

Figure 1 summarises the battery cell production sites in Europe that are in planning, under construction or partly already in operation[26]. These 45 sites represent over 56 billion Euros of investment and more than 43,000 jobs and provide the potential for Europe to become self-sufficient in battery cells as early as 2028 as an integrated value chain.



		Start of production	Max. Capacity	Investments in Mio. EUR	Jobs
Norway					
1	FREYR	2024	43	4500	1500
2	MORROW	2024	43	470	2000
Sweden					
3	northvolt	i. o.	60	4000	2500
4	northvolt	2025	50	n/a	1000
5	northvolt	i. o.	0.35	750	1000
6	northvolt	2025	50	2900	n/a
Great Britain					
7	amte	i. o.	0.5	n/a	n/a
8	Envision AESC	i. o.	38	1185	1650
	NE Nanotech Energy	n/a	n/a	1140	n/a
Russia					
9	Rosatom	2026	12	n/a	2000
Germany					
10	northvolt	2025	60	n/a	3000
11	国轩高科	2023	18	n/a	n/a
12	PowerCo	2025	40	1300	2500
13	QuantumScape	2024	21	n/a	n/a
14	Tesla	n/a	100	5000	2000
15		i. o.	10	40	n/a
16	CATL	i. o.	100	1800	2000
17	SVOLT	2025	16	n/a	n/a
18	SVOLT	2027	24	1700	2000
19	acc	2025	40	2168	2000
20	Leclanché	i. o.	2.5	48	n/a
21	CELLFORCE	2024	1	n/a	n/a
22	VARTA	2026	2	1000	500
Poland					
23	LG Energy Solution	i. o.	65	2800	1800
Belgium					
24	ABEE	n/a	3	n/a	n/a
France					
25	Verkor	2025	50	1600	1200
26	acc	2023	40	2600	1700
27	Envision AESC	2027	31.5	800	1200
28	BOLLORÉ	i. o.	0.25	n/a	n/a
29	saft	2021	0.2	200	n/a
Czech Republic					
30	MES	i. o.	1.2	38	250
Slovakia					
31	InoBat	2026	10	100	150
Hungary					
32	SK Innovation	i. o.	17.5	1500	1410
33	Samsung SDI	i. o.	40	n/a	n/a
34	CATL	n/a	100	7340	n/a
35	SK Innovation	2028	30	1980	2500
Serbia					
36	ElevenEs	2026	16	n/a	n/a
	InoBat	2025	32	n/a	n/a
Italy					
37	ITALVOLT	2024	70	4000	4000
38	FAAM	i. o.	8.3	505	n/a
39	acc	2024	40	2000	n/a
Spain					
40	Envision AESC	2025	50	n/a	3000
41	Phi4tech	n/a	2	80	150
42	PowerCo	n/a	40	3500	3500
43	Phi4tech	2027	20	400	200
Portugal					
44	CALB	2025	45	n/a	n/a
Europe					
	Eurocell	2023	6	740	n/a
	PowerCo	n/a	120	n/a	n/a

Figure 3 Battery cell production site in Europe

A PFAS restriction without a derogation for batteries, and a review clause, will stop these battery cell production sites operating in Europe.

[25] A European Response to the US Inflation Reduction Act, T&E report January 2023, https://www.transportenvironment.org/discover/a-european-response-to-us-inflation-reduction-act/

[26] Figures include EU Member States and European Economic Area countries – therefore Russia, UK & Serbia have not been included in our calculations. Figures obtained from IPCEI Market Analysis Q4 2022, https://www.ipcei-batteries.eu/fileadmin/Images/accompanying-research/publications/2023-02-BZF_Kurzinfo_Marktanalyse_Q4_22-ENG.pdf.

EV batteries

Batteries are critical to the functioning of society to enable electric vehicles to replace sales of new combustion engine vehicles by 2035. On 29 June 2022, all climate ministers of the 27 EU member states agreed to the European Commission's proposal (part of the 'Fit for 55' package) to effectively ban the sale of new internal combustion vehicles by 2035 (through '[introducing] a 100% CO_2 emissions reduction target by 2035 for new cars and vans')[27]. Requiring new cars sold in the EU to emit zero CO_2 from 2035 would make it impossible to sell new internal-combustion engine cars. In 2026, the Commission will assess whether hybrid vehicles or CO_2-neutral fuels could comply with the goal with future technological developments. The Commission commented that it would keep an “open mind” but that at present, hybrids did not deliver sufficient emissions cuts and alternative fuels were prohibitively expensive.

Most EU Member States have also signed up to the COP26 declaration on accelerating the transition to 100% zero emission cars and vans[28]. All signatories support an accelerated transition to zero emission vehicles in line with achieving 100% of new car and van sales being zero emission in leading markets by 2035, and by making them accessible, affordable and sustainable in all regions by 2030.

These climate proposals aim to ensure the EU – the world’s third-biggest greenhouse gas emitter – reaches its 2030 target of reducing net emissions by 55% from 1990 levels. Doing so will require governments and industries to invest heavily in electric vehicles.

A PFAS restriction without a derogation for batteries, and a review clause, will stop sales of new and second-hand electric vehicles in Europe.

Industrial batteries

In electricity generation, batteries enable grids to install more renewable energy capacity using solar and wind sources. One of the well-known shortcomings of solar and wind energy sources is their large variability in power generation - the sun does not always shine, and the wind does not always blow. Battery storage helps renewable generators reliably integrate with existing grids by storing the excess generation and by smoothing the energy distribution.

Batteries also help traditional suppliers manage the stability of energy distribution thanks to their unique ability to quickly absorb, store, and deliver electricity as needed. Among its many uses, batteries help operators regulate the frequency of the electrical current - an important aspect of electricity transmission – to help store electricity until transmission capacity is available and help maintain capacity reserves. Batteries also make isolated and off-grid installations viable and less dependent on diesel generators.

While there are many technologies used for utility-scale energy storage, rechargeable lithium batteries have become favoured in new installations due to their flexibility and scalability, and their declining costs. At the beginning of the 1990s, the storage capacity that is required to power a regular-sized house for a day would have cost about 75,000 Euro and the battery package would have weighed 111kg[29]. The same level of capacity can now be obtained at a cost of around 2,000 Euro from a 40kg, small backpack-sized cell.

[27] https://www.consilium.europa.eu/en/press/press-releases/2022/06/29/fit-for-55-council-reaches-general-approaches-relating-to-emissions-reductions-and-removals-and-their-social-impacts/
[28] https://www.gov.uk/government/publications/cop26-declaration-zero-emission-cars-and-vans/cop26-declaration-on-accelerating-the-transition-to-100-zero-emission-cars-and-vans
[29] https://www.economist.com/graphic-detail/2021/03/31/lithium-battery-costs-have-fallen-by-98-in-three-decades

Industrial batteries also include small primary lithium batteries, which are essential for applications that require long battery lifetimes (up to 25 years) or instant readiness after long standby periods (for applications such as pacemakers, defibrillators, emergency alarm systems, and remote IoT applications).

A PFAS restriction without a derogation for batteries, and a review clause, will inhibit the growth of renewable energy and stop the sales of life-saving equipment.

Portable batteries

The public in Europe rely on their electronic devices to continue to function in an emergency when a main power source is not available. For example, a long battery life is needed in communication devices such as smartphones, tablets and laptops so that in case of a health or safety incident, the device can continue to function to enable people at risk to continue to communicate effectively with the emergency response authorities. Batteries provide indispensable back-up power to these communication devices in case of a power cut.

Today's society is an information-rich world which is becoming more and more portable. Portable electronic devices including laptops, tablets, mobile phones, and wearable electronic devices are critical to support the rapid growth of information processing and sharing in society. Without batteries, these devices would not be portable and instead would require permanent connection to a fixed power source.

From VOIP to global telecom carriers, portable electronic devices enable people to travel the world and stay connected. To respond effectively to global pandemics such as COVID 19, remote workers and international businesses need to be able to utilize video calls and conference calls via the Internet to keep their businesses going without interruption. Portable electronic devices support increased productivity by enabling working from home opportunities that simply were not available previously. At the same time, more flexible working arrangements have enabled a larger cross-section of society to contribute their knowledge and skills into the workplace.

Portable electronic devices have enabled more people to access education opportunities. Online seminars allow people to learn in a faster, more convenient, and efficient fashion.

Portable electronic device help people to carry out complex tasks in a simpler, quicker manner. Smart bracelets and health apps enable people to monitor, analyse and alter personal health habits. Many hospital systems have online gateways that allow patients to obtain their medical records, or communicate with their physician online, nearly instantly. Batteries are indispensable to make these devices portable so that they can deliver these critical functions to society.

Significant financial costs can be expected to arise due to the lack of substitutes for PFAS in lithium-ion batteries:

1. Annual value of EU sales: In 2022, the computer hardware market in Europe generated a total revenue of over 60 billion euros, selling around 630 million units. Storage units made up the majority of volume at approximately 462 million units, followed by laptops and keyboards, both with approximately 42 and 40 million units sold, respectively.[30]
2. Indirect cost - European employment in the ICT sector: In 2022, more than 9 million persons worked as ICT specialists across the European Union (EU). The highest number (2.1 million) worked in Germany, which provided work to more than one-fifth

[30] Statista, 2023 see https://www.statista.com/forecasts/1256748/volume-segments-computer-hardware-europe

(22.6 %) of the EU's ICT workforce. France (1.2 million) had the second largest ICT workforce (13.0 % of the EU total), followed by Italy and Spain (both 0.9 million; 9.6 % and 9.4 % respectively).[31]

3. Cost to companies in the EU: In a survey conducted by the IDC (2010), 68 % of respondents confirmed that the battery lifetime on their notebook computers was not sufficient for their business needs, and over half stated that battery failures caused problems for their business. The most common problem was lost productivity, cited by 45 % of respondents, followed by lost/delayed sales (22 %) and loss of critical company data (17 %).
4. Material efficiency via optimized design: The yearly rate of estimated material saving if dedicated functionality for the optimization of the lifetime of batteries (a.1) were used ranges from around 2 360 to 5 400 tonnes (t) of different materials per year. About 450 t of cobalt, 100 t of lithium, 210 t of nickel and 730 t of copper could be saved every year.[32]
5. R&D, retooling, retesting, recertifying supply chain costs: not able to be estimated.
6. Cost to consumers & companies in the EU to repair/replace electronic devices on more frequent cycles: A Eurobarometer survey observed that, when a main failure occurs, 77 % of EU citizens would rather repair their goods than buy new ones, but ultimately have to replace or discard them because they are discouraged by the cost of repairs and the level of service provided (European Commission, 2014b). Viegand Maagøe and VITO (2017) reported a typical lifetime of 5 years for notebooks, 6 years for desktop computers. (Sources: Viegand Maagøe and VITO, 2017. Preparatory study on the Review of Regulation 617/2013 (Lot 3) — Computers and Computer Servers & Flash Eurobarometer 388 report of June 2014 entitled 'Attitudes of Europeans towards waste management and resource efficiency'.)
7. Impact of downtime to EU businesses when electronic devices fail: Data in the public domain tends to focus on the cost to businesses resulting from network outages rather than devices, but costs will vary according to the sector and size of the business but will include productivity losses, replacement costs, and lost sales.
8. Impact to employment: Approximately 45 battery cell production sites in Europe that are in planning, under construction or partly already in operation represent 56 billion Euros of investment and 43,000 jobs (PCEI Market Analysis Q4 2022, https://www.ipcei-batteries.eu/fileadmin/Images/accompanying-research/publications/2023-02- BZF_Kurzinfo_Marktanalyse_Q4_22-ENG.pdf). This will aid Europe to become self-sufficient in battery cells as early as 2028 as an integrated value chain. Without PFAS derogations for batteries, these battery production sites will stop operating in Europe.

A PFAS restriction without a derogation for batteries, and a review clause, will stop Europe from achieving Green Deal digitalisation objectives.

[31] Eurostat, 2023, ICT Specialists in Employment, https://ec.europa.eu/Eurostat/statistics-explained/index.php?title=ICT_specialists_in_employment#Number_of_ICT_specialists

[32] Tsiropoulos, I., Tarvydas, D. and Lebedeva, N., Li-ion batteries for mobility and stationary storage applications, https://publications.jrc.ec.europa.eu/repository/handle/JRC113360

3. Coating materials

3.1. Anti-fingerprint coating

Name of PFAS substance(s): Fluoropolymers (e.g. PTFE), Perfluoropolyether (PFPE), Perfluoroalkoxy alkanes (PFA)

General summary on the application category

PFAS substances are widely used in anti-fingerprint coatings in various electronic products such as laptops, smartphones, keyboards and visual devices.

These coatings are used because they are chemically inert, easy to clean, and have excellent aging performance, abrasion resistance (due to the self-lubricating property of PFAS) and adhesion durability.

The anti-fingerprint coating creates a layer of water- and oil-resistant material with a water contact angle greater than 110º and oil contact angle greater than 80º, effectively preventing grease and various chemicals from sticking to the surface. The coating also allows easy removal of dust and dirt (from hand creams and tomato ketchup to alcohol and sunscreen) from the surface.

ChemSec has highlighted silicone alternatives, however during testing they have demonstrated more severe fouling as compared to PFAS coatings when tested with multiple substances, including artificial sweat, vegetable oil, coke and coffee etc., and poorer abrasion resistance and durability. They also exhibit a water contact angle of less than 100º meaning they are much harder to clean as compared to PFAS coatings.

The finger is often coated with sebum, an oily substance. The oil-phobic characteristics of PFAS coated on substrate can remove the sebum, and the touch feeling is smooth without sluggishness. However, if there is no PFAS coating, an oil-phobic coating, the sebum is adhered on the substrate. The sebum adhered on the substrate makes the sliding motion un-smooth. Silicone based coating has hydrophobic but not oil-phobic characteristics. The sebum is therefore kept on the silicone-based coating surface, making the sliding motion unsmooth.

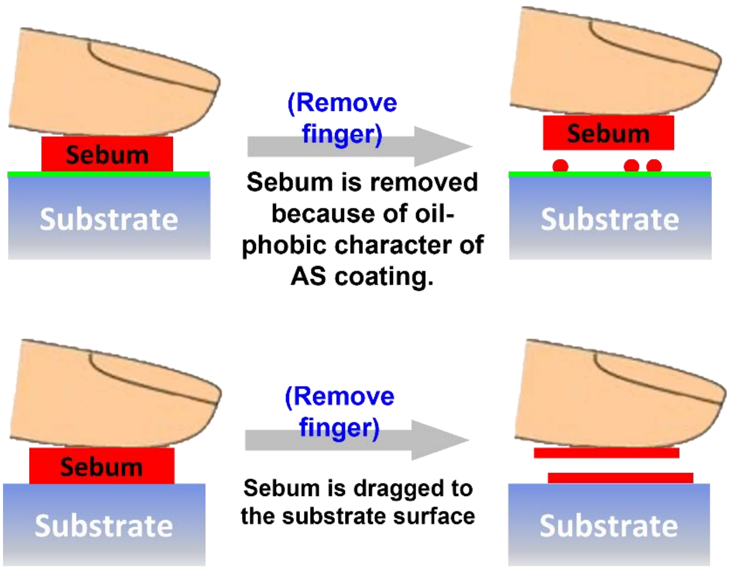


Figure 4 Oil-phobic characteristics of PFAS anti-fingerprint coating

The annual tonnage and emissions (at sub-sector level) and type of PFAS associated with the relevant use

Insufficient information to quantify/See confidential annex for details.

The key functionalities provided by PFAS for the relevant use[33]

1. Very low surface energy on the substrate surface to promote water and oil repellency (>=110° water contact angle; >=80° oil contact angle)
2. High chemical resistance, against water and oil-based materials
3. High abrasion resistance and low friction coefficient (< 0.3)
4. High adhesion durability
5. 100% visible light transmittance possible in <100 nm coating thicknesses

For which uses of PFAS is there no alternative?

Outlook: No alternative has yet been identified.

R&D activity: Some potential non-PFAS alternatives have been assessed - mainly Si-based materials, but also PU and chlorinated chemistries.[34]

Alternatives cannot match the performance of PFAS:

- Surface tension / energy of alternatives is not as low as PFAS. Alternatives are unable to achieve water contact angle >=110°, and oil contact angle >=80° which causes wetting of surface.
- The anti-fouling performance of alternatives is not as good as PFAS. Coatings based on PFAS exhibit much better easy-cleaning ability than Si-based coatings.
- Chemical stability and resistance of alternatives is not as good.
- Abrasion resistance of alternatives is not good, resulting in poor long-term durability [Supplier Survey 2023, OECD]
- Temperature stability/resistance of PFAS is superior, which can operate at >200 °C[35]
- Thicker coating may need to be applied for alternative [OECD]. Silica-based coatings such as silicone polymers can be used as alternatives to radiation curable coatings in electronics as they have similar properties and therefore can carry out similar function as PFASs used in this application. In electronics, however, PFAS can be applied in a thinner layer compared to non-PFAS alternatives - fluoropolymers are typically applied in a coating thickness of 1-2 µm (nano coating), whereas alternatives such as acrylic, PU and silicone are applied at >25 µm.[36]

Si-based alternatives may meet lower specifications for abrasion resistance, contact angle and anti-fouling tests, but these are not acceptable per industry and customer experience

[33] Source: Supplier Survey 2023
[34] Source: Supplier Survey 2023, Chemsec, OECD
[35] ChemSec (2023), Check Your Tech: A guide to PFAS in Electronics, https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fchemsec.org%2Fapp%2Fuploads%2F2023%2F04%2FExcel_ChemSec-Electronics-Guide.xlsx&wdOrigin=BROWSELINK
[36] Chemsec (2023)

requirements and will result in shorter product service life. In addition, silicone coating absorbs oil, is sticky, causes cross contamination and leads to adhesion loss of other components.[37]

Substitution:

- The time required to develop a new material that meets all the performance requirements is unknown. It is estimated to take at least 2 years for suppliers to study, screen and identify a potential substitute.
- Once a potential substitute is identified, it will take 1.5 years for material qualification, manufacturing process development and part level qualification (environmental aging simulation, adhesion duration, storage stability, easy cleaning performance).

Proposed derogation

Paragraph 2(c) shall apply from (**6.5 years** after entry into force) to **anti-fingerprint coatings** in electrical and electronic equipment. By [18 months before the derogations are due to expire] the Commission will review derogations in light of new scientific available information and information on alternative materials or processes and if appropriate modify this derogation accordingly.

3.2. Coating and paint for enhanced abrasion resistance in EEE

Name of PFAS substance(s) PTFE

General summary on the application category

Components inside devices can corrode or degrade when exposed to contaminants, moisture or wear. The degradation can reduce the electrical and mechanical performance of the device and cause device failure in some cases. Manufacturers use specialized paints/coatings to protect these sensitive components.

Fluoropolymers are used as additives/binders in paints because they confer protective properties on the paints such as durability, weatherability and resistance to corrosion and dirt pick up as well as acting as a barrier to UV deterioration and providing a soft feel 'texturizer' for some applications. Fluoropolymers commonly used in paints are primarily based on PVDF, PTFE, FEP, ETFE and FEVE. They impart excellent self-lubricating property, wear resistance, water, heat and chemical resistance and high-performance electrical insulation. These characteristics help extend the lifespan of components and improve their fire safety.

Product durability is a key focus of policy efforts as part of the Circular Electronics Initiative and has been a key feature in the review of Ecodesign Regulation 617/2013 (Lot 3) - Computers and Computer Services.

Si-based alternatives have been tested but have so far failed to meet performance and durability requirements.

[37] Chemsec (2023)

The annual tonnage and emissions (at sub-sector level) and type of PFAS associated with the relevant use

Insufficient information to quantify -

The key functionalities provided by PFAS for the relevant use[38]

1. Very low surface energy on the substrate surface to promote water and oil repellency (>=110° water contact angle; >=80° oil contact angle)
2. Excellent durability and abrasion resistance (also due to very low friction coefficient)
3. Wide temperature range and thermal stability (-30℃ -150℃)
4. High resistance to chemicals and compatibility with oxygen
5. Excellent adhesion durability

For which uses of PFAS is there no alternative?[39]

Outlook: No alternative has yet been identified.

R&D activity: Alternatives examined included PE waxes and Si-based solutions.

Alternatives cannot meet performance and durability requirements:

- Worse abrasion durability
- Worse chemical resistance
- Worse anti-fouling performance

Si-based alternatives may meet lower specifications for abrasion resistance, contact angle and anti-fouling tests, but these are not acceptable per industry and customer experience requirements and will result in shorter product service life. In addition, silicone absorbs oil, is sticky, causes cross contamination and leads to adhesion loss of other components.

Substitution:

- The time required to develop a new material that meets all the performance requirements is unknown. It is estimated to take at least 2 years for suppliers to study, screen and identify a potential substitute.
- Once a potential substitute is identified, it will take 1.5 years for material qualification, manufacturing process development and part level qualification (environmental aging simulation, adhesion duration, storage stability, easy cleaning performance).

Proposed derogation

Paragraph 2(c) shall apply from (**6.5 years** after entry into force) to **fluoropolymer coatings and paints for enhanced abrasion resistance** in electrical and electronic equipment. By [18 months before the derogations are due to expire] the Commission will review derogations in light of new scientific available information and information on alternative materials or processes and if appropriate modify this derogation accordingly.

[38] Source: Supplier Survey (2023)
[39] Source: Supplier Survey (2023)

3.3. Coating in connectors

Name of PFAS substance(s) Fluoropolymers

General summary on the application category

Plug-in connections are used wherever components or assemblies need to be connected temporarily. Electrical contacts have basically two main tasks: the possibility to mechanically separate an electrical connection and the transmission of electrical energy without losses in closed position. As they are used in a wide range of different environments, like heat or damp heat, the contact surface of the electrical contact has to meet various requirements.

The main function of this PFAS coating on the gold plated elements is to seal micro pores on the surface and prevent corrosion. Thin gold plating can be microscopically porous and corrosion would lead to increased contact resistance. For plastic parts, the PFAS anti-flux coating helps to ensure efficient soldering when performing surface mounting - limiting the flow of solder when being applied.

To date, no alternatives have been found.[40]

The annual tonnage and emissions (at sub-sector level) and type of PFAS associated with the relevant use

Insufficient information to quantify/See confidential annex.

The key functionalities provided by PFAS for the relevant use

1. Low wettability (through low surface tension / energy)
2. Sealing micro-sized holes offering effective corrosion protection

For which uses of PFAS is there no alternative?

Outlook: Potential alternatives all contain PFAS according to the supply chain. It is important to find a material that does not stick during the manufacturing process.

Substitution[41]*:*

- The time required to develop a new material that meets all the performance requirements is unknown. It is estimated to take at least 2 years for suppliers to study, screen and identify a potential substitute.
- Once a potential substitute is identified, typical duration of manufacturing process update and testing takes at least 20 months, depending on application and the required tooling investment.

[40] Supplier Survey (2023)
[41] Supplier Survey (2023)

Proposed derogation

Paragraph 2(c) shall apply from (**6.5 years** after entry into force) to **fluoropolymer coatings in connectors** in electrical and electronic equipment. By [18 months before the derogations are due to expire] the Commission will review derogations in light of new scientific available information and information on alternative materials or processes and if appropriate modify this derogation accordingly.

3.4. Optical isolation layers for display applications

Name of PFAS substance(s) Fluoropolymers (e.g. PTFE), Perfluoropolyether (PFPE)

General summary on the application category

PFAS-containing low optical loss and refractive index coatings and adhesives are used to preserve total internal reflection (TIR) of the light in advanced display applications like waveguides. Waveguides leverage specific optical properties of the material to guide wavelengths if sound, light or other radiational energy across the material. Basic examples would be optical fibers and magnetrons within microwaves. If the optical properties are not maintained then the light will not be effectively transferred across the material by either absorption or misdirection losses. Key requirements for effective transmissions are low optical loss (<0.5%), low RI (<1.35), ability to cure at ambient or low (<80C) temperatures, low moisture absorption, non-yellowing, PFAS-containing materials and high elongation at break. Currently, the PFAS-containing materials are the only HVM-compatible option available that can satisfy the required optical and mechanical properties of the coatings.

The annual tonnage and emissions (at sub-sector level) and type of PFAS associated with the relevant use

Insufficient information to fully quantify, but we can elaborate on the expected emission points, mitigations in place, potential volumes.

Expected Volumes – The end use of this material will be used in EEE. Market acceptance will be a significant variable in determining the total number of products on the EU market. Each product would contain approximately 1 g of PFAS.
Manufacturing - Substance will be applied in a closed loop system that is under strictly controlled conditions.
Recovery - This material will be contained in EE and subject to WEEE. Expected 90% recovery/refurb/reuse of the product.

The key functionalities provided by PFAS for the relevant use

1. Low Refractive index (<1.35)
2. Low optical loss in visible region (<0.5% over 2 um)
3. Low moisture absorption
4. Good adhesion between various interfaces
5. Low modulus and high elongation at break to accommodate for CTE mismatch between layers

For which uses of PFAS is there no alternative?

Outlook:
Alternative commercially available materials like silicones are limited to RI of ~1.40 making them unsuitable for these applications. The high refractive index causes the light to deflect at a much greater angle thus distorting the projections to an indistinguishable state. There is active academic research in porous low RI materials, but these materials are brittle and suffer from high moisture absorption making them unsuitable for these applications as well. In recent years, the coatings industry has initiated the research and development of hollow nanoparticles matrix composite materials to achieve low RI (~1.36) and low temperature curable materials. These materials are in early stage R&D with long cycle times for development and currently suffer from high moisture absorption and delamination.

Substitution:

- The time required to develop a new material that meets all the performance requirements is unknown. It is estimated to take at least 4 years for suppliers to study, screen and identify a potential substitute.

- Once a potential substitute is identified, it will take 1.5 years for material qualification, manufacturing process development and part level qualification (environmental aging simulation, adhesion duration, storage stability, TIR performance).

Proposed derogation

Paragraph 2(c) shall apply from (**6.5 years** after entry into force) to **Optical Isolations Layers For Coatings**. By [18 months before the derogations are due to expire] the Commission will review derogations in light of new scientific available information and information on alternative materials or processes and if appropriate modify this derogation accordingly.

3.5. Coatings: Socio-economic impacts

The consequential economic (in euros) and social (e.g. jobs) impacts arising from any restriction of PFAS in respect to its use in coatings is difficult to quantify. However, significant financial costs can be expected to arise because of the inability to substitute.

While industry will face increased costs associated with conducting repairs in warranties and searching for alternatives, perhaps the greatest cost impact will be felt by businesses and consumers to replace electronic devices on more frequent cycles due to device failure and/or loss of consumer expected performance, and the impact to EU businesses as a result of downtime when products fail.

1. Annual value of EU sales: In 2022, the computer hardware market in Europe generated a total revenue of over 60 billion euros, selling around 630 million units. Storage units

made up the majority of volume at approximately 462 million units, followed by laptops and keyboards, both with approximately 42 and 40 million units sold, respectively.[42]

2. Cost to companies/consumers in the EU to repair/replace electronic devices on more frequent cycles: A Eurobarometer survey observed that, when a main failure occurs, 77 % of EU citizens would rather repair their goods than buy new ones, but ultimately have to replace or discard them because they are discouraged by the cost of repairs and the level of service provided (European Commission, 2014b). Viegand Maagøe and VITO (2017) reported a typical lifetime of 5 years for notebooks, 6 years for desktop computers.[43]
3. Impact of downtime to EU businesses when electronic devices fail: Data in the public domain tends to focus on the cost to businesses resulting from network outages rather than devices, but costs will vary according to the sector and size of the business but will include productivity losses, replacement costs, and lost sales.
4. Total sector agnostic annual savings through extended component lifetime: Fluoropolymer coatings, linings and components prevent corrosion in demanding environments. Each percent reduction in corrosion is estimated to deliver savings of some €150m per year across Europe. Amongst other benefits, they support savings in maintenance through increased component lifetime. Consultation suggested their use effectively doubled the lifetime of equipment, potentially yielding savings in the order of €100m annually. (Source, FPG, Plastic Europe, 2017 https://fluoropolymers.plasticseurope.org/application/files/7816/1167/4026/Final_SEA_Fluoropolymers_summary2017_3.pdf)
5. R&D, retooling, retesting, recertifying supply chain costs: not able to be estimated.

[42] Statista (2023), https://www.statista.com/forecasts/1256748/volume-segments-computer-hardware-europe

[43] Viegand Maagøe and Vlaamse Instelling voor Technologisch Onderzoek NV (VITO) (2017) Preparatory study on the Review of Ecodesign Regulation 617/2013 (Lot 3) - Computers and Computer servers. Task 7 Report: Policy Measures and Scenario Analysis, https://computerregulationreview.eu/sites/computerregulationreview.eu/files/Preparatory%20study%20on%20review%20computer%20regulation%20-%20Task%207%20VM%2019072018.pdf

4. Anti-dripping agents

Name of PFAS substance(s) PTFE

General summary on the application category

Flame retardant polycarbonate (PC) resins and alloys, such as PC/ABS used in thin-wall (thickness <1.0 mm) electronics applications play a critical role in consumer safety and require the use of PTFE as an anti-drip additive. These flame-retardant polycarbonate resin formulations are used where product safety (mitigated risk of flame/fire and/or electrical shock) is of utmost importance.

Thin-walled parts reduce the amount of plastic used and therefore the amount of plastic waste produced during the manufacturing process as well as at the electronic devices' end of life. Before these tough thin-wall flame retardant polycarbonates were available, typical wall thicknesses in consumer electronics were 2-3 mm, which in comparison can lead to a 100% to 200% increase in resource consumption and solid waste generation, depending upon the electronic application design requirements. As the devices are subsequently lighter, have resulted in reduced scope 3 emissions (category 4- upstream transportation and distribution, and category 9 downstream transportation and distribution)[44]

Our justification for requesting derogation of PTFE as anti-drip agent in flame retardant polycarbonate compounds comprises two elements:

- there are no alternatives to polycarbonate that provide adequate impact resistance and ductility for thin wall (<1.0 mm) applications in electronic products
- in order to ensure that the polycarbonate thin wall has adequate flame retardancy, it is essential to use PTFE as the anti-drip agent.

Alongside many unique properties, polycarbonate is an inherently tough material which provides device integrity during and after an impact event, so that the electronic device can continue to function, and does not produce an electrical hazard (short circuit, shock hazard) or a fire hazard. There are no alternative engineering plastics available today that provide the necessary combination of impact resistance, ductility, and flammability properties for thin-walled (<1 mm) electronic device parts. These properties are crucial to:

- provide a durable product that does not break during normal use, including drops and other foreseeable events,
- ensure safety by avoiding exposure of life circuitry, and
- meet EU regulatory requirements on the safety of electrical device.

The next best material is polyphenylsulfone (PPSU) which has almost half the ductility. By extension, we can expect that electronic products with thin walls (<1.0 mm) made from PPSU would be twice as fragile compared to the same products made with polycarbonate. Increased fragility means increased risk that the device may break after an impact event, which may result in electrical hazard (short circuit, shock hazard) or fire hazard.

[44] RCOM Ref 4009, RCOM Ref 4407

To ensure that thin-walled polycarbonate resins and alloys have adequate flame retardancy, it is essential to use PTFE as the anti-drip agent. PTFE, in combination with flame retardant additives, increases the ignition resistance of the polycarbonate thereby lowering the probability of a fire event. If a flame event does occur, the unique properties of PTFE help prevent flames from spreading and allow individuals more time to escape a fire.

Extensive research in the plastic industry has not found any alternatives that provide adequate flammability performance for thin-walled polycarbonate while also maintaining adequate impact resistance and ductility. Plastics manufacturers have carried out in-house experiments to investigate whether they could develop alternative additives that could be used instead of PTFE. None of the alternatives that were tested were able to provide adequate flame-retardant properties without significantly degrading impact resistance or other mechanical properties.[45]

The annual tonnage and emissions (at sub-sector level) and type of PFAS associated with the relevant use

No PTFE is released from parts manufactured from thin-walled polycarbonates during their use phase.[46] At end-of-life, when these articles containing 0.1-0.5 weight% of PTFE in the polycarbonate matrix will eventually enter the waste stage, the amount of PFAS emissions depends on the waste (pre-) treatment method, e.g., recycling/re-use, landfilling and incineration. However, PTFE is a fluoropolymer that is not water soluble and therefore does not present the specific hazards which are found with non-polymeric PFAS. PTFE is chemically, thermally, and biologically stable and therefore is not expected to transform to dispersive nonpolymeric PFAS when disposed of in a landfill. A recent study[47] presented results from OECD guideline biodegradation studies demonstrating that PTFE is stable and does not degrade to non-polymeric PFAS under environmentally relevant conditions. Further, PTFE meets the criteria to be considered a Polymer of Low Concern, PLC, which has negligible leachables, unreacted monomers, and oligomers most likely destroyed in use processing and would therefore not be expected to significantly contribute to landfill leachate.

The key functionalities provided by PFAS for the relevant use[48]

Nearly all electronic devices have an inherent risk of fire and a risk of shock. Product safety standards use material fire resistance and electrical insulation requirements as two critical safety elements to help mitigate these risks. For fire resistance, there are several common industry test standards that require materials to resist ignition, burning, and the dripping of flaming particles. One common standard is "*UL 94, the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances*" which is now harmonized with the IEC 60707, 60695-11-10 and 60695-11-20 standards and the ISO 9772 and 9773 standards that are used to demonstrate compliance to flame retardant requirements in the EU. There are 6 flame classifications of materials that are used in enclosures, structural parts and electrical insulators in electrical devices: HB, V-2, V-1, V-0, 5VA and 5VB. The higher ratings – V-1, V-0, 5VA and 5VB - all require that samples do not drip flaming particles.

Since polycarbonate is designed to be shaped/flowed by heat, direct flame application can lead to melting and dripping of the polycarbonate before or during ignition. Any flaming melting/dripping has the chance of spreading flaming material beyond the initial ignition event and is almost always more pronounced in thinner rather than thicker walls. PTFE is the only viable additive for polycarbonate resins used in thin walls that can inhibit dripping **and** retain

[45] RCOM Ref 4481
[46] RCOM Ref. 4044
[47] Stephen H. Korzeniowski et al. (2022), A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers, Integrated Environmental Assessment and Management Vol. 19 Issue 2, https://setac.onlinelibrary.wiley.com/doi/10.1002/ieam.4646#pane-pcw-references
[48] RCOM Ref 4009, RCOM Ref 4407

all the impact resistance and ductility properties which are essential for product safety and compliance with regulatory requirements.

During melting and shaping of the polycarbonate into injection molded parts, the PTFE does not melt and instead undergoes a physical form change from being semi-spherical particles to highly elongated fibrils. These long fibrils form an entangled network inside the polycarbonate resin matrix. During a flame event, this network of PTFE fibrils does not burn/ignite and instead helps promote char formation and provides much higher melt strength to the thin polycarbonate wall. PTFE as an anti-drip agent is typically used in the range of 0.1-0.5% by weight of the total polycarbonate resin formulation.

For which uses of PFAS is there no alternative?

Outlook: No alternative has yet been identified.

R&D activity: Various flame-retardant materials have been examined as potential alternatives to polycarbonate resins, including PP, Nylon, PPE/PS, Polyetherimide, PPSU, and PEEK.

Why there are no alternatives to polycarbonate resins: Toughness

In addition to flame resistance, it is essential for product safety that thin plastic walls have adequate toughness to

- provide a durable product that does not break during normal use, including drops and other foreseeable events
- ensure safety by avoiding exposure of live circuitry, and
- meet EU regulatory requirements of the electrical device.

Toughness is comprised of a combination of two physical properties: impact resistance and ductility. Impact resistance is the material's *ability to absorb shock or impact energy without breaking*. Ductility is the material's ability to stretch without breaking.

A material's impact resistance and ductility can be measured using Notched Izod Impact (NII) and Tensile Elongation (TE). These techniques measure the amount of energy a material can absorb during impact and the percentage amount the material will stretch before breaking in controlled laboratory settings, following standardized test methods (e.g., ASTM D256[49]/ ISO 180[50] for NII and ASTM D639[51]/ISO 527[52] for TE). The higher the impact resistance and the ductility, the tougher the material is and the more resistant it is to cracking or breaking.

As highlighted in Table 1 polycarbonate resin formulations provide unmatched impact resistance and ductility in the afore-mentioned tests compared to other engineering plastics, while also providing the required flame resistance, as measured by the ability to pass UL94 V0 flame testing at less than 1.0 mm thickness. The other engineering plastics in the below table were selected, based on our technical expertise, as most likely to represent viable alternatives to polycarbonate blends. However, as described below, none of these other thermoplastics represent viable alternatives to polycarbonate based on our research.

[49] Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics (astm.org)
[50] ISO 180:2019 - Plastics — Determination of Izod impact strength
[51] Standard Test Method for Tensile Properties of Plastics (astm.org)
[52] ISO 527-1:2019 - Plastics — Determination of tensile properties — Part 1: General principles

Property Comparsion				
Material (non-reinforced)	**Property**	**Flame Resistance**	**Impact/Crack Resistance**	**Ductility**
		Passes UL94 V-0 @<1.0 mm?	Notched Izod Impact, % of Reference	Elongation @Break, % of Reference
	Polycarbonate Blend	☑	100% (Ref)	100% (Ref)
	Nylon	☑	4% (96% decrease)	4% (96% decrease)
	PPE/PS	☑	12% (88% decrease)	14% (86% decrease)
	Polyetherimide	☑	4% (96% decrease)	55% (45% decrease)
	PPSU	☑	83% (17% decrease)	55% (45% decrease)
	PEEK	☒	11% (89% decrease)	46% (54% decrease)
	Polypropylene	☒	4% (96% decrease)	120% (20% increase)

Table 2 Flame resistance, impact resistance and ductility of engineering plastics compared to polycarbonate

As can be seen in Table 1, several materials can achieve similar flame resistance to the polycarbonate, however none of these materials have a comparable combination of both impact resistance and ductility (hence, overall toughness).

Why there are no alternatives to PTFE for thin wall polycarbonate

There are several strategies that can be employed to increase resistance to flame dripping by increasing the melt strength or the stiffness of the material with either viscosity enhancers or mechanical fillers. However, Table 2 highlights that none of these strategies can provide the necessary flammability performance for thin-walled polycarbonate while also maintaining adequate impact resistance and ductility.

Highly branched/high viscosity polycarbonate can increase the melt strength and reduce flame dripping. However, this results in a significant reduction in impact resistance and ductility by 86% and 56% respectively and does not provide adequate overall flammability performance at less than 1.0 mm wall thicknesses.

Glass fiber or other inorganic fillers (Clay, Talc, Carbon Fiber) can be added to increase the stiffness of the material and reduce flame dripping. However, these additives must be used at relatively high loadings (20-50% or more by weight) to have a significant effect on flame dripping properties, and these high loadings cause a dramatic decrease in the ductility and impact resistance of the material. Glass, Talc and Clay fillers, at 20 weight % loading significantly reduce the impact resistance and ductility by 84% and 96% respectively (and these properties will continue to deteriorate as filler loading increases), and do not provide adequate overall flammability performance at less than 1.0 mm wall thicknesses. Carbon fiber does provide adequate overall flammability performance at less than 1.0 mm wall thicknesses but significantly reduces the impact resistance and ductility by 90% and 99% respectively.

Property Comparison in PC

	Property	Flame Resistance	Impact/Crack Resistance	Ductility
PTFE Replacement		Passes UL94 V-0 @<1.0 mm?	Notched Izod Impact, % of Reference	Elongation @Break, % of Reference
	PTFE	☑	100% (Ref)	100% (Ref)
	Branched/High Viscosity Resin	☒	14% (86% decrease)	44% (56% decrease)
	Mineral (Glass, Talc, Clay)	☒	16% (84% decrease)	4% (96% decrease)
	Carbon Fiber	☑	10% (90% decrease)	1% (99% decrease)

Table 3 Flame resistance, impact resistance and ductility of alternative anti-drip agents compared to PTFE in polycarbonate

As can be seen in the table, only one alternative approach to PTFE (carbon fiber) can achieve adequate overall flammability performance, however the significant reduction in impact resistance and ductility does not allow it to meet product safety requirements and so this approach cannot be used in design and manufacture of consumer electronics.

Substitution:

There are no alternatives to PTFE available today for thin-wall flame retardant polycarbonate resins. A wide range of potential alternatives have already been tested and found to fail to provide the necessary properties. A new round of extensive, fundamental laboratory research will be needed to attempt to identify a completely new material, unknown today, that may potentially be developed into an alternative to PTFE. It is estimated to take up to 8 years for this basic research.

If a new alternative material is identified it would take several more years to test, qualify, certify, and start manufacturing parts from this replacement material. Companies may need to make changes to their manufacturing equipment and processes to use the new material in their injection molding lines. These changes to manufacturing equipment and processes may be significant and require extensive time and capital investment.

Product requalification is a very time-consuming exercise which will require extensive resources over many years. The completion of this task will require sufficient test house capacity and transition time to requalify all existing thin-wall flame retardant polycarbonate resin parts in products which are used in Europe for safety and performance. For a company with a wide range of existing product designs, we estimate it could take up to 5 years to carry out the necessary manufacturing equipment changes and product re-qualifications.

Proposed derogation

Paragraph 2(c) shall apply from (**13.5** years after entry into force) to PTFE used as **anti-dripping for polycarbonate resins and alloys (includes thermoplastics, such as Polycarbonates (PC), Polyvinyl Chloride (PVC), Polyamides, Acrylonitrile Butadiene Styrene (ABS), Polycarbonates (PC) and Acrylonitrile Butadiene Styrene (ABS) blend, Polypropylenes (PP), Thermoplastic Polyurethane (TPU), Polyethylenes (PE), Polyesters**.) **used for thin-walled parts** in electrical and electronic equipment.

4.1. Anti-dripping agents - socio-economic impacts

Statistics from several European countries reveal that electrical equipment account for 25 - 30% of all domestic fires, estimated in 273,000 fires per year. Fires can be generated by devices connected to the mains power, or battery powered devices. Lithium-ion batteries, in a fault condition, are also capable of overheating leading to ignition and subsequent explosion.

Flame retardancy has been proven to work and continues to be a powerful tool in the overall efforts to prevent fire related injuries and save lives. One of the most important benefits of flame retardancy in product design is they can stop small ignition events from turning into larger fires. Even if ignited material with flame retardancy also delay the spread of fire to give people sufficient time to escape. For example in the EU, due to the introduction of increased fire safety standards — the number of fire victims fell by more than 48% in France from 1982 to 2012, and by 56% in the UK from 1982 to 2013. Overall Europe has achieved substantial improvements in fire safety, with fire fatalities dropping by 65% over the last 30 years[53]. Since 2017, nearly different 500 types of electronic products have been recalled, withdrawn, or banned from sale in the EU due to fire hazards[54].

Other materials and components used in electronics are insufficient to prevent or delay the spread of fire from electronics. For example, protective components within electronics can reduce but not eliminate the risk of fire from electrical malfunction/failures. For example, a thermal fuse in a motor operated appliance will offer protection against an abnormal overload condition but it will not protect against other component failures like overheated power switches, connectors, wiring etc.

Another example is current-limiting components such as circuit breakers that are triggered by current rather than voltage. Once they are triggered, current limiting devices restrict power from reaching the equipment being protected without having to dissipate that power as heat. Therefore, there is virtually no limit to the amount of energy that they can handle. However, current-limiting devices do not generally respond fast enough to protect equipment from fast

[53] Modern building alliance Europe: Fire Death Rate Trends: An International perspective
[54] Safety Gate: the EU rapid alert system for dangerous non-food products

transient overvoltage's generated by lightning or electrostatic discharge which can lead to a flashover/arcing.

It is therefore essential to continue to guarantee the availability of PTFE and flame-retardant polycarbonate for the safety of electrical equipment on the European market until an effective and safe alternative can be found.

The consequential economic (in euros) and social (e.g. jobs) impacts arising from any restriction of PFAS in respect to its use as anti-drip additive in polycarbonate plastics is difficult to quantify. However, significant financial costs can be expected to arise.

1. **Annual value of EU sales**: In 2022, the computer hardware market in Europe generated a total revenue of over 60 billion euros, selling around 630 million units. Storage units made up the majority of volume at approximately 462 million units, followed by laptops and keyboards, both with approximately 42 and 40 million units sold, respectively.[55]
2. **Indirect cost - European employment in the ICT sector**: In 2022, more than 9 million persons worked as ICT specialists across the European Union (EU). The highest number (2.1 million) worked in Germany, which provided work to more than one-fifth (22.6 %) of the EU's ICT workforce. France (1.2 million) had the second largest ICT workforce (13.0 % of the EU total), followed by Italy and Spain (both 0.9 million; 9.6 % and 9.4 % respectively).[56]
3. **R&D, retooling, retesting, recertifying supply chain costs:** not able to be estimated.
4. **Cost to companies/consumers in the EU to repair/replace electronic devices on more frequent cycles**: A Eurobarometer survey observed that, when a main failure occurs, 77 % of EU citizens would rather repair their goods than buy new ones, but ultimately have to replace or discard them because they are discouraged by the cost of repairs and the level of service provided (European Commission, 2014b). Viegand Maagøe and VITO (2017) reported a typical lifetime of 5 years for notebooks, 6 years for desktop computers.[57]
5. **Impact of downtime to EU businesses when electronic devices fail**: Data in the public domain tends to focus on the cost to businesses resulting from network outages rather than devices, but costs will vary according to the sector and size of the business but will include productivity losses, replacement costs, and lost sales.

[55] Statista, 2023, https://www.statista.com/forecasts/1256748/volume-segments-computer-hardware-europe
[56] Eurostat, 2023, ICT Specialists in Employment, https://ec.europa.eu/Eurostat/statistics-explained/index.php?title=ICT_specialists_in_employment#Number_of_ICT_specialists
[57] Viegand Maagøe and Vlaamse Instelling voor Technologisch Onderzoek NV (VITO) (2017) Preparatory study on the Review of Ecodesign Regulation 617/2013 (Lot 3) - Computers and Computer servers. Task 7 Report: Policy Measures and Scenario Analysis, https://computerregulationreview.eu/sites/computerregulationreview.eu/files/Preparatory%20study%20on%20review%20computer%20regulation%20-%20Task%207%20VM%2019072018.pdf

5. Cables/Connectors

General summary on the application category

A wide variety of materials is available as insulation and jacket for cables and connectors. Many types of plastics, rubbers and fluoropolymers are used in different applications. Fluoropolymers (PTFE, FEP, PVDF and PFA) are only chosen when other materials cannot meet the specific requirements on dielectric properties, flame and heat resistance, chemical inertness and/or durability. They are predominantly used in Direct Current (DC) cables and coaxial cables, but fluoropolymers can also be required for other cable types in demanding applications.

A DC cable is an electrical connector for supplying direct current power to electronic devices like computers and laptops.

Coaxial cables are used to carry high-frequency electrical signals. They are used in the electronics sector for the transmission of data - coaxial cables allow for high bandwidth and to transfer data over shorter distances in typically commercial and consumer settings. They differ from other shielded cables because the dimensions of the cable and connectors are controlled to give precise, constant conductor spacing, which is needed for it to function efficiently as a transmission line. Coaxial cables work by carrying data in the center conductor, while the surrounding layers of shielding perform to prevent harmful radiation while minimizing signal loss (also called signal attenuation). The first layer, called the dielectric, provides distance between the core conductor and the outer layers, as well as some insulation.

A discrete wire is a wire with a single conductor that terminates on one connector contact. When discrete wires are used to make cable assemblies, it is known as a discrete cable assembly. Discrete cables are commonly used for power transfer in the cable circuit design when the transmission current is higher within the same usable space in the device.

The uses of fluoropolymers (PTFE, FEP and PFA) are essential to the functioning of several types and/or uses of cables. PTFE, FEP and PFA are robust fluoropolymer materials that are used to insulate cables to improve performance for demanding applications. They have superb flame-retardant properties: no additional flame retardants are needed (reduces the use of halogenated flame retardants), they have high melting points and low rates of heat release and low smoke generation.

For coaxial cables with a diameter exceeding a quarter inch / 6.3mm alternative materials such as polyethylene foam can be used for certain applications. The minimum diameter relates to a minimum thickness of the dielectric material (reducing radio frequency signal losses to an acceptable level). This material has a much lower flammability rating which is acceptable only in specific applications.

Fluoropolymers also have excellent electrical properties (which means very low losses when transmitting high signals) and the widest temperature range of any plastic material – being able to withstand everything from -200ºC up to +260ºC and even up to +400ºC for a short length of time, which means they can transmit high power and withstand the high soldering temperature. Furthermore, they are highly resistant to sunlight, and therefore unlikely to degrade even in outdoor conditions. They provide excellent resistance to oils and other chemicals and UV light. They have superior mechanical flexibility – no plasticizers are needed (reduces the use of ortho-phthalates) and have the lowest coefficient of friction of any solid materials. Fluoropolymers are hydrophobic and resistant to hydrolysis; the typical properties and dimensional stability remain unchanged even after long immersion in water which is good for cables/connectors for outdoor use.

There are no other chemicals that can provide all of these critical properties in combination in a standalone substance for cables/connectors. The uses of fluoropolymers in cables and connectors also enhance the product durability which is a key focus of policy efforts as part of the Circular Electronics Initiative and has been a key feature in the review of Ecodesign Regulation 617/2013 (Lot 3) - Computers and Computer Services.

Alternatives highlighted by ChemSec and by the Dossier Submitter

Analysis by ChemSec highlighted a high degree of uncertainty on whether alternatives were available.[58] This has been corroborated through extensive supplier engagement. No alternatives have yet been found that meet all the properties offered by these PFAS substances in cables and connectors.

The Dossier Submitters proposed alternatives for wire insulation. These non-PFAS alternatives are PEEK, PC and EDPM. A review was conducted to ascertain their feasibility as viable non-PFAS alternatives, focusing upon several prominent properties.

Dielectric Constant

Most fluoropolymers have a dielectric constant of ~ 2.0.[59] This is extremely critical as the size of electronic devices continues to shrink, which introduces new obstacles such as signal crosstalk, power consumption and time delays, as a result, fluoropolymers with low dielectric constants are needed to achieve faster and stable signal transmission.[60] Such dielectric characteristics are the result of the fluoropolymers' symmetrical molecular structure $(C_2F_4)n$ and the short distance between the carbon and fluorine[61].

The three proposed non-PFAS alternatives have much higher dielectric constants ranging from 2.7 – 4.5[62], which will result in much slower and unstable signal transmission. This will greatly affect the functioning, safety and quality of the electronic product for which these cables/connectors are utilised. Thicker insulation might solve this problem, but not in all applications there is sufficient space. Consequently, on this critical property alone, none of the proposed non-PFAS alternatives are suitable to replace PFAS for all cable applications.

Dissipation Factor

The dissipation factor can also be used to assess the characteristics or quality of an insulating material in applications such as cables, connectors, terminations, joints etc. The lower the value, the better the dissipation factor. Fluoropolymers have a low value of 2.0[63] which provides a highly efficient insulator. EPDM also performs well with this quality with a dissipation factor of 2.5[64], however, the other proposed non-PFAS alternatives PC and PEEK

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58 ChemSec (2023), Check Your Tech: A guide to PFAS in Electronics, https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fchemsec.org%2Fapp%2Fuploads%2F2023%2F04%2FExcel_ChemSec-Electronics-Guide.xlsx&wdOrigin=BROWSELINK

59 Matweb (2023), Material Property Data, viewed 14 June 2023, < https://www.matweb.com/>

60 Dong, J., Sang, X., Yin, W. and Chen, X. (2023) Preparation of fluorinated epoxy-phthalonitrile resins with excellent thermal stability and low dielectric constant. Journal of Applied Polymer Science, 140, p. 1-9

61 Daikin 2023, Fluoropolymers Selection Guide, viewed 13 June 2023, https://www.daikinchemicals.com/solutions/products/fluoropolymers.html

62 Matweb (2023); Gunasekaran, S., Natarajan, R.K., Kala, A. and Jagannathan, R. (2008) Dielectric studies of some rubber materials at microwave frequencies. Indian Journal of Pure and Applied Physics, 46, p. 733-737.

63 Omnexus 2023, The Material Selection Platform, viewed 14 June 2023, https://omnexus.specialchem.com/

64 Thorne & Derrick 2023, Properties of EPDM & Silicone Rubbers, viewed 13 June 2023, https://www.powerandcables.com/euromold-connectors-properties-performance-40-years-of-market-leadership

have dissipation factors of 9 and 30[65] respectively which are not best suited for cables/connectors.

Coefficient of Friction

Fluoropolymers have a Coefficient of Friction (COF) in the range of 0.02 - 0.08[66] which are effectively the lowest of any known solid material. Such properties have proven to be invaluable to the electronics industry in providing sustained durability. PC has the closest COF with a range of 0.05-0.18[67] to that of the fluoropolymers. PEEK has higher values of 0.15-0.40[68] while EPDM has very high values of 1.36 - 2.76[69] which are not suitable for cables/connectors.

Flame Retardancy

In terms of flame retardancy, a primary safety function, fluoropolymers are unique with their extremely high Limiting Oxygen Index (LOI) of ~95%[70] which inherently means they are non-flammable. The proposed alternatives have LOI values ranging from 19.5 - 24[71]. Taking EPDM with the lowest LOI value of 19.5, implies that it is a highly flammable substance that restricts its further application and development particularly within the electronics industry[72]. PC and PEEK also have low LOI values which would require flame retardant additives to be employed. However, the "Regulatory Strategy for Flame Retardants" published by the European Chemicals Agency in March 2023, which stated that "the substances in scope of this strategy are in principle all flame retardants.", places a very high degree of uncertainty on the future availability of flame retardants that would be required for the non-PFAS alternatives proposed by the Dossier Submitters.

In essence, the proposed non-PFAS alternatives have some of the necessary properties required for use in cables/connectors. However, they all have inappropriate characteristics that would require in some cases, the addition of supplemental chemical substances to render them functional which are also on a roadmap to be regulated under the REACH regulation. Others such as EPDM with its flammability properties precludes them on safety grounds from undertaking a meaningful function with cables/connectors.

Non-PFAS Alternatives Identified Through Research

Focusing upon research into non-PFAS alternatives has required an extensive literature review to determine what if any non-PFAS alternatives are being considered for cables and. The on-line library search engine utilised for this review was Summon™.

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65 Omnexus 2023, The Material Selection Platform, viewed 14 June 2023, https://omnexus.specialchem.com/
66 Matweb (2023); Gunasekaran, S., Natarajan, R.K., Kala, A. and Jagannathan, R. (2008) Dielectric studies of some rubber materials at microwave frequencies. Indian Journal of Pure and Applied Physics, 46, p. 733-737.
67 Matweb (2023)
68 Matweb (2023)
69 Mukhopadhyay, A. (2014) Friction and wear characteristics of indigenous 'EPDM' rubber under dry sliding condition. ARME, 3, (2), p. 1-25.
70 Omnexus (2023)
71 Omnexus (2023)
72 Tang, G., Hu, Y. and Song, L. (2013) Study on the flammability and thermal degradation of a novel intumescent flame-retardant EPDM composite. Procedia Engineering, 62, p. 371-376

Error! Reference source not found.4 illustrates the keywords/phrases utilised in an effort to comprehend what research into non-PFAS alternatives for cables and connectors taken place or indeed is still on-going.

Keyword or Phrase	# of Results	Results of Relevance to PFAS in Cables/Connectors/Capacitors
PFAS	68,857	Reviewed the first 1,000 results. None of them were relevant.
PFAS in electronics	1,791	None
Non PFAS alternatives in electronics	19	None
PFAS alternatives in electronics	78	None
Fluoropolymer alternatives in electronics	84	Most of the results focused upon fuel cells, membrane materials for alternative energy and sustainability applications. None were relevant for cables, connectors and capacitors.
PFAS in electrical cables	188	There were some relevant results, but the papers emphasised the benefits of fluoropolymers in cable products.
Fluoropolymer alternatives in electrical cables	10	None
PFAS in electrical connectors	8	None
Fluoropolymer alternatives in electrical connectors	0	None

Table 4 PFAS literature review for non-PFAS alternatives in cables, connectors and capacitors

Based upon the findings in Table 4, it is apparent that if there is on-going research into non-PFAS alternatives for cables and connectors, none of it is finding its way into the public domain. This scenario is more than likely a result of the lack of research into these electronic components/products.

Waste

Latest data from Eurostat showed that the recycling rate for separated WEEE stood at 84.5% in 2020.[73] Due to the likely presence of POPs, antimony trioxide and plasticizers in cables, they attract a hazardous waste code. Indeed, since the introduction of more stringent requirements in respect to POPs, any WEEE plastic waste suspected of containing POPs are either burnt in high temperature incineration (i.e. cement kilns) or disposed of in hazardous waste landfills.

In the next three sections 5.1 – 5.3 examples are given of cables and connectors for which there is no PFAS-free alternative for all uses. These examples are not exhaustive. Other types of cables may also require the use of PFAS in demanding applications/environments.

[73] https://ec.europa.eu/eurostat/web/circular-economy/monitoring-framework

5.1. DC cable insulation

Name of PFAS substance(s) PTFE, FEP and other fluoropolymers

CAS Number(s) 9002-84-0, 25067-11-2, 25190-89-0 and more

The annual tonnage and emissions (at sub-sector level) and type of PFAS associated with the relevant use

Insufficient information to quantify/See confidential annex for details.

The key functionalities provided by PFAS for the use in DC cable insulation

1. High temperature stability

   Melting point of FEP is 285°C and PTFE is 327°C. These are significantly higher than potential alternative materials[74]

2. High flame retardant ratings

   The UL flammability ratings of FEP and PTFE are both V-0. This is essential to ensuring the fire safety of the product. Alternative materials typically have lower flammability ratings and therefore could compromise the safety of the product.[75]

3. High chemical resistance[76]: Fluoropolymers (e.g. FEP or PTFE) are inert to acid and base. This is a key characteristic of fluoropolymers to ensure safety and well protection on the conductor inside.

4. High mechanical flexibility (see details below)[77]

For which uses of PFAS is there no alternative?

Outlook: Analysis by ChemSec highlighted a high degree of uncertainty whether alternatives were available. This has been corroborated through extensive supplier engagement. No alternatives have yet been found that meet all properties offered by these two substances in this use.

R&D activity: To date, materials that have been examined include TPE, PVC as well as polyolefins, such as PE and PP.

- **PE, PP and TPE have relatively low melting points compared to PFAS and cannot meet the high temperature stability requirement for certain applications.**
  The melting point for the insulation material is key to DC cables. This is particularly crucial due to the soldering/welding process involved in the manufacturing process. When soldering, temperatures around 300°C are transmitted to the insulation through the conductor. If the material's melting point is significantly below 300 °C, it can lead to insulation burns and ultimately result in malfunction. For instance, the melting point of PE typically ranges from 130 to 135 °C. PP has a melting point that typically ranges from 130 to 171 °C. TPE has a melting point around 60-200 °C. PFAS materials, on the other hand, have high melting points up to 327 °C. The melting point of the material is crucial in ensuring the insulation's integrity and preventing malfunctions.

[74] Supplier Survey 2023; RCOM Ref. 4011, 3909, 3961
[75] Supplier Survey 2023
[76] RCOM Ref. 4011
[77] Supplier Survey 2023, RCOM Ref. 4011

In addition, the operating temperature must be taken into account. The operating temperature for DC cables can go up to 80°C. TPE has a low melting point below 80°C, while other materials have melting points above 80°C.
PFAS is the only type of material that remains structurally stable and does not deform or melt under both two conditions, which results from its exceptional heat resistance and thermal stability. This characteristic is crucial in ensuring the safety of the cable.

- **PE, PP and TPE have relatively low flame-retardant ratings as compared to PFAS**
  High flame resistance is essential for the DC cables used in consumer electronics as it plays a significant role in ensuring user safety and protecting property. Manufacturers need to prioritize incorporating flame-resistant materials in DC cables to meet stringent safety requirements.
  PFAS materials exhibit excellent flame retardant performance and have a UL flammability rating of V-0. PP, PE and TPE materials cannot achieve the same flame retardant rating as PFAS materials.

- **PE and PP have lower mechanical flexibility as compared to PFAS**
  The flexibility and durability for DC cable application is essential to ensuring that the cables can withstand mechanical stress, bending, and dynamic movement without failure. The elongation at break value for FEP typically ranges from 300% to 400%, PP is less than 100%, PE is above 100% and TPE can exhibit a range from 300% to 500% depending on the specific type, grade, and formulation. TPE is a good alternative in terms of flexibility and durability, but it is important to note that flexibility and durability along not guarantee to meet the relevant safety requirements.

- **PVC has poor high temperature stability**
  PVC is often used as wire insulation for moderate temperatures. It can however not be used for temperatures above 70~100 °C. Another disadvantage is the halogen content of PVC.

Substitution:
- The supply chain has reported potential alternative materials to replace PFAS in DC cable applications. However, it will require significant product resign and requalification, and may reduce the safety performance of the cables. The time required to verify the alternative materials is at a minimum:

- 12 months for cable level development and testing: develop specification of raw cable, update manufacturing process, and cable reliability testing and certification.
- 12 months for device level integration testing and certification.
  - If the alternative material does not work, the time required to develop a new material that meets all the safety and performance requirements is unknown. It is estimated to take at least 1-2 years for suppliers to study, screen and identify a potential substitute.
- After successful implementation in a single product, a similar cycle of development and testing is required for the entire product portfolio.

5.2. Coaxial cable and discrete cable insulation and jacket

Name of PFAS substance(s) PFA, FEP, PTFE

CAS Number(s) 26655-00-5, 25067-11-2, 9002-84-0

The annual tonnage and emissions (at sub-sector level) and type of PFAS associated with the relevant use

Insufficient information to quantify.

The key functionalities provided by PFAS for the relevant use[78]

1. Compliance with safety standard UL1354
2. High temperature stability
3. Melting point of FEP is 285°C , PTFE is 327°C and PFA is 305°C. These are significantly higher than potential alternative materials
4. Good electrical performance which ensures reliable signal transmission over a wide range of frequencies. PFAS has low dielectric constant which minimizes signal loss when it's being transferred through the cable hence maintaining excellent signal integrity. Application may malfunction without excellent signal integrity.
5. Low dielectric constant which enables smaller cable diameter (compared to using alternative materials) while maintaining the required electrical performance
6. High insulation resistance and dielectric strength which improves cable reliability and safety, preventing breakdown of equipment, insulation issue or short circuit accidents
7. High flame retardant ratings
8. The UL flammability ratings of FEP, PFA and PTFE are V-0. This is essential to ensuring the safety of the product. Alternative materials typically have lower flammability ratings and therefore could compromise the safety of the product.
9. High mechanical flexibility

   Fluorinated polymers, like FEP and PTFE possess superior Shore D hardness compared with PE and PP:

Material	Shore D
PTFE	D55
PFA	D60
FEP	D55
PVDF	D80
PEEK	D85
PE	D60-D70
PP	D77-D83

   The material with lower Shore D hardness provides better flexibility and better durability. Some cables, like antenna cables, in electronic device often need to pass through the hinge and then must be abraded and rotated following hinge operation. The high shore D hardness insulator cannot be an adequate buffer for the conductor inside, and therefore the conductor cannot bear the frequent twist and abrasion. The

[78] Supplier Survey 2023, ChemSec 2023; RCOM Ref. 4011, 3909, 3691

low hardness of PTFE, FEP and PFA can provide an adequate buffer to protect the conductor and also bear the frequent twist and abrasion. This feature also ensures a longer life cycle for cables used in electronic devices.

10. High chemical resistance: Fluorinated polymers, no matter whether FEP or PTFE, are inert to acid and base. This is a key character of FEP and PTFE for safety to ensure the well protection on the conductor inside.

For which uses of PFAS is there no alternative?

Outlook: Analysis by ChemSec highlighted a high degree of uncertainty whether alternatives were available. This has been corroborated through extensive supplier engagement. No alternatives have yet been found that meet the properties offered by these two substances in this use.

R&D activity: PE and PP, TPE, PVC and silicone resins have been evaluated as alternatives.

- **Non-PFAS materials cannot meet high frequency electrical performance requirements**
  PFAS materials (PTFE, FEP, PFA) are effective in handling high-frequency signals - they can meet the attenuation requirement and support signal transmission over a wide range of frequencies from a few megahertz (MHz) to several gigahertz (GHz) or higher. On the other hand, TPE, PP, PVC, and PE have a frequency range that only extends from a few kilohertz (KHz) to several hundred megahertz (MHz), rendering them unable to meet the gigahertz-range application requirements. A thicker cable insulation might solve this problem, but this does not fit in all applications.
- **Using non-PFAS materials will result in larger cable diameter which does not meet the required specification of a coaxial cable**
  A coaxial cable must have its characteristic impedance controlled, most commonly at 50Ω, to transmit a signal. The value of characteristic impedance changes depending on the dielectric constant of the insulated core and the outer diameter of the insulated core. If a material with a high dielectric constant is used to insulate the coaxial cable, the cable diameter will be increased. Therefore, it is necessary to use materials with a dielectric constant as low as possible for the insulation of coaxial cables. PFAS materials have a dielectric constant that is lower than that of non-PFAS materials. FEP, PFA and PTFE have a relative dielectric constant of 2.1, and is characterized by being able to form an insulating coating as thin as 0.02mm by extrusion molding. On the other hand, PVC has a dielectric constant of 3.1 to 7.0, and the minimum thickness that can be extruded is 0.15mm. Therefore, if the coaxial cable using PFA has an outer diameter of 1 mm, the coaxial cable using PVC will have an outer diameter of 1.4 mm. Similarly, in the case of TPE, it has a dielectric constant is 3 to 8, and the minimum thickness that can be extruded is 0.2 mm, so the outer diameter of the coaxial cable will be 1.8 mm. The dielectric constant of silicone resin is 2.6~3.7, and the minimum thickness that can be extruded is 0.05mm. Therefore, the outer diameter of the coaxial cable will be 1.06mm.
  In summary, resins other than PFAS have a larger dielectric constant and a larger minimum wall thickness that can be extruded, so the outer diameter of the cables will be larger and cannot meet the product specification.
- **PE, PP and TPE have relatively low melting points compared to PFAS and cannot meet the high temperature stability requirements**
  The melting point for the insulation material is key to coaxial cables and discrete cables. This is particularly crucial due to the soldering/welding process involved in the manufacturing process. When soldering, temperatures around 300°C are transmitted

to the insulation through the conductor. If the material's melting point is significantly below 300 °C, it can lead to insulation burns and ultimately result in malfunction. For instance, the melting point of PE typically ranges from 130 to 135 °C. PP has a melting point that typically ranges from 130 to 171 °C. TPE has a melting point around 60-200 °C. PFAS materials, on the other hand, have high melting points of up to 327 °C. The melting point of the material is crucial in ensuring the insulation's integrity and preventing malfunctions..

During use phase of electronic products, PP and PE cable jackets are not suitable for high temperature applications.

- **PE, PP and TPE have relatively low flame retardant ratings as compared to PFAS** High flame retardancy is essential for coaxial cables and discrete cables used in consumer electronics as it plays a significant role in ensuring user safety and protecting property. Manufacturers need to prioritize incorporating flame retardant materials in cables to meet stringent safety requirements. PFAS materials (PTFE, FEP, PFA) exhibit excellent flame retardant performance and have a UL flammability rating of V-0. PP, PE and TPE materials cannot achieve the same flame retardant rating as PFAS materials.

- **PE and PP have lower mechanical flexibility as compared to PFAS** The flexibility and durability for coaxial cable and discrete cable application is essential to ensuring that the cables can withstand mechanical stress, bending, and dynamic movement without failure. The elongation at break value for FEP typically ranges from 300% to 400%, PP is less than 100%, PE is above 100% and TPE can exhibit a range from 300% to 500% depending on the specific type, grade, and formulation.

  TPE is a good alternative in terms of flexibility and durability, but it is important to note that flexibility and durability along not guarantee to meet the relevant safety and electrical performance requirements.

- **PVC was also disregarded due to its halogen content and poor high-temperature stability**[79]

- **Silicones have lower mechanical strength**

  Silicone wire insulation can withstand temperatures up to 180 °C. However, its tensile strength and mechanical properties are not good enough. ChemSec also confirmed that rubber substitutes have less mechanical strength and less abrasion resistance and that silicone insulation would lead to chemical deposition on the sensors, leading to malfunctions. [Source: ChemSec 2023]

- **Non-PFAS materials are not as resistant to chemicals as PFAS materials**

  When there is a risk of cables being exposed to chemicals, the jacket must be resistant to these chemicals. The material of choice depends on the chemicals it has to be resistant to. To some chemicals only PFAS materials are resistant.

Conclusion

It can be concluded that alternative materials do have some of the required properties and are suitable for use in less-demanding applications. However, for more demanding applications only PFAS materials have all the required properties.

[79] Supplier Survey 2023

Substitution:

- The time required to develop a new material that meets all the safety and performance requirements is unknown because for some properties no material is currently known. It is estimated to take at least 2 years for suppliers to study, screen and identify a potential substitute.
- If a substitute is eventually available, the time for substitution is at a very minimum:
    - 12 months for cable level testing: develop specification of raw cable, update manufacturing process, cable reliability testing and certification
    - 15 months for device level integration testing and certification.

5.3. Connector jacket

Name of PFAS substance(s) PTFE, FEP

CAS Number(s) 9002-84-0, 25067-11-2

The annual tonnage and emissions (at sub-sector level) and type of PFAS associated with the relevant use

Insufficient information to quantify.

The key functionalities provided by PFAS for the relevant use[80]

1. Good dielectric properties
2. High/low temperature stability
3. Good chemical resistance
4. Mechanical properties of resin

Limited data from supply chain

For which uses of PFAS is there no alternative?

Outlook: ChemSec's research has been unable to find an alternative that delivers all of the critical properties in cables and connectors (ChemSec, 2023) which has been corroborated through extensive engagement with suppliers.

R&D activity: Alternatives examined by the industry for connector applications include PA and LCP, but there is no positive result yet.[81]

In general, products using alternatives cannot meet at least one of the safety or performance requirements (mechanical properties, dielectric strength, flame retardancy, temperature and chemical stability).[82]

[80] Supplier Survey 2023
[81] Supplier Survey 2023
[82] RCOM Ref 4011

Substitution:

- The time required to develop a new material that meets all the safety and performance requirements is unknown. It is estimated to take at least 2 years for suppliers to study, screen and identify a potential substitute.
- If and when a substitute is available, it is estimated to take at least 12 months to produce and qualify the new part.

Proposed derogations – Cables/Connectors

Paragraph 2(c) shall apply from (**13.5 years** after entry into force) to **fluoropolymers in cable insulation and jacket and connectors**.

5.4. Socio-economic impacts

The consequential economic (in euros) and social (e.g. jobs) impacts arising from any restriction of PFAS in respect to its use in cables and connectors are difficult to quantify. However, significant financial costs can be expected to arise because of the inability to substitute and because of the strategic importance the EU has placed in developing an advanced digital and data economy as part of its European Data Strategy & communication "Shaping Europe's digital future"".

1. Annual value of EU sales: In 2022, the computer hardware market in Europe generated a total revenue of over 60 billion euros, selling around 630 million units. Storage units made up the majority of volume at approximately 462 million units, followed by laptops and keyboards, both with approximately 42 and 40 million units sold, respectively[83]
2. Indirect costs - European employment in the ICT sector: In 2022, more than 9 million persons worked as ICT specialists across the European Union (EU). The highest number (2.1 million) worked in Germany, which provided work to more than one-fifth (22.6 %) of the EU's ICT workforce. France (1.2 million) had the second largest ICT workforce (13.0 % of the EU total), followed by Italy and Spain (both 0.9 million; 9.6 % and 9.4 % respectively).[84]
3. Indirect European employment - data professionals: Professionals working in the new and growing data economy rely on the efficient transfer of data. When publishing the EU's data strategy for the EU, the number of data professionals was expected to grow from 5.7m in 2018 to 10.9m in 2025, touching nearly every sector across the economy.
4. Indirect financial consequences of less efficient data transmission: The European Commission estimates that the EU's data economy will be worth €829 billion in 2025, from 2% to 6% of regional GDP[85]
5. Wider economic impacts - expected growth: Christensen et al (2018) estimated, using the RHOMOLO model, that implementing the third pillar of the Investment Plan for

[83] Statista, 2023, https://www.statista.com/forecasts/1256748/volume-segments-computer-hardware-europe
[84] Eurostat, 2023, ICT Specialists in Employment, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_specialists_in_employment#Number_of_ICT_specialists
[85] EU factsheet, https://ec.europa.eu/commission/presscorner/detail/en/fs_20_283

Europe, including efficiency gains from the Digital Single Market, would contribute to a 1.5% increase in GDP per year until 2030 and create between 1 and 1.4 million jobs.[86]

6. R&D, retooling, retesting, recertifying supply chain costs: not able to be estimated.
7. Fluoropolymer related impact[87]

   Employment:

   - Indirect and induced employment resulting from the production of fluoropolymers: The average GVA per employee in relevant industries is €100,000.
   - Overall, in the EU around 4,500 employees are directly employed in manufacture of fluoropolymers, and in the wider sector an estimated 4,400 people. This suggests some 8,900 people in total are sustained directly and through indirect and induced effects by the production of fluoropolymers. This does not include employment in sectors using fluoropolymers, which is many multiples higher. (P23)
   - Volumes of fluoropolymers placed on the market in the EEA in 2020: Around 40,000 tonnes of fluoropolymers estimated to be sold in EEA (P10)
   - Growth projections: The EU Chips Act is anticipated to allow the EU to reach its ambition of doubling its current market share of semiconductor technology to 20% in 2030. This indicates that fluoropolymers will likely follow a similar trend over this period. (P11)
   - Sales value of products sold in the EEA in 2020: €750million (P14)
   - Two estimates of Downstream applications market of fluoropolymers in EU: sales to electronic sector in 2020:
     - 3,500 tonnes of fluoropolymers, value: €70 million (source: 2017 FPG SEA study)
     - 4,000 tonnes and €80 million (source: studies supporting PFAS restriction proposal)

   Note: this means the EU electronics sector is around 10% of fluoropolymer volumes in the EU. Sales value estimates are consistent at approx. 10%.

[86] M. Christensen, A. Conte, F. Di Pietro, P. Lecca, G. Mandras, & S. Salotti (2018), The third pillar of the Investment Plan for Europe: An impact assessment using the RHOMOLO model (No. 02/2018). JRC Working Papers on Territorial Modelling and Analysis
[87] FPG 2022 report https://fluoropolymers.plasticseurope.org/application/files/1216/5485/3500/Fluoropolymers_Market_Data_Update_-_Final_report_-_May_2022.pdf

6. Capacitors

Name of PFAS substance(s) PTFE, PTFE co-polymer, Poly(difluoromethylene),. alpha.-(cyclohexylmethyl)-.omega.-hydro-, etc.

CAS Number(s) 65530-85-0

General summary of the application category

PFAS is used in several materials such as electrodes (anode), masking, seals, coatings, insulators, and paste materials. The properties they provide include:

- highly reliable seal against electrolyte diffusion along the tantalum anode wire.
- resist distortion during the oxidation and impregnation process.
- binder for electrodes – similar application as PFAS in batteries

Non-PFAS Alternatives Identified Through the Supply Chain or Research

The electronics industry has a very deep and complicated supply chain which operates on a global basis. Ascertaining data on feasible non-PFAS alternatives for capacitors has yielded no drop-in replacements to date. Nonetheless, the investigation will continue indefinitely.

Moving beyond the supply chain and focusing upon research into non-PFAS alternatives has required an extensive literature review to determine what if any non-PFAS alternatives are being considered for capacitors. The on-line library search engine utilised for this review was Summon™.

Error! Reference source not found. illustrates the keywords/phrases utilised in an effort to comprehend what research into non-PFAS alternatives for capacitors has taken place or indeed is still on-going.

Keyword or Phrase	# of Results	Results of Relevance to PFAS in Cables/Connectors/Capacitors
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PFAS in electronics	1,791	None
Non PFAS alternatives in electronics	19	None
PFAS alternatives in electronics	78	None
Fluoropolymer alternatives in electronics	84	Most of the results focused upon fuel cells, membrane materials for alternative energy and sustainability applications. None were relevant for cables, connectors and capacitors.
PFAS in capacitors	62	There were some relevant results, but the papers emphasised the benefits of fluoropolymers in capacitors.
Fluoropolymer alternatives in capacitors	5	None

Table 5 PFAS literature review for non-PFAS alternatives in cables, connectors and capacitors

Based upon the findings in **Error! Reference source not found.**, it is apparent that if there is on-going research into non-PFAS alternatives for capacitors, none of it is finding its way into the public domain. This scenario is more than likely a result of the lack of research into these electronic components/products.

The combined lack of data on non-PFAS alternatives from the supply chain in conjunction with the lack of research into these electronic components/products, surmises that there are no drop in alternatives currently available and the likelihood of such alternatives being available at the entry into force timeframe is questionable.

Proposed derogation

Consequently, it is requested that a derogation covering the uses of various capacitor types is granted from the proposed REACH Restriction on PFAS for **13.5 years** after entry into force.

7. Grease & Lubricants

7.1. Grease/lubricants on mechanical parts in EEE

Name of PFAS substance(s) PTFE; Perfluoropolyether (PFPE) oil; Ethene, 1,1,2,2-tetrafluoro-, oxidized, polymd.

CAS Number(s) 9002-84-0; 60164-51-4; 69991-61-3

General summary on the application category

PFAS-containing greases are used on mechanical parts (e.g. hinge of laptops) in electronic products. These greases are used because they offer a low friction coefficient, have a wide service temperature range, are chemically inert, oxidation resistant, and have excellent material compatibility.

The use of PFAS greases are essential to ensuring long service life and durability of the products. Product durability is a key focus of policy efforts as part of the Circular Electronics Initiative and has been a key feature in the review of Ecodesign Regulation 617/2013 (Lot 3) - Computers and Computer Services.

As an example, laptop hinge lifecycle test is one of the many tests that are conducted to ensure the durability of the devices. As of yet, no alternatives can meet the industry standard durability requirements. For alternatives tested so far to replace PFAS, the projected part service life is (at a maximum) approximately half of the service life achievable by using PFAS.

The annual tonnage and emissions (at sub-sector level) and type of PFAS associated with the relevant use

Insufficient information to quantify.

The key functionalities provided by PFAS for the relevant use[88]

1. Lowest known coefficient of friction (≤ 0.1)
2. Stable coefficient of friction and wear resistance over extended period of time
3. Chemically inert, oxidation resistant and excellent material compatibility
4. High temperature stability and wide service temperature range (-35℃-250℃)

For which uses of PFAS is there no alternative?[89]

Outlook: Despite extensive exploration, suitable alternatives have yet to be identified.

R&D activity: Among the substitutes trialed are PE, graphite, molybdenum(IV) disulfide, PVD surface treatment and even no grease entirely.

1. Not using grease at all on computer hinge frames and supports, resulted in the hinge breaking after a limited number of lifecycle tests which corresponds to less than 5% of the target service life time of the part.

[88] Supplier Survey (2023)
[89] Supplier Survey (2023)

2. Alternative surface treatment, such as Physical Vapor Deposition (PVD), was trialed. The intention of PVD is to achieve lower roughness of the surface, which is helpful to lower the friction between different surfaces. This has failed due to poor bonding between the surface and the PVD layer, as the PVD layer peeled off after a limited number of lifecycle tests which corresponds to less than 5% of the target service lifetime of the part. The peeled-off PVD layer also increases the friction of the hinge, therefore further reducing the hinge life.
3. Use of high precision turning process to achieve low roughness of the surface. This has failed to meet lifecycle and torque degradation requirements.
4. Use silicone or polyol ester to replace PFAS. However, both failed due to inadequate lubricant ability and inadequate thermal stability. These features of PFAS make it irreplaceable so far, especially with regards to extending the lifecycle of electronic devices.[90]

	Thermal Stability	Oxidation Stability	Hydrolytic Stability	Fire Resistance	Lubricating Ability
PFPE	E	E	E	E	E
Polyol Ester	G	G	G	G	G
Silicone	G	G	G	G	P

E: excellent; G: good; P: poor.

5. The use of other solid lubricant such as graphite and Molybdenum(IV) disulfide cannot pass the lifecycle test. Estimated service life for parts using these lubricants is approximately half of the service life achievable by using PFAS grease/lubricants.

Substitution: Time for substitution

- The time required to develop a new material that meets all the performance requirements is unknown. It is estimated to take at least 1-2 years for suppliers to study, screen and identify a potential substitute.
- Once a potential substitute is identified, it will take 1.5-1.8 years for material qualification (grease stability after aging, tribology test) and Hinge qualification (assembly + reliability test, part level assembly + reliability test, device level assembly + reliability test).
    - If the alternative material does not work, the time required to develop a new material that meets all reliability and performance requirements is unknown. It is estimated to take at least 1-2 years for each study and screening cycle to identify potential candidates.

Proposed derogation

Paragraph 2(c) shall apply from **(13.5 years** after entry into force) to **grease and lubricants** used in electrical and electronic equipment.

[90] Driving Auto Performance Through Lubricant Selection (https://pages.chemours.com/rs/509-VCL-038/images/Whitepaper_Auto_101_2017edits.pdf)

7.2. Lubricant in connectors

General summary on the application category

Plug-in connections are used wherever components or assemblies need to be connected temporarily. Electrical contacts have basically two main tasks: the possibility to mechanically separate an electrical connection and the transmission of electrical energy without losses in closed position.

As they are used in a wide range of different environments, like heat or damp heat, the contact surface of the electrical contact has to meet various requirements. Further, fretting corrosion continually exposes fresh layers of the metal surface to oxidation.

PFAS containing lubricants are used in gold-plated connectors to protect the part against oxidation and fretting corrosion, while also minimizing degradation through contact wear, thus helping to extend the connector life (Supplier Survey, 2023).

Product durability is a key focus of policy efforts as part of the Circular Electronics Initiative and has been a key feature in the review of Ecodesign Regulation 617/2013 (Lot 3) - Computers and Computer Services.

A thin film of lubricant can also reduce mating force by as much as 80 percent, an important factor in connector assembly. For electronic connectors with dozens or even hundreds of pins, a low insertion force helps to ensure solid connections.

No alternatives have been successful to replace PFAS to date.[91]

The annual tonnage and emissions (at sub-sector level) and type of PFAS associated with the relevant use

Insufficient information to quantify - may reference Cefic socio-economic study once it becomes available.

The key functionalities provided by PFAS for the relevant use

1. Low coefficient of friction (≤ 0.1) which protects the connector from mating and unmating forces and improves durability
2. High corrosion resistance
3. Stable coefficient of friction and wear resistance over extended period of time
4. High temperature stability and wide service temperature range (-35℃-250℃)

For which uses of PFAS is there no alternative?

Outlook: No alternatives have been identified to date. ChemSec suggested alternatives have proved to be unsuccessful substitutes.

R&D activity: Supply chain reported that all the potential alternatives evaluated so far contain PFAS. Other non-PFAS wax or grease are not suitable for industrial use. Suppliers are actively looking for alternative coating liquid that is not sticky in the manufacturing process, which has been the case when testing silicone alternatives.[92]

[91] Supplier Survey (2023)
[92] Supplier Survey (2023)

Alternative dry coatings have been tested and failed for either corrosion or cosmetics. Alternative lubricants have been tested and do not meet performance requirements.[93] After some usage, the coating is also peeled off easily and then peeled-off particles further increase the surface friction. The higher surface friction reduces the lifecycle of parts.

Substitution:

- The time required to develop a new material that meets all the performance requirements is unknown. It is estimated to take at least 1-2 years for suppliers to study, screen and identify a potential substitute.
- Once a potential alternative is identified, it will take 1.8-2 years for testing lifecycle, assembly line optimization, and evaluation of mass production.
  - If the alternative material does not work, the time required to develop a new material that meets all reliability and performance requirements is unknown. It is estimated to take at least 1-2 years for each study and screening cycle to identify potential candidates.

Proposed derogation

Paragraph 2(c) shall apply from **(13.5 years** after entry into force) to **grease and lubricants** used in electrical connectors.

[93]ChemSec (2023), Check Your Tech: A guide to PFAS in Electronics, https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fchemsec.org%2Fapp%2Fuploads%2F2023%2F04%2FExcel_ChemSec-Electronics-Guide.xlsx&wdOrigin=BROWSELINK

8. Cooling in data centres

Introduction

The growth rate of data volume globally is nothing but astonishing. Information produced by the EU Commission as part of its EU Data Strategy illustrates a phenomenal 530% increase predicted from 2018 to 2025. Indeed, it is estimated that during the same timeframe, the value of the data economy to the EU will grow from €301 in 2018 to €828 billion by 2025 (Figure 5.0).

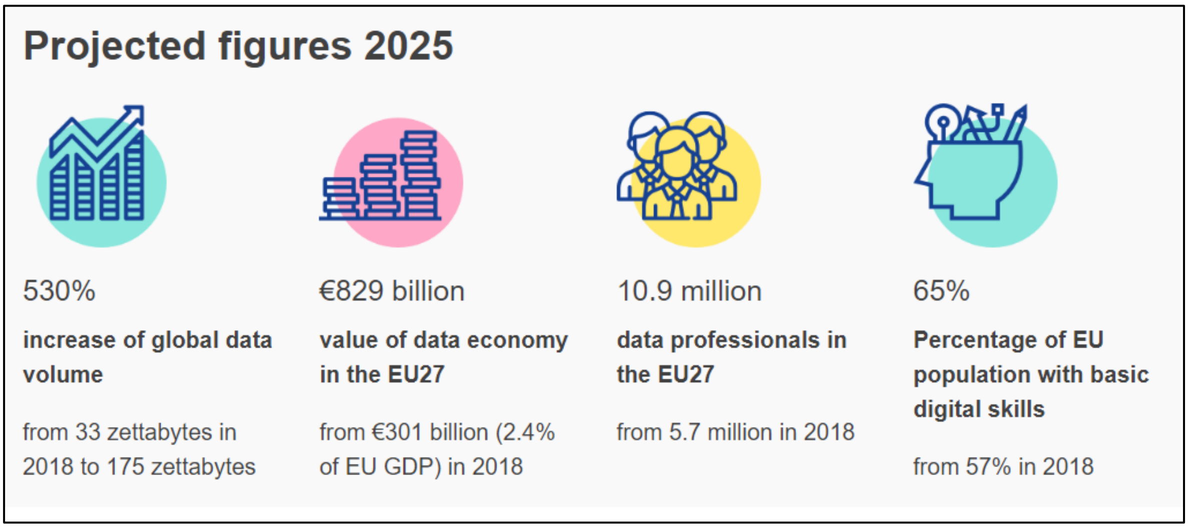

Figure 5 EU Data Strategy projected figures for 2025

In an effort to sustain or meet such data demands, there needs to be an equivalent increase in computational power. It's not just a case of doing more of the same as what's been done in the past to augment the necessary computational power. The growth rate of Artificial Intelligence (AI) and high-performance computers has driven the need for more powerful processors and hardware accelerators. This has resulted in generating significant increases in silicon or processor thermal design power (TDP) beyond 1kW/each processor and semiconductor package thermal density.

These semiconductor devices are housed in servers which in turn are accommodated in data centres. Simultaneously, there is regulatory focus on reduced energy consumption, increased energy efficiency at data centre level, reuse of waste heat from data centres as well as meeting sustainability goals. Together these trends are creating significant strain on today's data centres which require alternatives to today's state-of-the-art cooling technologies to handle the coming data demands.

Issues with Current Cooling Technologies

Cooling of data centres is frequently the largest energy loss in the facility and as such represents a significant opportunity to improve efficiency. The primary cooling methods employed in data centres are air and water based.

The objective of airflow management is to circulate only the necessary amount of air through the data centre at any time that is required to remove the heat actually created by the IT equipment. This means no air returns to the cooling system without absorbing heat and no air circulates more than one time through the IT equipment.[94] When considering water-based cooling methods, the water utilised needs to be sufficiently chilled which can have a significant impact on the data centre's energy efficiency. Due to the changing climate, water is becoming a precious commodity in several geographies across the globe including the EU and several regulations are being imposed on data centre operators to limit the use of water for data centre cooling applications such as towers or evaporative air cooling. Also, to cool high wattage processors, water needs to be chilled using chillers therefore reducing the overall efficiency of cooling solutions.

These air- and water-cooled methodologies are becoming increasingly inefficient with the cooling load required for the greater demands of server products. Consequently, alternative cooling methodologies have been investigated to cater for today's requirements but more importantly future needs as well.

Alternative Cooling Technologies

Unfortunately, there are no commercially available alternatives that address the future needs for high TDP, high heat flux silicon, and global energy efficiency demands that have no PFAS chemistry. Traditional forced air cooling has already been optimised within the practical limits of data centre airflow delivery. Traditional propylene glycol-water based fluids support high TDP but fall short on supporting high package thermal density as compared to pumped refrigerant 2-phase cooling. Also, due to the lower effective heat transfer of legacy liquid cooling methods, more power is required for primary loop water chillers and secondary loop fluid pumps (Figure 2.0) when compared with the pumped refrigerant 2-phase cooling method (Figure 3). It's important to note that water or air chillers used for current data centre cooling is already or will be shortly using one of these hydrofluoroolefins (HFO) refrigerants.

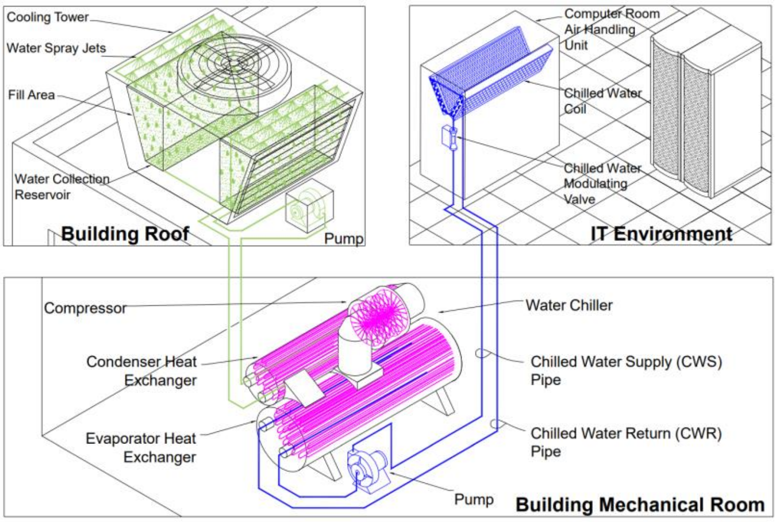

Figure 6 Traditional air-cooled data centre using water-cooled chiller system[95]

Put another way, refrigerant-based server level cooling allows deployment of AI silicon into markets where warm facility water usage is required to meet its energy efficiency and sustainability targets.

[94] Joint Research Centre (2023) Best Practice Guidelines for the EU Code of Conduct on Data Centre Energy Efficiency. European Commission.
[95]Image courtesy of Schneider Electric

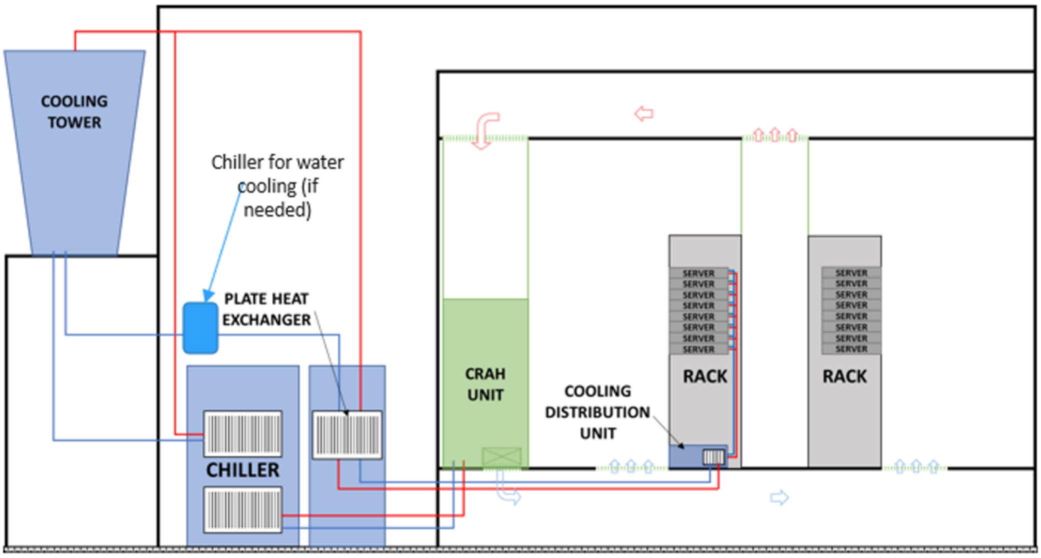

Figure 7 Hybrid air cooled data centre using propylene glycol fluid in server racks with water cooled chiller system or pumped refrigerant fluid in server racks eliminating high power water-based chiller systems

The use of F-gases particularly HFOs have shown to be extremely efficient in performing the required cooling of server products in data centres through this application known as two phase liquid-vapour cooling. This involves the circulation of low-to-medium pressure refrigerants (HFOs) through cold plates attached directly to high-powered AI silicon.

In this approach, the refrigerant is circulated through cold plates as a saturated liquid, absorbing heat from processors before it vaporizes. Due to higher latent heat of vaporization (compared to just sensible heat for single phase water-based cooling), the process requires relatively small pumping power and is vastly more capable and efficient than traditional air and water-based cooling methods. Please note this is a different technology to what is known as immersion cooling. The HFOs of interest that fulfil this cooling distribution function are captured in Table 6.0.

Refrigerant	Pressure	Chemistry	GWP	ODP	Toxicity	Flammability
R513A	medium	HFC/HFO	573	0	low	zero
R515B	medium	HFO	299	0	low	zero
R1234ze	medium	HFO	6	0	low	mild
R1234yf	medium	HFO	<1	0	low	mild
R1233zd	low	HFO	1	0	low	zero

Table 6 Suitable HFOs for Date Centre Cooling

The characteristics of the HFOs outlined in Table 6.0 illustrate excellent global warming potential which significantly supports the EU's climate ambition's goals as the more typically utilised F-gases in data centres such as R134a and R410a have global warming potentials of 1,430 and 2,088 respectively. One major advantage of these medium pressure refrigerants is with their low boiling point (well below traditional atmospheric temperature) if emitted or leaked,, it would immediately vaporize and not contaminate soil or ground water. Also, the half-life of these refrigerants is very short compared to traditional PFAS coatings and other compounds.

The cooling system itself is known as a cooling distribution unit (CDU) and is a closed system. This hardware utilises fluoropolymers such as gaskets and seals given their unique characteristics in addition to prolonging the service life of the CDU. There are no intentional releases of the HFOs with this technology. Currently there is less than one tonne of HFOs utilised globally for this application. These refrigerants are handled only by trained technicians as per HVAC industry protocols who have passed extensive certifications such as those outlined in the EU F-gases regulation, US EPA 608 etc. Hence, the safe use and handling of these refrigerants is already being monitored and is not handled by any non-certified technicians.

Suitability of Dossier Submitter Proposed Non-PFAS Alternatives

The Dossier Submitter in its Annex XV report proposed several non-PFAS alternatives for electronics cooling in data centres. Two of these proposed alternatives - Hydrocarbon Systems and Ammonia - had been questioned by the Dossier Submitters themselves on grounds of flammability and toxicity issues which would reside inside the data centre hall. The other non-PFAS alternatives such as basic ventilation, small-scale air-conditioning systems and water are simply not feasible given the pending demands of cooling technologies with the anticipated growth in data volume.

Critique of Dossier Submitter Conclusions Concerning HFO Emissions

The HFOs outlined in Table 6.0 which are needed to run this cooling distribution technology are known to degrade in the atmosphere to trifluoroacetic acid (TFA). Although, the cooling technology is not designed to release HFOs, it is important to stress the degradation profile of these F-gases to illustrate the low risk they pose to the environment and consequently should be seen as a viable and pragmatic solution to the current and pending cooling demands within data centres.

The Dossier Submitter noted in the PFAS Annex XV report in the section dealing with PFAAs (arrowheads and precursors), "as most of these substances are expected to ultimately degrade in the environment to TFA (details in Annex B.4.1.), they will contribute to the overall exposure to and risks of PFAAs". Such a statement or indeed conclusion by the Dossier Submitter is not accurate when examined against the number of peer reviewed studies conducted and even ECHA itself on TFA. According to the trifluoroacetic acid (TFA)[96] REACH registration dossier and Chemical Safety Report (CSR), this substance does not fulfil the criteria for a PBT or vPvB substance under Annex XIII REACH. Neither does it raise equivalent levels of concern under Article 57(f) REACH.9In this respect, ECHA already reviewed/evaluated the TFA dossier without concluding that further regulatory actions were needed. The United Nations Environment Programme (UNEP) in its Environmental Effects Assessment Panel in 2020 noted that "Historical and current measurements of TFA in soil and surface-water indicate de minimis risks when compared to no-effect-concentrations (NOECs) in laboratory and field-based testing". UNEP also called out what they identified as erroneous claims that TFA was toxic to plants, and to set the record straight stated that "There is no scientific basis for this conclusion and risks from current and future releases of TFA from the use of fluorinated precursors regulated under the Montreal Protocol to aquatic and terrestrial plants are de minimis".

In their 2022 report, UNEP highlighted that "There has been considerable discussion as to the inclusion of TFA in the class PFAS for regulatory purposes…We are of the opinion that the

[96] Trifluoroacetic acid, EC no: 200-929-3, CAS no: 76-05-1, Molecular formula: C2HF3O2

properties of TFA indicate that it should not be included in this class for the purposes of generic regulatory risk assessment".

It would appear that the Dossier Submitter and the United Nations Environment Programme have diametric opinions about TFA and consequently HFOs in terms of their risk and suitability for inclusion into a PFAS grouping effort for regulatory purposes.

EU Initiatives

The proposed cooling technology will fully support many of the EU Commission's priority policies. These include Energy and Climate policy, the vast number of initiatives captured under the Green Deal, EU Chips Act and indeed the Digital Decade.

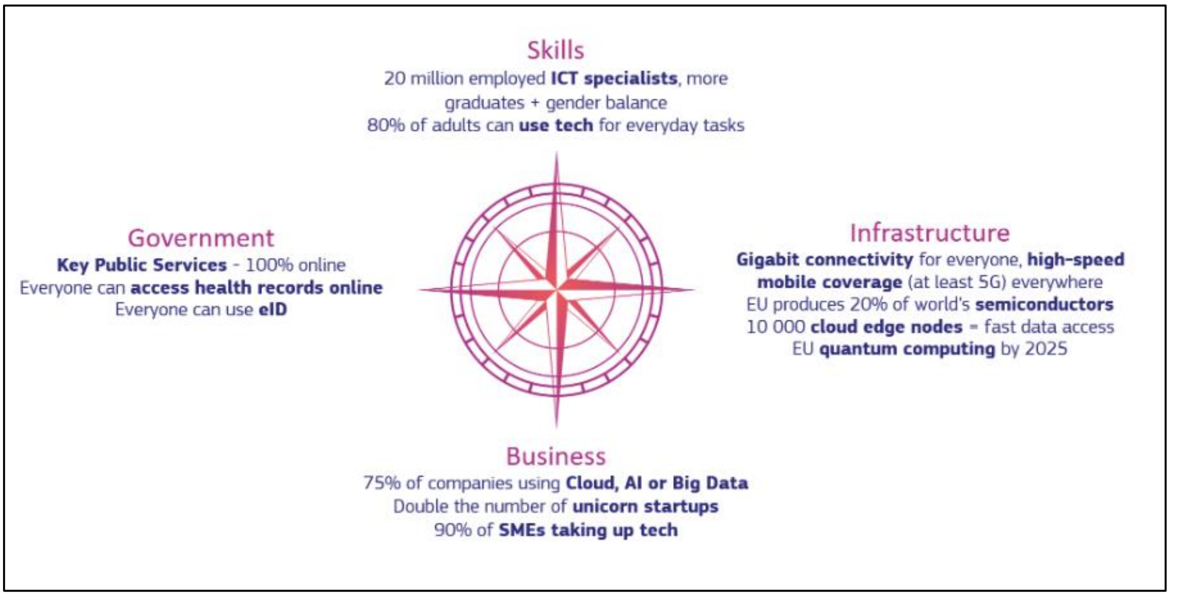

Figure 8 Europe's Digital Decade Targets for 2030

Upon examining the primary strands of the Digital Decade, Figure 8.0 depicts the associated policy programme with targets and objectives for 2030. All of these - Skills, Infrastructure, Business and Government necessitate the use of data centres. It is imperative that these data centres utilise a superior and sustainable cooling technology such as that provided through the cooling distribution systems outlined.

Proposed derogation

Consequently, it is critically important that this technology, including its refrigerant chemistries (HFOs) and hardware (fluoropolymers), are appropriately granted a time-unlimited derogation.

References

ECHA (2023) PFAS Reach Annex XV Restriction Report. European Chemicals Agency.

EU Commission 2023, Digital Decade Strategy, viewed 3rd July 2023, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/europes-digital-decade-digital-targets-2030_en

EU Commission 2023, European Data Strategy, viewed 3rd July 2023, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en

Joint Research Centre (2023) Best Practice Guidelines for the EU Code of Conduct on Data Centre Energy Efficiency. European Commission.

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UNEP (2022) Environmental Effects of Stratospheric Ozone Depletion, UV Radiation, and Interactions with Climate Change. UN Environmental Effects Assessment Panel.

9. Mechanical Applications

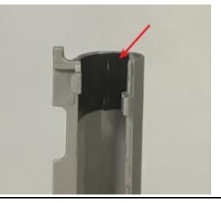
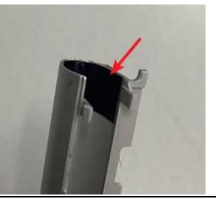
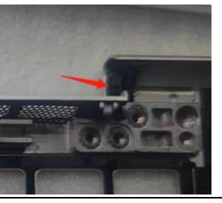
General summary of application category

PTFE is used as an additive in plastic parts to meet tribiology requirements (e.g., friction, wear, lubrication). It is widely used in printers for gears, rollers and other plastic parts that require low friction, wear, and noise.

There is no drop-in replacement for PTFE, but there are potential alternatives materials, such as silicone, wax, polyethylene, aramid, and graphite. **It is unlikely that one material will be able to substitute all of applications of PTFE.**

Another important use of PTFE is Teflon tape. There are a lot of components and parts in one electronic device. Especially in mobile devices, the parts or components may abrade each other during operation. For example, local abrasion causes the conductors to break. Copper is most used as conductor in electronic device because of its good extensibility, good conductivity and abundance in the world. However, even if there is jacket outside to protect the copper wire, the stress or heat of abrasion still can break the copper wire. Teflon tape is often used to increase the durability and robustness in specific locations.

Another example are the coaxial cables in charge of transmitting the signal of antenna module to the circuit board. The coaxial cables pass through the hinge, and the part in the hinge is often abraded when laptops are opened and closed. The stress of the hinge operation may cause the coaxial conductor to break. The best solution to improve cable durability under hinge operation is to apply Teflon tape. The coefficient of friction (0.05-0.20) is low and therefore the coaxial cable can be protected.

Purpose	Location	Photos
Protect cable close to hinge cap to reduce the friction between cable and hinge cap.	hinge cap inside	 
Protect cable close to the base close to the C cover horn protrusion. Reduce the friction between C cover inside and cable.	C COVER inside horn protrusion	 

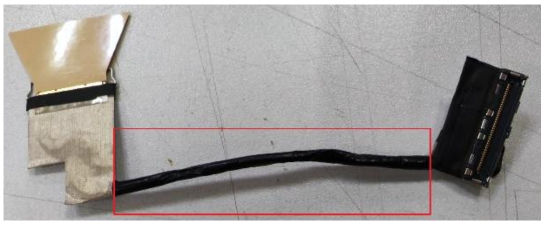
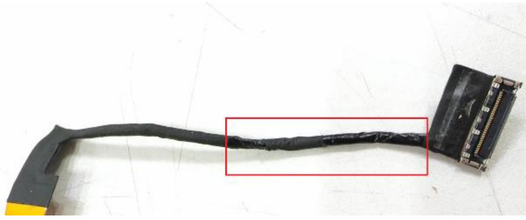
Reduce the abrasion between cable outside and enclosure inside during hinge operation.	1. antenna cable in/out location 2. Hub Cable in/out location 3. EDP Cable in/out location	  

Table 7 Teflon tape application examples

The annual tonnage and emissions and type of PFAS associated with the relevant use

Insufficient information to quantify.

For which uses of PFAS is there no alternative

For the wear-resistance improvement application, HDPE is often the alternative candidate to replace Teflon, because of the similar chemical structure. However, Teflon still has a smaller coefficient of friction (COF) for better durability. Based on COF, PET and PI are also often mentioned to replace Teflon and both these two materials posess good heat resistance. However, the brittleness of PET and PI make the tape less durable than Teflon.

	COF (coefficient of friction)
Teflon	0.05-0.2
PE (HDPE)	0.29
PET	0.19
PI (polyimide)	0.22

It must be noted that PTFE has a much higher heat deflection temperature and corrosion resistance whereas HDPE has an excellent strength-to-weight ratio. Currently there is no alternative for durability-enhancement application in electronic devices. For desktop platforms, like DTO tower, AiO or monitors, the slighter space limitation can use HDPE tapes, PI tapes or PET tapes to enhance the durability by thicker usage. For mobile devices, like laptops or tablets, the components are all compressed in a small space. To get good durability in limited space and achieve the desired lifecycle, Teflon is the only one option so far.

Physical Property	HDPE	PTFE
Melting Point (°C)	120-140	327
Density (g/cm3)	0.96	2.15
Ultimate Tensile Strength (MPa)	31.7	10.3 - 20.6
Water Absorption (ASTM D570) (% by weight)	0.1	< 0.01
Heat Deflection Temperature (°C) @ 0.45 MPa	90	120
Tensile Elongation (%)	600	100 - 200
Dielectric Strength (kV/mm)	17 - 24	20 - 48

Proposed derogation

Paragraph 2(c) Shall apply from (**6.5 years** after entry into force) to **PTFE and Teflon tape used in mechanical applications for electronic equipment**. By (18 months before the derogations are due to expire) the Commission will review derogations in light of new scientific available information and information on alternative materials or processes and if appropriate, modify this derogation accordingly.

10. Ingress Protection Vents for Communication Devices

General summary on the application category

Devices used for communications, which includes smartphones and wearable electronic devices like smart watches and wireless headphones, have become a part of everyday life for citizens in Europe and critical for use in emergencies. In 2022, approximately 200 million smartphones and 80 million wearable devices were sold in the EU[97]. These devices must have openings to the environment to allow for pressure equalization, the transmission of acoustic signals to and from microphones and speakers, and to enable sensors to collect environmental data like air and water pressure. Users expect that their device will not be damaged or destroyed if it falls into water, is exposed to rain, or is cleaned.

Due to the sensitive nature of the electronics (microphones, speakers, sensors, circuits) in these devices, they can be easily damaged by particulates, water, oils, cleaners and other contamination.

To overcome this issue, device manufacturers provide ingress protection by using a PFAS-based microporous vent. The protection helps eliminate component failures, extends the life of the device, and reduces the environmental waste from prematurely replaced devices. These vents contain an extremely low mass of PFAS, are often only 4 mm in diameter and weigh approximately 40 µg. Without effective protection against external contaminants such as liquids and dusts, devices fail and must be replaced. Figure 9 illustrates how a vent for air and/or sound transmission is assembled into a typical smartphone.

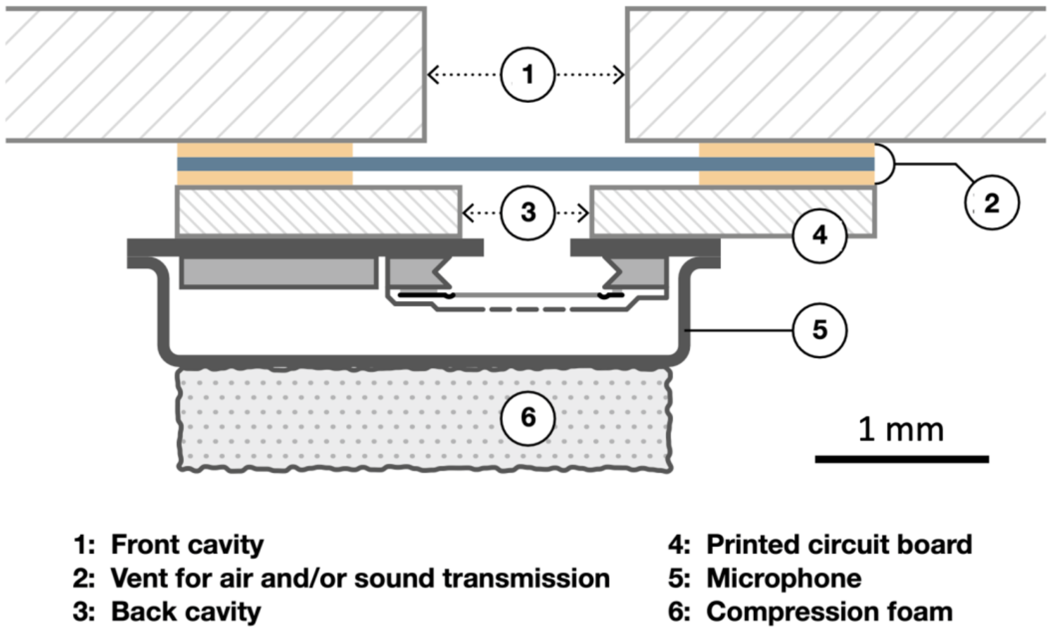


Figure 9 Ingress protection vent for air and/or sound transmission in a typical smartphone

A derogation for the use of PFAS in Ingress Protection Vents for Communication Devices is needed because:

[97] International Data Corporation (IDC), https://www.idc.com/prodserv/insights/manufacturing/latest-research

- **Protecting communications devices from failure due to liquid or dust ingress is a critical function** for hundreds of millions of EU citizens in personal, professional, and sometimes emergency settings. Increasing the longevity of such devices is also an important factor in reducing electronic waste and the consumption of critical raw materials.
- Currently, **no alternative is available** that would prevent device failure and that would not require PFAS chemistry.
- An **exceptionally low volume of PFAS is required** for this end use in the EU (< 35 kg annually).
- Decades of research has not provided a suitable alternative. If suitable alternative materials are identified in the future as a result of ongoing research, which is currently ongoing, it would take several additional years to develop, test and produce devices that can incorporate the alternative materials.
- Without a derogation, there would be a significant increase in the failure rate of these devices which both the general population and professionals (emergency services, transport operators, etc.) rely on for their daily and urgent communications. This would result in an increase in waste and resource consumption. Furthermore, consumers could face a cost increase of more than €600 per device to replace damaged devices, which at an EU level amounts to a cost of more than €20 billion per year. These costs are not justified given the exceptionally low volume of PFAS required for this end use.

In the following sections we provide detailed evidence for this derogation based:

- The **performance requirements** for ingress protection in devices used for communications
- The **lack of availability of alternatives** that would provide the required level of performance
- The **time required** for research and development to investigate and evaluate potential alternative materials, and if a feasible alternative is identified, the time required to identify develop, test and commercialize a new vent in a device
- The **extremely low volume of PFAS** needed for this application in comparison to the **large socio-economic cost** of restricting the use.

Performance Requirements for Ingress Protection Vents

Ingress protection vents for communication devices have a wide range of unique and technically demanding requirements. The primary challenge is providing ingress protection whilst enabling adequate airflow.

At the device level, a common standard used for communications devices is the Ingress Protection rating (or IP rating), which is an international standard (IEC 60529) used to rate the degree of protection or sealing effectiveness in electrical enclosures against intrusion of objects, water, dust or accidental contact. It corresponds to the European standard EN 60529. A summary of the rating system is shown in table 4 below.

Protection Against Foreign Solid Object (X)		**Protection Against Liquid (Y)**	
0	No protection	0	No protection

1	Protection against solid objects > 50 mm, such as a hand	1	Protection against vertically dripping water, some ingress permitted
2	Protection against solid objects > 12.5 mm, such as a finger	2	Protection against dripping water with enclosure tilted up to a 15° angle
3	Protection against solid objects > 2.5 mm, such as tools	3	Protection against spraying water
4	Protection against solid objects > 1.0 mm, such as wire or small screws	4	Protection against splashing water
5	Dust resistant, limited protection from the ingress of dust, ingress of dust not sufficient to cause harm	5	Protection against jets of water directed at the enclosure
6	Dust-tight, total protection from the ingress of dust	6	Protection against powerful jets of water directed at the enclosure
		7	Protection against submission or exposure to water up to 1 m for a period of 30 minutes
		8	Continuous immersion in more than 1 meter of water for 30 minutes in test conditions subject to agreement between manufacturer and user.
		9k	Protection against high pressure and temperature water jet

Table 8 Ingress Protection (IP) standards : Ingress Protection Rating Format: IP X Y

IP 68 means a total protection from the ingress of dust and continuous immersion in more than 1 meter of water for 30 minutes in test conditions agreed on between a manufacturer and user, meaning that a device with an IP68 rating may be designed to withstand 3 meters immersion or 6 meters immersion. Meeting this rating is critical for everyday and emergency performance.

In addition to IP rating, there are more challenging requirements placed on communications devices that protect from challenges that arise in common use cases. For example, devices must often retain their immersion protection after coming in contact with soapy water, as might happen when a smart phone is cleaned or dropped in a sink, or when a smartwatch is worn during hand washing. This requirement puts more stringent contamination resistance requirements on vents to prevent premature device failure. Soapy water is just one of many potential low surface tension fluids that may challenge vents in this application, all of which are more likely to cause ingress and potential device failure than a pure water challenge.

Microporous Structure - Good Sound Transmission and Ability to Equalize Pressure

The immersion protection capability of a membrane against ingress of liquids or solid particles is determined by multiple factors of which porosity has a large impact. Large pores allow more ingress than small ones. At its extreme, the ultimate material for immersion protection is a full density, non-porous material (e.g. having no opening, for example a sheet of metal) which allows no liquid ingress. However, this approach does not provide the needed breathability or acoustic properties to function as a vent on a communications device.

The membranes which are used in these vents for air and/or sound transmission need to be a thin and low-mass membrane with mechanical properties and porous microstructure that enable optimal transmission of air and/or sound. In some cases, the membrane vibrates easily and quickly in response to sound waves, converting their airborne energy to mechanical vibrations. These vibrations are reproduced on the other side of the membrane to create high-quality acoustics. In other cases, the vent microstructure is permeable enough to allow direct transmission of the sound waves through the membrane's porosity.

The optimized permeation properties enable the vent structure to rapidly equalize pressure changes due to temperature increases or decreases or air pressure differences as they may occur, e. g., during air transports. The vent structure also protects sensitive electronics against condensation from water vapour entering the device, and minimize stress on device seals originating from high air pressures.

Hydrophobicity and Oleophobicity - Barrier to water and oily liquids

For ingress protection, the material needs to be hydrophobic enabling the membrane to repel water and, at the same time, oleophobic enabling it to repel oily fluids. The ability to repel substances is dependent on surface energy. Surface energy is a typical material property used to characterize hydrophobicity and oleophobicity.

Thermal Stability

Some ingress protection vents must also survive the extremely high temperatures (250 °C) associated with the soldering processes used for device assembly. While the device shown in Figure 2 shows an ingress protection vent that is attached to the outer casing of a device, some applications for ingress protection for communication devices require the vent to be integrated into an individual electrical component (e.g. integrated into the microphone or a sensor). This approach allows for more robust device designs, removes potential leak points in adhesive seals to the outer casing, and can thereby further reduce the risk of device failure due to water ingress. But integrating the ingress protection vent into the electrical component requires that the ingress protection material can survive temperatures associate with solder reflow, a process used to attach the electrical component to a circuit board. This solder reflow process often uses temperature in excess of 250°C.

Uses of the PFAS and Assessment of Alternatives

Why Fluoropolymers and other PFAS can uniquely deliver the needed performance

Today, only PFAS based vents can meet the combination of the above-described highly demanding requirements. Polytetrafluoroethlene (PTFE) is the primary material used for vents in communications devices. Additional fluoropolymers and other PFAS listed below in Table 2 are used to construct the finished vent article and provide an enhanced oleophobic surface on the PTFE membrane so that it more effectively repels oils, sweat, cleaning solutions, and other common fluids that can threaten device reliability.

Microporous structure

PTFE is the only known material that has the inherent physical properties listed above and can also be expanded into a thin, strong microporous membrane. All of these in combination deliver the key characteristics necessary for this end use.

Its microstructure facilitates the transmission of air and sound, while effectively repelling water, other fluids and particulates. **It is the unique combination of the properties listed below which have not been identified in any other alternative materials, or combination of materials, that have been investigated by leading vent manufacturers to date.**[98]

The PTFE membrane is engineered with a porous microstructure that enables optimal transmission of air and/or sound. The thinness and specific pore size allows sufficient acoustic transmission.

The transmission properties of the expanded PTFE membrane also enable the vent structure to be air permeable to rapidly equalize pressure changes, protecting sensitive electronics against condensation and minimizing stress on device seals. The combination of small pore size and hydrophobicity enable resistance to wetting with water. The image of an expanded PTFE membrane in Figure 3 shows the complex microscopic pores providing this combination of properties. For a sense of scale, a very fine human hair (30 microns in diameter) would cover the entire field of view in this image.

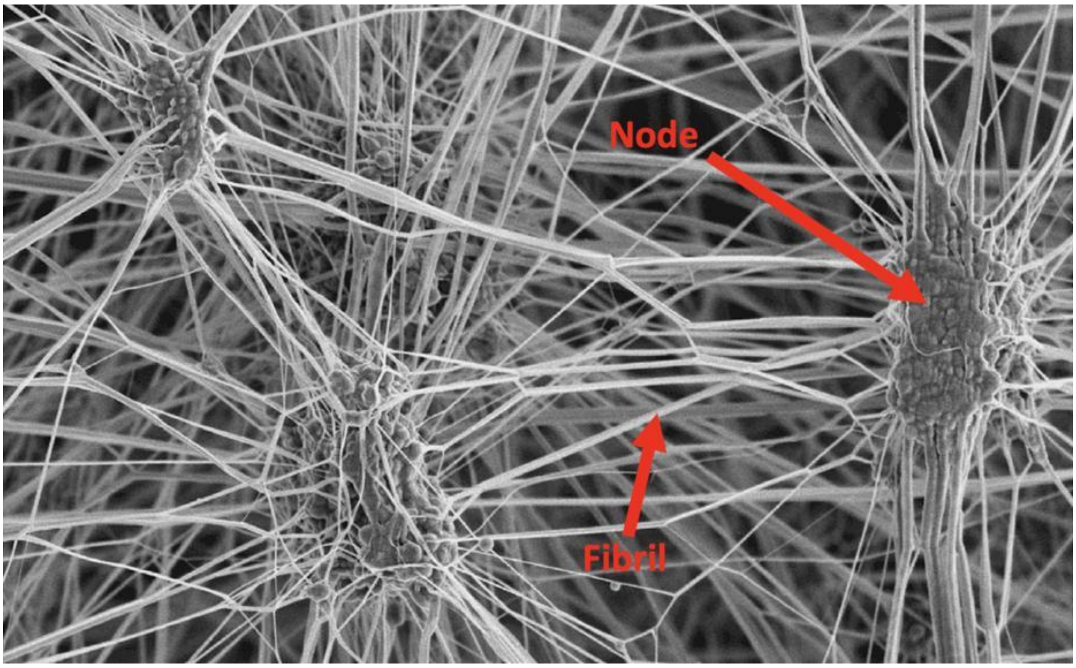


Figure 10 Example of ePTFE Microstructure Showing the Node and Fibril Microstructure

The image above shows a “node and fibril” microstructure which is characteristic of an expanded PTFE membrane. “Fibrils” are the thin fibers, and “nodes” are the solid regions to which the fibrils are connected.

Very few polymers can be processed into microporous structures, and the process used for producing PTFE membranes[99], known as “paste processing and expansion”, is particularly well-suited to creating a wide range of microstructures and thicknesses of membranes not typical of other membrane fabrication processes.

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[98] RCOM Ref 4520

[99] This process, known as paste-processing, was first described in US Patent 3,953,566, assigned to W. L. Gore and Associates. The process is also outlined with some detail in “Expanded PTFE Applications Handbook: Technology, Manufacturing and Applications” by Sina Ebnesajjad.

The membrane properties that result from such a process depend on many factors, including the starting polymer properties, the temperature at which the membrane is expanded, and the amount of stretching that is applied during the expansion process. The wide range of process space allows for a wide array of ePTFE membranes to be manufactured through this process. One key attribute of PTFE is that it has a very wide range of temperatures over which it can be stretched (from around room temperature up to in excess of 300°C). The expansion process converts starting polymer particles (called “fine powder”) into “fibrils”, and polymer that is not converted into fibrils remains in “nodes”, resulting in expanded PTFE’s characteristic node and fibril structure in a high porosity form. The node and fibril microstructure of PTFE membranes is well-known[100] to offer a unique combination of air permeability, water resistance, mechanical strength, and acoustic transmission.

The membrane can optionally be laminated with other support materials, coated, or otherwise treated to impart additional properties. For example, the membrane can be treated with additional PFAS in the form of a coating or surface treatment to increase its oleophobicity and contamination resistance, further adding to the unique combination of material properties of the PTFE membrane.

PTFE is the only polymer that has been found to be capable of being commercially produced using the above-described process. Extensive research and development by leading vent manufacturers[101] has not identified any other polymer material which:

- is compatible with paste processing
- can be expanded to produce a microporous membrane
- is available in the fine powder form required for paste processing
- has a wide processing temperature range
- can currently be developed into commercial processes.

Therefore, there are no known alternative membranes with this characteristic microstructure.

Hydrophobicity

Hydrophobicity is the ability a solid material to resist the spreading of water on its surface. Hydrophobicity is a key property for a material which is used to manufacture a membrane to provide ingress protection of communication devices. Membranes made from polymers with hydrophobic polymers resist wetting with water and thereby prevent water entry into devices which can cause failure. The greater the hydrophobicity, the better a mmbrane can resist wetting. The less hydrophobic a material is, the more likely it is that it will fail to resist wetting with water and lead to device failure.

Surface energy is a fundamental measure of hydrophobicity. The lower the surface energy, the more hydrophobic a material is.

Expanded PTFE is naturally hydrophobic and has a surface energy of 19 dynes/cm. This allows it to easily repel fluids with surface tensions above 40 dyne/cm, such as water (72 dynes/cm) and coffee (40 dyne/cm). When treated with an additional fluoropolymer, the surface energy can be further decreased.

[100] US Patent 6512834B1 “Acoustic protective cover assembly”, W. L. Gore and Associates
[101] RCOM Ref 4520

Not all polymers are hydrophobic, and no other polymer as inherently hydrophobic as PTFE can be processed into as broad an array of microstructures as PTFE.

An extension of hydrophobicity is oleophobicity, which requires even lower surface energy, and enables non-wetting properties with lower surface tension fluids and will be discussed later.

Oleophobicity/Contamination Resistance

Oleophobic treated PTFE has a reduced surface energy and can effectively repel fluids with very low surface tensions.

For example, the surface tension of household cleaners range from 27–32 dynes/cm, and the surface tension of isopropanol (a key component of rubbing alchohol) is 22 dynes/cm. If these fluids were to penetrate through a vent during cleaning, they could cause catastrophic damage to electronic components. In the later section detailing alternatives assessment, we will provide specific data that shows that the presence of an oleophobic treatment on a PTFE membrane enables durable water resistance after a vent is exposed to soapy water. Without this treatment, exposure of a communication device to soapy water (e.g. cleaning a device, dropping a cell phone in a sink, vigorously washing one’s hands while wearing a smartwatch) could significantly degrade its immersion protection, leading to device failure.

In addition to reducing the ingress of liquids, the oleophobic properties of treated PTFE reduce the wettability of the acoustic vent membrane, so that liquids do not remain on the membrane and degrade acoustic performance or risk clogging the microstructure.

Achieve IP68 Standards

Although the expanded PTFE membrane is extremely thin, its unique structure is engineered to effectively repel debris, water, and other fluids. It also provides ingress protection up to IP68 standards, which represents complete protection from particles and at least 1 meter immersion protection (at a level that is specified by the manufacturer). The membrane has a complex, three-dimensional microstructure which provides a tortuous path through the material. This complex, tortuous path traps very small particles with high efficiency creating an effective barrier to particles of varied sizes. The image below is a scanning electron micrograph of a membrane used for ingress protection for communication devices. The pores in this microstructure are considerably smaller than one micron in diameter, and their complex geometry ensure capture of small particles.

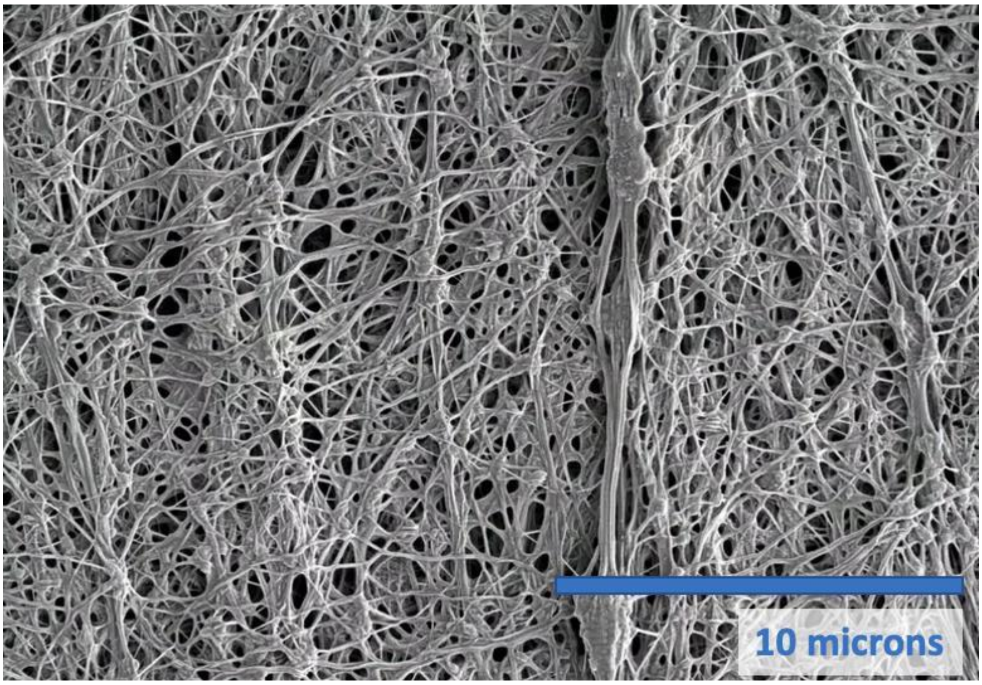

Figure 11 Typical Membrane used in Ingress Protection Vents

In addition to having the appropriate microstructure, the membranes must have sufficient strength to survive the mechanical challenge associated with pressurization. For example, if a membrane is used to protect a device from immersion in 6 meters of water, the water will apply a pressure of 60 kilopascals to the surface of the membrane when under challenge. Under this applied pressure, the membrane must not break or significantly deform in a way that would allow water to enter and damage components, thus causing device failure.

Thermal stability

Many ingress vents must also survive the soldering processes used for device assembly and cope with high temperatures (≥250°C).

PTFE is a very thermally stable polymer, only melting at temperatures well above 300°C, allowing its use in such conditions. Most other polymers that can be made into porous materials cannot survive such temperatures. For example, porous membranes can be made from polyethylene, polyurethane, PVDF, nylon, and polysulfone but all of these polymers start degrading well below 250°C. Two thermally stable polymers that can be made into porous membranes are PEEK (polyether ether ketone) and PI (polyimide). However, they have considerably higher surface energy than PTFE (42 dynes/cm[102] and 44 dynes/cm[103]), and therefore do not have the required hydrophobicity and oleophobicity properties. They are also not compatible with the process used to make PTFE membranes, so they do not offer the characteristic node and fibril microstructure known to be associated with strong performance in this application.

There are no polymers available today that can survive the high temperatures experienced during the component soldering process and can also be engineered to provide

[102] http://www.surface-tension.de/solid-surface-energy.htm, accessed 5/22/2023
[103] https://ntrs.nasa.gov/api/citations/20090026494/downloads/20090026494.pdf, accessed 5/22/2023

microstructure, hydrophobicity, and oleophobicity of a PTFE membrane with an oleophobic treatment. PFAS-based treatments that can be applied to PTFE also can survive such temperatures.

Alternative Materials Referenced in the Restriction Proposal

The Dossier Submitters (DSs) researched the electronics applications of PFAS in detail (as presented in Annex A Table A.1, page 5) and the use of polytetrafluoroethylene (PTFE) is listed in the context of sound-permeable membrane (Restriction Proposal Annex A, Table A.48, page 107). The properties required and provided by PTFE are acknowledged (air permeability, water pressure resistance, liquid repellence and acoustics characteristics).

However, in Annex E of the Restriction Proposal where the derogation and availability of alternatives are discussed, the Dossier Submitters did not assess the need for PFAS in these applications.

Alternatives mentioned by the dossier submitters (DS) in the restriction proposal for the broad category of electronics are not suitable for protection of devices used for communications.

No non-PFAS alternatives are available that would prevent device failure. Alternative non-PFAS materials, and combinations of alternative non-PFAS materials, may be able to replace a singular property, but as discussed in this document, multiple properties are required simultaneously in communication devices. Thus, the only currently viable material is a composite article made from fluoropolymers and other PFAS.

In the analysis of alternatives, the applications described in this document fall within the succinct statement by the DSs that considering *"the inconclusive evidence pointing to the non-existence of technically and economically feasible alternatives at EiF in all other uses, no derogation is proposed"* (Annex E, Table E.131, page 404). The applications described in this document do not appear to have been included in the DS analysis of alternatives for electronics. Considering the broad variety of applications of PFAS in electronics and that the DSs chose to discuss together alternatives covering electronics, semiconductors and even energy sectors (Annex E, section E.2.11.2. from page 389), it remains unclear which alternatives have been considered for PFAS in acoustics vents in communications devices.

In this document, we provide evidence that there are no currently available technically and economically feasible alternatives for ingress protection, and therefore a derogation is warranted.

Assessment of Alternatives

The Dossier submitters identified several materials as potential alternatives for PFAS applications in electronics and semiconductors (Annex E, table E.128, page 396). Not all these materials are relevant to ingress protection for communication devices. We will only discuss technologies which are relevant to the application referenced in this submission.

Non-porous covers (urethane, silicone, PEEK)

Non-porous covers such as urethane, silicone or PEEK can be used to cover apertures when immersion protection is needed with satisfactory sound transmission. However, these materials do not breathe and do not allow for pressure equalization, which is required to alleviate pressure changes that may arise due to typical use (e.g. going up in an elevator or airplane or due to temperature changes), and may in turn also degrade sound transmission. If pressure is not equalized, it will build, applying undue forces to the membrane, device seals, and every other internal component. Such forces will destroy the membrane, break seals, and damage components that are critical to the function and continued survival of the device. **Therefore, non-porous covers are not a viable alternative to ingress protection vents.**

Woven mesh covers

Woven mesh covers can protect an aperture from liquid splash, light spray or rain. However, any dust particles smaller than the defined hole size will pass through these mesh covers because they consist of a single-layer grid and spacing pattern with a defined hole size. Moreover, this alternative will not protect against immersion or aggressive spray. A device which is not robustly protected can allow ingress of dust, which can degrade or induce failure in sensitive components like microphones. A device without protection from immersion is subject to water ingress, which can lead to total device failure. **Therefore, woven mesh covers are not a viable alternative to ingress protection vents.**

Alternate porous membrane

A variety of non-PFAS polymers can be used to fabricate porous membranes, but these cannot be processed to yield the characteristic node and fibril microstructure of expanded PTFE associated with suitable applicability in ingress protection vents for communication devices. These non-PFAS polymers are also not water repellent (do not have low enough surface energy) and so are not viable alternatives for ingress protection vents.

There are several processes that can be used to produce porous membranes from non-PFAS materials. Phase inversion processing is a type of process for making porous membranes by transforming a polymer solution into a solid state in a controlled manner. Electrospinning is a process that uses high voltage to spin fibers from polymer solutions. Track etching is a process that uses nuclear tracks to create pores in polymer films. Sintering is a process which fuses particles of polymer into membranes. The diagrams below show representative examples of membranes made through each of these processes. In each case, it is readily apparent that the membranes have different microstructures than what is shown in Figure 4.

Phase Inverted Membranes

Phase inverted membranes have no presence of node and fibril microstructure. An example of such a membrane is a Polysufone (PES) membrane[104], shown below. **Polysufone is not water repellent because it has surface energy of 47 dynes/cm, which is much too high for use as an ingress protection vent.**

[104] https://www.sigmaaldrich.com/US/en/product/mm/gpwp04700, accessed 5/23/2023

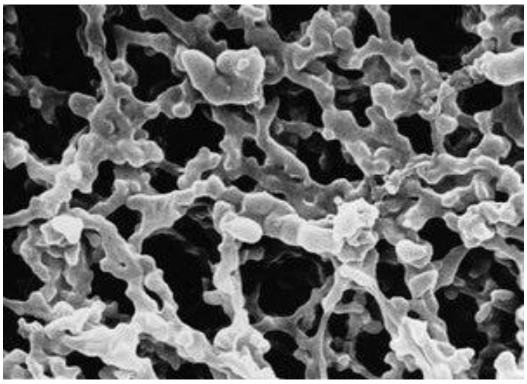

Figure 12 Porous PES

Track Etched Membranes

Track etched membranes do not have a node and fibril structure. An example of this technology, a track etched PET membrane[105], is shown below. **PET is not water repellent because it has a surface energy of 39 dynes/cm, which is too high for use as an ingress protection vent. In addition, these membranes are of low porosity, and offer poor permeability.**

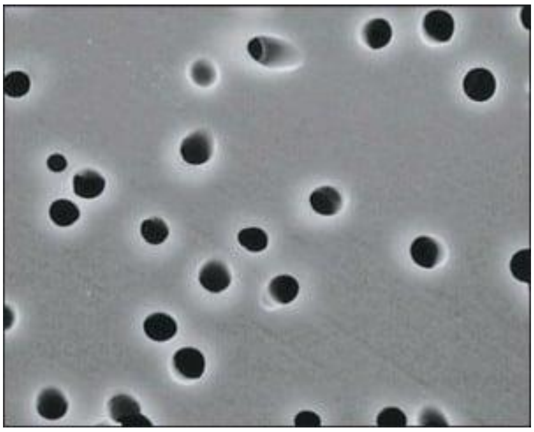

Figure 13 Porous PET

Sintered Polymer Membranes

Sintered polymer membranes do not have a node and fibril microstructure. An example of this type of membrane, a sintered polymer membrane, is shown in the diagram below. **These membranes have a low porosity and are relatively thick. Furthermore, the sintered polymer membranes are not water repellent and are not a viable alternative to ingress protection vents.**

[105]https://www.sterlitech.com/blog/post/etching-the-tracks-in-a-polycarbonate-track-etched-membrane-filter, accessed 5/22/2023.

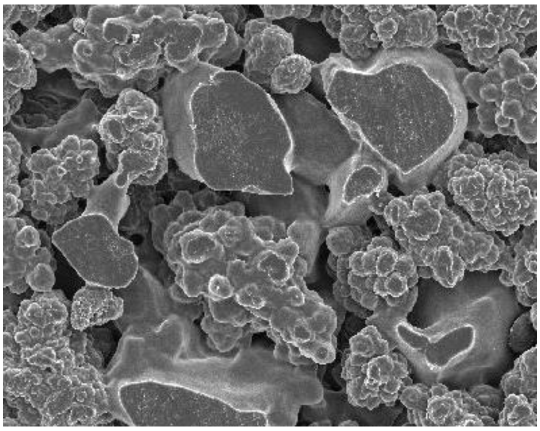

Figure 14 Sintered porous membrane[106]

Electrospun Membranes

Electrospun membranes are comprised of extremely long fibers, which do not have connection points at nodes like in a node and fibril microstructure, as can be seen in the diagram below[107]. Such membranes are also typically characterized by having low cohesive strength. **Electrospun membranes offer some features that may be useful for venting applications for communication devices, but are either comprised of polymers which are not water repellent because they have high surface energy (polyurethane, nylon, e.g.) or they are fluoropolymers (PVDF, e.g.).** One electrospun membrane has been characterized more completely as will be described in the following section.

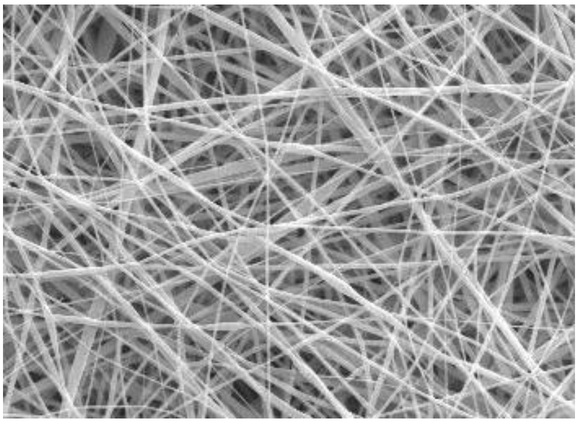

Figure 15 Electrospun Membrane

Polyethylene (PE) and polyurethane (PU)

Two potential membrane technologies which appeared to have some level of hydrophobicity and well-established manufacturability are expanded polyethylene (PE) and electrospun polyurethane (PU). These were selected by a leading vent manufacturer for more thorough evaluation as their property profiles indicated they may possibly be potential candidate

[106] https://www.porex.com/porous-polymers-technology/, accessed 5/22/2023.
[107] http://electrospintech.com/generalcharacteristics.html#.ZGu7EuzMLfs, accessed 5/22/2023.

alternative materials ().[108] As shown in Table 5, samples having average pore sizes similar to current PFAS vent solutions were selected.

Sample Type	**Average Pore Size [microns]** [109]
Commercial ePTFE + PFAS Coating (GAW342)	0.50
Commercial ePTFE (GAW337)	0.61
ePE Reference #1	0.69
ePE Reference #2	0.43
Electrospun Polyurethane Reference	0.43

Table 9 Membranes Selected for Contamination Resistance Study

These membranes were evaluated for their immersion protection properties when subjected to industry qualification methods which model typical mobile device consumer behavior. As highlighted above, an ingress protection level of IP68 means a total protection from the ingress of dust and continuous immersion in more than 1 meter of water (in agreement with the manufacturer and user) for 30 minutes. In this case, the immersion depth that is relevant for these materials is 6 meters, so that was the depth at which testing was performed.

Table 6 shows survival probability in a water submersion test after exposure[110] to soapy[111] water for each membrane material, which is a typical qualification method for electronic devices. After exposure to 0.01 % soap in water (ten times less concentrated than a standard solution), all candidate alternative materials (ePE and electrospun polyurethane) as well as uncoated ePTFE exhibit a failure rate of 50 % or greater.

All alternative materials and **uncoated ePTFE** exhibit a survival probability near 0 % after exposure to a standard soapy water solution of 0.1 % soap in water. In contrast, more than 80 % of samples made of ePTFE with an additional PFAS coating pass the submersion test after exposure to 0.1 % soapy water.

[108] RCOM Ref 4520
[109] Pore sizes of these membranes were determined via a bubble point measurement on a Quantachrome 3GzH capillary flow porometer, in accordance with ASTM F316-03.
[110] Samples of these flat sheet membranes with a diameter of 1.5mm were prepared, and small droplets of soapy water (20 microliters in volume) were placed on the surface of the parts. Soap solutions were prepared in a range of concentrations (e.g. 0.01% v/v, 0.1% v/v, 1% v/v). The samples were dried in an oven at 60°C for three hours until completely dry. Once dry, samples were pressurized with clean water on the soapy membrane surface at a pressure equivalent to submersion in 6 meters of water (0.6 bar)[110]. If water was passed through the membrane, the time was noted, and the test was marked as a failure.
[111] The soap is a mixture of sodium lauryl sulfate (SDS or SLS), lauramine oxide (LO), sodium chloride (NaCl), and water. The ratio of SLS:LO:Salt is 5:2:3, and the mixture is 80% water by mass.

Sample Type	0.01 % Soap/Water	0.1 % Soap/Water
Commercial ePTFE + PFAS Coating (GAW342)	> 80 %	> 80 %
Commercial ePTFE (GAW337)	< 30 %	~ 0 %
ePE Reference #1	< 20 %	~ 0 %
ePE Reference #2	< 40 %	~ 0 %
Electrospun Polyurethane Reference	~ 50 %	~ 0 %

Table 10 6 meters water submersion survival probability

Despite having comparable average pore size to fluoropolymer based membranes, PE and PU did not show sufficient resistance to wetting after exposure to soapy water.

Only the expanded PTFE membrane with PFAS coating showed acceptable survival in the water immersion challenge after a typical soapy water exposure. This is attributable to its low surface energy, which is a unique property of PFAS materials.

One of the reasons why expanded PE membranes and electrospun PU membranes fail the soapy water test is that these polymer membranes are not as inherently low surface energy as expanded PTFDE, and therefore not as inherently hydrophobic. Polyethylene has a surface energy of 30 dynes/cm, polyurethane has a surface energy of 38 dynes/cm, while PTFE has a surface energy of 19 dynes/cm.

They also do not offer thermal stability comparable to PTFE, which does not melt until temperatures in excess of 300°C. Ultra-high molecular weight PE, the most thermally stable grade of PE, melts at approximately 150 °C, at which point structure and other properties will degrade considerably. Thermal degradation of PU can also begin at temperatures as low as 150 °C[112].

So, while membranes made with these potential alternative materials have some properties similar to PTFE membranes, their level of performance in testing shows that they are not suitable alternatives in their current forms due to fundamental material properties inherent to their chemistry. **Therefore, Polyethylene (PE) and polyurethane (PU) membranes are not viable alternatives to ingress protection vents.**

Other Design Approaches

Alternative design approaches which have been considered are shown below, however **they do not provide ingress protection, and are therefore not viable alternatives.**

[112] https://www.americanchemistry.com/industry-groups/center-for-the-polyurethanes-industry-cpi/resources/library/polyurethanes-and-thermal-degradation-guidance

Alternative Technologies/Design: As the DSs focus essentially on alternative materials, we would like to complement the alternative discussion and present option that requires an alternative technology/design.	**<u>Open apertures</u>** Open apertures provide unimpeded sound, but provide no protection from dust, liquids or immersion. Designs with open apertures are highly susceptible to component failures and decreased device life, so this approach is not a feasible alternative. **<u>Sealed housings</u>** Sealed housings protect electronic devices by providing a barrier against water or dust but prevent pressure and temperature equalization. As the device generates heat or experiences changes in pressure (due to going up in an elevator or an airplane, e.g.), pressure will build inside the housing. These internal pressure changes put significant stress on the housing seals which over time will fail, allowing water and contaminants to enter. This approach has similar downsides to non-porous covers, and neither represents a reasonable alternative.

Table 11 Alternative Design Approaches

<u>Conclusion</u>

For more than 20 years leading material suppliers and device producers have looked for alternative materials and methods for protecting communications devices, but nothing has proven capable of meeting sufficient performance as compared to the PFAS based vents. There has been significant incentive based on the high value and large number of users for this application.

Why a 13.5 year Derogation is Required

The DSs have not specifically assessed the need for fluoropolymers and other PFAS in membranes for ingress protection, as the draft PFAS restriction is currently written, these products would fall under the default transition period of 18 months after EiF. We have demonstrated that no alternative is currently available which meets the performance requirements, and in the following we will illustrate the timeframe needed in the unpredictable case that a new material would be discovered or invented for this application.

Despite the high cost of raw materials[113] and the inherent incentive to find cheaper alternatives, no viable alternative materials have been identified and developed to date for use in communications devices. We, and other key actors in the supply chain, estimate it could take at least another five years to identify and develop possible alternative polymer materials. This first step involves discovery, to which a specific timeline cannot be planned.

[113] The Restriction Dossier refers multiple times to higher costs of fluoropolymers (Annex E, page 285, 390, 444, 458, 504, ...)

Any possible alternative materials will then need further development to optimise them for specific application requirements (e.g., ingress protection and acoustic performance). We estimate that steps within this stage could take more than a year. The ingress protection and acoustic properties of these alternative materials will need to be evaluated to ensure that they provide adequate performance.

The final optimised material will then need to be manufactured into vent components so that reliability testing can be carried out, ultimately leading to creation of a new supply chain for assembly in devices that users may come to rely on.

Steps for substitution	What activities does this step entail?	Time required for step
Discovery	Identify and develop suitable alternative materials. Material and process development from lab discovery to prototype scale. This will involve independent development of membrane and treatment technologies, as well as confirmation of their compatibility.	**Unknown** Estimate 3-5 years for this use
Development	Optimise material for specific application requirements (e.g. ingress protection and acoustic performance). This may involve transitioning processes to pilot scale or small-scale manufacturing.	1-2 years
Certification	Reliability testing of manufactured components, and initial validation of reliability in prototype device and/or representative testing.	1-2 years
Production	Investment, installation, and qualification of new mass production capability. Establishing robust material supply chain.	1-2 years
End Device	Development cycle of new communications device products, including establishing specific performance criteria (ingress protection, acoustic transmission, pressure equalization, etc.) in collaboration with end device manufacturer, developing tooling specific to individual devices, in-house and third party testing, and validation of processes for conversion into parts for installation in devices.	1-2 year
Total		**7-13 years**

Table 12 Estimated Timeline for Substitution

Material use and emissions

The amount of PFAS required for this end use is extremely low - less than 35 kg of PFAS are placed on the market in the EU each year.

We estimate that the total annual number of new smartphones and wearable communication devices sold in the EU with IP68 ingress protection ratings is approximately 172,000,000.

A typical vent for air and/or sound transmission for a smartphone has an estimated diameter of 4 mm (with an inner diameter of 1.6 mm) and the thickness of the fluoropolymer membrane is about 0.007 mm. The typical density of the membrane in smartphone vents is about 0.4 g/cm^3 and a typical smartphone generally has four microphones (two at the bottom of the phone, one at the top of the phone and one on the back of the phone to assist with video recording) and two speakers (one at the bottom of the phone and one at the top of the phone). Therefore, the total amount of PFAS in a typical smartphone due to vents is estimated at about 0.2 mg which results in an estimated total annual weight placed on the market in the EU of about 35 kg per year.

Ingress protection vents are not a significant source of PFAS emissions across their lifecycle

Without a derogation, devices which both the general population and a wide range of professionals (police, emergency medical and fire services, military, transport operators, etc.) rely on for their daily and urgent communications would have an increased failure rate. This will lead to disruption to routine and critical communications and have a significant environmental and financial impacts on EU citizens.

- **Productivity and Safety Impact –** PFAS based vents are critical to the performance and reliability of communications devices which are essential to daily life and work for hundreds of millions of EU citizens. In addition to being important for daily communication and coordination, these devices are also used for critical communication with emergency services (medical, police and fire) and more recently have begun to track and report critical health care data including glucose levels, heart health data, along with automatic car crash and fall detection. A failed device isn't just an inconvenience, it can delay or prevent critical lifesaving services.
- **Environmental Impact** – Management of electronic waste is an important priority. PFAS based mobile device vents prevent device damage, increase product longevity which in turn keeps millions of devices from being disposed each year. When a device prematurely fails, more waste is generated and critical raw materials, energy, and associated greenhouse gas emissions are required to replace these devices creating a greater burden on the environment.
- **Financial Impact –** Without PFAS based vents, the rate of failed devices will increase significantly, creating a significant productivity and financial burden for EU citizens who must invest hundreds of millions of Euros each year on replacement devices. In 2016, it was estimated that 100,000 phones were damaged per day before high levels of Immersion Protection ratings were widespread. Consumers could face a cost increase of greater than 600 euro/device due to replacement of prematurely failed devices, which at an EU level amounts to a cost of more than €20 billion per year.

  There would be an impact to industry as well. Communications devices represent a large and growing industry that generates significant income and supports a large number of jobs in the EU. Value chain disruptions from restricting a key component for communications devices may therefore significantly impact the EU economy.

Proposed derogation

Paragraph 2(c) shall apply from (**13.5 years** after entry into force) to **PFAS used in ingress protection vents for communication devices**. By (3 years before the derogation is due to expire) the Commission shall review this derogation to assess whether alternatives are now available or whether further renewal of this derogation is needed and publish amendments to the Regulation.

11. Mobile Telecommunication network infrastructure equipment

General summary of the application category

Mobile telecommunication network infrastructure equipment uses high power Radio Frequency (RF) signals to communicate with various mobile devices. For several applications within the RF-signal path the combination of dielectric- and mechanical-properties of materials are essential. This is the case in applications where the wavelength of the signal is of similar length as the physical dimensions of the design.

PFAS in the form of fluoropolymers are today used in radio frequency (RF) related parts of the (B2B) mobile telecom network infrastructure equipment (NIE). For example, Radio Units (which amplify the electrical digital signals to high power RF signals), RF cables and connectors (which connect the Radio Unit with the Antenna) and Antenna parts (that send the signal from the base station to the mobile devices connected with it).

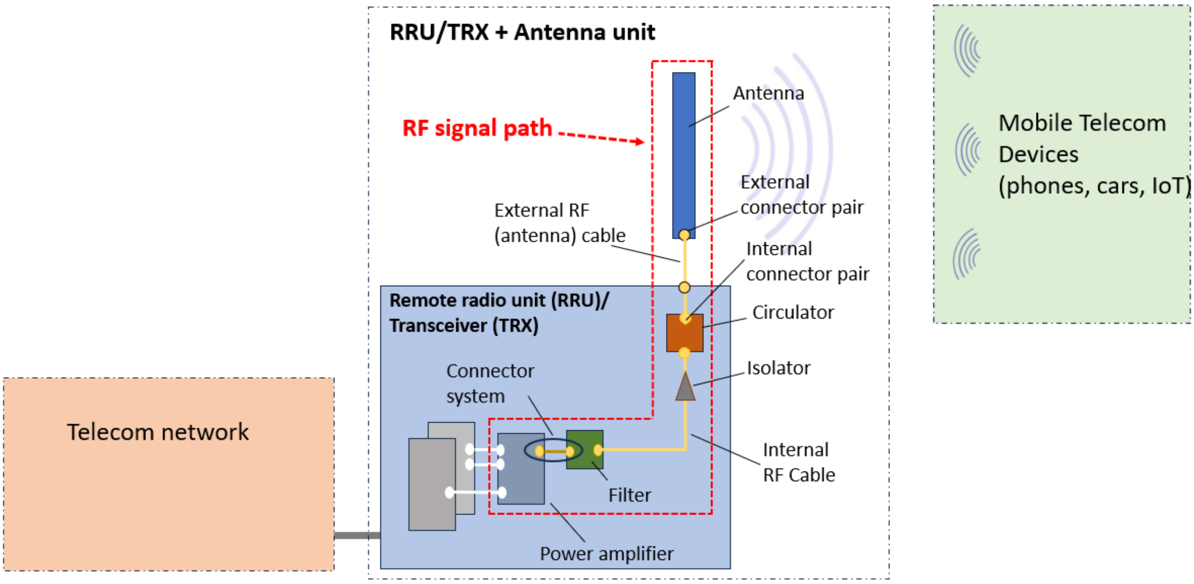

Figure 16 Schematic representation of the wider telecommunication network (left), the mobile telecommunication network infrastructure equipment containing the RF-signal path which via the antenna communicates with mobile devices through electro-magnetic waves.

Reasons for use

The fluoropolymer (e.g. PTFE, PFA) key material properties related to electro-magnetic radio frequency waves are Dissipation factor (or RF loss factor) (Df), Passive Intermodulation (PIM) and Relative permittivity (Dk) which are essential for the performance and energy efficiency of the high power RF signal carrying part of mobile telecom NIE. Fluoropolymers, and primarily PTFE, because of the above properties as well as intrinsic fire retardancy and mechanical properties, have been widely used in the industry as the material of choice for the RF-signal path.

For certain applications within the RF-signal path the combination of low Dk, low Df and low PIM levels are necessary and currently only achievable with fluoropolymer materials. The RF-signal carrying parts are what are called "transmission lines" where the mechanical dimensions of the design are as important as the electrical design. This implies that whenever alternatives will be provided by polymer producers, all the designs of RF-signal path will need to be reviewed. The RF-signal path is dimensionally designed for the fluoropolymer chosen with its dielectric characteristics. Changing the polymer means changing dielectric properties of the insulator, including the dimensions of the interfaces of coaxial connectors as well as the printed circuit boards in both the radio and antenna part of the system. The performance reduction by switching to materials with higher levels of Dk and/or Df cannot be fully compensated by dimension adaptations. For example, the currently most prevalently used Printed Circuit Boards (PCB) material (FR-4: a glass reinforced epoxy material) cannot come close to meeting these requirements.

The use of fluoropolymers in applications associated with high power radio communication technology (i.e. professional infrastructure equipment with output power and frequencies beyond Bluetooth and Wifi) including radio and television broadcasting is ubiquitous due to the fact that it combines excellent dielectric properties with mechanical properties.

Alternative materials parameter comparison

Features	PTFE	LCP	TPX	PEEK	PEI	PE
Dielectric Constant (Dk)	~2.1	~3.0	~2.2	~3.0	~3.1	~2.3
Dissipation factor (Df)@ 10GHz	<0.001	<0.002	<0.001	<0.003	<0.004	<0.001
PIM (dBc)	-164	-149	-149	-149	-149	-149
Abrasion resistance	++	+	+	++	+	+
Operation temperature	++	+	+	++	+	--
Machinability	++	+	+	+	+	+
Corrosion/Weathering resistance	++	+	+	++	+	+
Price	+	+	--	---	--	--
Manufacturability	- (CNC, Compression Molding)	++ (Injection molding)	++ (Injection molding)	++ (Injection molding)	++ (Injection molding)	++ (Injection molding)

The impact of differences in these properties is significant. Especially when used at frequencies in the 1 to 10 Giga Herz range used for telecommunications. For example, PCBs are used for several different components and applications in passive and active antennas for mobile telecommunication NIE. The electrical requirements and especially the radio frequency parameters and their tolerances are tightly defined and demanding for the materials. Only very special material set-ups for dual- and multilayer PCB realizations can fulfil these requirements.

Standard requirements of antennas for mobile telecommunication

Three main electrical requirements define and determine the material choice for PCBs for mobile telecommunication antennas. One additional aspect is essential for production robustness and acceptable yield:

- high power level (e. g. >= 400 W input power for a single low-band system at 600-900 MHz)
- high efficiency = low losses necessary
- very low level of PIM
- resilience to production processes, e.g. several soldering processes (including subsequent repair if needed)

Requirements for PCB materials

With the requirements for the antennas, it is possible to derive the requirements for the base materials (or substrates) and the general set-up of PCBs:

- losses should be as low as possible (losses generate heat and require higher amplifier power to produce the required output power)
- very low level of PIM
- high level of peel strength of copper foil

A comparison of mean values of losses of typical materials with and without fluoropolymers used in the antenna industry can be seen in fig. 17. With this comparison it can be shown, that fluoropolymer materials have a clear advantage compared to non-PFAS materials due to lower losses which will also reduce heating in components for high power applications.

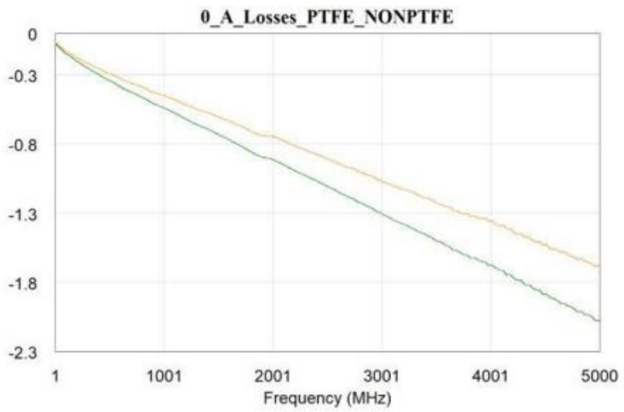

Figure 17 Mean values of losses of typical PTFE- (orange/upper line) and non-PTFE (green/lower line) materials over frequency. Measured with 50 Ohm lines, length of 560 mm. Three typical materials for PTFE and non-PTFE, 20 samples each candidate. Y-scale in dB indicating clearly lower losses of PTFE candidates

In fig. 18 a comparison of mean values of PIM of several typical PTFE- and non PTFE-candidates is made. The PIM performance is far better with PTFE materials and gives sufficient buffer for antenna applications.

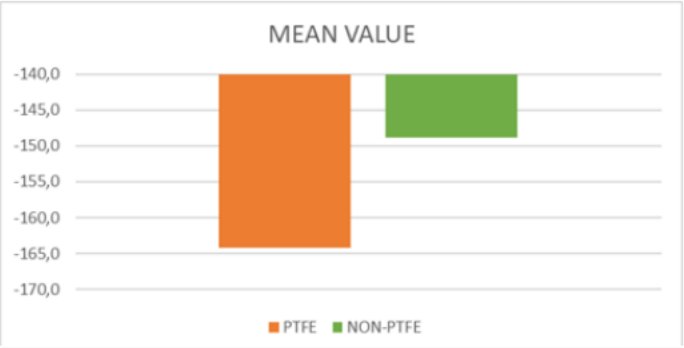

Figure 18 ***Mean values of Passive Intermodulation of typical PTFE- (orange/left) and non-PTFE (green/right) material. Measured with test coupons at 2x20 W at 900 MHz, 1800 MHz and 2600 MHz. Three typical materials for PTFE and non-PTFE, 20 samples each candidate. Y-scale in dBc. As this is a logarithmic scale, the difference of 15 dB in value means that the PIM power is ca 30 times higher for the alternative material, indicating better performance of PTFE materials.***

Process and product robustness and reliability of PCBs is a matter of copper foil peel strength. Higher levels of initial peel strength will better survive several production steps (e.g. sequence of soldering processes) than a low starting level.

Typical peel strength levels for PTFE and non-PTFE materials are between 0,72-0,88 N/mm for non-PTFE and 1,75-2,4 N/mm for PTFE materials. That means, the peel strength for PTFE materials is at least twice of the level of non-PTFE materials. This results in significant higher robustness, yields and life time for components and products using PTFE based PCBs.

These properties play a similar role in all other parts in the RF-signal path such as connectors, cables and filters. Generally the stability of parameters over larger volumes (e.g. lengthy cables) and subsequent batches is critical to the repeatability of the production processes involved.

Exception to the need for fluoropolymers in cables is in certain outdoor antenna cables where in larger diameter cable (from a quarter inch / 6.3mm or larger) where polyethylene foam can be used. This material has a much lower flammability rating which is less of an issue in outdoor cables and is possible due to the larger dimensions both in conductors and dielectric (reducing signal losses to an acceptable level) which in turn reduces the minimum bend radius but allows for lower weight per length of cable.

Explanation of key parameters

- **Relative permittivity (Dk)** (or dielectric constant) is single most important parameter to describe electrical behavior of a certain material. Repeatability of Dk and tight tolerances are necessary for high requirements and quality. Combination of low Dk and Df are necessary for certain high power and low-PIM applications. Currently only PTFE meets these requirements. Non-PTFE materials with low Dk values have higher Df values = higher level of heating of systems and lower efficiency. Relative permittivity - Wikipedia
- **Dissipation factor (Df)** (or Radio Frequency loss factor) **=** Parameter for electrical losses in the material, defines the efficiency of the system. High efficiency means lower waste of energy during operation and less internal heating of system. Internal heating causes problems with electronical and mechanical components and reduces lifetime/robustness/reliability of system in general. Dissipation factor - Wikipedia
- **Passive Intermodulation (PIM) =** Passive Intermodulation (PIM) is a nonlinearity inherent in electrical components that distorts the transmitted signal, causing lower signal quality as well as additional out-of-band emissions. These types of non-linearity are very difficult to compensate and can degrade the sensitivity of the receiver causing loss of coverage. Passive Intermodulation (PIM) -Wikipedia

Interdependencies

Since connectors are used as interface between the components of the RF-signal path (see Fig. 16): **Radio** (board mounted connector) / (cable mounted connector) **cable** (cable mounted connector) / (board mounted connector) **antenna** any dimensional change in either connector or cable will affect the whole design of the RF-signal path.

Connector dimensions are highly standardized and a change in dimensions will require time to develop new standards to ensure various brands can be used without introducing reliability issues. Any change of materials (if at all possible) will require qualification of all materials involved, redesign of the whole product and reliability testing as well as conformity testing to ensure all essential requirements are met both at material level and at system level. Since viable PFAS-free drop-in alternatives for the uses described above are not available today, many years are needed to identify, qualify and design-in substitute materials.

Additionally, there is significant raw material and supply chain infrastructure dedicated to testing and acquiring PFAS materials that will have to be reorganized and run-in to use alternative materials, either with current vendors or new vendors that will have to be vetted and on-boarded.

Substitution timeline

(Example for implementing a substitute in one model radio printed circuit board (PCB)):

1. **Identify potential substitutes** (2-3 years minimum as no alternatives are on the horizon according to material suppliers)
2. **Qualify substitutes** at material level, assembly level & initial reliability testing (1-2 years)
3. **Develop PCB**, produce & qualify samples of the PCB- assembly (2 year)
4. **Develop system enclosure**, test & qualify at system level (1-2 years)
5. **Conformity testing**: Initiate and pass 3rd party conformity testing (1 year)
6. **Production ramp up:** Start-up of volume production from material vendors through to final product assembly (1 year)

Assuming that each step is successful, the **best-case scenario** for substituting the PCB material in one radio will take 8 to 10 years to complete. The engineers that need to do this work are currently the ones working on the development of the next generation (more circular, more energy efficient) 5G equipment as well as 6G equipment. In order to build a PFAS free Mobile Communications site at least the radio, connectors, cable and antenna would need to pass system level conformity testing – and this would be for just one model.

Multiple models are needed to build an efficient communications network. Once the substitute material initial application is a success, the substitution in other models can build on that and will take less time. However, 12 years at minimum will be required to complete the substitution in the portfolio if no barriers are encountered.

For spare parts none of the above is viable since the product dimensions are set – and cannot change unless a 100% compatible material is found.

Emissions

Emissions to the environment are not expected during the lifetime of the article. Under normal conditions of use the materials are not exposed to mechanical wear and tear and as there are no volatile PFAS components, no emission are to be expected during the lifetime of a product.

The main potential emissions will be generated during manufacturing (production waste) and during the waste phase. Both production and end of life ewaste are managed and treated in a controlled fashion. as electronic waste (not from private households) and will be handled and disposed of according to, at minimum, the requirements of the EU WEEE Directive.

Proposed derogations:

Paragraph 2(c) shall apply from (**13.5 years** after entry into force) to PFAS used **for fluoropolymers meeting the PFAS definition in radio frequency related parts of mobile telecommunication network infrastructure equipment**. **The European Commission shall review this derogation by 3 years before its expiry to assess whether alternatives are now available or whether further renewal is needed and to publish amendments to the Regulation.**

An exemption for fluoropolymers used in spare parts for radio frequency related parts of mobile telecommunication Radio Access equipment.

Environmental impacts and emissions

The quantity of fluoropolymers that are introduced in the EEA in Mobile Telecom Radio Access Equipment (Remote Radio Unit (RRU) or Transceiver (TRX) + Antenna system including all parts in the RF signal path) based on averages over the various types of products (such as single/multiple frequency band, passive or active antenna) and the anticipated market in the EEA for such equipment is estimated at 277.5 ton per year (industry total). (Low estimate: 225.8t /y; High estimate 340.9t)[114]. As the uses described above may not be included in table 1 of the ANNEX XV RESTRICTION REPORT – Per- and polyfluoroalkyl substances (PFASs).

This volume is likely to decrease over time as future equipment designs continue to result in next generation products that are more efficient as regards to the amount of materials used and any substitutes that are identified will be implemented.

With respect to spare parts the quantities are negligible 1) due to the very high reliability nature of telecommunication network equipment failure rates are very low over the normal lifetime of products and 2) failures that do occur in most cases are caused by failing electronic components on the PCB assembly. The PCB assembly is usually repaired by replacing the defect component and subsequently utilized in future repairs. While failure of the PCB itself or associated connectors and cables is rare it cannot be ruled out and replacement parts must be available during the agreed lifetime of the product.

Socio-economic impact

It is difficult for the telecom network equipment manufacturers to estimate the socio-economic impact of replacing fluoropolymers as far as equipment pricing because there are no clear replacement solutions identified and while extensive research and development efforts are required the costs to citizens are unlikely to be prohibitive.

An uncontrolled phase out of fluoropolymers, without any alternatives with similar performance, would increase signal loss and RF output power (increased Df and Dk values), leading to higher energy use, while at the same time the signal quality would deteriorate (worse PIM levels). Further, fire resistance would need to be achieved with intentionally added flame retardants; material properties could not be guaranteed during the entire life cycle (10-20 years) resulting in reduced product lifetime; and high operational temperatures would be challenging for non-fluoropolymer materials. Further, fluoropolymers show good performance

[114] Based on product analysis data and EEA market share assumptions for the industry; details in the confidential annex

in the production processes (high soldering temperatures), where alternatives would lead to higher scrap levels during production. Lastly, since the material characteristics are important for the overall design of the equipment, an immediate change to non-fluoropolymer materials cannot be performed. Hence, sub-optimal substitution may affect both industry and consumers.

Consequently, the whole product needs to be redesigned, tested and qualified, which takes a long time. Hence, there would be a risk that telecommunication infrastructure equipment could not be placed on the market for a period after the entry into force and transition period of the restriction.

The additional time requested will, however, minimize unnecessary market and supply chain disruptions in the sector, prevent a delay of roll-out and upgrading of current mobile communication networks. Socioeconomic impacts linked to a delay in mobile network evolution will include reduced economic growth and reduced access to mobile digital services for all end-users.

As substitutes for fluoropolymers when implemented in new product designs will change the form factors of the products the provision of spare parts for the repair of current network elements is impossible without a specific derogation for repair. Without that derogation, mobile network operators will struggle to consistently provide consistent mobile telecom services even if substitution for new products would be achieved.

Dependable mobile network services are critical to the functioning of modern society.

Notes:

1. The details of the specific PFAS (fluoropolymer) applications as well as issues identified with substitution may vary between companies and therefore cannot be disclosed publicly. More details can be provided by each individual company.
2. Relevant manufacturers of the above-mentioned coaxial connectors plan to submit an industry wide request for derogation that would outline their efforts to identify and suggest alternative materials.
3. Similarly, relevant manufacturers of the above-mentioned Printed Circuit Board materials plan to submit a request for derogation that would outline their efforts to identify and suggest alternative materials.

RECEIVED
By: OAH on 3/1/2024
James Votaw Attachment

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March 1, 2024

Katrina Kessler
Commissioner
Minnesota Pollution Control Agency
520 Lafayette Road N
St. Paul, MN 55155-4194

Re: Comments of Valmet Inc.
New Rules Governing Currently Unavoidable Use Determinations
Revisor's ID Number R-4837; OAH Docket No. 71-9003-39667

Dear Commissioner Kessler:

On behalf of Valmet, Inc. and Valmet Flow Control Inc. (Valmet or the Company), we appreciate the opportunity to comment on considerations for developing proposed rules for determining when products should be exempt from the January 1, 2032, ban on distribution and sale of products containing intentionally added PFAS.

Enclosed are Valmet's comments on the particular issues raised by the Agency in its Request for Comments document, together with detailed information on a number of Valmet's products that contain PFAS (fluoropolymers and fluoroelastomers) for which Currently Unavoidable Use (CUU) determinations would be warranted. Minnesota Statutes 116.943, subdivision 5(c). The comments include additional background on the Company's products, the important role played by fluoropolymers and fluoroelastomers in the listed CUU products, the particular challenges and costs of attempting substitutions in complex equipment, and the societal impacts of the bans going into effect without appropriate CUU exemptions.

Valmet's comments also urge the Agency to interpret the scope of the products rule to be limited to consumer products and to exclude industrial products. Its comments demonstrate the impracticability and high cost of applying these rules to industrial products and the limited benefit.

Thank you for your consideration of these materials. We look forward to further engagement on this important topic. Please contact me for any additional information or clarification of any matter presented.

Very truly yours,

James G. Votaw
Partner

Enclosures:

- Comments of Valmet, Inc. - Rules Governing Currently Unavoidable Use Determinations
- Valmet CUU Product Group Spreadsheet

Cc: Valmet Inc.
Valmet Flow Control Inc.

Comments of Valmet Inc. and Valmet Flow Control Inc.
New Rules Governing Currently Unavoidable Use Determinations
Revisor's ID Number R-4837; OAH Docket No. 71-9003-39667

Valmet, Inc. and Valmet Flow Control Inc. (Valmet or the Company), appreciates the opportunity to comment on considerations for developing proposed rules for determining when, Minnesota Statutes 116.943, subdivision 5(c), products should be exempt from the January 1, 2032, ban on distribution and sale of products containing intentionally added PFAS (Currently Unavoidable Use Determinations).

At the outset, we urge the Agency to adopt a common sense understanding of the appropriate scope of the statute. A plain reading of the words of the statute indicates that the PFAS in products prohibition should apply only to *consumer* goods (including their individual components), and we encourage the Agency to take that approach.[1] Applying the prohibition to most industrial goods will not significantly reduce human exposure or environmental release and, as Valmet's submission illustrates, it will be enormously complicated and costly to implement.

In addition to the following comments, the Company also supports the comments to be submitted by the Flow Control Coalition. For Valmet, the Coalition's proposal represents a thoughtful, balanced and pragmatic approach to managing PFAS while ensuring that critical functions of industry and society continue while at the same time, mitigating adverse impacts on businesses, communities, and public health.

A. Products Containing PFAS for Which Currently Unavoidable Use Determinations are Warranted

As requested by the Agency, Valmet is submitting information on a number of its products that contain PFAS (fluoropolymers and fluoroelastomers) for which Currently Unavoidable Use determinations are warranted, as provided by Minnesota Statutes 116.943, subdivision 5(c). We understand that the Company will have further opportunities to (1) identify additional products warranting CUU determinations and (2) to provide additional supportive information and argument if needed. This product information and brief CUU determination

[1] "Product" is defined as "*an item … prepared for sale to consumers, including but not limited to its product components*…". M.S. 116.943, subd. 1(q). While the definition certainly includes consumer products and their components wherever they are distributed (whether sold or used for consumer or industrial use) ("*product components, sold or distributed for personal, residential, commercial, or industrial use, including for use in making other products*"), the definition is still bounded the foundational characteristic that the covered products are limited to those that are "*prepared for sale to consumers*." This definition does not cover products (and their components) that are only distributed for industrial (non-consumer) uses, such as industrial paper manufacturing equipment, industrial boilers or emission control devices. We understand that Maine has taken a different approach, but if the statute were intended to cover non-consumer industrial products, the definition would only need to refer to "*all products.*" The Agency needs to give meaning to that additional language, but not in a way that is internally inconsistent.

justification is provided in the accompanying CUU Product Group spreadsheet. Those listings and brief justifications should be read together with these narrative comments for full context.

B. Valmet Inc. and Valmet Flow Control

Valmet is a leading global developer and supplier of process technologies, automation and services for the pulp, paper, energy and other process industries.

A number of Valmet's products contain fluoropolymer and fluoroelastomer components. As detailed in the accompanying CUU Product Group Proposals Spreadsheet, these are highly engineered products and include paper, tissue and board production machines and related technologies; pulp mills; and material handling technologies for each of these. The Company also produces energy for power and heating production, gasifiers, and related automation solutions and air emission control technologies for all of the above and other sectors of process industry. These in turn contain a wide range of fluoropolymer and fluoroelastomer components, including power cable insulation, seals, gaskets, metal and glass protective coatings, mechanical parts, hoses, connectors, windows, spray nozzles, heat exchanger coatings, o-rings, valve and valve components, gasket sealings; flange sealing, bearings, filling rings, valves, swinging prevention plates, chemical dosing pump membranes and seals, flue gas filters, pulp and paper manufacturing components (special rills, headbox flow ducts, drying cylinders and pressure vessels, stretchers and guides, tail threading equipment, high pressure cleaning and cutting components, and steam and condensate joints).

These end products are used and critical to the operation of a wide range of industrial applications. Valmet's technologies are used in the production of pulp, paper, tissue, board, bioenergy, biofuels, biochemicals and different bio-based materials. In addition to these, Valmet's technologies cover a range of processes used in the circular economy, such as fiber-to-fiber textile recycling, chemical plastics recycling, high-efficient energy recovery from waste, and emission control equipment and automation. The Company's automation technologies and industrial internet solutions are used even more widely, from the automation of food production lines and LNG terminals to balancing city wide electricity and heat production as well as municipal water and wastewater systems. The Company's intelligent valves are used in a wide variety of different process industries to transfer, for example, hydrocarbons and hydrogen in pipelines. The Company's emission control systems are used in industry and the marine sector. The Company's measurement systems are used in industry to ensure steady performance and quality.

C. Essential Function of Fluoropolymers and Fluoroelastomers

These highly engineered systems may contain thousands of components designed, tested and built to work together in particular environments. Fluoropolymer and fluoroelastomer components are often used in these manufacturing and processing systems because of their many exceptional properties, including, as needed, low coefficients of friction, inertness to most chemicals, tolerance of high temperatures, and overall durability. There are no practicable substitutes for the fluoropolymer components. Indeed, it would be necessary to develop hundreds of substitutes to match the properties of the full variety of tuned fluoropolymer and fluoroelastomer products developed over years to meet specific needs. Even if these were available, it would take years to test performance and compatibility of the new materials, and perhaps additional years to develop supply chains and customer acceptance. Furthermore, many of our products, such as pressure vessels, need to comply with various standards, such as the

ASME pressure vessel code. Materials we use in such products must comply with certain material standards and the standardization process for new materials takes typically many years.

Without them, any system built during the last 40 years will not operate as designed. Without spare parts that are tested and certified, and which from a technical perspective also fit the existing design, the Company could not serve its customers, and capital investments by the Company's customers would soon become stranded assets as existing systems will shut down when replacement parts become unavailable. As discussed herein, that could be expected to shut down significant industries, such as pulp and paper manufacturing and in the energy sector.

D. Practical Impacts of a PFAS Product Ban

1. Example: Pulp and Power Industry

Pulp and paper industry (HTS group 8439) provides a remarkable variety of products to current society, from newspapers and books to packaging, tissue solutions for hygiene products, as well as production of pulp for textile applications. Machines to produce these use numerous components (pneumatic and hydraulic cylinders, valves, sliding bearings, self-lubricating bearings, sealings, hydraulic and pneumatic fittings, rotating joints) verified for special process requirements and many of these include fluoropolymer and fluoroelastomers components. These components in general, provide high thermal, abrasion and chemical resistance properties for the machinery. PFAS containing components are used as surface treatments on rolls, which improve the runnability of the machine, for example lowering friction and hence lowering the energy consumption of the process. Shortened equipment lifetimes or reconditioning intervals would mean extra use of resources and increased energy consumption. The Company estimates that equipment lifetimes could drop by half or more from existing levels if enhanced functionality from fluoropolymer and fluoroelastomers were lost due to a ban. This could result in the permanent shutdown of production lines.

As an example, PVDF fluoropolymer is used in the headbox components in paper machines (HTS product category 8439). Producing PFAS plastic components for this application is much more energy efficient than producing them from steel. Possible alternative non-PFAS plastic components would have shorter lifespan and therefore unexpected failures would be more common. This would result in higher spare part costs and loss of production. In addition, part breakages would lead to increased maintenance work which typically is hands on work in a high-risk environment. In principle, these fluoropolymer components could be replaced with substitute stainless steel components, but production of stainless steel is more energy intensive than producing plastics. In addition, related to stainless steel, there is a heavy competition for some raw materials, such as nickel, with battery and car industry.

Other examples from the pulp and paper industry include PTFE fluoropolymer coated steel bands, sealings and rotating couplings that are critical for severe operating environments such as high temperature, contact with harsh chemicals, acids and hydrocarbons, and friction. To avoid the use of PTFE in this context, when a viable substitute is not available, would require a massive redesign and rebuilding of the paper machines with a subsequent loss of production. If the hydraulic sealings fail, there will be releases and potential exposure to contained chemicals and oil.

However, some substitutes have been identified. For hydraulic static sealing applications there might be alternatives for FKM in some applications, such as nitrile butadiene rubber (NBR) or Hydrogenated NBR (HNBR), but product lifetimes for these substitutes are much shorter with much greater operation and maintenance costs over lifecycle. And U.S. EPA currently is completing a TSCA risk evaluation for all conditions of use for 1,3-butadiene and may soon impose severe restrictions on the use of that chemical going forward.

In energy production, chemical resistance especially is required. PFAS are used, for example, in heat exchanger coatings at temperatures that range from 32º to 392ºF. There are many environments where metallic heat exchangers suffer from extremely rapid corrosion.

The current pulp, energy and paper mill plants are the result of decades of design, redesign and development work. There are many PFAS-containing components in the processes, such as valves, pumps, filters, chemical dosing units, coatings and related automation solutions electronics etc. These pulp and energy production solutions are tightly linked to each other and have multiple interdependencies in their operations. In addition, there are other supporting processes such as flue gas cleaning, essential for the plant to operate according to permits. Rapidly redesigned plant sites without any PFAS-components would be much less efficient and manufacturing of some high-end types of paper (such as lightweight packaging grades and graphic paper) would not be possible at all. For example, without any resistant fluoropolymer components, operating temperature would be required to be decreased from by 300ºC to 120ºC (e.g., by replacing hot thermal oil heating by hot water) which would have a significant impact on the production rate and the quality of paper (estimated 10-30% lower machine speed combined with unexpected breakdowns and more frequent shutdowns for maintenance). In addition, it would not be possible to use dryers (due to high temperature conditions) and this leads to a lower quality of paper (insufficiently dried paper cannot be used in converting or printing processes). The ban also would lead to traditional types of fabric change methods, maintenance and shutdown times would increase and overall, the time efficiency of the production machinery would decrease.

To conclude, reliability of paper making lines would drop dramatically, down time for the machines would increase, resulting in losses in production and decrease of the competitiveness of the industry.

2. Example: Flow Control Products

Flow control refers to management of movements of liquids and gases in a variety of processes. A variety of the Company's valves, pumps and related supplies can be used in pulp, paper and board industry, mining and metals, chemicals, refining, energy and in many other process industries as well as municipal water and gas infrastructure. Most of valves are equipped with components (seals, bearings, o-rings, liners, actuator bodies, lubricants and coatings) made from a wide range of fluoropolymers and fluoroelastomers, formulated to meet the specific needs of each type of application. These fluoropolymer and fluoroelastomer materials are chosen for flow control components because their superior performance in demanding harsh conditions, such as high temperature, harsh chemicals, high friction, and their combinations. The critical uses include spare parts for existing installations as well as supply of new technology.

Fluoropolymers and fluoroelastomers are used in valves for sealing purposes, *i.e.*, to prevent leakages through the valve, when it is closed and to prevent fluid media from escaping into the atmosphere through shaft sealing. If these are substituted with less performing material, the risk for fugitive emission is high and these emissions may be harmful for both the employees and the environment. In most application areas in the process industry, there are currently no viable alternatives for fluoropolymers. Proposed substitutes, such as graphite packing rings without PTFE lubrication, resulted in more fugitive emissions which is not acceptable trade-off in industrial processes.

Banning valves (and replacement parts) containing PFAS would have far reaching effects. One process plant, for example, may have thousands of industrial valves installed. Banning PFAS-containing components (99% of current valves in use) would have a huge impact in industrial operations. It also may prevent the completion of new industrial infrastructure.

3. Example: Future Solutions

In addition, as industry is trying to tackle the future challenges, such as building for the hydrogen economy, banning fluoropolymers would be a significant setback. For example, there are no alternatives for sealing applications related to storage and transport of hydrogen as the hydrogen molecule is so small that there is always a leak if alternative polymers are used.

Banning PFAS components would have a major impact also to automation of industries as PFAS-components are widely used in electronics, for example, circuit boards, semiconductors, capacitors, wire insulation and cables, mechanical parts, windows etc., which are parts included in the Company's technology deliveries. PFAS-free components are not readily available on the market and PFAS are needed for high performance in demanding industrial environments so these systems may become unavailable in this state.

Banning fluoropolymers also would have serious implications for national and international trade flows. The fluoropolymer containing technologies banned in Maine or Minnesota will continue to be used elsewhere, giving companies in the same industries in other states or countries a competitive advantage. Policymakers should expect industries hobbled by industrial product policies to shift production, if they can, to site processing facilities located elsewhere in the U.S. or abroad.

E. Considerations for Alternative Technologies

1. The question of alternatives: no "drop-in" solutions

Potential alternatives to fluoropolymers and fluoroelastomers evaluated to date have been inadequate, even for non-critical applications. They have not performed as well as fluoropolymers and fluoroelastomers. Their use results in higher energy consumption, more frequent maintenance, and lower service life, leading to increased consumption of raw materials and generating more waste. For example, so far, the best identified alternative material for PTFE for seals in valves is Polyether ether ketone (PEEK). However, the properties of PEEK are less favorable than those of PTFE. First, the coefficient of friction is 3.5 - 4.5 times higher in PEEK (0.35-0.45) compared to PTFE (0.1). This means much higher energy consumption of valves and a higher wear rate of the seals. A higher wear rate leads to a faster increase in leakages and increased waste in the related industrial process. Second, PEEK is much more rigid and brittle than PTFE, and its compressive modulus is much higher than that of PTFE. These properties can cause the valve seat to be less flexible to deformation against the mating surface, therefore, the internal tightness of the valve is reduced. Third, the corrosion resistance of PEEK is not as good as that of PTFE. For instance, PEEK is not chemically compatible with strong acids (HCl, H2SO4, etc.), and these chemicals are often used in chemical processing industry. There is no margin for deficient performance of the equipment, when the risk for environmental, health and safety hazards is obvious. More maintenance work and required repairs will lead to unexpected shutdowns and hence further increase these risks.

There are alternative materials that can be used in less demanding applications, but no alternative has all the properties of most fluoropolymers. For example, in paper production, in some parts stainless steel component could be used, but it has poor friction resistance, leading to wearing of counterparts and consequently to higher risk of unexpected breaks and health and safety incidents, and also to significantly higher energy consumption.

Alternatives to some parts in the Company's technologies may be available, and we are actively looking for them. But even in these cases, lengthy testing program including redesign and re-certification of products would be necessary before they could be used (for example, testing, redesign and recertification of automation electrical systems may be very lengthy).

3. Long transition times required

A lot of luck was involved when fluoropolymers were discovered, and it is far from certain that alternative materials meeting the needs in the process industry will be found within the current transition period. In the Company's sector for example, it is not uncommon that it takes 15-30 years from innovation to market uptake. In the case of the PFAS ban, creating well-functioning substitute materials is not all that is needed to substitute fluoropolymers.

In process industry, new components and chemicals are seldom "drop-in solutions." All the components and parts in the machinery need to be matched together and redesigned, validated, standardised, tested, and certified. This may need to be performed for thousands and thousands of components and parts. Industries that have developed complex systems with thousands of components and parts over decades cannot be expected to develop alternatives, and then iteratively redesign and test processes using the new materials in a few numbers of years. Furthermore, the fluoropolymers are used so widely, that it is doubtful that a limited number of trained personnel, laboratories and certification bodies can meet the testing needs in such a few short years even if solutions were already available.

For example, valves, depending on their application, need to pass the following extensive certification testing: The most time-consuming certification testing is done for fugitive emission testing, according to API 641 or ISO 15848-1. Furthermore, the valves need to comply with internal tightness tests according to API 598, ISO 5208 and others, such as fire-safe tests according to API 607. Due to the duration of a certification test (average 7 weeks for one valve) and a high number of fugitive emission certificate tests (over 150 pieces) the testing to re-certify valves with new material replacing PFAS will take approximately 20 years just to cover the Company's current valve offerings. This testing can take place only after finding suitable substitute materials for PFAS components and when redesigning of the whole product offering is complete.

Without exemptions, some sectors such as pulp and paper manufacturing, would have to be completely redesigned and they would inevitably lose their production capacities and competitiveness because of the performance of the alternatives (it would basically be a return to 30 years old technologies). Taken into consideration, that redesigned applications are unlikely to pass the certification criteria shortly and the plants will not necessarily pass environmental and safety standards and permits conditions directly, this would lead to closure of plants and consequent unavailability of the corresponding pulp, paper, board, tissue, bioenergy, biofuels, biochemicals, and biomaterials.

F. Response to the Agency's Specific Request for Comment

1. *Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?*

Criteria should be established for recognizing "currently unavoidable uses" (CUU) that warrant exemption from bans on products containing PFAS. Criteria are necessary as a guide for consistent and reasoned decision-making.

The CUU criteria should include aspects related to the functioning of society. For example, if PFAS are banned in 2032, the ban could reasonably be expected to (1) directly impact the availability of replacement parts for existing capital equipment of all kinds designed to operate with components containing PFAS, (2) causes businesses or public institutions to close or suspend operations (in whole or in part); and (3) significantly decrease reliability of the processes and the competitiveness of the operations that current use PFAS-containing components (*e.g.*, by switching to less durable components).

Fluoropolymers and fluoroelastomers (PFAS) are critical components in a wide variety of products and assemblies used in process industries due to the physical demands of those applications and the exceptional properties of the materials. They are used because they are extremely useful and enable a wide range of technologies in large and small ways. They are used, for example in industrial equipment valves, and for sealings, lubricating, insulating, coatings, and other critical functions. Over the course of the past decades, innovators have sought to take advantage of these properties by incorporating them where needed to improve the functioning, efficiency and durability of a wide range of equipment and processes.

For example, a wide variety of products such as machines for producing paper, board and tissue, energy infrastructures and renewable fuels production and many circular economy processes include PFAS materials as integrated, critical parts of their functioning. Adequate substitutes are generally unavailable, but even if they were, the process of reengineering nature, complex systems such as those described is very costly and cannot be done at all except over time. New equipment may be able to take advantage of that kind of incremental innovation, but existing capital equipment and infrastructure designed and perhaps certified to incorporate fluoropolymer and fluoroelastomer technologies will continue to need fluoropolymer enabled replacement parts to operate.

Premature or improvident product bans have the potential to be disruptive in wide swaths of the economy in this state by forcing some operations to curtail operations or close. This may have significant consequences to the green transition, as well as the competitiveness, growth and jobs due to risks in the operational capacity of the several industrial sectors.

When assessing the currently unavoidable uses from the perspective of functioning of society, all these commodities and products mentioned above are critical in modern life.

2. *Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?*

Costs should be considered in defining "reasonably available." Costs of substitution should be measured in a practical way as they will be experienced by those incurring the costs. For example, this would include (a) simple costs of purchase, (b) full costs of successful substitution (e.g., redesign compatible and performance and durability testing); (c) increased operating costs over equipment lifetimes; (d) costs of lower performance (e.g., emissions, spills, increased maintenance ,more frequent replacement); (e) costs of lost jobs and economic output; (e) increased costs to replace incompatible equipment and all other transition casts. An important factor in determining the cost of transitions is the time period over which the transition will occur. Reasonable time frames for forced transitions will dramatically increase societal costs.

Inherent in the concept of a "reasonable" cost is the concept of *proportionality* – a cost that is appropriate or fair; sensible and moderate. Is the cost to make the (forced) substitution proportionate to the expected quantifiable benefit from the substitution? Proportionally more cost might be tolerated for forms and applications of PFAS that, without substitution, are more likely to represent a release to the environment and to the general population. Conversely, if the substitution is unlikely to result in little if any significant reduction in human exposure or environmental release, it would be disproportionate and unreasonable to incur any significant cost to achieve that marginal reduction. We submit that fluoropolymers and fluoroelastomers included in articles are unlikely to be sources of human exposure or environmental release due to their physical form and chemical composition. This potential is even lower when the fluoropolymers and fluoroelastomers are used within heavy industrial processing equipment and electronics.

Purported alternatives for fluoropolymers and fluoroelastomers available to date, even for non-critical applications, have so far always had lower level of performance, higher energy consumption, required more maintenance and lower service life, leading to increased consumption of raw materials and generating more waste. There is no margin for deficient performance of the equipment, as the risk for environmental, health and safety hazards is obvious.

Therefore, it is very difficult to define 'reasonable' costs threshold in process industry, as viable, well performance alternatives do not exist. In addition, in process industry, it is seldom possible to change one article without any effects on the others. Therefore, the total costs are not limited to the article to be replaced, but instead, when changing one article, the whole process may need to be redesigned to avoid unwanted effects. In addition, substitution of separate items may lead to decreased efficiency, temporary shutdowns, increased resource use and in general, to increased costs of stranded assets. Thus, the costs are multiple compared to the costs of a separate item and as substitution of items may lead to lower performance of the process, which inevitably increases daily running costs and has an effect on the competitiveness of the company. Therefore, taking into account all possible costs, both direct and indirect costs, calculating the total costs is impossible.

The definition of "reasonable available" should be limited to cases in which substitution is indisputably technically and economically feasible and available in conventional supply chains and substitution does not increase the health and safety risks of individuals or environment. If the component gets "reasonably available" status, the transition period should be minimum of 25 years to avoid the loss of competitiveness of the industrial sector. In addition, a permanent derogation for spare parts in existing machinery and plants is necessary.

4. *What criteria should be used to determine the safety of potential PFAS alternatives?*

PFAS-containing components currently in use must be able to be used in industrial processes until the safety and overall effects of the alternatives on the environment and users have been thoroughly evaluated to avoid unwanted trade-offs. To be deemed "reasonably available," candidate substitute materials should be safer from a life cycle perspective than the PFAS materials they would replace. It would be unreasonable to expect substitutions to be made with materials that would not be perform at the same level as the existing materials.

Thorough testing is needed for alternatives to ensure their use is positive in all perspectives. The testing should include testing in its operational environment, whatever it is, to ensure it meets the quality required in the process as well as the operational safety aspects. The process industry is full of complex interdependencies and changing one component in the process may have effects on various others. The use of alternative materials may significantly increase the risk leaks of hazardous (elevated temperature, corrosive, reactive, toxic, hot, pressure) process gases and liquids and pressurized media to the workplace or the environment.

From a safety perspective, reasonable acute and chronic human health toxicity and ecotoxicity assessment is necessary. A holistic analysis of the results should also consider the volumes/amounts of alternative components, so that the net effect from various perspectives is positive compared to the currently used PFAS containing components.

5. *How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?*

PFAS-containing components currently in use must be able to be used in industrial processes until safe and effective alternatives have been identified, and adequate and appropriate transition periods have elapsed. These should be set on an individual product basis to take into account, for example, necessary performance validation and verification procedures applicable to the equipment. In addition, trade in spare and replacement parts for existing equipment designed to function with fluoropolymer and fluoroelastomer components must be permitted indefinitely where substitution would be impracticable. Large capital equipment may be in service for decades. And for complex equipment, CUU status must continue to apply until all PFAS-containing components in the affected equipment can be replaced.

In process industry, new components and chemicals are seldom "drop-in solutions." Components are designed to operate as integral and connected parts of complex systems. Before changing the composition of one component of the system, the parts need first to be innovated, matched together and redesigned, validated, standardized, and certified. All this takes years.

When taking the investment decisions, companies rely also to the stability and predictability of the regulatory environment of the society. When investing to a new process industry plant, a service life up to 30 to 60 years is expected. To support successful industrial activity, regulatory processes should be iterative only and avoid sudden bans without a particularly significant reason. One example of iterative approach may be that using spare parts in running plants are exempted from the ban.

Currently unavoidable uses components may be reviewed in regular intervals, for example in every 8th year. And after the review, the same 25 years transition period is needed for any industrial use, as demanding any short-term changes in processes *i.e.*, regressive legislation would be fatal for industries.

6. *How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?*

Products should be defined for exemption at the whole product level and should automatically be considered to include (1) all component parts, (2) spare and replacement parts for such products sold separately and (3) all products and materials needed to produce the CUU exempt equipment. Agency information submission systems should be designed to accept upload of template worksheets (*e.g.*, CSV files) and automatically populate the Agency's data management systems. This permits submitters efficiently to prepare information offline using standard commercial software, and allows effect error free transfer of submitted data into Agency systems.

8. *Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?*

MPCA should not make CUU determinations based on the submitted examples. But the Agency should use the submitted examples to design and vet its information management and decisional making systems, and then present its tentative analysis of some or all of the submitted examples to demonstrate how it would anticipate making decisions in the future, including information needed and decisional criteria. Those proposed approaches to different decisional criteria should be made available for public comment.

9. *Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination*

During a consultation process in 2023, our company identified over 170 uses for PFAS containing materials only in our technologies, and the list is unlikely to be exhaustive. In addition to the large number of uses, one process technology plant may have thousands of parts with PFAS. For example, just the number of valves in one process plant can be in thousands. When considering any potential bans of PFAS-components, we support broad exemptions for industrial actors. There are currently no viable alternatives for most fluoropolymers in technology applications in process industry. The critical applications are technology components such as seals, O-rings and coatings that are used in industrial processes exposed to harsh conditions (temperature, chemicals, high friction and their combinations) and include spare parts to existing installations as well as supply of new technology. Given these uses, replacement would be a high cost, low practical benefit exercise.

Our view is, that in process industry, the use of PFAS-containing products and components ensures greater safety overall as they are often the best tools to assure the mechanical integrity of closed systems handling hazardous materials of all kinds. They also enable many other protective technologies, such as air emission control equipment and electronic control systems. They will also enable low carbon technologies, such as hydrogen fuels and advanced recycling technologies. For industrial uses, any risk from air emissions or water discharges, if any, should be managed by traditional pollution prevention regulation rather than simple bans of PFAS-containing components.

G. Conclusion and Contact

Valmet appreciates the opportunity to comment on the Agency's emerging approach to developing and implementing the PFAS in products rules. For clarifications or additional information from Valmet in connection with these requests, please contact:

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Enclosure: Valmet CUU Product Group Proposals Spreadsheet

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Applicable HTS US Group / GPC code	Component	GPC code if available	Applicable HTS US Code- (import)	HTS description	Role of PFAS	Essential Use Definition* (*Key presented below)	Available Alternative Technologies / results in functionally equivalent product?	Available Alternative Technologies / Reduce potential harm to human health or environment
8439	Pulp, paper and board technologies			Machinery for making pulp of fibrous cellulosic material or for making or finishing paper or paperboard (other than the machinery of heading 8419); parts thereof:		**3**		
8441	Pulp, paper and board technologies			Other machinery for making up paper pulp, paper or paperboard, including cutting machines of all kinds, and parts thereof:		**3**		
	Drying section components		8419.90.20	Parts of machinery and plant for making paper pulp, paper or paperboard	FPM, FKM, FFKM and PTFE are used in sealing and bearing applications where high temperature resistance is needed. Also low friction properties of PTFE is key factor.	2	Drying cylinders and related components are pressure vessels. Currently, there exists no direct replacement for PFAS materials for high temperature drying section components applications in all their properties.	
	Special rolls		8420.10.20.00	Calendering or similar rolling machines for making paper pulp, paper or paperboard	FKM, FFKM and PTFE are used in sealing applications where oil resistance and high temperature resistance are needed. Also low friction properties of PTFE is key factor.	2	No substitutes for FKM, FFKM, PTFE material in sealing or for PTFE material in chemical and abrasion resistance. For high temperature applications (150-300°C) thermo rolls there is not known substitute for FFKM and PTFE seals.	For hydraulic static sealing applications there might be alternatives for FKM such as NBR or HNBR, but lifetime is much shorter which has negative effect on sustainability.
	Special rolls		8439.99.10.00	Parts of machinery for making paper or paperboard	FKM, FFKM and PTFE are used in sealing applications where oil resistance and high temperature resistance are needed. Also low friction properties of PTFE is key factor.	2	No substitutes for FKM, FFKM, PTFE material in sealing or for PTFE material in chemical and abrasion resistance. For high temperature applications (150-300°C) thermo rolls there is not known substitute for FFKM and PTFE seals.	For hydraulic static sealing applications there might be alternatives for FKM such as NBR or HNBR, but lifetime is much shorter which has negative effect on sustainability.
	Roll covers, surface treatments		8439.99.10	Parts of machinery for making paper or paperboard	Mainly PTFE, are utilized on these products for improving runnability, to reduce friction, and for great chemical and temperature resistance.	2	Alternatives have a negative effect on the total runnability and the operational sustainabilty.	
	Headbox flow ducts		8439.99.10		PVDF tubes are used for their chemical and abrasion resistance properties, to improve surface flow.	2	No substitutes for PVDF for headbox flow ducts replacing PVDF in all its properties.	
	Drying section components		8439.99.10	Runnability components, stretchers & guides, doctors, tail threading components, high pressure cleaning and cutting components, steam& condensate joints	FPM, FKM, FFKM and PTFE are used in sealing and bearing applications where high temperature resistance is needed. Also low friction properties of PTFE is key factor.	2, 3	Drying cylinders and related components are pressure vessels. Currently, there exists no direct replacement for PFAS materials for high temperature drying section components applications in all their properties.	

Applicable HTS US Group / GPC code	Component	GPC code if available	Applicable HTS US Code- (import)	HTS description	Role of PFAS	Essential Use Definition* (*Key presented below)	Available Alternative Technologies / results in functionally equivalent product?	Available Alternative Technologies / Reduce potential harm to human health or environment
	Special rolls		8439.99.50.00	Parts of machinery for finishing paper or paperboard	FKM, FFKM and PTFE are used in sealing applications where oil resistance and high temperature resistance are needed. Also low friction properties of PTFE is key factor.	2	No substitutes for FKM, FFKM, PTFE material in sealing or for PTFE material in chemical and abrasion resistance. For high temperature applications (150-300°C) thermo rolls there is not known substitute for FFKM and PTFE seals.	For hydraulic static sealing applications there might be alternatives for FKM such as NBR or HNBR, but lifetime is much shorter which has negative effect on sustainability.
	Headbox flow ducts		8439.99.50.00		PVDF tubes are used for their chemical and abrasion resistance properties, to improve surface flow.	2	No substitutes for PVDF for headbox flow ducts replacing PVDF in all its properties.	
	Dryer fabric		5911:32:00	Textile products and articles, for technical uses, Weighing 650 g/m2 or more	PFTE	2	No substitutes available.	
8483	Other components			Transmission shafts (including camshafts and crankshafts) and cranks; bearing housings, housed bearings and plain shaft bearings; gears and gearing; ball or roller screws; gear boxes and other speed changers, including torque converters; flywheels and pulleys, including pulley blocks; clutches and shaft couplings (including universal joints); parts thereof:	various PFASes	2	No substitutes available.	
8481	Analyzers			Taps, cocks, valves and similar appliances, for pipes, boiler shells, tanks, vats or the like, including pressure-reducing valves and thermostatically controlled valves; parts thereof:	PTFE, FPM, FFKM, modified PTFE coatings and sealings	2	No substitutes available	
7307	Analyzers			Tube or pipe fittings (for example, couplings, elbows, sleeves)	PTFE, FPM, FFKM, modified PTFE coatings and sealings	2	No substitutes available	
9032	Analyzers			Automatic regulating or controlling instruments and apparatus; parts and accessories thereof:	PTFE, FPM, FFKM, modified PTFE coatings and sealings	2	No substitutes available	
	Analyzers		3917.32.0010	Tubes, pipes and hoses and fittings therefor (for example, joints, elbows, flanges), of pvc	PTFE, FPM, FFKM, modified PTFE coatings and sealings	2	No substitutes available	
	Spray nozzle, plate coating		8424.90.90.80	Parts of mechanical appliances (whether or not hand operated) for projecting, dispersing or spraying liquids or powders; fire extinguishers, whether or not charged; spray guns and similar appliances; steam or sand blasting machines and similar jet projecting machines; parts thereof:	PVDF, PTFE	2	No substitutes available with sufficient temperature and chemical resistance.	

Applicable HTS US Group / GPC code	Component	GPC code if available	Applicable HTS US Code- (import)	HTS description	Role of PFAS	Essential Use Definition* (*Key presented below)	Available Alternative Technologies / results in functionally equivalent product?	Available Alternative Technologies / Reduce potential harm to human health or environment
	Heat exchanger coatings		8419.50.50.00	Heat exchange units: other	FEP	2		
8421	Swinging prevention plates			Centrifuges, including centrifugal dryers; filtering or purifying machinery and apparatus, for liquids or gases; parts thereof:	PTFE	2	Yes, porcelain, but breaks down too easily	
	Chemical dosing pump membranes/sealings		8413.90.	Pumps for liquids, whether or not fitted with a measuring device; liquid elevators; part thereof:	Thermal and chemical operating environment is harsh, inertia and resistance required	2		
8421	Filters / filtering of flue gas			Centrifuges, including centrifugal dryers; filtering or purifying machinery and apparatus, for liquids or gases; parts thereof:	Thermal and chemical operating environment is harsh, inertia and resistance required	2, 3		
	Filters / filtering of flue gas		8421.99.01.80	Centrifuges, including centrifugal dryers; filtering or purifying machinery and apparatus, for liquids or gases; parts thereof: other parts	Thermal and chemical operating environment is harsh, inertia and resistance required	2, 3		
	Bearing	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	3920.99.1000	Film, strip and sheets, all the foregoing which are flexible.	Mainly PTFE or reinforced PTFE have good chemical and temperature resistance, low friction coefficient for reduced wear and operating energy. On dynamic sealing products they reduce fugitive emissions.	2, 3	There are no substitute materials.	Not available.
	Bearing	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	8481.90.9085	Other parts of valves	Mainly PTFE or reinforced PTFE have good chemical and temperature resistance, low friction coefficient for reduced wear and operating energy. On dynamic sealing products they reduce fugitive emissions.	2, 3	There are no substitute materials.	Not available.
	Bearing	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	8483.30.8065	Bearing housings; plain shaft bearings: and other	Mainly PTFE or reinforced PTFE have good chemical and temperature resistance, low friction coefficient for reduced wear and operating energy. On dynamic sealing products they reduce fugitive emissions.	2, 3	There are no substitute materials.	Not available.
	Gasket	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	3920.99.1000	Other plates, sheets, film, foil and strip, of plastics, noncellular and not reinforced, laminated, supported or similarly combined with other materials: Over 0.152 mm in thickness, and not in rolls	Mainly PTFE or reinforced PTFE, create tight static sealing to reduce fugitive emissions, and additionally, have great chemical and temperature resistance	2, 3	PFAS-free graphite packing rings has been tested.	Not available. PTFE-free packing ring resulted in more fugitive emissions, which is not acceptable. All certified low fugitive emission packing products contain PTFE.

Applicable HTS US Group / GPC code	Component	GPC code if available	Applicable HTS US Code- (import)	HTS description	Role of PFAS	Essential Use Definition* (*Key presented below)	Available Alternative Technologies / results in functionally equivalent product?	Available Alternative Technologies / Reduce potential harm to human health or environment
	Gasket	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	6815.19.0000	Carbon fibers; articles of carbon fibers for non-electrical uses; other articles of graphite or other carbon for non-electrical uses; other objects	Mainly PTFE or reinforced PTFE, create tight static sealing to reduce fugitive emissions, and additionally, have great chemical and temperature resistance	2, 3	There are no substitute materials.	Not available.
	Gasket	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	8481.90.9085	Taps, cocks, valves and similar appliances, for pipes, boiler shells, tanks, vats or the like, including pressure-reducing valves and thermostatically controlled valves; parts thereof: and other parts	Mainly PTFE or reinforced PTFE, create tight static sealing to reduce fugitive emissions, and additionally, have great chemical and temperature resistance	2, 3	There are no substitute materials.	Not available.
	Compression packing	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	3920.99.1000	Other plates, sheets, film, foil and strip, of plastics, noncellular and not reinforced, laminated, supported or similarly combined with other materials: Over 0.152 mm in thickness, and not in rolls.	Mainly PTFE or reinforced PTFE, create dynamic sealing to reduce fugitive emissions and reduce wear and operating energy due to the low friction coefficients. Additionally, they have great chemical and temperature resistance.	2, 3	There are no substitute materials.	Not available.
	Compression packing	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	6815.19.0000	Carbon fibers; articles of carbon fibers for non-electrical uses; other articles of graphite or other carbon for non-electrical uses; other objects	Mainly PTFE or reinforced PTFE, create dynamic sealing to reduce fugitive emissions and reduce wear and operating energy due to the low friction coefficients. Additionally, they have great chemical and temperature resistance.	2, 3	There are no substitute materials.	Not available.
	Compression packing	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	8481.90.9085	Taps, cocks, valves and similar appliances, for pipes, boiler shells, tanks, vats or the like, including pressure-reducing valves and thermostatically controlled valves; parts thereof: and other parts	Mainly PTFE or reinforced PTFE, create dynamic sealing to reduce fugitive emissions and reduce wear and operating energy due to the low friction coefficients. Additionally, they have great chemical and temperature resistance.	2, 3	There are no substitute materials.	Not available.

Applicable HTS US Group / GPC code	Component	GPC code if available	Applicable HTS US Code- (import)	HTS description	Role of PFAS	Essential Use Definition* (*Key presented below)	Available Alternative Technologies / results in functionally equivalent product?	Available Alternative Technologies / Reduce potential harm to human health or environment
	Seat	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	3920.99.1000	Other plates, sheets, film, foil and strip, of plastics, noncellular and not reinforced, laminated, supported or similarly combined with other materials: Over 0.152 mm in thickness, and not in rolls	Critical sealing elements of valves. Mainly PTFE or reinforced PTFE and FKM are essential materials to create tight static and dynamic sealings, to reduce fugitive emissions, and to reduce wear and operating energy due to their low friction coefficient.	2, 3	There are no substitute materials.	Not available.
	Seat	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	4016.93.5010	Gaskets, washers and other seals: other parts and o-rings	Critical sealing elements of valves. Mainly PTFE or reinforced PTFE and FKM are essential materials to create tight static and dynamic sealings, to reduce fugitive emissions, and to reduce wear and operating energy due to their low friction coefficient.	2, 3	There are no substitute materials.	Not available.
	Seat	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	8481.90.9085	Taps, cocks, valves and similar appliances, for pipes, boiler shells, tanks, vats or the like, including pressure-reducing valves and thermostatically controlled valves; parts thereof: and other parts	Critical sealing elements of valves. Mainly PTFE or reinforced PTFE create tight static and dynamic sealings, to reduce fugitive emissions, and to reduce wear and operating energy due to their low friction coefficients. Additionally, they can be used in a broad temperature range including cryogenic temperature to 260C with great chemical resistance.	2, 3	There are no substitute materials.	Not available.
	Elastomer sealing elements	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	4016.93.5010	Gaskets, washers and other seals: other parts and o-rings	Create static sealings. FKM, FFKM is used as the internal liner that is for both static and dynamic sealings. They have a great corrosion resistance and broad usable temperature range and can be compounded into versatile grades to achieve various level of hardness and durability to meet different service requirements.	2	There are no substitute materials.	Not available.
	Actuator parts	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	8412.31.0080	Pneumatic power engines and motors: Linear acting (cylinders) and other	PTFE coating is used due to the great corrosion resistance and resistance to UV degradation	2	There are no substitute materials.	Not available.

Applicable HTS US Group / GPC code	Component	GPC code if available	Applicable HTS US Code- (import)	HTS description	Role of PFAS	Essential Use Definition* (*Key presented below)	Available Alternative Technologies / results in functionally equivalent product?	Available Alternative Technologies / Reduce potential harm to human health or environment
	Actuator parts	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	8412.90.9025	Of pneumatic power engines and motors: Linear acting and motors	Similar to valve bearing product, PTFE is utilized due to its low friction coefficient for reduced wear and operating energy	2	There are no substitute materials.	Not available.
	Lubricant	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	3403.19.5000	Lubricating preparations (including cutting-oil preparations, bolt or nut release preparations, antirust or anticorrosion preparations and mold release preparations, based on lubricants) and preparations of a kind used for the oil or grease treatment of textile materials, leather, furskins or other materials, but excluding preparations containing, as basic constituents, 70 percent or more by weight of petroleum oils or oils obtained from bituminous minerals: other	Lubricant is used on valves in oxygen service. Perfluoropolyether(PFPE) oils and greases thickened with PTFE have demonstrated high compatibility with oxygen, and they are suitable for liquid oxygen and gaseous oxygen services. As a lubricant, it is used to reduce friction.	2	There are no substitute materials.	Not available.
	Seals	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	3920.99.1000	Film, strip and sheets, all the foregoing which are flexible: Over 0.152 mm in thickness, and not in rolls	Unreinforced and reinforced PTFE and elastomers have great chemical and temperature resistance, and low friction coeffcient which can reduce wear and operating energy.	2	There are no substitute materials.	Not available.
	Seals	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	4016.93.5010	Other articles of vulcanized rubber other than hard rubber: other, O-rings	Unreinforced and reinforced PTFE and elastomers have great chemical and temperature resistance, and low friction coeffcient which can reduce wear and operating energy.	2	There are no substitute materials.	Not available.
	Seals	10004024 Valves/Fittings - Water and Gas 10008011 Valves/Fittings Accessories/Replacement Parts - Water and Gas	8481.90.9085	Hand operated and check appliances, other parts	Unreinforced and reinforced PTFE and elastomers are used to manufacture these seals as chemical and temperature resistance is needed, and they have low friction coeffcient which can reduce wear and operating energy.	2	There are no substitute materials.	Not available.

Applicable HTS US Group / GPC code	Component	GPC code if available	Applicable HTS US Code- (import)	HTS description	Role of PFAS	Essential Use Definition* (*Key presented below)	Available Alternative Technologies / results in functionally equivalent product?	Available Alternative Technologies / Reduce potential harm to human health or environment
	Wires and Cables		8544	Insulated (including enameled or anodized) wire, cable (including coaxial cable) and other insulated electric conductors, whether or not fitted with connectors; optical fiber cables, made up of individually sheathed fibers, whether or not assembled with electric conductors or fitted with connectors:	Fluoropolymers, mainly PTFE or reinforced PTFE, are utilized on these products for good chemical and temperature resistance.	2	The alternatives available does not usually fulfil the required thermal and chemical resistance or durability.	Not available.
	Printed / Multilayer Circuit boards		8534	Printed circuits	Spare parts need to be availabe to enable the operating system.	2	The alternatives available does not usually fulfil the required thermal and chemical resistance or durability.	Not available.
	Printed / Multilayer Circuit boards		8543.90.15	Printed circuit assemblies	Spare parts need to be availabe to enable the operating system.	2	The alternatives available does not usually fulfil the required thermal and chemical resistance or durability.	Not available.
	Capacitors		8532	Electrical capacitors, fixed, variable or adjustable (pre-set); parts thereof:		2		Not available.
	Polymer optical cables		8486	Machines and apparatus of a kind used solely or principally for the manufacture of semiconductor boules or wafers, semiconductor devices, electronic integrated circuits or flat panel displays; machines and apparatus specified in note 11(C) to this chapter; parts and accessories:	Fluoropolymers, mainly PTFE or reinforced PTFE, are utilized on these products for good chemical and temperature resistance.	2	No non-PFAS alternatives available.	Not available.
	Polymer optical cables		8544	Insulated (including enameled or anodized) wire, cable (including coaxial cable) and other insulated electric conductors, whether or not fitted with connectors; optical fiber cables, made up of individually sheathed fibers, whether or not assembled with electric conductors or fitted with connectors:	Fluoropolymers, mainly PTFE or reinforced PTFE, are utilized on these products for good chemical and temperature resistance.	2	No non-PFAS alternatives available.	Not available.

Applicable HTS US Group / GPC code	Component	GPC code if available	Applicable HTS US Code- (import)	HTS description	Role of PFAS	Essential Use Definition* (*Key presented below)	Available Alternative Technologies / results in functionally equivalent product?	Available Alternative Technologies / Reduce potential harm to human health or environment
	Semiconductors		8541	Semiconductor devices (for example, diodes, transistors, semiconductor-based transducers); photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light-emitting diodes (LED), whether or not assembled with other light-emitting diodes (LED); mounted piezo-electric crystals; parts thereof:	Spare parts need to be availabe to enable the operating system.	2	No technically feasible "drop-in" non-PFAS alternatives available.	Not available.
	Hoses		3917	Tubes, pipes and hoses and fittings therefor (for example, joints, elbows, flanges), of plastics:	FEP, PFA, PTFE, PVDF; Temperature resistance required.	2	Not available.	Not available.
	Connectors		8536	Electrical apparatus for switching or protecting electrical circuits, or for making connections to or in electrical circuits (for example, switches, relays, fuses, surge suppressors, plugs, sockets, lamp-holders and other connectors, junction boxes), for a voltage not exceeding 1,000 V; connectors for optical fibers, optical fiber bundles or cables:	PVDF	2	No non-PFAS alternatives available.	Not available.

*Key: Essential use definitions
1) significant increase in negative healthcare outcomes;
2) Significantly interrupt the daily functions on which society relies
3) An inability to mitigate significant risks to human health or the environment

#SPILL!

RECEIVED
By: OAH on 3/1/2024
Mark Chaffee Attachment

Taco Comfort Solutions
A Taco Family Company

March 1, 2024

To: Minnesota Pollution Control Agency
Via Electronic Submission - public eComments website

RE: Request for Comments: Planned new Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID number R-4837.

Taco, Inc. is an industry leading manufacturer of pumps, valves and controls based in Cranston, Rhode Island. Taco stands firmly behind efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. However, we express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. It's important to acknowledge that PFAS play a vital role in ensuring product functionality in critical applications in order to meet stringent safety standards. Our products are used extensively in critical applications to move water for heating, cooling, and domestic hot water distribution in commercial and residential applications.

In line with our commitment to finding balanced solutions, we have worked through our industry associations: Hydraulic Institute, Fluid Sealing Association, Valve Manufacturers Association, the Water and Wastewater Manufacturers Association (a.k.a. the Flow Control Coalition) which have developed a comprehensive Currently Unavoidable Uses (CUU) proposal, that is being submitted to the states of Maine and Minnesota. This proposal is founded upon expert knowledge of the design of critical processes, and incorporates valuable insights gathered from diverse stakeholders including design engineers, end-users and manufacturers of critical system components.

By engaging engineers and experts from the various segments of the fluid handling industry, the Associations have applied a collaborative, systems level approach to this complex issue. Highly corrosive materials, high temperatures, harsh environments, public health and comfort, accessibility and life-cycle considerations all are part of the design criteria of the industrial and other process systems which currently require PFAS as there are no viable alternatives to handle toxic substances, prevent hazardous leaks and fugitive emissions, ensure clean air and water, etc.

Taco actively participated in the consultation process and supports the Flow Control Coalition's submission. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS and ensuring that critical functions of industry and society continue while at the same time, mitigating adverse impacts on businesses, communities, and public health.

Sincerely,

Mark Chaffee
VP Governmental Affairs and Commercial & Industrial Product Management
Taco Comfort Solutions
1160 Cranston St | Cranston, RI 02920 | TacoComfort.com

XPSA
EXTRUDED POLYSTYRENE FOAM ASSOCIATION

RECEIVED
By: OAH on 3/1/2024
Andrew Brackbill Attachment

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March 01, 2024

XPSA Comments in Response to Minnesota Pollution Control Agency (MPCA) Request for Comment on PFAS in Products Currently Unavoidable Use Rule

XPSA is the trade association representing manufacturers of extruded polystyrene (XPS) foam insulation products. XPSA members collectively manufacture more than 95 percent of all XPS destined for use in the United States market. XPSA promotes the safe use of XPS foam insulation in commercial and residential construction. XPSA formally submits this request to the MPCA for a Continuing Unavoidable Use designation for XPS foam insulation, and any product where the only "PFAS", per the current definition, added are hydrofluoroolefins and hydrochlorofluoroolefins (HFOs/HCFOs).

XPS foam insulation is a high-efficiency foam plastic insulation product which offers unique performance characteristics that make it a valuable insulation product. XPS foam insulation has excellent compressive strength and moisture resistance characteristics, as well as a high R-value, which makes it ideally suited for certain kinds of insulation applications where there is no alternative capable of providing the same performance. XPS foam is used to insulate commercial and residential buildings, generating significant energy efficiency benefits. Its properties also make it uniquely suited for certain desirable engineering applications.

Some of the applications for which XPS foam insulation is uniquely suited include insulating below grade foundations, which allows for the use of frost-protected shallow foundations - a practical and more sustainable alternative to deeper, more-costly foundations in cold regions with seasonal ground freezing.[1] XPS foam insulation is also the preferred insulation specification choice for protected membrane insulation installations, which facilitate "blue" or "green" roof construction, allowing the efficient use of rooftop space for urban greening and to aid in stormwater collection.

In addition, state codes for energy efficiency often have prescriptions for continuous insulation in combination with cavity insulation – this is a baseline prescriptive path in the energy codes for northern climate zones. XPS foam insulation is an important product for continuous insulation applications and for reducing energy consumption, which is a recognized priority of most state building codes. Minnesota's own state energy codes specify a combination of R13 cavity insulation with R5 continuous insulation for climate zone 6 (Southern Minnesota) as one of two prescriptive options.[2]

In recent years, XPSA members have moved away from high-GWP blowing agent formulations to low-GWP blowing agents. This transition took many years and presented a challenging engineering problem. All XPSA members now use blowing agent blends with a 100-yr GWP below 150. This transition to low-GWP blowing agents puts XPSA members in compliance with the recent EPA AIM Act Technology Transition rule, which has established a 100-yr GWP limit of 150 as of 1/1/2025 for 'Polystyrene – extruded boardstock and billet' products.[3]

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[1] Demystifying Rigid, Cellular Polystyrene Insulations Brooks R, Coppock T, Fischer M, Dillon M, Guo M, Woodcraft V. https://xpsa.com/wp-content/uploads/2024/02/Demystifying-Polystyrene-Insulations-IP-BG-04.pdf

[2] Minnesota 2020 State Energy Code Residential Provisions – Table R402.1.1 Insulation and Fenestration Requirements by Component

[3] https://www.federalregister.gov/d/2023-22529/p-973

In order to comply with these GWP limits, XPSA members transitioned from the use of hydrofluorocarbons into the use of hydrofluoroolefins and hydrochlorofluoroolefins (HFOs/HCFOs), which are the only replacement technology to work in manufacturing XPS foam insulation and ensure XPS foam insulation product performance. The use of HFO/HCFOs will be an ongoing need for the XPSA members. Unfortunately, because the definition of PFAS in Minnesota Statute 116.943 is overbroad, HFOs and HCFOs would fall under the statutory definition of PFAS, which would eventually remove XPS products from the marketplace in Minnesota.

In response to question 6 of the Request for Comment, XPSA suggests that MPCA should certainly *not* allow stakeholders to request a PFAS use not be determined to be currently unavoidable. Under the statute, the burden of proof is already on industry and manufacturers to prove that their existing products are net beneficial to society. In other words – the law already bans all PFAS that cannot be demonstrated to have unavoidable uses. Opening the record to suggestions from stakeholders that certain uses should not be considered unavoidable (which is already the presumption of the existing legal language) will only increase the workload for MPCA.

In response to questions 7 and 8 of the Request for Comment, XPSA suggests that the MPCA immediately exempt from the requirements of the statute any product where the only "PFAS" added are HFOs/HCFOs. These chemicals are not classified as biopersistent, bio-accumulative or toxic.[4] Any product which uses these chemicals is likely to generate a request for a CUU in future. MPCA could reduce the volume of eventual filings for products manufactured with HFOs and HFCOs by making an initial currently unavoidable use determination for any product made with these chemicals.

XPSA takes issue with the definition of PFAS in the statue – it is an overly broad definition which will impose a blanket ban on thousands of chemicals which are industrially useful and not substantially harmful to human health or society. An example of a responsible definition of "PFAS" is found in the US EPA reporting rule published October 11, 2023, which does not include HFOs or HCFOs. In fact, there are approximately 23,000 additional substances besides HFOs whose only fluorine atom is in a terminal -CF_3 and that do not share a fluorinated substructure that is likely to result in their persistence in the environment, nor degrade to a substance that shares toxicological or physiochemical properties with the PFAS of real concern, like PFOA, PFOS, or GenX.[5] In addition, the US EPA has also deemed HFO/HCFO blowing agents "acceptable" as a replacement for HFC blowing agents under the Significant New Alternatives Policy (SNAP) program. EPA determined that HFO foam blowing agents "reduce overall risk to human health and the environment compared to other substitutes for the particular end-use."[6] The MPCA therefore should take the very broad definitions of the statute into account when issuing CUUs, to alleviate the substantial burden that this law will impose on the citizens of Minnesota. CUUs should be readily issued to products (like XPS foam insulation) which rarely come into contact with human beings in situ, are made with chemicals of little toxicological concern, and cannot easily be replaced by alternative products available in the market today.

XPS foam insulation manufacturers - and the vendors who supply raw materials to the industry - spent more than a decade researching and developing HFO and HCFO blowing agent blends to replace HFC

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[4] Sources, fates, toxicity, and risks of trifluoroacetic acid and its salts: Relevance to substances regulated under the Montreal and Kyoto protocols. Solomon K, Velders G, Wilson S, Madronich S, Longstreth J, Aucamp P, Bornman J. *Journal of Toxicology and Environmental Health B*, June 2016.

[5] Federal Register :: Toxic Substances Control Act Reporting and Recordkeeping Requirements for Perfluoroalkyl and Polyfluoroalkyl Substances

[6] Final Rule, Protection of Stratospheric Ozone: Listing of Substitutes Under the Significant New Alternatives Policy Program in Refrigeration, Air Conditioning, and Fire Suppression, 88 Fed. Reg. 26382, 26414 (Apr. 28, 2023).

blowing agents. There are no alternatives available, at present, to the HFO/HCFO blends now in use in XPS foam insulation. It is also unlikely that any blend could be found which would provide the needed insulation properties and not also fall under the overly broad definition of "PFAS" in Minnesota Statute 116.943.

XPS foam insulation is a unique building product with valuable properties, which has contributed significantly to the push for energy efficiency and sustainable construction across the United States. XPS foam insulation should be evaluated in light of the overall effects it has on energy use, the environment, and the long-term public health and environmental implications of reduced CO_2 emissions, which are a net positive.[7] For the reasons contained in this letter, we respectfully urge the Minnesota Pollution Control Agency to provide a Currently Unavoidable Use designation for the blowing agents used in XPS foam insulation, allowing it to remain in the marketplace to keep Minnesotans warm and safe.

Best,

Michael Fischer
Executive Director
Extruded Polystyrene Foam Association (XPSA)
529 14th Street NW, Suite 1280
Washington, DC 20045

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[7] Life Cycle Greenhouse Gas Emissions Reduction From Rigid Thermal Insulation Use in Buildings M.H. Mazor, J.D. Mutton, D.A.M. Russell, G.A. Keoleian, J. *Ind. Ecology*, 15, 2, pp 284–299, April 2011.

Rosanna Imholte Attachment RECEIVED
By: OAH on 3/1/2024

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March 1, 2024

Submitted via Minnesota Office of Administrative Hearings eComments Website

Ms. Katrina Kessler
Commissioner
Minnesota Pollution Control Agency
520 Lafayette Road N
St. Paul, MN 55155-4194

Re: MPCA Request for Comments regarding *Currently Unavoidable Use Determinations in Products Containing Per-and polyfluoroalkyl (PFAS),* Revisor ID No. R-4837

Dear Ms. Kessler,

Polar Semiconductor (Polar) offers the following comments on the PFAS regulations being developed by the Minnesota Pollution Control Agency (MPCA) as authorized in Chapter 60 of H.F. 2310. The MPCA has requested comments on planned new rules for the *Currently Unavoidable Use Determinations in Products Containing PFAS* (Revisor ID No. R-4837).

Polar wholeheartedly supports the goal of limiting the release of harmful PFAS substances into the environment. Polar is concerned, however, about the incompatibility of PFAS regulations with the State's goal to expand its semiconductor industry. In these comments, Polar offers recommendations on how the rules should be drafted to protect the environment while simultaneously allowing semiconductor manufacturing to thrive in the State. Polar also reiterates its support for the comments submitted by the semiconductor industry association SEMI in response to the MPCA's request for comments.

POLAR AS AN ECONOMIC DRIVER AND ENVIRONMENTAL STEWARD

Polar is a Minnesota-based company that produces integrated circuits and discrete semiconductor devices on 8-inch wafers at its fabrication facility in Bloomington. Polar's processes start with a bare silicon substrate and end with a finished wafer containing functional devices. Polar is the largest semiconductor chip manufacturing facility in Minnesota. Semiconductors are a necessary part of all electronic devices, controlling and managing the flow of electric current and enabling advances in communications, computers, transportation, military systems, and clean energy. Polar supplies products to a diverse group of end market users, with approximately 60% of its manufactured wafers dedicated to the automotive sector. The remaining share of Polar's wafers cater to industrial, commercial, and defense customers. Demand for semiconductors is projected to increase with the electrification of nearly every part of the economy and society.

Polar is in the midst of an exciting transformation. With help from the Minnesota Investment Fund, Job Creation Fund, Minnesota Forward Fund and potentially, federal CHIPS Act funding, Polar plans to expand within its current footprint and increase manufacturing capacity by 85%. This expansion will create 74 construction jobs and 98 new full time Minnesota-based jobs at Polar's Bloomington facility.

Polar prioritizes sustainability at its facility and is committed to reducing or mitigating its environmental impact. It maintains an ISO 14001 certified Environmental Management System (EMS) and has established environmental improvements goals related to hazardous waste reductions, water conservation, and greenhouse gas emission reductions. For example, Polar recently transitioned operations to be powered 100% by renewable energy through purchased Renewable Energy Certificates.[1]

CRITICAL ROLE OF PFAS IN SEMICONDUCTOR MANUFACTURING

PFAS-containing materials are essential components of semiconductor manufacturing. While completed semiconductor devices do not contain intentionally added PFAS, liquid chemicals and fluorinated gases, which either are PFAS themselves or contain intentionally added PFAS, are necessary inputs in the manufacturing process. For example, fluorocarbon gases, the molecular structure of which meets the statutory definition of PFAS, are used in plasma etch processes, fluorinated chemicals are used in photolithography, and fluorinated chemicals are used as refrigerants and heat transfer fluids. The carbon-fluorine chemistry of these PFAS-containing materials alters surface tension, thermal stability, and chemical compatibility in ways essential to the semiconductor manufacturing process. Despite years of extensive research, there have been no viable PFAS-free alternatives identified. In short, the semiconductor manufacturing process is enormously dependent on PFAS, for which there are currently no viable alternatives.[2] Because PFAS-containing products are critical for semiconductor manufacturing, the 2032 ban on all products containing intentionally added PFAS would hamstring the ability of all semiconductor manufacturers in Minnesota, including Polar, to manufacture their products.

Polar recognizes that PFAS can have impacts to human health and the environment, and is committed to finding alternatives to PFAS-containing materials. In the meantime, Polar is actively investigating various technologies including ion exchange to mitigate potential PFAS in discharged treated wastewater. However, during the period of transition, Polar believes the State should balance its dual commitments to environmental protection and creating a thriving semiconductor manufacturing ecosystem in Minnesota by making an exemption for semiconductor manufacturing inputs with intentionally added PFAS as a currently unavoidable use.

COMMENTS ON *CURRENTLY UNAVOIDABLE USE DETERMINATIONS*

1) **Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?**

    Polar supports SEMI's proposed language regarding criteria that places responsibility on manufacturers or trade groups to assess and provide documentation that its products are essential for health, safety or functioning of society **and** that PFAS substitutes are not available.

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[1] Xcel Energy Renewable*Connect

[2] Semiconductor Industry Association (SIA) Background on Semiconductor Manufacturing and PFAS (May 17, 2023).

The commissioner shall grant a currently unavoidable use determination for PFAS applications or end products, and for the supply chain production activities required to produce such PFAS applications or end products, when the commissioner has evidence, or when a manufacturer, organization, or other entity has submitted evidence, that an application, product or category of products provides benefits relating to health, safety, or the functioning of society and that there are no reasonably available alternative substances or technologies for that use. A product shall be deemed to provide benefits to the functioning of society where the manufacturer has submitted evidence that the product fulfills identified consumer, commercial, or industrial demands for the product in Minnesota.

2) Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?

In evaluating "reasonably available" potential PFAS alternatives, the MPCA should consider both commercial availability and performance equivalence.

An August 2023 U.S. Department of Defense report discussed the current unavailability of PFAS alternatives - with the necessary functional performance properties - for the semiconductor industry, and the time required to bring alternatives to market. (*Report on Critical Per- and Polyfluoroalkyl Substance Uses*[3]):

Currently, no alternatives to PFAS have been identified that can provide the functional properties required for photolithography or some applications in semiconductor manufacturing equipment. Even if alternative chemicals and technologies were discovered today, due to the extremely complex qualification process throughout the value chain, it would take another 15 years to deploy them in high-volume manufacturing. Therefore, continued access to PFAS is a prerequisite for high-volume and advanced semiconductors. Lack of continued access to PFAS could lead to an inability to produce and supply semiconductor manufacturing technology.[3]

While Polar is committed to finding alternatives, it is unlikely that any will be reasonably available in the next decade. Even if alternatives are found, it is unlikely that they will be commercially available to manufacturers for an additional period, or they may be available only at a high cost. Polar, like all manufacturers, must also spend time confirming that the alternative is an acceptable replacement.

In developing regulations, MPCA should allow semiconductor manufacturers to continue use of PFAS-containing inputs to produce semiconductor chips until there is a commercially available alternative that allows the same standards of production and is widely available on the market at a competitive price point. These standards for "reasonable availability" will allow a transition to non-PFAS containing products while growing a domestic semiconductor manufacturing industry competitive with international foundries.

[3] https://www.acq.osd.mil/eie/eer/ecc/pfas/docs/reports/Report-on-Critical-PFAS-Substance-Uses.pdf

3) **Should unique considerations be made for small businesses with regards to economic feasibility?**

Polar does not have comments on this issue at this time.

4) **What criteria should be used to determine the safety of potential PFAS alternatives?**

Polar does not have comments on this issue at this time.

5) **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?**

Polar supports SEMI's proposed language regarding length of currently unavoidable use determinations:

CUU determinations should be indefinite, because this is needed to give manufacturers the necessary repose to rely on the originally issued determination, and Section 116.943 does not authorize a time-limited scheme. Indefinite determinations reflect how, especially for the semiconductor industry, the identification of PFAS, search for potential alternatives, testing of potential alternatives, and implementation of appropriate alternatives takes many years. Therefore, members of our industry need to be able to rely on a CUU determination for long enough for these steps to occur, and this time cannot be reliably estimated at the onset of the determination.

6) **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?**

The MPCA should encourage groups of manufacturers or trade groups to submit currently unavoidable use determination requests to prevent duplication and reduce the MPCA's reviewing burden, but also allow individual manufacturers to submit requests as needed. MPCA should provide an electronic format for requests and solicit detailed information such as PFAS type and use applications.

7) **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.**

If companies are required to seek individualized currently unavoidable use determinations, Polar would submit a currently unavoidable use determination request for products used in its manufacturing and support processes including, but not limited to, fluorocarbon gases and fluorinated liquid chemicals used in photolithography and etch processes, fluorinated chemicals used as refrigerants and heat transfer fluids, and fluoropolymers and other PFAS used in production of high-purity water. If required, Polar would submit detailed documentation showing the necessity of each product for its semiconductor manufacturing.

8) Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

Polar requests that the MPCA begin the 'currently unavoidable use' designations now as a part of this rulemaking. One of these initial designations should be for inputs and materials used in semiconductor manufacturing and associated support processes as currently unavoidable uses.

CONCLUSION

Polar is proud to be the largest semiconductor chip manufacturing facility in Minnesota. Without carefully crafted regulations or a currently unavoidable use exemption for semiconductor manufacturing products, the PFAS prohibition will have a profound impact on Polar's short-term expansion, Polar's long-term viability, and the semiconductor manufacturing industry in the State.

Thank you for the opportunity to provide comments to the MPCA on currently unavoidable use determinations. Polar welcomes further discussion with the MPCA on the role of PFAS in semiconductor manufacturing and mitigation measures underway.

Sincerely,

Surya Iyer
President and Chief Operating Officer
Polar Semiconductor LLC

Rosanna Imholte
Facilities Manager - EHS
Polar Semiconductor LLC

 RECEIVED
By: OAH on 3/1/2024

March 1, 2024

Commissioner
Katrina Kessler
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, Minnesota, 55155-4194

Via https://minnesotaoah.granicusideas.com/

RE: Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS) and Lead in keys

Dear Commissioner. Kessler:

The powersports industry which includes several hundred companies represented by the Motorcycle Industry Council (MIC)[1], the Specialty Vehicle Institute of America (SVIA)[2], and the Recreational Off-Highway Vehicle Association (ROHVA)[3] write to request "essential for health, safety, or the functioning of society" and currently unavoidable use (CUU) determination for motorcycles, all-terrain vehicles (ATVs) and recreational off-highway vehicles (ROVs which are also commonly referred to as side-by-sides or UTVs). We also ask for relief from the ban on lead and cadmium in keys and keychains.

Existing law would prohibit any product containing per- and polyfluoroalkyl substances (PFAS) being sold in Minnesota after January 1, 2032, unless the Minnesota Pollution Control Agency (MPCA) determines that it is essential for health, safety, or the functioning of society, or is a currently unavoidable use.

The state is asking:

1) **Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?**
2) **Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?**

[1] The Motorcycle Industry Council (MIC) is a not-for-profit, national trade association representing several hundred manufacturers, distributors, dealers and retailers of motorcycles, scooters, motorcycle parts, accessories and related goods, and allied trades.

[2] The Specialty Vehicle Institute of America (SVIA) is the national not-for-profit trade association representing manufacturers, dealers, and distributors of all-terrain vehicles (ATVs) in the United States. SVIA's primary goal is to promote safe and responsible use of ATVs.

[3] The Recreational Off-Highway Vehicle Association (ROHVA) is a national, not-for-profit trade association formed to promote the safe and responsible use of recreational off-highway vehicles (ROVs – sometimes referred to as side-by-sides or UTVs) manufactured or distributed in North America. ROHVA is also accredited by the American National Standards Institute (ANSI) to serve as the Standards Developing Organization for ROVs. More information on the standard can be found at https://rohva.org/ansi-standard/.

The MPCA should absolutely consider criteria be defined for "essential for health, safety, or the functioning of society" and those criteria should include essential vehicle needs used for transportation, law enforcement, first responders, search and rescue, and recreation. Many of these vehicles have parts and components that require PFAS that are currently unavoidable uses (CUU).

The powersports industry is a nearly $48 billion economic driver in the United States with $1.4 billion of that being in Minnesota where our vehicles are designed, researched, and built. Motorcycles, ATVs and ROVs are complex vehicles which are required to comply with many state and federal regulations from the Federal Motor Vehicle Safety Standards (FMVSS) at the National Highway Traffic Safety Administration (NHTSA), the Consumer Product Safety Commission (CPSC), the Environmental Protection Agency (EPA) and more. Numerous parts and components in our powersports vehicles contain PFAS to withstand extreme heat and chemical blends in fuel and other fluids, and for water resistance, corrosion resistance, and friction properties. Likewise, PFAS are used in electrical insulation to provide flexibility and durability which maintains safe operating conditions. For example, fuel hoses must withstand a myriad of fuel blends while maintaining flexibility and structural integrity to prevent cracking or catastrophic leaks. Gaskets used throughout the vehicles must stand up to high heat and various fluids to keep vehicles functioning properly while simultaneously ensuring fluids and fuel vapors do not exit the vehicle causing clean air violations, environmental contamination, and risk of vehicle fires. Proper gaskets must be used to ensure compliance with clean air mandates by EPA and states.

Without an essential for health, safety, or the functioning of society designation and a CUU exclusion for these vehicles and parts, the state risks an exit from the market of motorcycles, ATVs, and ROV which are used by Minnesotans for commuting, recreation, agriculture, law enforcement, parks and forest officials, fire, rescue, and the military. The state would also lose access to replacement parts for thousands of powersports vehicles leaving law enforcement, first responders, and state agencies that utilize the vehicles without critical tools to accomplish their jobs that are vital to security and functioning of society.

We have also attached a considerable list of Global Product and Harmonized Tariff Codes for vehicles, parts and components which we request CUU designation.

During the global COVID-19 pandemic the U.S. Department of Homeland Security recognized a critical need for powersports to continue functioning and granted our manufacturers suppliers and dealers Essential Service destination under their national CISA Guidance. Below are examples of powersports vehicles used by first responders and government entities:



When it comes to the questions of "Should costs of PFAS alternatives be considered in the definition of "reasonably available," we absolutely believe that cost of alternatives should be considered not only on an economic basis, but also on a risk to life and the environment. As noted earlier, there are currently not alternatives available for many of our products, but if/when alternatives are discovered they need to be economically feasible. As was also noted, PFAS is necessary to protect human life and the environment by preventing the leaking of chemicals and fuels that could ignite or contaminate surroundings.

Request for Safe Harbor Provisions for Products Currently in the Market

In addition to granting our vehicles and parts "essential for health, safety, or the functioning of society" and CUU designations, there needs to be recognition and allowance for vehicles and replacement parts that are already in inventory across Minnesota awaiting sale. Manufacturers, dealers, service stations, and parts distributors likely have multiple years of replacement parts and other products already in distribution channels and in inventory at retailers. A failure to allow safe harbor language for these products would mean that every dealership, repair shop, aftermarket distributor, and retailer would need to return or dispose of all inventories that arrived prior to implementation of this new law. That is simply not feasible and could cause scores of small businesses to shutter their doors and walk away from their livelihood.

A provision banning lead and cadmium in keys and keychains was also tucked into the large PFAS bill (HF 2310 became [Minn. Stat. § 325E.3892](https://www.revisor.mn.gov/statutes/cite/325E.3892)) and there was no grace period for transitioning away from the chemicals. Our manufacturers and dealers have significant concerns about this provision and we've reached out to MPCA to voice the concerns. Staff there suggested we include our concerns in these comments and indicated that they will be releasing a "Q&A" document soon.

We are specifically concerned with Sec. 24, which states that keys, key chains, and key rings are products that a "person must not import, manufacture, sell, hold for sale, or distribute or offer for use in this state any covered product containing: (1) lead at more than 0.009 percent by total weight (90 parts per million); or (2) cadmium at more than 0.0075 percent by total weight (75 parts per million)."[4] There was no rule making, safe harbor provision, or phase-in period for these products and our we are seeking relief from the new law.

Lead is present in keys of all types and fashion, including typical blade-style keys as well as key fobs that may contain a blade or just solder for circuitry. Because nearly every key and key fob required to operate cars, motorcycles, snowmobiles, OHVs, boats, outdoor power equipment and other craft contain lead or cadmium, this provision affects thousands of products and countless businesses across MN. Due to this provision of HF 2310 passing with an immediate effective date, it has given manufacturers no time to adequately research and explore alternatives to comply with requirements. Minnesota must allow manufacturers sufficient time to find possible replacements.

We request that Minnesota provide temporary relief from the new law while exploring a more workable standard for the chemicals in keys. For example, the proposed end-of-life vehicles directive (ELV Directive) being considered by the European Union (EU) would allow for products containing lead to be no more than 0.1% by weight, and cadmium to be no more than 0.01% by weight[5]. This is a more feasible solution that allows for manufacturers to be certain they can comply with state law requirements.

We take compliance very seriously and the current law which has an extremely low threshold and allowed no time to transition away from existing keys, keychains, and key fobs, is one that put virtually everyone selling products with keys in Minnesota immediately out of compliance. That was not likely the intent of the provision which was tucked into a massive bill. The intent is likely to reduce the amount of lead in those products to a level that still allows for proper functioning of keys while also minimizing the amount of lead and cadmium in the products.

[4] https://www.revisor.mn.gov/statutes/cite/325E.3892
[5] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2023:451:FIN

We sympathize with the MPCA's herculean task of drafting regulations for [Minn. Stat. § 325E.3892] and stress that the issues we've addressed above are of paramount concern. The regulations you write today could have a major impact on manufacturing and sales in the state of vehicles that are essential to society, and on the economy of Minnesota as a whole. Thank you for your consideration and we stand ready to answer any questions and to work with you on additional sensible and targeted relief for the powersports industry from this overly broad PFAS and lead law.

Sincerely,

Scott P. Schloegel
Senior Vice President Government Relations
Motorcycle Industry Council (MIC)
Specialty Vehicle Institute of America (SVIA)
Recreational Off-Highway Vehicle Association (ROHVA)

MIC/SVIA/ROHVA Powersports Industry Currently Unavoidable Use (CUU) Designation Requests 2024

In addition to designation of our vehicles as CUU, we need CUU designation for replacement parts used to service our vehicles. Please see the list below.

GPC Codes	HTS Codes	Item Description	PFAS Function
10003031	8714.10.0050	Headlights (Automotive)	
10003038	8714.10.0050	Driving Lights	
10003084	8714.10.0050	Electrical Other (Automotive)	
10003166	8714.10.0050	Rings/Grommets	
10003168	8714.10.0050	Springs	
10003170	8714.10.0050	Bearings/Bushings	
10003173	8714.10.0050	Tubing	
10003254	8714.10.0050	Hoses	
10005232	8714.10.0050	Batteries (Automotive)	
10005256	8714.10.0050	Fuel Pumps (Non-Powered)	
10005258	8714.10.0050	Gas Fuel Bottles/Canisters (Empty)	
10005412	8714.10.0050	Light/Motion/Sound Sensors	
10001472	8714.10.0050	Switchboxes	
	8714.10.0050	Valve stem seal	high temperature durability
	8714.10.0050	Piston	low friction property
	8714.10.0050	Cam chain tensioner	low friction property
	8714.10.0050	Gasket	high temperature durability, avoid sticking
	8714.10.0050	Cam chain tensioner lifter	low friction property
	8714.10.0050	Connected rod bearing	high temperature durability
	8714.10.0050	Water pump shaft bearing	high temperature durability
	8714.10.0050	Oil seal	high temperature durability
	8714.10.0050	Head cover gasket	high temperature durability
	8714.10.0050	Reed valve comp	high temperature durability
	8703.93.60	OUTER, CLUTCH	low friction property

	8703.93.60	CENTER, CLUTCH	low friction property
	8703.93.60	PLATE, CLUTCH PRESSURE	low friction property
	8708.40.1110	GEAR, M-2 18T	low friction property
	8708.40.1110	WASHER, SPECIAL	low friction property
	8703.93.60	PLATE, CLUTCH LIFTER CAM	low friction property
	8708.40.1110	SHAFT A, SHIFT FORK	low friction property
	8708.40.1110	OIL SEAL, COUNTER SHAFT	high temperature durability
	8714.92.5000	NIPPLE, SPOKE	low friction property
	8714.94.9000	PIPE COMP, BRK	corrosion resistance (Brake Fluid resistance)
	8714.94.9000	CALIPER, ASSY L FR	low friction property
	8714.94.9000	CALIPER, ASSY L FR	low friction property
	8708.99.8105	HOSE COMP B, FR BRK	Fuel resistance
	8714.91.2000	FORK ASSY, R FRONT	low friction property
	8714.91.2000	FORK ASSY, R FRONT	low friction property
	8714.91.2000	TUBE, OUTER	low friction property
	8714.91.2000	BUSH, GUIDE	low friction property
	8708.80.65	CUSHION ASSY, REAR	low friction property
	8708.80.65	DAMPER COMP, REAR	low friction property
	8714.10.0050	STATOR COMP AC Gen. (Heat-resistant wire)	high temperature durability
	8714.10.0050	STATOR COMP AC Gen. (Heat-resistant wire)	high temperature durability
	8714.10.0050	STATOR COMP AC Gen. (Heat-resistant wire)	high temperature durability
	8714.10.0050	SUB CORD, ENG (Heat-resistant wire)	high temperature durability
	8714.10.0050	WINKER Assy FR (Ventilation filter)	water repellency
	8714.10.0050	LIGHT Assy LICENSE (Ventilation filter)	water repellency
	8714.10.0050	SW Assy START STOP (Rotating sliding part)	low friction property
	8714.10.0050	SW Assy START WINKER (Electrical terminals)	Electrical contact stability
	8714.10.0050	SENSOR AIR FUELRATIO R (Sealing rubber)	high temperature durability
	8714.10.0050	SENSOR Assy OXYGEN (Sealing rubber)	high temperature durability
	8714.10.0050	VLV Assy EX-AI	high temperature durability

	8714.10.0050	SOL VLV PURGE CONT. (O-ring)	Fuel resistance
	8708.70.60	SENSOR, WHEEL SPEED.RR (Heat-resistant wire)	high temperature durability
	8708.99.5500	RUBBER PROTECTOR MOUNT	high temperature durability
	8708.99.5500	RUBBER PROTECTOR MOUNT	high temperature durability
	8714.10.0050	Injector O ring	Fuel resistance, high temperature durability
	8714.10.0050	Injector O ring (High pressure)	Fuel resistance, high temperature durability
	8714.10.0050	PACKING, FUEL PUMP	Fuel resistance, EVAPO EM
	8714.10.0050	High pressure plastic hose	Fuel resistance, EVAPO EM
	8714.10.0050	High pressure rubber hose	Fuel resistance, EVAPO EM
	8714.10.0050	Fuel rubber tube	Fuel resistance, EVAPO EM
	8714.10.0050	O-RING, INLET PIPE	Fuel resistance, high temperature durability
	8703.21.0150	ATV/UTV </= 1,000 cc	
	8703.21.0110	ATV/UTV </= 1,000 cc	
	8703.80.0020	ATV/UTV Electric Propulsion	
	8703.31.0100	ATV/UTV Diesel </=1,500 cc	
	8711	Motorcycles (including mopeds) and cycles fitted with an auxiliary motor, with or without side-cars; side-cars	
	8711.10.00	Motorcycle </= 50 cc	
	8711.20.00	Motorcycle > 50 cc and </= 250 cc	
	8711.30.00	Motorcycle > 250 cc and </= 500 cc	
	8711.40.00	Motorcycle > 500 cc and </= 800 cc	
	8711.50.00	Motorcycle > 800 cc	
	8711.50.0060	Motorcycle > 800 cc	

	8711.60.00	Motorcycle Electric Propulsion	
	8711.60.0050	Motorcycle Electric Propulsion	
	8711.60.0090	Motorcycle Electric Propulsion	
	8703.22.0110	ATV/UTV 1,000 cc - 1,500 cc	
	8703.21.0130	ATV/UTV </= 1,000 cc	
	8703.10.5060	ATV/UTV Other	
	8703.23.0140	ATV/UTV 1,500 cc - 3,000 cc	
	8703.32.0110	ATV/UTV Diesel 1,500 cc - 2,500 cc	
	8703.10.1000	Vehicle designed for traveling on snow	
	8708.99.8180	Other vehicle parts	
	9903.88.67	Other vehicle parts product of China	

RECEIVED
By: OAH on 3/1/2024

March 1, 2024

Katrina Kessler, Commissioner
Minnesota Pollution Control Agency
520 Lafayette Rd. N.
St. Paul, MN 55155-4194

Via eComment at https://minnesotaoah.granicusideas.com/

Re: Minnesota's Planned New Rules Governing Currently Unavoidable Use Determinations About Products Containing Per- and Polyfluoroalkyl Substances ("PFAS"), Revisor's ID No. R-4837

Dear Commissioner Kessler:

PRBA – The Rechargeable Battery Association ("PRBA") appreciates the opportunity to respond to the Minnesota Pollution Control Agency's ("MPCA") request for comments regarding the planned new rules for currently unavoidable use determinations (CUU). As part of our responses to MPCA's request for comments, PRBA requests a CUU determination for rechargeable and non-rechargeable batteries.

PRBA is a non-profit trade association representing manufacturers of batteries and the products powered by them. Our members manufacture approximately 55% of the lithium-ion battery cells produced in the world today. Our membership also includes battery assemblers, battery recyclers, retailers, airlines, and leading manufacturers of mobile telephones, tablet and laptop computers, point-of-sale terminals, hand-held scanners, power tools, flashlights, outdoor power equipment, medical devices, electric vehicles, military defense products. We were established in 1991, when the portable consumer product revolution had just begun.

Unless a CUU exemption is granted, the state's 2032 ban will put an end to the sale or distribution of rechargeable and non-rechargeable batteries in Minnesota. The CUU exemption provision is part of Minnesota's law precisely to allow MCPA to anticipate and avoid the significant disruption to safety, health, and the functioning of society that would result. PRBA is pleased to provide responses to MPCA's questions listed in the request for comments. Our responses reference PRBA's request for a CUU exemption submitted to Maine,[1] which was prepared with the need to be responsive to MCPA's questions, in mind (Attachment 1).

1. **Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?**

In Section 2 of Attachment 1, PRBA explains in detail the criteria by which rechargeable and non-rechargeable batteries are essential to the safety and functioning of critical domestic

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[1] Maine Department of Environmental Protection, *PFAS in Products: Currently Unavoidable Uses* (Last visited February 29, 2024).

infrastructures such as transportation, communications, construction, and for transitioning to a clean energy-based economy. They are used in automobiles, phones, computers, security systems, safety lighting, life-saving medical devices, military equipment. Rechargeable and non-rechargeable batteries meet the definition of "essential" at every industrial, institutional, and consumer level product. Merriam Webster defines the term essential as "something necessary, indispensable, or unavoidable."[2] Given the diversity of products impacted by this law, we request that MPCA allow industry the ability to make their own case for how their products are essential with the common meaning of the term essential as a guidepost.

2. **Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?**

PRBA submits that MPCA should consider all associated costs that companies incur over the time it takes to implement alternatives across the complex supply chains for batteries and the products in which they are used. In Section 4 of Attachment 1, PRBA describes the state of alternatives for PFAS in rechargeable and non-rechargeable batteries and the length of time that will be needed to explore and adopt other options.

3. **Should unique considerations be made for small businesses with regards to economic feasibility?**

PRBA supports having MPCA take into consideration the important concerns of small businesses in administering the CUU exemption.

4. **What criteria should be used to determine the safety of potential PFAS alternatives?**

In determining the safety of potential PFAS alternatives, PRBA supports a risk-based approach, as described in Section 3 of Attachment 1.

5. **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?**

PRBA supports CUU determinations that are not time limited. As described in Section 4 of Attachment 1, to identify alternatives for PFAS in rechargeable and non-rechargeable batteries will take many years. The myriad of products that batteries power do not align with a single transition period. Projected timeframes for research and development often have to be adjusted to reflect changing circumstances. MPCA should not expend additional resources meeting with industry, reviewing requests for extensions, or engaging in additional rulemakings for this purpose.

6. **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?**

PRBA supports exemptions for broad product categories. PRBA would like MPCA to focus its resources on making CUU determinations, and avoid the additional time and resources

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[2] "Essential", Merriam-Webster.com (2024). **Error! Hyperlink reference not valid.**

associated with responding to requests for other kinds of determinations. It is not clear these other determinations are permitted by the law. Product manufacturers are in the best position to know their products, whether alternative ingredients are feasible, and the time and resources associated with transitioning ingredients. We think the information in Attachment 1 meets the needs for such requests.

7. **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.**

PRBA respectfully requests that MPCA grant an exemption for the product category of rechargeable batteries and non-rechargeable batteries. PRBA believes that these products fulfill all the requirements for a CUU determination, as explained in Attachment 1.

8. **Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?**

PRBA supports having MPCA make initial CUU determinations that are not time limited as part of this initial rulemaking. We request that rechargeable and non-rechargeable batteries be one of the categories included in the rulemaking. PRBA believes that due to the essential nature of rechargeable and non-rechargeable batteries, the lack of available alternatives prior to the 2032 ban, and growing uncertainty around the negative socio-economic consequences of a ban, CUU determinations should be made as soon as possible.

9. **Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.**

PRBA believes that a CUU exemption should apply to the ban as well as the reporting requirement, set to become effective in Minnesota as of January 1, 2026.

* * *

PRBA would welcome an opportunity to discuss these comments with you and answer any questions. PRBA respectfully requests that MPCA grant our request to provide a currently unavoidable use exemption in proposed and final regulations for rechargeable and non-rechargeable batteries. For further information about these comments, please do not hesitate to contact George Kerchner, PRBA Executive Director, who can be reached at (202) 719-4109 or gkerchner@wiley.law.

Respectfully submitted,

George Kerchner, Executive Director

PRBA - The Rechargeable Battery Association

Attachment 1

March 1, 2024

Melanie Loyzim, Commissioner
Maine Department of Environmental Protection
17 State House Station
Augusta, Maine 04333-0017
PFASProducts@maine.gov

Re: Request to Maine for a Currently Unavoidable Use ("CUU") Exemption for the Product Category of High Performance, Advanced Rechargeable and Non-rechargeable Batteries

Dear Commissioner Loyzim:

PRBA – The Rechargeable Battery Association ("PRBA") appreciates the opportunity to submit to the Maine Department of Environmental Protection's ("MDEP") a request to exempt the product category of high performance, advanced rechargeable batteries and non-rechargeable (primary) batteries as a currently unavoidable use pursuant to 38 M.R.S. §1614.

PRBA is a non-profit trade association representing manufacturers of rechargeable and non-rechargeable batteries and the products powered by them. Our members manufacture approximately 55% of the rechargeable lithium-ion battery cells produced in the world today. Our membership also includes battery assemblers, battery recyclers, retailers, airlines, and leading manufacturers of mobile telephones, tablet and laptop computers, point-of-sale terminals, hand-held scanners, power tools, flashlights, outdoor power equipment, medical devices, hybrid and electric vehicles, and military defense products. We were established in 1991, when the portable consumer product revolution had just begun.

A 2030 ban on the use of rechargeable and non-rechargeable batteries would significantly disrupt the health, safety and functioning of society in Maine, and raises concerns with respect to national security and the stability of our domestic infrastructure. There are no safe or feasible alternatives for their per- and polyfluoroalkyl substances ("PFAS") components that could be made available by this deadline. The following information explains how the exemption criteria specified by MDEP are met in this case.

1. **Type Of Product Including Global Product Classification ("GPC") Brick Category and Code, or If Not Applicable, The Harmonized Tariff System ("HTS") Code.**

The scope of this document includes the following types of high performance, advanced rechargeable and non-rechargeable batteries:

- **Rechargeable Batteries**

    - Lithium ion
    - Nickel cadmium
    - Nickel metal hydride
    - Metal air
    - Sodium ion
    - Zinc ion
    - Lithium metal
- **Non-rechargeable Batteries**
    - Lithium metal
    - Zinc air
    - Silver oxide

The GPC brick category for the rechargeable and non-rechargeable batteries listed above is Brick 10000546 Batteries; the specific codes are provided with this submission as Attachment A. The GPC brick category/codes for the products that contain rechargeable and non-rechargeable batteries are too numerous to list. The applicable six-digit HTS codes are shown in **Figure 1** below. Details for these listings are also included in Attachment B.

Figure 1. HTS Classifications for Rechargeable and Non-rechargeable Batteries

Non-rechargeable Batteries		**Rechargeable Batteries**
8506.10 Silver oxide		8507.30 Nickel cadmium
8506.50 Lithium metal		8507.50 Nickel metal hydride
8506.60 Zinc air		8507.60 Lithium ion
		8507.80 Other
		8507.90 Parts (cells)

2. The Intended Use and How Batteries are Essential for the Health, Safety, and Functioning of Society.

Rechargeable and non-rechargeable batteries are essential to the safety and functioning of critical domestic infrastructures such as defense, aerospace, transportation, communications, and construction, and for transitioning to a clean energy-based economy. They are used in automobiles, satellites, phones, computers, security systems, lighting, life-saving medical devices, and military equipment. Many rechargeable batteries provide back-up power for critical industrial and institutional assets from power plants to data centers to hospitals and schools and serve as energy storage systems for electrical grids. The major consumer market segments for rechargeable and non-rechargeable batteries are automotive (*e.g.*, cars, trucks, marine vessels and navigation, e-scooters, e-bikes, golf carts), consumer electronics (*e.g.*, smartphones, laptops, computers, tablets), medical devices (*e.g.*, hearing aids, pacemakers, and other wearable devices), and energy storage systems, with consumer electronics accounting for the largest revenue share (in excess of 31.0%).[1] Other key segments include rechargeable power tools, flashlights, LED lighting, vacuum cleaners, digital cameras, wristwatches, and calculators.

With respect to the essential role of rechargeable and non-rechargeable batteries to critical domestic infrastructures, the U.S. Department of Defense ("DOD"), in its August 2023 Report on Critical Per- and Polyfluoroalkyl Substance Uses, includes rechargeable batteries among the sectors of strategic importance.[2] DOD explains the critical uses of batteries manufacturing, and concludes that "the battery industry's ability to make products for a broad range of commercial and military applications would be greatly impacted if PFAS were no longer available for use in these components."[3]

In accordance with Section 6(g) of the Toxic Substances Control Act ("TSCA"), EPA also recently concluded that rechargeable batteries are essential to serve critical infrastructure such as transportation systems, security systems, as well as to energize the national defense base.[4] To reach such a conclusion, EPA must find that (1) a specific condition of use is critical or essential, (2) that no technically and economically feasible safer alternative is available, and (3) that discontinuing the use would significantly disrupt the national economy, national security, or critical infrastructure or that the specific condition of use of the chemical substance or mixture, as compared to reasonably available alternatives, provides a substantial benefit to health, the environment, or public safety.[5]

Rechargeable and non-rechargeable batteries support the functioning and climate control necessary to operate large scale data centers for information management by Maine's state and local governments, businesses, and institutions. They serve in backup generator power sources to ensure the safe operation of hospitals in Maine during severe weather events and power outages and protect public health by powering essential medical equipment. Lithium ion batteries are the leading technology in the emergence of large-scale energy storage systems ("ESS"), which are one of the lynchpins needed for renewable energy sources to power Maine's businesses, institutions, and households.

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[1] Grand View Research, *Lithium-ion Battery Market Size, Share & Trends Analysis Report By Product (Lithium Cobalt Oxide, Lithium Iron Phosphate, Lithium Nickel Cobalt Aluminum Oxide), By Application (Automotive, Consumer Electronics), By Region, And Segment Forecasts, 2024 – 2030* (2018-2022).

[2] Department of Defense, *Report on Critical Per- and Polyfluoroalkyl Substance Uses, Pursuant to Section 347 of the James M. Inhofe National Defense Authorization Act for Fiscal Year 2023 (Public Law 117-263)* (August 2023).

[3] *Id*. at page 6.

[4] Trichloroethylene: Regulation Under the Toxic Substances Control Act ("TSCA"), Proposed Risk Management Rule, 88 Fed. Reg. 74712, 74745 (Oct. 31, 2023).

[5] 15 U.S.C. 2605(g)(1) (2016).

Rechargeable and non-rechargeable batteries make a great many essential contributions to consumer health and safety and the functioning of society among consumers. It has taken 30 years to develop and commercialize batteries for electric vehicles ("EVs").[6] The expansion of this automotive sector in Maine and across the country is contributing to environmental health and the functioning of society by reducing our dependence on fossil fuels and lowering our carbon footprint. Batteries that power pacemakers keep these individuals safe, contribute to their improved health and wellness, and reduce the societal burdens of intensive medical care as a whole. The performance of batteries in hearing aids also keep people safe and provide enhanced opportunities to function and interact with others.

Each year from 2010 through 2020, the worldwide sale of rechargeable lithium ion batteries increased by no less than twenty five percent.[7] This increase in use has created a highly competitive global market for both domestic battery manufacturers and the companies that use these batteries in their products. Manufacturers of rechargeable lithium ion batteries must continuously improve technology and be responsive to customer needs to successfully attract business opportunities away from the global competition. An exponential increase in the use of rechargeable lithium ion batteries in products is expected to continue on a global scale. A market report from Grand View Research states:[8]

> "The global lithium ion battery market size was estimated at USD 54.4 billion in 2023 and is projected to register a compound annual growth rate (CAGR) of 20.3% from 2024 to 2030. Automotive sector is expected to witness significant growth owing to the low cost of lithium ion batteries. Global registration of electric vehicles (EVs) is anticipated to increase significantly over the forecast period. The U.S. emerged as the largest market in North America in 2023. Increasing EV sales in the country owing to supportive federal policies coupled with the presence of several players in the U.S. market are expected to drive product demand. Federal policies include the American Recovery and Reinvestment Act of 2009, which established tax credits for purchasing electric vehicles."

Other federal policy drivers include New Corporate Average Fuel Economy ("CAFÉ") standards, mandated fuel economy standards for passenger cars and commercial vehicles, and

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6 Korean Battery Industry Association, KBIA Comments on the PFAS Restriction Proposal (August 25, 2023)(Attachment D), p. 5.

7 Avicenne Energy, The Rechargeable Battery Market and Main Trends, 2020 – 2030(September 28, 2021).

8 Grand View Research, *Lithium-ion Battery Market Size, Share & Trends Analysis Report By Product (Lithium Cobalt Oxide, Lithium Iron Phosphate, Lithium Nickel Cobalt Aluminum Oxide), By Application (Automotive, Consumer Electronics), By Region, And Segment Forecasts, 2024 – 2030* (2018-2022).

efforts to reduce carbon emissions. According to Grand View Research, the market for lithium ion batteries is projected to grow from the current level of $60 billion to $182.5 billion in 2030 – the same time that Maine's ban is scheduled to go into effect.[9] Similar projections are consistently echoed by other economic analyses. A 2019 report co-authored by McKinsey and Company projected yearly growth of 25 percent by 2030,[10] while a more recent analysis by McKinsey's Battery Insights team in 2022 projects that the larger value chain (*i.e.*, from mining to reclamation) could grow by over 30 percent annually to a value of more than $400 billion by 2030.[11] These larger forces at play need to be taken into consideration by MDEP.

3. **How the Specific Use of PFAS in the Product is Essential to the Function of the Product. If This Use of PFAS is Required By Federal or State Law or Regulation, Provide Citations To That Requirement.**

To understand the potential magnitude of Maine's ban on health, safety, and the functioning of society requires an explanation of the function of PFAS in rechargeable batteries. A detailed scientific and technical description of the PFAS used in rechargeable batteries is provided in the report included as Attachment C. This report was prepared by the trade association for the rechargeable battery industry in Europe, RECHARGE, for derogation from the proposed restrictions on PFAS under consideration by the European Commission. ("RECHARGE report"). Resistance to chemical degradation and tolerance at elevated temperatures are crucial for battery performance to protect public safety, which necessitates the use of PFAS in all rechargeable battery technologies in these key components:[12]

- Active material masses;
- Cathode binders;
- Separator coatings,
- Electrolytes;
- Casings, valves, gaskets, washers & membranes; and
- Coatings.[13]

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[9] *Id.*

[10] McKinsey and Company, *Battery 2030: Resilient, sustainable, and circular* (January 16, 2023)**Error! Hyperlink reference not valid.**.

[11] *Id.*

[12] Recharge, *Application for derogations from PFAS REACH restriction for specific uses in batteries* (April 2023), p.7.

[13] *Id.*

For example, rechargeable battery manufacturing involves the use of fluoropolymers (*e.g.*, polytetrafluoroethylene ("PTFE")) and polyfluoroalkyl acids ("polyFAAs") in multiple subcomponents.[14] Table 1 on page 8 of the RECHARGE report provides a list of current binder formulations used in active material masses in which PFAS are used. These formulations often include PTFE as well as and Polyvinylidine difluoride ("PVDF") as binder materials in the active material masses in electrodes in a wide range of battery technologies.

The use of PFAS is state-of-the-art for high performance batteries today due to both performance and safety. There are no commercialized alternatives to PTFE and PVDF to make cathode binders function properly in terms of mechanical stability, electrochemical stability, oxidation resistance, and processability. PTFE offers mechanical cohesion for electrode integrity throughout the battery lifecycle, provides uniform electrode density for consistent performance, and contributes to a low moisture content, which is absolutely essential for battery integrity.[15] Among many other attributes, PVDF's high ignition temperature of 346° C makes it highly stable and ideal for consumer product applications. There are a number of other specific uses of these materials that are both complex and essential, such as avoiding hydrogen fluoride emissions, provide dependable insulation, resistance to weathering and deterioration, and ultraviolet ("UV") light resistance.[16]

PRBA supports a risk-based approach to regulation. Rechargeable and non-rechargeable batteries do not use PFAS types such as Perfluorooctanoic acid ("PFOA"), Perfluorooctanesulfonic acid ("PFOS") and Perfluorohexane sulphonic acid ("PFHxS"). In contrast, the potential toxicity of PTFE and PVDF polymers is classified as lower than any potential (and lower performing) alternative chemistry.[17] Importantly, PFAS components are enclosed within the rechargeable or non-rechargeable battery. The battery is most often enclosed in the product. Therefore, there is little to no likelihood of human exposure and there is no release to the environment during the useful life of the product. Maine has already recognized that it is appropriate to regulate the disposal of PFAS-containing products through the state's waste management laws, rather than through a law instituting a PFAS ban. Therefore, the likelihood of improper end-of-life disposal is minimized significantly by Maine's recycling programs for rechargeable batteries, such as the Call2Recycle program.[18] Batteries are typically

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[14] Department of Defense, *Report on Critical Per- and Polyfluoroalkyl Substance Uses, Pursuant to Section 347 of the James M. Inhofe National Defense Authorization Act for Fiscal Year 2023 (Public Law 117-263)* (August 2023), p. 6.

[15] Recharge, *Application for derogations from PFAS REACH restriction for specific uses in batteries* (April 2023), p.11.

[16] *Id.* at p.13.

[17] Korean Battery Industry Association, KBIA Comments on the PFAS Restriction Proposal (August 25, 2023), p. 18.

[18] Maine Department of Environmental Protection, *Battery Recycling* (last visited Feb. 12, 2024).

recycled via pyrometallurgical/hydrometallurgical processes, in which the temperatures destroy all PFAS types, resulting in the disassociation of the fluorine moieties. Perfluoromethane, one of the most stable forms of PFAS, disassociates at 1380° C, well below the process temperatures at recycling facilities that are more in the range of 1400° C – 1600° C.[19]

4. Whether There Are Alternatives For This Specific Use Of PFAS Which Are Reasonably Available.

Pursuant to 38 M.R.S. §1614(1)(B), a "currently unavoidable use" means a use of PFAS that the department has determined by rule under this section to be essential for health, safety, or the functioning of society and for which alternatives are not reasonably available. We refer MDEP to the RECHARGE report for understanding the lack of feasible and safe alternatives in rechargeable batteries. At present, there are no reasonably available alternatives for each and every component. Table 2 on page 19 of the RECHARGE report summarizes the the status of alternatives under development; in most cases, no feasible alternative to exists.

The transition away from these materials will take many years. During the stakeholder engagement process in the EPA rulemaking mentioned earlier in these comments, battery separator companies indicated that a 25-year transition period would be necessary for just one, single solvent ingredient used as a processing aid. According to industry experts, at least 40 years is needed to commercialize a PFAS-free EV battery, and additional time may be necessary beyond that to confirm that the technology is dependable and achieves the same level of performance.[20] The number of components in rechargeable batteries makes for an even more complex transition period. Maine's ban is schedule to go into effect only six years from now, which is not enough time for our industry to find and implement alternatives at a commercial scale. There are numerous steps in the process of identifying alternatives. These include basic research and development, prototype testing, extended trial use to evaluate performance, safety testing, retooling, and customer vetting and approval. Every product in which the rechargeable battery is used must also undergo rigorous safety and performance testing. The downstream users of these batteries will require additional time to evaluate the quality, safety, and performance of their products, which often involves a period of additional years, at the research, pilot, and large commercial scale – for thousands of different applications.

Further, we request that MDEP clearly indicate that the exemption applies to the need to provide notification as well as the 2030 product ban. Based on the foregoing information, we respectfully recommend this exemption and offer the following language to capture the scope of the exemption coverage that is needed for rechargeable and non-rechargeable batteries:

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[19] Korean Battery Industry Association, KBIA Comments on the PFAS Restriction Proposal (August 25, 2023), p. 11.

[20] *Id.* at 12.

Pursuant to 38 M.R.S. §1614(1)(B), the following product categories are exempt from notification and the prohibition on sale of products containing intentionally added PFAS:

* * *

Rechargeable and non-rechargeable batteries, whether contained in another product or not, and their ingredients and components, including but not limited to lithium ion, nickel cadmium, nickel metal hydride, metal air batteries, sodium ion, zinc ion, lithium metal, zinc air, and silver oxide batteries.

Moreover, due to the myriad and diverse products which these batteries power, there is no single time limit that would be suitable for an exemption for rechargeable and non-rechargeable batteries. MDEP can and should avoid the need to spend more resources to re-engage with industry and undertake additional rulemakings to extend specific product exemptions.

PRBA would welcome an opportunity to discuss these comments with you and answer any questions. We applaud MDEP for recognizing that in seeking to protect its citizens by regulating substances of global concern, exemptions are needed for products like rechargeable and non-rechargeable batteries that are essential for the health, safety, or functioning of society. PRBA respectfully requests that MDEP grant our request to provide a currently unavoidable use exemption in proposed and final regulations for rechargeable and non-rechargeable batteries. George Kerchner, PRBA Executive Director, can be reached at (202) 719-4109 or gkerchner@wiley.law

Respectfully submitted,

George Kerchner, Executive Director
PRBA – The Rechargeable Battery Association

Attachments:

A. Applicable Global Product Classification (GPC) Codes

B. Applicable HTS Codes

C. RECHARGE Comments on EU REACH Derogation

D. KBIA Comments on EU REACH Derogation

BRICK CODE CATEGORIES FOR RECHARGEABLE AND NONRECHARGEABLE BATTERIES
Source: GPC

- Segment 78000000 Electrical Supplies
  - Family 78040000 Electrical Cabling/Wiring
  - Family 78020000 Electrical Connection/Distribution
    - Class 78021100 Batteries/Chargers
      - Brick 10000546 Batteries
        - Attribute 20000664 Battery Constituent
          - Attribute Value 30004177 ACID
          - Attribute Value 30003639 ALKALINE
          - Attribute Value 30006894 BOTTOM CELL
          - Attribute Value 30006041 LITHIUM
          - Attribute Value 30005487 MERCURY
          - Attribute Value 30006860 NICKEL HYBRID
          - Attribute Value 30006040 NICKEL-CADMIUM
          - Attribute Value 30006861 SILVER OXIDE
          - Attribute Value 30002515 UNCLASSIFIED
          - Attribute Value 30002518 UNIDENTIFIED
          - Attribute Value 30006892 ZINC CARBON
        - Attribute 20000663 Rechargeable/Non-rechargeable
          - Attribute Value 30004787 NON RECHARGEABLE
          - Attribute Value 30004788 RECHARGEABLE
          - Attribute Value 30002518 UNIDENTIFIED
        - Attribute 20001709 Target Use/Application
          - Attribute Value 30014492ACCU CAMCORDER
          - Attribute Value 30013485 PHOTO ACCU/CHARGER

- Attribute Value 30002515 UNCLASSIFIED
- Attribute Value 30002518 UNIDENTIFIED

□ Attribute 20002639 Type of Battery

- Attribute Value 30013384 CONSOLE BATTERY
- Attribute Value 30014544 DECT (Digital Enhanced Cordless Telecommunications
- Attribute Value 30014545 DECT (DIGITAL ENHANCED CORDLESS TELECOMMUNICATIONS) TELEPHONE BATTERY
- Attribute Value 30013390 MOBILE PHONE BATTERY
- Attribute Value 30013378 MP3 BATTERY
- Attribute Value 30006893 PHOTO BATTERY
- Attribute Value 30013389 PROJECTOR BATTERY
- Attribute Value 30002515 UNCLASSIFIED
- Attribute Value 30002518 UNIDENTIFIED
- Attribute Value 30013377 UNIVERSAL BATTERY

■ Brick10000704 Batteries/Chargers Variety Packs

■ Brick10005764 Battery Boxes

■ Brick10000548 Chargers

Harmonized Tariff System (HTS) Codes

Heading / Subheading

8507

Article Description

Electric storage batteries, including separators therefor, whether or not rectangular (including square); parts thereof

Unit of Quantity

General

Special

Heading / Subheading

8507.10.00

Article Description

Lead-acid storage batteries, of a kind used for starting piston engines

Unit of Quantity

General

3.5%

Special

Free (A, AU, B, BH, C, CL, CO, D, E, IL, JO, KR, MA, OM, P, PA, PE, S, SG)

Heading / Subheading

Article Description

12 V batteries

Unit of Quantity

General

Special

Heading / Subheading

8507.10.00.30

Article Description

Not exceeding 6 kg in weight

Unit of Quantity

No., kg

General

Special

Heading / Subheading

8507.10.00.60

Article Description

Exceeding 6 kg in weight

Unit of Quantity

No., kg

General

Special

Heading / Subheading

8507.10.00.90

Article Description

Other

Unit of Quantity

No., kg

General

Special

Heading / Subheading

8507.20

Article Description

Other lead-acid storage batteries

Unit of Quantity

General

Special

Heading / Subheading

8507.20.40.00

Article Description

Of a kind used as the primary source of electrical power for electrically powered vehicles of subheadings 8703.40, 8703.50, 8703.60, 8703.70 or 8703.80

Unit of Quantity

No., kg

General

3.5%

Special

Free (A*, AU, B, BH, CL, CO, D, E, IL, JO, KR, MA, OM, P, PA, PE, S, SG)

Heading / Subheading

8507.20.80

Article Description

Other

Unit of Quantity

General

3.5%

Special

Free (A*, AU, B, BH, C, CL, CO, D, E, IL, JO, KR, MA, OM, P, PA, PE, S, SG)

Heading / Subheading

8507.20.80.10

Article Description

Of a kind described in subheading 9903.45.25

Unit of Quantity

No., W

General

Special

Heading/ Subheading

Article Description

Other

Unit of Quantity

General

Special

Heading / Subheading

8507.20.80.31

Article Description

6 V batteries

Unit of Quantity

No., kg

General

Special

Heading / Subheading

8507.20.80.41

Article Description

12 V batteries

Unit of Quantity

No., kg

General

Special

Heading / Subheading

8507.20.80.61

Article Description

36 V batteries

Unit of Quantity

No., kg

General

Special

Heading / Subheading

8507.20.80.91

Article Description

Other

Unit of Quantity

No., kg

General

Special

Heading/ Subheading

8507.30

Article Description

Nickel-cadmium storage batteries

Unit of Quantity

General

Special

Heading / Subheading

8507.30.40.00

Article Description

Of a kind used as the primary source of electrical power for electrically powered vehicles of subheadings 8703.40, 8703.50, 8703.60, 8703.70 or 8703.80

Unit of Quantity

No.

General

2.5%

Special

Free (A, AU, B, BH, CL, CO, D, E, IL, JO, KR, MA, OM, P, PA, PE, S, SG)

Heading/ Subheading

8507.30.80

Article Description

Other

Unit of Quantity

General

2.5%

Special

Free (A, AU, B, BH, C, CL, CO, D, E, IL, JO, KR, MA, OM, P, PA, PE, S, SG)

Heading / Subheading

8507.30.80.10

Article Description

Sealed

Unit of Quantity

No.

General

Special

Heading / Subheading

8507.30.80.90

Article Description

Other

Unit of Quantity

No.

General

Special

Heading / Subheading

8507.50.00.00

Article Description

Nickel-metal hydride batteries

Unit of Quantity

No., kg

General

3.4%

Special

Free (A, AU, B, BH, C, CL, CO, D, E, IL, JO, KR, MA, OM, P, PA, PE, S, SG)

Heading / Subheading

8507.60.00

Article Description

Lithium-ion batteries

Unit of Quantity

General

3.4%

Special

Free (A, AU, B, BH, C, CL, CO, D, E, IL, JO, KR, MA, OM, P, PA, PE, S, SG)

Heading / Subheading

8507.60.00.10

Article Description

Of a kind used as the primary source of electrical power for electrically powered vehicles of subheadings 8703.40, 8703.50, 8703.60, 8703.70 or 8703.80

Unit of Quantity

No., kg

General

Special

Heading / Subheading

8507.60.00.20

Article Description

Other

Unit of Quantity

No., kg

General

Special

Heading / Subheading

8507.80

Article Description

Other storage batteries

Unit of Quantity

General

Special

Heading / Subheading

8507.80.41.00

Article Description

Of a kind used as the primary source of electrical power for electrically powered vehicles of subheadings 8703.40, 8703.50, 8703.60, 8703.70 or 8703.80

Unit of Quantity

No.

General

3.4%

Special

Free (A, AU, B, BH, CL, CO, D, E, IL, JO, KR, MA, OM, P, PA, PE, S, SG)

Heading / Subheading

8507.80.82.00

Article Description

Other

Unit of Quantity

No., kg

General

3.4%

Special

Free (A, AU, B, BH, C, CL, CO, D, E, IL, JO, JP, KR, MA, OM, P, PA, PE, S, SG)

Heading / Subheading

8507.90

Article Description

Parts

Unit of Quantity

General

Special

Heading / Subheading

8507.90.40.00

Article Description

Of lead-acid storage batteries

Unit of Quantity

kg

General

3.5%

Special

Free (A, AU, B, BH, C, CL, CO, D, E, IL, JO, KR, MA, OM, P, PA, PE, S, SG)

Heading / Subheading

8507.90.80.00

Article Description

Other

Unit of Quantity

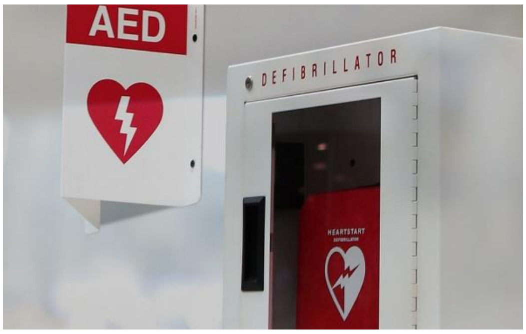
kg

General

3.4%

Special

Application for derogations from PFAS REACH restriction for specific uses in batteries



April 2023

First submission

By RECHARGE

RECHARGE Members

Industry Members

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Executive Summary

The PFAS (Per and polyfluoroalkyl substances) REACH restriction proposal will have a major impact on the battery industry. This document provides RECHARGE's feedback to the public consultation and the latest proposal of 22 March. For specific applications where PFAS are used in batteries, RECHARGE is **requesting derogations and additional transition times to provide sufficient time for the battery industry to identify and implement alternative non-PFAS solutions**.

Batteries are a main enabler for the transition towards low-emission mobility, decarbonised energy generation and digitalisation. Batteries power a wide range of general public applications such as smartphones, tablets, power tools, hearing aids, defibrillators, safety lighting in public buildings, and provide many services to industry such as back-up power for mission critical industrial assets (from nuclear power plants to data centres), energy storage systems for electrical grids, traction power to forklift trucks and AGV's, and deliver energy to a wide variety of machines such as drones, rockets, satellites and IoT objects. Batteries also provide power to an increasing number of mobility solutions such as e-bikes, e-scooters and electric vehicles. They generate significant economic growth and provide jobs for millions of people.

This document details what types of PFAS are used in batteries and why, whether there are non-PFAS alternatives available, what are the tonnages of PFAS consumed and emitted, the socio-economic impact assessment of the proposed PFAS restriction for the battery value chain and finally proposes best practices that the battery industry and legislators could implement to further minimise emissions. All statements provided in this document are supported by scientific evidence.

Contents

1 Introduction and scope

RECHARGE represents over 60 organisations spanning all aspects of the battery value chain. The scope of this document as feedback to the ECHA consultation includes the following types of high performance, advanced rechargeable and lithium batteries:

- Lithium-ion rechargeable batteries (also known as Li-ion batteries)
- Lithium (Li) primary batteries (also known as primary Lithium batteries)
- Nickel–based rechargeable batteries (Ni-Cd and Ni-MH)
- Metal air batteries
- Zinc oxide batteries
- Silver oxide batteries
- Sodium-ion (Na-ion) rechargeable batteries
- Zinc-ion (Zn-ion) rechargeable batteries
- Solid-state batteries
- Lithium metal rechargeable batteries
- Other battery technologies currently under research

The only type of rechargeable battery which does not use PFAS is lead-acid batteries. However, lead-acid batteries have a low energy density. Lead-acid batteries cannot be used as suitable alternatives for the technologies presented above and applications they serve. These technologies serve applications where a variety of performances are required, amongst which are high energy, high power, very long life, superior reliability, ability to withstand extreme temperatures. Lead-acid batteries have limited capacity in these respects and cannot be considered as suitable alternatives. In addition, lead compounds used for battery manufacturing and lead metal have been recommended by ECHA for inclusion on Annex XIV respectively in the 6th and 11th recommendations.

Batteries are a main enabler for the transition towards low-emission mobility, decarbonised energy generation and digitalisation. Batteries power a wide range of **general public** applications such as smartphones, tablets, power tools, hearing aids, defibrillators, safety lighting in public buildings, and provide many services to **industry** such as back-up power for mission critical industrial assets (from nuclear power plants to data centers), **energy storage systems** for electrical grids, traction power to forklift trucks and AGV's, and deliver energy to a wide variety of machines such as drones, rockets, satellites and IoT objects. Batteries also provide power to an increasing number of **mobility** solutions such as e-bikes, e-scooters and electric vehicles. They generate significant economic growth and provide jobs for millions of people. Batteries are essential to ensure the sustainable development of society and provide critical environmental and social benefits.

This document has been produced using information provided by our members, company reports, governmental publications, patent reviews and academic articles. All statements provided in this document are supported by scientific evidence.

This is a first submission. RECHARGE will update this document with additional information during the public consultation.

2 Why are PFAS used in batteries and where?

Batteries are comprised of two electrodes, a separator and an electrolyte, as schematized in Figure 1. Each electrode consists of an active material mass which is coated onto a current collector.

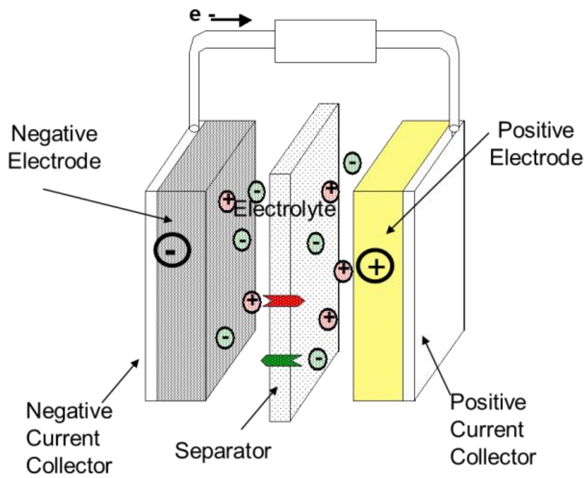

Figure 1. Components of a battery

PFAS have very unique properties:

- Water, oil and dirt repellent
- Durable under extreme conditions (high temperature, pressure, and aggressive chemicals)
- Electrical and thermal insulation.

As chemical resistance and tolerance to a high range of working temperatures are crucial for batteries, PFAS are used in key components for all high performance and lithium battery technologies. PFAS are used in key components in:

- Active material masses
- Electrolytes
- Valves, gaskets, washers & membranes
- Coatings

2.1 PFAS used in active material mass of electrodes

Each electrode is a composite which is manufactured by coating an active material mass onto a current collector (as shown in Figure 2). The active material mass comprises an active material, conductive additives (when needed) and a binder material.

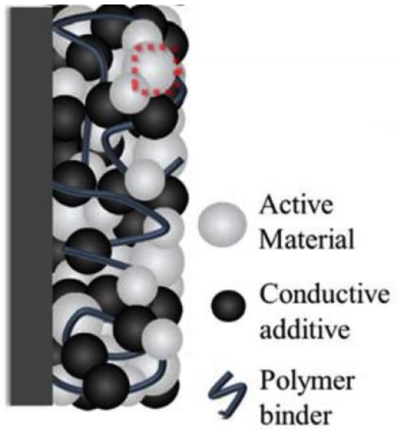

Figure 2: Composite electrode materials

Binder material is used to hold the active material particles together within the composite electrode and to provide a strong connection between the electrode and the current collector. The binder material plays an important role in the manufacturability of the battery and in the battery performance.

Due to their unique properties, both Polytetrafluroethylene (PTFE) and Polyvinylidine difluoride (PVDF – both homopolymer and copolymer) are used as binder materials in the active material masses in electrodes in a wide range of battery technologies, as detailed in Table 1.

Table 1. Binders used in active material masses for different battery technologies

Battery technology	Positive electrode	Negative electrode	Electrolyte
Li-ion (wet-process)	**PVDF** with NMC, NCA, LCO, LMO, LFP active masses	SBR/CMC with graphite anode, **PVDF** with LTO anode	Liquid organic electrolyte
Li-ion (dry process)	**PTFE** with NMC active mass	SBR/CMC with graphite anode	Liquid organic electrolyte
Na-ion	**PVDF** with PBA, Na-NFM and phosphate based active masses	**PVDF** with hard carbon anodes	Liquid organic electrolyte
Solid-state LMP	PEO with LFP active mass	No binder required for metallic lithium anode	Polymeric layer including PEO and **PVDF**
Ni-based rechargeable batteries	**PTFE** with Ni(OH)2 foam active mass	**PTFE** with Cd or MH electrode	Liquid alkaline electrolyte
Primary Li-SOCl2	**PTFE** with carbon anode	No binder required for metallic lithium	SOCl2 electrolyte
Primary Li-SO2	**PTFE** with carbon anode	No binder required for metallic lithium	SO2 electrolyte
Primary Li-MnO2	**PTFE** with Mn02 active mass	No binder required for metallic lithium	Liquid organic electrolyte
Primary Zn-Air	**PTFE** with MnO2 active mass	**PTFE**-membrane	Liquid alkaline electrolyte
Lithium metal rechargeable	**PVDF (and PTFE), with** with NMC, NCA, LCO, LMO, LFP	No binder required for metallic lithium	Liquid organic electrolyte, PE/PP or cellulose separator

2.1.1 PVDF used in active material mass of electrode

Although the PVDF binder comprises only a small portion of the composite electrode (typically 2–5% of the mass of the electrode[1]), the binder plays four important roles in battery performance. The PVDF binder:

- helps to disperse the active material and the conductive additive in the solvent during the fabrication process, enabling a homogeneous distribution of the slurry,
- holds the active material and the conductive additive together and connects them to the current collector, ensuring the mechanical integrity of the solid electrode without significantly impacting electronic or ionic conductivity (see Figure 2),
- acts as an interface between the composite electrode and the electrolyte. In this role, the PVDF binder protects the composite electrode from corrosion and the electrolyte from depletion while facilitating ion transport across this interface,
- tailors the viscosity of the slurry to allow a smooth coating onto the current collector during electrode manufacturing.

PVDF has several unique properties that enable it to fulfil these critical roles:

- **Mechanical properties**, including stiffness, toughness and hardness as well as good adhesion to the active material, the conductive additive, and the current collector. PVDF ensures the flexibility of electrode for cylindrical designs. The positive electrode binder must be able to withstand the forces that result from the expansion and contraction of active materials during charge/discharge cycles,
- **Thermal properties**, particularly thermal stability, are also important, both for the high temperatures commonly used for curing and drying during electrode fabrication and also for operation of the battery at various temperatures,

[1] Cholewinski, A., Si, P., Uceda, M., Pope, M., & Zhao, B. (2021). Polymer Binders: Characterization and Development toward Aqueous Electrode Fabrication for Sustainability. *Polymers*, *13*(4), 631–. https://doi.org/10.3390/polym13040631

- **Good dispersive capabilities** are important to help distribute the slurry evenly over the current collector during fabrication,
- **Chemical and electrochemical stability** are essential properties to enable the binder to function for long periods and over numerous cycles without degradation of the battery. The positive electrode binder must not react with any other components or intermediates formed during operation. In particular, the positive electrode binder must remain stable at the high and low voltage potentials experienced by the cathode. PVDF is the only proven material that can sustain a large voltage range from 0 to 5V at industrial scale for various battery designs (cylindrical, prismatic and pouch cell) and high-capacity cells. This stability guarantees its safe use in the electrochemical environment of the lithium cell.

All Lithium-ion battery manufacturing processes use PVDF as the binder material for all types of positive electrodes. Many other binder materials have been evaluated as replacements for PVDF, however all other materials have been found to oxidise at the high voltage at the positive electrode.

PVDF was previously also used as the binder material for all negative electrodes, however companies using graphite negative electrodes have successfully substituted PVDF with water-based CMC/SBR binder materials. For other types of negative electrodes using higher voltage materials such as lithium titanate oxide (LTO), NTO (Niobium Titanate Oxide)[2] the use of PVDF binder material is required because no research on alternative non-PFAS binders has proved sufficiently conclusive for transfer to industrialization to date.

For Sodium-ion rechargeable batteries, some research is ongoing regarding non-PFAS SBR/CMC binder materials for some hard carbon/PBA cells but this research work has not yet been scaled up. PVDF is preferred with some other PBA materials[3] and with hard carbon[4].

---

[2] Next-Generation SCiB^{TM} supporting smart mobility in the age of MaaS, Using Niobium Titanium Oxide (NTO) as a next-generation anode material. (n.d.). https://www.global.toshiba/ww/products-solutions/battery/scib/next/nto.html

[3] Wessels, C., D., Motallebi, S., (2020). Electrolyte Additives for Electrochemical Devices. Patent No.: US 10 862 168 B2. https://app.dimensions.ai/downloads/patents?ucid=US-10862168-B2

[4] Barker, J. & Heap, R., (2020). Metallate Electrodes. United States Patent. Patent No.: US 10 756 341 B2. https://patentimages.storage.googleapis.com/4e/07/f0/c9dd46a4691e63/US10756341.pdf

Next generation Lithium-ion battery developments are focussed on producing cathodes using a dry process which avoids the need for NMP solvent. This dry process will significantly reduce energy consumption and lower environmental footprint. However, the dry process requires the use of PTFE or PVDF as the cathode binder material[5,6].

2.1.2 PTFE used in active material masses of electrode

Industry outreach has confirmed that all leading manufacturers of primary batteries based on the technologies listed in Table 1 use PTFE, or another fluoropolymer, as the binder material for the positive electrode. PTFE is used as the binder material for the positive electrode in Lithium primary batteries to provide three main functions:

1. Mechanical cohesion between the positive electrode particles to enable electrode integrity during cell assembly and throughout the lifecycle of the battery storage and use,
2. Lubricant to allow the electrode particles to slide over each other during electrode formation (compression) giving uniform electrode density that is important to consistent battery performance and longevity,
3. Lower water absorption during mixing (PTFE is a hydrophobic material) and more complete drying during electrode baking - low moisture content is critical in Lithium chemistry.

PTFE provides a unique combination of properties that are essential for the performance and durability of Lithium primary batteries:

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[5] Xi, X., Mitchell, P., Zhong., L. & Zou, B., (2009). Dry particles based adhesive and dry film and methods. Unites States Patent Application Publication. Publication No.: US 2009/0239127 A1 http://pdfs.oppedahl.com/US/20090239127.pdf

[6] *BMW Poster at IBA 2022,*
Degen, F., & Kratzig, O. (2022). Future in Battery Production: An Extensive Benchmarking of Novel Production Technologies as Guidance for Decision Making in Engineering. IEEE Transactions on Engineering Management, 1–19. https://doi.org/10.1109/TEM.2022.3144882;
Li, Y., Wu, Y., Wang, Z., Xu, J., Ma, T., Chen, L., Li, H., & Wu, F. (2022). Progress in solvent-free dry-film technology for batteries and supercapacitors. *Materials Today (Kidlington, England)*, *55*, 92–109. https://doi.org/10.1016/j.mattod.2022.04.008;
Lu, Y., Zhao, C.-Z., Yuan, H., Hu, J.-K., Huang, J.-Q., & Zhang, Q. (2022). Dry electrode technology, the rising star in solid-state battery industrialization. Matter, 5(3), 876–898. https://doi.org/10.1016/j.matt.2022.01.011

- **High chemical stability** against the solvents used in Lithium primary batteries (such as thionyl chloride, sulphur dioxide and organic solvents),
- **High electrochemical stability**, which is necessary due to the high voltages (up to 3.9 V),
- **High temperature stability** to withstand the temperature necessary for drying the electrodes and provide stability in high temperature applications,
- **Good adhesion properties** to hold the active mass together in the electrode and provide adhesion to the current collector,
- **Good dispersion properties** to ensure the uniformity during the manufacturing of the electrodes,
- **Unique fibrillation properties**, very low concentrations are needed to hold the active mass in place without covering the active mass surface, this provides excellent porosity, which is needed for good penetration of the electrolyte,
- **Mechanical flexibility** to allow the winding of the electrode during cell assembly.

Polyvinyl alcohol (PVA, CAS 9002-89-5) or Poly(acrylic acid) (PAA, CAS 9003-01-4) may be added to the positive electrolyte binder material to create void volume after baking, this helps with electrolyte absorption.

PTFE is also used as the binder material for the positive and negative electrodes in industrial stationary Ni-Cd and Ni-MH rechargeable batteries.

2.2 PFAS used in electrolytes

PFAS is used in the electrolytes for Lithium-ion rechargeable, Lithium primary, Lithium metal rechargeable, and Sodium-ion rechargeable batteries.

In rechargeable batteries, LiPF6 (which is not a PFAS) has been widely used in older battery technologies for many years. However, recent advances in battery technology have established the use of PFAS substances as state-of-the-art for high performance batteries today, including as additives and as Lithium salt with PFAS anion. These include Lithium salts of PFAS monomers such as Li-Triflate

(CAS 33454-82-9), LiTFSI (CAS 90076-65-6), LiBETI (CAS 132843-44-8), LiFAP (LiPF3(CF2CF3)3n and LiTDI (CAS 761441-54-7). Examples of PFAS additives include Tris(2,2,2-trifluoroethyl)borate (TFEB CAS 659-18-7) and Trifluorotoluene (TFT CAS No. 98-08-8). PFAS substances are also used as gelifiers for Lithium-ion polymer batteries. Sodium bis(trifluoromethylsulfonyl)imide (NaTFSI CAS 91742-21-1) may be used for Na-ion batteries.

These advanced PFAS substances have properties which increase the electrolyte stability through chemical mechanisms such as capturing water and avoiding hydrogen fluoride emissions. The increased stability of the electrolyte provides significant increases in lifetime duration of the battery and battery operating temperature range. The PFAS substances are widely used in next generation Lithium-ion rechargeable batteries and particularly in the case of solid-state batteries.

For Lithium metal rechargeable batteries, polyfluorinated ether solvents, such as 1,1,2,2-Tetrafluoroethyl 2,2,3,3-tetrafluoropropyl ether, are essential to ensure adequate battery cycling lifetimes. This chemically inert solvent (in particular to Li metal) has unique properties that can reduce the viscosity of the cell and therefore the conductivity of the Lithium metal rechargeable batteries.

For Lithium primary batteries, the lithium manganese dioxide (Li-MnO2) electrochemical system is widely used in coin cells and cylindrical consumer cells such as CR2 and CR123A (one of the main electrochemical systems used for Lithium primary batteries), as well as in many cylindrical Lithium primary cell types for industrial applications. Li-MnO2 cells contain an electrolyte composed of organic solvents and a lithium salt. Lithium perchlorate (CAS 7601-90-3) has traditionally been used as the lithium salt, however lithium perchlorate has been found to act as an endocrine disruptor. Lithium perchlorate is the subject of ongoing regulatory management options analysis (RMOA) and is expected to become restricted. As a result, many manufacturers of primary Lithium batteries have already transitioned to using Li-Triflate (CAS 33454-82-9) and LiTFSI (CAS 90076-65-6) for cylindrical Li-MnO2 cells in general, and LiBETI (CAS 132843-44-8), LiFAP (LiPF3(CF2CF3)3n and LiTDI (CAS 761441-54-7) especially for high power Lithium primary cells (similar to the substitution observed in in rechargeable Lithium-ion cells). The use of the PFAS salts instead of lithium perchlorate also provides increased stability and performance as well as higher safety levels. Perchlorates in dry form are explosive materials which can explode in case of a thermal runaway of the battery or a fire.

2.3 PFAS used in valves, gaskets, washers, permeable membranes

PFAS is used in valves, gaskets, washers, and permeable membranes for Lithium-ion rechargeable, Lithium primary, solid-state batteries, Lithium metal rechargeable and Zinc air batteries.

Gasket sealings and washers, shown in Figure 3 for cylindrical cells and Figure 4 for prismatic cells[7], are critical components in batteries to prevent leakage of the electrolyte from the inside and penetration of moisture from the outside. Electrolyte leakages can cause short circuits and severe safety issues.

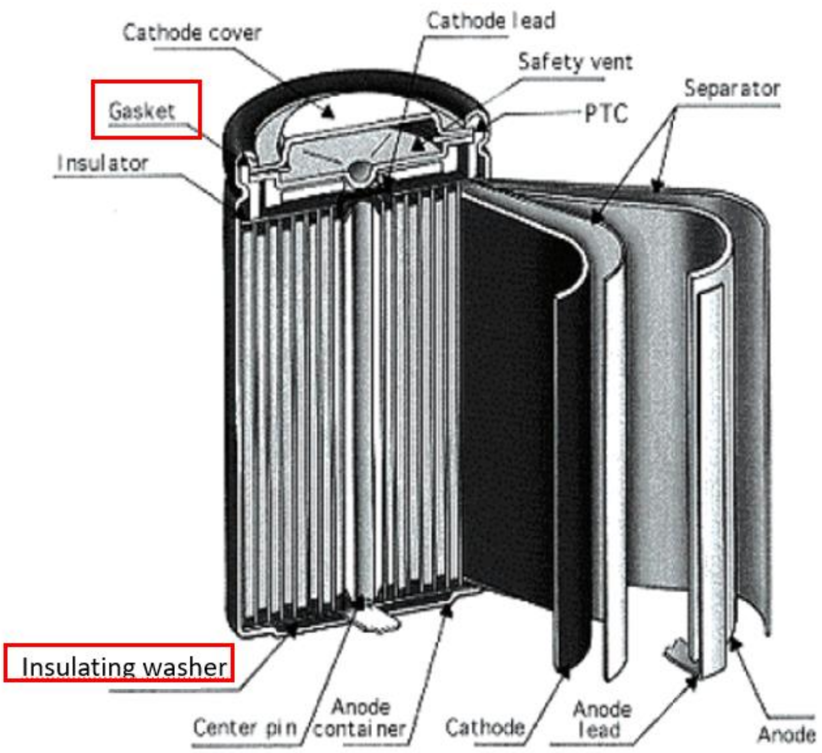

Figure 3. Gasket and washer in a cylindrical cell

[7] Arora, P., & Zhang, Z. (John). (2004). Battery Separators. *Chemical Reviews*, *104*(10), 4419–4462. https://doi.org/10.1021/cr020738u

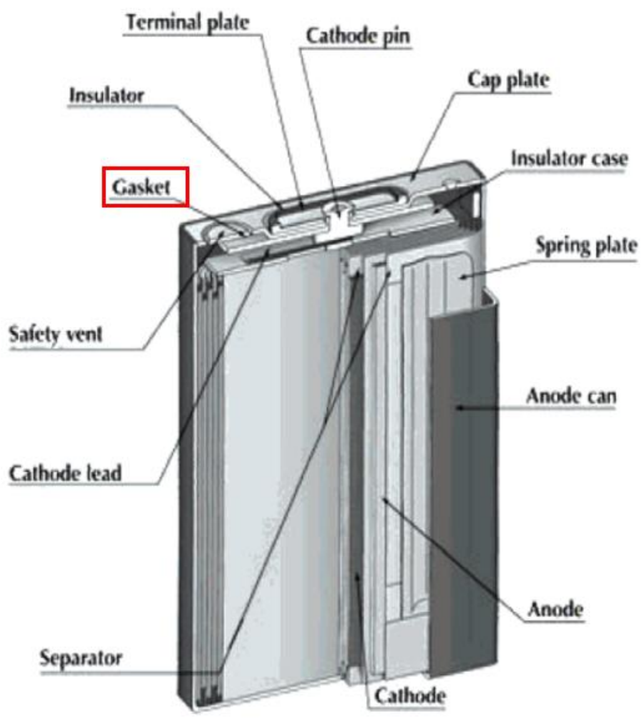

Figure 4. Gasket in a prismatic cell

For some applications used in mild temperature ranges, non-PFAS gasket sealing materials like PBT or PEI provide an adequate sealing performance. However, in high energy density Lithium-ion rechargeable and Lithium metal rechargeable batteries (e.g., high power batteries for automotive, industrial applications and power tools) it is crucial to employ very thin high-performance gaskets with high chemical and thermal stability, and high permeation resistance. This stability for high power and high temperature cells can only be provided by PFAS-based materials such as PTFE, PFA, FEP, VDF, HFP and FKM.

PTFE is not used for sealing gaskets in Li-MnO2 primary Lithium batteries. However, some industrial primary Lithium batteries use Li-SOCl2 and Li-SO2 electrolytes which are much more aggressive materials. SOCl2 is highly reactive and can violently release hydrochloric acid upon contact with water and alcohols. Sealing gaskets and washers for these much more aggressive materials require the use of PFAS-based materials such as FEP, PTFE, glass fiber with PTFE coating. These PFAS-based materials are critical to ensure the long lifetime of the battery, typically around 20 years. FEP is the preferred material for use in internal washers of high-power spiral primary Lithium Li-SOCl2 batteries because it provides excellent insulating properties and prevents internal shorts, thereby ensuring safe design and operation.

PTFE glass fiber washers are also used in Li-MnO2 and Li-SO2 industrial batteries to increase safety, especially in high temperature applications and safety-sensitive applications such as aviation. However, it may be possible to replace PTFE with another high-temperature non-PFAS polymer in these applications.

Zinc air batteries have the highest energy density of any practical battery system and operate by allowing oxygen to access the battery and react with the zinc. The oxygen is reacted on a catalytic surface inside the cell. Air permeable PTFE membranes are necessary to allow air to enter the battery whilst also preventing the release of the alkaline electrolyte from the battery. PTFE has unique hydrophobic properties and air permeability properties to achieve this critical function.

2.4 PFAS used in separator coatings

The separator is an indispensable part of batteries which separates the negative electrode from the positive electrode to prevent internal short circuits, whilst not participating in electrochemical reactions. At present, the most commonly used commercial separators are polyolefin separators, such as polypropylene (PP), polyethylene (PE) and multi-layer composite separators (PP-PE-PP)[8]. The layer materials are processed to make them porous by including tiny pores or voids at 35-45% porosity. The typical pore size is 200 nm - 1 μm which is large enough for the lithium ions to move smoothly through the separator.

Commercial tri-layer PP/PE/PP separators take advantage of the difference in the melting point of PP (165°C) and PE (135°C), using PE as the shutdown layer and PP to protect structural integrity. When the cell temperature rises near the melting point of the PE layer, the PE layer will melt at a temperature of 135°C and close the pores in the separator to stop the current flow while the PP layer, which has a

[8] Costa, C. M., Lee, Y. H., Kim, J. H., Lee, S. Y., & Lanceros-Méndez, S. (2019). Recent advances on separator membranes for Lithium-ion battery applications: From porous membranes to solid electrolytes. *Energy Storage Materials*, *22*, 346-375. https://doi.org/10.1016/j.ensm.2019.07.024

higher melting temperature than PE, remains solid. However, such protection is only effective below the melting point of PP.

To provide better thermal and mechanical stability, commercially available ceramic coated separators have been developed. Ceramic particles, such as alumina, silica, or zirconia can be mixed with polymeric binders and slurry-coated onto the polyolefin separators. In comparison to PP layers, ceramic coatings offer a better electrolyte wettability, which translates into better Li-ion transport through the separator and therefore a better performance of the battery. Although ceramic coatings have proven effective in improving the thermal stability of separators, the effectiveness of the protection is still limited by the thermal stability of the polymeric binder used.

Some companies use PVDF as the binder material for the ceramic coating to provide good adhesion to the electrolyte/composite electrode, as well as providing good adhesion of the ceramic coating to the separator. Other companies have developed non-PFAS binders which also provide good levels of adhesion to the separator and the electrolyte/composite electrode. Some organisations are researching the use of binder-free, thin-film ceramic-coated separators which may be able to provide improved safety for Lithium-ion batteries[9].

2.5 PFAS used in solid-state batteries

Several technical solutions are considered as fundamental to solid-state batteries, particularly for the development of solid-state electrolytes:

a. Polymer
b. Ceramic Sulfide
c. Ceramic Oxide

Polymer electrolyte is used in Lithium-metal-polymer (LMP) solid-state batteries and is already in production. Another solid electrolyte is based on ceramic sulfide. A third category of solid-state batteries are based on ceramic oxides. The last two are still under development at present.

[9] Gogia, A., Wang, Y., Rai, A. K., Bhattacharya, R., Subramanyam, G., & Kumar, J. (2021). Binder-Free, Thin-Film Ceramic-Coated Separators for Improved Safety of Lithium-ion Batteries. *ACS Omega*, *6*(6), 4204–4211. https://doi.org/10.1021/acsomega.0c05037

The architecture of LMP batteries is illustrated in Figure 3 and is based on using polymers as electrolytes and managing their chemical interfaces.

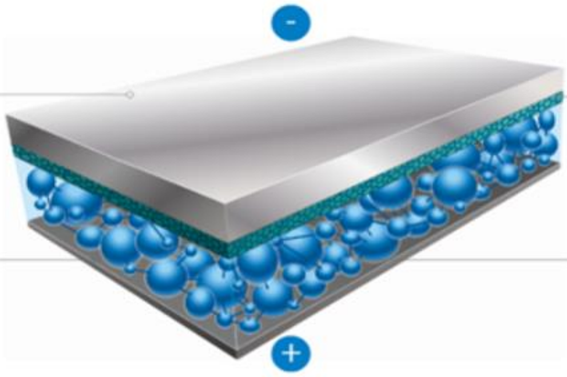

Figure 5. Schematic diagram of an LMP solid-state battery

The Lithium salt LiTFSI is used for the electrolyte and the cathode because it:

- has good conductivity allowing high power performance,
- is compatible with water (it does not hydrolyze and since there is water within the process, a salt that is stable in water is needed)
- is compatible with Lithium (also needed given the anode is Li-Metal)

PVDF is used as a binder in the electrolyte to provide mechanical strength and to act as an interface between the electrolyte and the electrodes.

These PFAS represent less than 5% of the cell's weight, but their role is crucial for the battery. PFAS are foreseen as even more important for the next generation of solid-state batteries. TFSI will be part of the cell recipe for its superior conductivity performances. PVDF is also expected to be a key component to ensure good adhesion between the cathode and the current collector.

3 Missing uses – analysis of alternatives

Table 2. Summary of derogation/transition period requests for various PFAS types, used in different types of batteries depending on current alternatives or alternatives in development

PFAS type	Where used in the battery	Type of battery	Alternatives available today?	Alternatives in development?	Derogation / transition period
PVDF	Binder in active material mass	Li-ion wet process (except for the graphite anode), Na-ion, Lithium metal rechargeable, solid-state	No	Preliminary research programmes funded by EU and Germany Govt	13.5 years
PTFE	Binder in active material mass	Li-ion dry process and semi-dry process, Lithium primary, Ni-Cd, Ni-MH, Zinc oxide, Metal air, Silver oxide, Zinc-ion rechargeable, Lithium metal rechargeable, solid-state	No	No	13.5 years
Various PFAS including LiTFSI, $LICF_3SO_3$ (triflate)	In electrolytes	Li-ion rechargeable, Lithium primary, Lithium metal rechargeable, Na-ion rechargeable batteries	Not for high performance/ next generation batteries	No - PFAS prevents 20% degradation of battery life.	13.5 years

PFAS type	Where used in the battery	Type of battery	Alternatives available today?	Alternatives in development?	Derogation / transition period
PTFE, FEP	Gaskets, washers	Chemically aggressive environments where PFAS is needed for electrochemical stability such as Lithium primary batteries using $Li\text{-}SO_2$ and $Li\text{-}SOCl_2$	No	No	13.5 years
PFA, VDF, HFP, FKM	Gaskets	High energy density batteries which require very thin high-performance gaskets such as Lithium-ion rechargeable batteries, Lithium metal rechargeable batteries	No other polymers have required mechanical properties and electrical insulation properties.	No	13.5 years
PTFE	Oxygen permeable membrane	PFAS hydrophobic properties are needed to facilitate air permeation and prevent alkaline electrolyte leakage in Zinc air batteries	No	No	13.5 years
PVDF, PTFE	Solid electrolyte/ gel polymer electrolyte	Solid-state batteries	No	No	13.5 years

PFAS type	Where used in the battery	Type of battery	Alternatives available today?	Alternatives in development?	Derogation / transition period
PTFE, PVDF	In coatings on the separator	Li-ion rechargeable, Lithium primary	Yes	Yes	Transition time of 6.5 years
PTFE, FEP, PFA, VDF, HFP, FKM	In valves, gaskets, washers	Li-ion rechargeable, Lithium primary, solid-state batteries where specific PFAS properties identified in section 3.1.4, 3.1.5 are not required	Yes	Yes	Transition time of 6.5 years

3.1 Uses where alternatives are not yet available

For the below uses where there are no alternatives available today, the chemicals industry will need to invest in research and development to build up the capacity and value chain for new innovative chemistries. The chemicals industry will need to make significant changes to existing research and development roadmaps which will be driven by industry demand for these new chemistries in Europe. In addition to research and development efforts, there is an immediate need for industrial investments to secure the manufacturing and the supply of chemicals to sustain the battery value chain in Europe. There is considerable uncertainty about the future of industry demand in Europe and therefore the timelines for these investments by the chemicals industry are not known. As a result, the battery industry requires derogation periods of at least 13.5 years for each of the below applications. If after the end of 13.5 years there are still no alternatives for specific applications, then the battery industry will need to apply to renew the derogation period for these specific applications.

3.1.1 Use of PVDF as the binder of the active material masses

PVDF is used as the binder material in the active masses for electrodes for Li-ion wet process (except for the graphite anode), Na-ion, Lithium metal rechargeable, and solid-state batteries. For the positive electrode, all attempts to replace PVDF binder materials with other polymers have caused cell performance and manufacturability issues. For the positive electrode, the degradation of alternative binder systems in the electrolyte has been demonstrated.

PVDF binder material is expensive (about 8-10 Euro/kg) and wet processes require the use of n-methyl-pyrrolidone (NMP) solvent (which is also expensive at about 2-6 Euro/kg) to dissolve the PVDF so that the slurry containing the binder material, active material and conductive additive can be dispersed evenly across the metal current collectors. NMP is classified in the EU as toxic to reproduction and its use is restricted under entry 71 of REACH Annex XVII. As a result, the use of NMP requires expensive solvent extraction and recovery systems. NMP also has a high boiling point of 210°C and so the curing and drying process has a high carbon footprint.

In view of the costs of PVDF and the health and safety concerns around the use of NMP solvent, many organisations have carried out research to try to find alternatives to PVDF as a binder material and NMP as the solvent. A peer reviewed academic article[10] indicates that PVDF as a latex can be used as the binder for the positive electrode with water as the solvent instead of NMP. Next generation Lithium-ion battery developments are focussed on producing positive electrodes using a dry process which avoids the need for NMP solvent. This dry process will significantly reduce energy consumption and lower the environmental footprint. However, the dry process still requires the use of PTFE or PVDF as the binder material for the positive electrode.

For Lithium-ion rechargeable batteries, PVDF was previously also used as the binder material for the negative electrode as well as for the positive electrode. For graphite negative electrodes, companies have successfully substituted PVDF with water-based CMC/SBR binder materials. CMC/SBR is now the most common commercially used binder material for the graphite negative electrodes due to its good

[10] Li, J., Lu, Y., Yang, T., Ge, D., Wood, D. L., & Li, Z. (2020). Water-Based Electrode Manufacturing and Direct Recycling of Lithium-ion Battery Electrodes—A Green and Sustainable Manufacturing System. *iScience*, *23*(5), 101081–101081. https://doi.org/10.1016/j.isci.2020.101081

cell performance, lower cost and reduced environmental impact[11]. For other types of negative electrodes using higher voltage materials such as Lithium titanate oxide (LTO), NTO (Niobium Titanate Oxide)[12] the use of PVDF binder material is required because no research on alternative non-PFAS binders has proved sufficiently conclusive for transfer to industrialization to date.

For Sodium-ion rechargeable batteries, some research is ongoing regarding non-PFAS SBR/CMC binder materials for some hard carbon/PBA cells but this research work has not yet been scaled up. PVDF is preferred with some other PBA materials[13] and with hard carbon[14].

The European Commission has recently funded the GIGAGREEN research project on dry alternatives and water-based binder systems for the positive electrode which propose to utilise a range of polymers including CMC/SBR, poly(acrylic acid), sodium alginate, polyurethanes and catechol-bearing polymers[15]. Whilst these initial research studies have indicated that these aqueous binder systems may have good adhesion properties, further research and development is required to investigate whether these alternatives have adequate chemical, mechanical, and electrical properties[16]. There are significant concerns about whether water-based CMC/SBR technology will have the necessary rheology and stability to match with today's positive electrode active materials such as LCO, NMC, NCA, LNMO, LFP. There are specific concerns about the use of water in the slurry production and the electrode coating, drying and calendaring processes, particularly if the water is not completely removed before the battery is assembled.

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[11] Hawley, W. B., & Li, J. (2019). Electrode manufacturing for Lithium-ion batteries—Analysis of current and next generation processing. *Journal of Energy Storage*, *25*(C), 100862–. https://doi.org/10.1016/j.est.2019.100862

[12] Next-Generation SCiB™ supporting smart mobility in the age of MaaS, Using Niobium Titanium Oxide (NTO) as a next-generation anode material. (n.d.). https://www.global.toshiba/ww/products-solutions/battery/scib/next/nto.html

[13] Wessels, C., D., Motallebi, S., (2020). Electrolyte Additives for Electrochemical Devices. Patent No.: US 10 862 168 B2. https://app.dimensions.ai/downloads/patents?ucid=US-10862168-B2

[14] Barker, J. & Heap, R., (2020). Metallate Electrodes. United States Patent. Patent No.: US 10 756 341 B2. https://patentimages.storage.googleapis.com/4e/07/f0/c9dd46a4691e63/US10756341.pdf

[15] Funding & tenders, Towards the sustainable giga-factory: developing green cell manufacturing processes (GIGAGREEN). (n.d.). https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/how-to-participate/org-details/999999999/project/101069707/program/43108390/details

[16] Cholewinski, A., Si, P., Uceda, M., Pope, M., & Zhao, B. (2021). Polymer Binders: Characterization and Development toward Aqueous Electrode Fabrication for Sustainability. *Polymers*, *13*(4), 631–. https://doi.org/10.3390/polym13040631

The Germany Government has funded the DigiBatt Pro 4.0[17] research project which also includes development of water-based binder systems for positive electrodes. As part of this research project, positive electrodes of around 100 metres in a lab scale with roughly 1/100 to 1/50 the scale of mass production have been produced using a nickel rich NCM cathode active material, $LiNi_{0.83}Co_{0.12}Mn_{0.05}O_2$. The cells could be successfully charged and discharged 1,000 times at 25°C before they fall below 80% of initial capacity. Whilst this research project appears to show promising results for very high nickel content batteries, correspondence with the project partners highlights that:

- Positive electrodes manufactured using water-based binder materials show increasing impedance/resistance with increasing numbers of charging and discharging cycles,
- The stability of the charging and discharging cycles is substantially lower than state-of-the-art positive electrodes using PVDF binder materials,
- The rapid increase in pH alkalinity of the water-based binder materials results in a very short shelf life for the mixed slurries, this would be very challenging for an industrial process as the mixture would go out of specification very quickly.

Further investigation of this research project confirms it focussed on a very specific high nickel NCM cathode active material at a moderate cell voltage of 4.2V. There is no evidence that this water-based binder material could be developed to meet the performance targets for positive electrodes with LCO chemistries operated at higher voltages, which is what many electronic devices use today.

It is also important to note that this research project focussed on a very specific cylindrical 21700 cell form factor used in certain automotive and power tool applications. Performance in this specific form factor is not directly transferrable to other cell form factors used in other applications. There are many unknowns which would need to be investigated before this technology could be adopted in other chemistries and other form factors, including:

- cycle life and calendar life and impedance growth under wide range of temperatures

[17] “*DigiBattPro 4.0 - BW*” - Digitized Battery Production 4.0 - Fraunhofer IPA. (n.d.). Fraunhofer Institute for Manufacturing Engineering and Automation IPA. https://www.ipa.fraunhofer.de/en/reference_projects/digibattpro.html

- swelling, fast charge cycling is unknown,
- electrode processibility for multilayer pouch cells and uniformity of coating is unknown,
- correspondence with the project partners highlighted that the positive electrodes manufactured using water-based binder materials show higher cell resistance and faster growth in resistance with increasing numbers of charging and discharging cycles with the high nickel NCM cathode active material. This trend is anticipated to become worse when industry moves to cathode active material operating at higher voltage, higher energy and higher power.

Furthermore, replacing the PVDF cathode binder likely requires the development of new cathode active material and Aluminium current collectors that are compatible with a new binder and solvent system. Water is known to cause poor cycle life and increased impedance growth in Lithium-ion cells. A new grade of active cathode powder may need to be developed to increase particle surface protection against water.

Replacing the PVDF cathode binder with new binder and solvent also requires development of a compatible electrode and cell manufacturing process and equipment. The necessary process and equipment change at mass production scale is unknown at this point and will be different for different companies depending on which alternative technology they pursue. The performance of mass production line produced PVDF free battery may have significant performance gaps compared with current batteries. Addressing these performance gaps may require a significant number of iterations of materials improvement, production process change and cell performance testing.

Given the above, we estimate that efforts to develop and commercialise high performance non-PFAS cathode binder, Al foil, active materials and corresponding cell manufacturing processes would take at least 10 years, followed by 5 years to commercialise the new technologies.

3.1.2 Use of PTFE as the binder of the active material masses

PTFE is used as the binder material in the active masses for electrodes for Li-ion dry process and semi-dry process, Li primary, Ni-Cd, Ni-MH, Zinc oxide, metal air, Silver oxide, Zinc-ion rechargeable, Lithium metal rechargeable and solid-state batteries.

There are currently no alternatives to PTFE due its unique combination of properties that are essential for the performance and durability of these batteries, especially for the:

- **fibrillation properties**, which produce an excellent mechanical electrode surface without covering the surface of the active material,
- **chemical properties**, including chemical stability in very aggressive environments,
- **hydrophobic properties**.

Alternative non-PFAS materials such as Polyvinyl alcohol (PVA, CAS 9002-89-5) and Poly(acrylic acid) (PAA, CAS 9003-01-4) have been tested as potential binder materials for the positive electrode and have been found to fail due to performance and manufacturability issues. The degradation of these alternative binder systems in the electrolyte has been demonstrated.

No research has been concluded on whether some of non-PFAS alternatives that are being investigated as potential replacements for PVDF as binders in Lithium-ion rechargeable batteries (see 3.1.1) may also be applicable to Lithium primary batteries. As a consequence, the timescale needed to investigate, develop and qualify alternatives for PTFE binder of the active material mass for Lithium primary batteries would be even longer than in the case of Lithium-ion rechargeable batteries.

3.1.3 Use of PFAS in electrolytes

Various PFAS substances are used in the electrolytes for Lithium-ion rechargeable, Lithium primary, Lithium metal rechargeable, and Sodium-ion rechargeable batteries. LiPF6 (which is not a PFAS) has been widely used in older battery technologies for many years. However, LiPF6 has been found to cause degradation in Li-ion cells, primarily from its thermal decomposition or hydrolysis to form acidic species. Recent advances in battery technology have established the use of PFAS substances as state-of-the-art for high performance batteries today, including as additives and as Lithium salt with PFAS anion.

PFAS electrolytes are used in advanced batteries to provide higher stability, increased performance and higher safety levels. This stability is provided by the high strength of the carbon-fluorine bond in the PFAS which is not present in the older electrolytes. As a result, the PFAS electrolytes provide 20% more battery life compared to LiPF6 electrolytes. This increased battery life provides sustainability benefits by extending the lifetime of the product.

In rechargeable batteries, Lithium salts of PFAS monomers such as Li-Triflate (CAS 33454-82-9), LiTFSI (CAS 90076-65-6), LiBETI (CAS 132843-44-8) and LiFAP (LiPF3(CF2CF3)3n are used to provide stability, performance and higher safety levels. There are no non-PFAS alternatives available today which provide similar stability, performance and safety levels. We estimate that research and development efforts to identify non-PFAS alternatives would take at least 10 years, followed by 5 years to commercialise the new electrolyte chemistry.

For Lithium primary batteries, Lithium salts based on monomolecular PFAS have been developed to replace the endocrine disruptor Lithium perchlorate and to improve the performance and durability of Lithium primary batteries (especially Lithium manganese dioxide batteries). Non-PFAS alternatives for Lithium perchlorate are currently not known and would have to be newly developed.

For Lithium metal rechargeable batteries, polyfluorinated ether solvents, such as 1,1,2,2-Tetrafluoroethyl 2,2,3,3-tetrafluoropropyl ether, are essential to ensure adequate battery cycling rates and lifetimes. This chemically inert solvent (in particular, inert to Li metal) has unique properties that can reduce the viscosity of the cell and therefore the conductivity of the Lithium metal rechargeable batteries. Non-fluorinated solvents can be used in combination with fluorinated ones, but not as a complete replacement primarily due to their lower chemical stability in conjunction with a metal Lithium electrode. There are no non-PFAS alternatives available today.

We estimate that research and development efforts to identify non-PFAS alternatives for electrolytes would take at least 10 years, followed by 5 years to commercialise the new electrolyte chemistries.

3.1.4 Use of PTFE & FEP in gaskets & washers in chemically aggressive environments

There are no alternatives to use of PTFE and FEP in gaskets and washers used in chemically aggressive environments such as the SO2 and SOCl2 substances used in electrolytes in primary Lithium batteries. SO2 and SOCl2 are very powerful oxidising agents which degrade almost all polymer types except PFAS materials. Degradation of the gasket and washer would result loss of battery component properties and release of the electrolyte. These primary industrial batteries using these electrolytes are required to operate for 20 years, significant research and development efforts will be needed to identify suitable alternatives which can provide the needed safety and long-term performance.

Polyimidazoles and fully chlorinated PVC may be some potential non-PFAS alternatives which may provide sufficient chemical stability against thionyl chloride in some applications. Thick bound fiberglass materials may also provide possible solutions. However, for chemically aggressive environments, more research on alternative materials is needed before the testing and final qualification can start, so that a derogation of 13.5 years is considered to be necessary.

3.1.5 Use of PFA, VDF, HFP, FKM in gaskets in high performance batteries which require very thin high performance gaskets

There are no alternatives to use of PFA, VDF, HFP, FKM in gaskets in high performance Lithium-ion rechargeable and Lithium metal rechargeable batteries (e.g., high power batteries for automotive, industrial applications and power tools) which require very thin high performance gaskets.

High power and high energy density batteries require very thin high performance gaskets[18]. Gaskets provide insulation between the positive and negative sides of the housings, a proper thermal functionality of the gasket is essential. This application needs a stable and compressive polymer which provides high levels of insulation to withstand the very high currents up to 280 amps which are found in these high performance batteries. Figure 6 compares the compressive properties of PFAS compared to other resins[19].

[18] Lui, J., Aoyama, T., Tsuda, H. & Sukegawa, M., (2019). Long-term reliability evaluation of fluororesin gasket for electrode of automotive lithium-ion battery using simulation. *VIII International Conference on Computational Methods for Coupled Problems in Science and Engineering*. https://upcommons.upc.edu/bitstream/handle/2117/190005/Coupled_2019-24-Long-term%20reliability%20evaluation.pdf

[19] Battery materials, Fluorochemicals, Daikin Global. (n.d.). https://www.daikinchemicals.com/solutions/products/battery-materials.html#anchor04

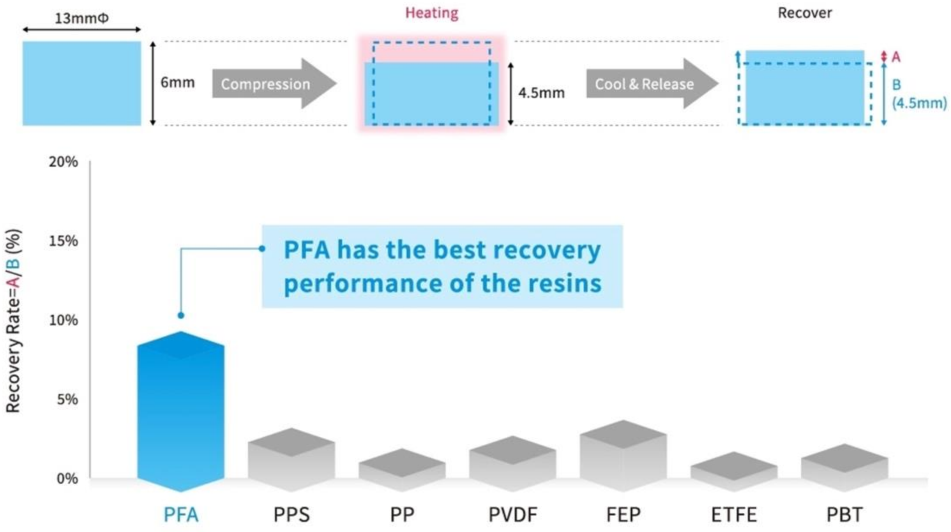

Figure 6. Compressive properties of polymer resins

PFAS provide a unique combination of electrical insulation and hydrophobic properties. Figure 7 compares the moisture permeation properties of PFAS compared to other resins[20]. As a result, the efficiency of the gasket performance is improved because of the reduced humidity absorption even when used at very low thickness.

[20] Ibid

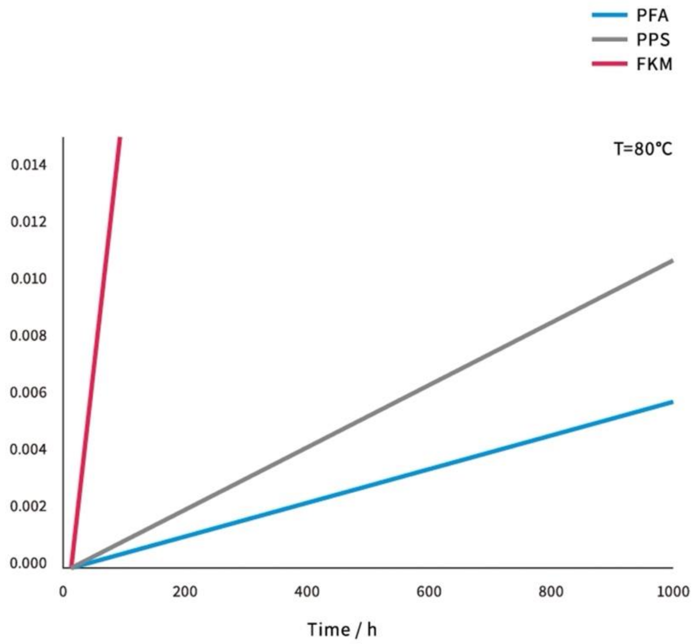

Figure 7. Moisture permeation of polymers

It will take significant time and effort for industry to investigate whether there are alternative polymers that can be used instead of PFAS in these gaskets. We estimate that research and development efforts to identify non-PFAS alternatives would take at least 10 years, followed by 5 years to commercialise the alternatives.

3.1.6 Use of PTFE in oxygen permeable membranes in Zinc air batteries

There are no known alternatives for use of PTFE in oxygen permeable membranes in Zinc air batteries or other types of alkaline metal-air batteries.

Zinc air batteries operate by allowing oxygen to access the battery and react with the zinc. The oxygen is reacted on a catalytic surface inside the cell. Air permeable PTFE membranes are necessary to allow air to enter the battery whilst also preventing the release of the alkaline electrolyte from the battery.

PTFE has unique hydrophobic properties and air permeability properties which allow gas molecules to pass through the membrane whilst at the same time preventing the release of the alkaline electrolyte. Extensive research would be needed to find alternatives. We estimate that research and development efforts to identify non-PFAS alternatives would take at least 10 years, followed by 5 years to commercialise the alternatives.

3.1.7 Use of PTFE / PVDF in solid electrolyte/ gel polymer in solid-state batteries

There are no available alternatives to the use of PVDF / PTFE as a binder in the solid electrolyte/ gel polymer in solid-state batteries. The PVDF / PTFE has unique properties that provide mechanical strength and act as an interface between the electrolyte and the electrodes in solid.

PVDF and co-polymers of PVDF are uniquely placed to enable solid electrolyte/gel polymers in batteries due to the presence of strong electron-withdrawing functional group (–C–F)[21]. These properties include high polarity, excellent thermal and mechanical strength, compatibility with organic solvents and chemical stability[22].

Extensive research would be needed to find alternatives. Research and development efforts to identify non-PFAS alternatives would take at least 10 years, followed by 5 years to commercialise the alternatives.

3.2 Uses where substitution is technically feasible but more time is required

As highlighted below, where substitution is technically feasible, the steps involved in substituting new materials into several subcomponents in a company's battery manufacturing process are considerably more complicated than in other industry sectors and therefore the battery industry requires a longer transition period of 6.5 years. Each new subcomponent needs to be developed and tested separately, and then the combination of the new subcomponents needs to be tested in the new battery and the product applications. Each company's battery manufacturing equipment and process lines also have unique aspects which are specific to that company's products and applications. Some companies may

[21] Manuel Stephan, A. (2006). Review on gel polymer electrolytes for lithium batteries. *European Polymer Journal*, *42*(1), 21–42. https://doi.org/10.1016/j.eurpolymj.2005.09.017

[22] Barbosa, J. C., Dias, J. P., Lanceros-Méndez, S., & Costa, C. M. (2018). Recent Advances in Poly(vinylidene fluoride) and Its Copolymers for Lithium-Ion Battery Separators. *Membranes (Basel)*, *8*(3), 45–. https://doi.org/10.3390/membranes8030045

need to make significant changes to their manufacturing equipment and process lines to accommodate the new subcomponents.

The below consecutive steps 1 to 4 are representative of the battery industry and present an optimistic scenario where no complications arise such as additional certification requirements or unforeseen customer validation requirements. For example, a significant amount of R&D resource will be needed to carry out the development of new subcomponents and the battery industry may face a shortage of qualified technical staff to carry out this work. In addition, a large amount of battery models and finished products containing batteries which are on the market today will need to be recertified and there may not be sufficient third-party certification companies available in the market today to provide these needed recertification services.

The battery industry will make every effort to work within a 6.5 years transition time. However, there may be some types of subcomponents where industry experience finds that it is not possible to achieve substitution within the 6.5 years and so the battery industry may need to apply for an extension to this transition period.

<u>Step 1: Substitute material identification for one subcomponent: up to 12 months</u>

Each company's battery manufacturing process is customised to meet the needs of that company's products. In many cases there are a range of chemistries that could be considered as alternatives for a specific subcomponent. The first step is assessment and laboratory verification to identify which target substitute material is likely to provide the best combination of properties for the specific subcomponent in the company's products. The identification of a target substitute material for one subcomponent alone can take up to 12 months. For example, in the case of the binder for the ceramic coating on the separator, companies which are currently using PVDF will need to evaluate several different alternatives to identify the best material for their application. There are several alternatives in use today which will need to be considered.

<u>Step 2: Separate development of each new subcomponent: 14 - 21 months</u>

This is the process of using the target substitute material to develop the new subcomponent and then to test it in a cell with an existing, already proven chemistry. This step is necessary to isolate the new subcomponent as the only variable that has changed in the cell. Once the cells are built, the testing of the cell cycling process can begin. It takes about 7 months to carry out 1000 test cycles of the cell build containing the new subcomponent, to check that it can meet swelling, impedance, capacity retention and other technical requirements after 1000 cycles. Some companies also need to carry out environmental testing of the subcomponent such as long-term storage at elevated temperatures. A cell build can fail the cycles tests, therefore most companies assume at least one additional iteration of the cell build will be required to refine the specific chemistry of the target substitute material. Therefore, this stage can take several multiples of 7 months, at least 14 to 21 months.

Step 3: Combination of all new subcomponents and chemistry development: 18 - 36 months

This is the process of integrating and developing all the new subcomponents into a next generation cell chemistry package. Each new subcomponent would need to be qualified as part of this larger chemistry package.

The integration and development process requires several cell builds to find a combination of components and process conditions that meets all electrochemical and safety requirements. Depending on the testing capacities at the company, some companies may need to carry out between 3 and 6 cell builds, as some cell builds may fail testing. It takes about five months to develop each cell build and carry out tests of the initial 250 cycles so that sufficient data can be collected to accurately inform the development of the next cell build. The final cell chemistry needs to be tested at 1000 cycles which takes 7 months. Therefore, it may take around 18 - 36 months to arrive at a validated battery chemistry which is ready to be integrated into a new product.

Step 4: Integration into existing product design and new product designs, and into manufacturing processes: 24 - 48 months

The next step is to integrate the new validated battery chemistry into existing product designs and new product designs, and to carry out testing on finished assembled products to ensure they meet all electrochemical, process, safety and reliability requirements and certifications. This requires requalification of the new battery in all existing products which are already in production in Europe. Companies will need to make changes to their manufacturing equipment and process lines to qualify the manufacturing of the new subcomponents, the integration of the new subcomponents into the cell and the integration of the new battery into existing and new products. These changes to manufacturing equipment and process lines may be significant and require extensive time and capital investment.

Product requalification is a very time-consuming exercise which will require extensive resources over many years. The completion of this task will require sufficient test house capacity and transition time to requalify all battery-powered products which are used in Europe for safety, performance and lifetime. Additionally, the process of re-certifying batteries for existing product designs may trigger other regulatory updates unrelated to the new subcomponents that could otherwise have been avoided. For a company with a wide range of existing product designs, this can take around 24 - 48 months.

4 PFAS consumption in tonnes and emissions during battery life cycle

4.1 PFAS consumption in tonnes

Further information will be provided in subsequent submissions.

4.2 Emissions during the battery life cycle

NOTE: This text repeats the information already provided by RECHARGE in the second call for evidence submitted in October 2021. Updated information will be included in subsequent submissions.

4.2.1 Emissions during battery manufacturing

For technologies using PVDF as binder

PVDF is mixed with its organic solvent NMP and other electrode components. A PDVF latex can also be used. This wet mix is then coated on a metallic foil. This electrode is further heated below the degradation temperature of PVDF. The dried electrode is then further used for cell manufacturing. Empty bags of PVDF, PVDF containing residues from the processes as well as scrap cathodes are collected as chemical wastes and disposed of according to applicable European regulations.

For technologies using PTFE as binder

PTFE dispersion is mixed with electrode components and carbon black. This wet mix is then processed and heated below the degradation temperature of the PTFE. The dried mix is then further used for cell manufacturing.

Empty drums of PTFE dispersion, PTFE containing residues from the processes as well as scrap cathodes are collected as chemical wastes and disposed of according to applicable European regulations.

Potential residues of PFAS from binders or electrolyte (either empty packaging or cleaning solutions) are always collected as chemical wastes and disposed of according to applicable European regulations**.** **No unintended and uncontrolled PFAS emissions are foreseen during battery manufacturing.**

4.2.2 Emissions during battery use

During battery manufacturing, active substances, binders (like PTFE and PVDF) and additives are embedded in a mechanical substrate to form electrodes. These electrodes are then further assembled with the other battery components such as separator, electrolyte, connectors, gaskets, washers and casing to obtain a finished battery. This battery is defined in the REACH regulation as "an article with no intended release" meaning that, **under normal and reasonably foreseeable conditions of use, no end-user of this battery will be exposed to any chemical substances. No PFAS emissions are foreseen during battery use.**

4.2.3 Emissions during battery recycling

Battery recycling is mandatory in Europe since 2006 according to the Battery Directive and will remain mandatory with higher recycling targets in the upcoming Battery Regulation. Fluoropolymers are totally decomposed (as compounds), during the pyrometallurgical recycling processes. The fluorine reports to the flue dust. Flue dust is further processed in a hydro-metallurgical process to extract specific remaining metal content. Also, the PFAS containing waste streams and product streams from the hydrometallurgical recycling process may be treated in high temperatures where fluoropolymers are totally decomposed (as compounds). **No unintended and uncontrolled PFAS emissions are foreseen during battery recycling.**

Further information will be provided in subsequent submissions.

5 Socio economic impact assessment for battery value chain

Further information will be provided in subsequent submissions.

6 Why RECHARGE seeks derogations and additional transition times, and industry best practices

Further information will be provided in subsequent submissions.

Glossary

FEP	Fluorinated ethylene propylene
HFP	Hexafluoropropylene
LiCF3SO3	Lithium trifluoromethanesulfonate
Li-ion	Lithium ion battery
LiSO2	Lithium sulfur dioxide battery
LiSOCl2	Lithium-thionyl chloride
LiTFSI	also known as TFSIL,i Lithium bis(trifluoromethanesulfonyl)imide
LMP	Lithium-metal-polymer
LTO	Lithium titanate oxide
Na-ion	Sodium ion rechargeable battery
NFM	Layered oxide of Ni, Fe, Mn (for Na-ion)
Ni-Cd	Nickel Cadmium battery
Ni-MH	Nickel metal hydride battery
NTO	Niobium Titanate Oxide
PBA	Prussian Blue Analogues
PFAS	Per and polyfluoroalkyl substances
PTFE	Polytetrafluoroethylene
PVDF	Polyvinylidine difluoride (both homopolymer and copolymer)
VDF	Vinylidene fluoride
Zn-ion	Zinc-ion rechargeable batteries

Korea Battery Industry Association

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August 25, 2023

KBIA comments on the PFAS Restriction Proposal

August 2023

First Submission

KBIA – Korea Battery Industry Association

Korea Battery Industry Association

About KBIA :

KBIA has 180 member businesses including world-leading battery manufacturers such as LG Energy Solution, Samsung SDI, and SK on, as well as companies in relevant materials, components, and recycling such as POSCO Future M and W-Scope. The association is committed to assisting Korea businesses in their responses to battery-related legislation with the aim to help them better run their business in the global markets.

The Korea Battery Industry Association and its member companies are very much in agreement with Europe's Green Deal policy and are working to achieve carbon neutrality. KBIA member companies are large-scale battery investors in Europe and contribute a lot to the promotion of the European battery industry, including the construction of manufacturing facilities in the EU. Korean battery manufacturer’s local production facilities is now significantly contributing to job creation in the Europe and be an essential part of the EU battery industry, playing pivotal roles in the global battery supply chain.

Due to the current PFAS regulations, the supply chain of LGES, Samsung SDI, and SKon has been disrupted, and we communicate the opinions collected from these companies as follows. We look forward to our views being positively considered to reflect Korea's opinion well.

KBIA – Korea Battery Industry Association

with LG Energy Solution, Samsung SDI, SK on

TABLE

A. Summary

KBIA member companies especially 'LG Energy Solution ("LGES"), Samsung SDI, and SK on' are the largest player in the European battery market. As such, we feels the urgency and responsibility to provide this comment addressing our grave concern that the proposed PFAS restriction will have adverse effects on the EU battery industry.

The Korean battery industry, led by LGES, Samsung SDI, and SK on has been the pioneer of the battery manufacturing sector since the beginning. It took 30 years to fully commercialize batteries for Electric Vehicles ("EV") and other important environment-friendly applications, such as Energy Storage Systems ("ESS"). From our over 30 years of experience, we know that **the currently suggested 13.5/6.5-year derogation period to replace PFAS materials in the battery industry is unrealistic and not achievable.**

Since replacing PFAS in batteries is practically impossible and any replacement will likely be an inferior solution, **the battery industry in its entirety should be excluded from the PFAS restriction** for the following compelling reasons:

① The scope of the restriction is overly extensive, resulting in the inclusion of PFAS substances that have **not been proven to be harmful** on the prohibited use list;

② Rechargeable batteries **release minimal amounts of PFAS** into the environment and provide little to no exposure to the human body throughout their life cycle;

③ It is not feasible to develop viable alternative PFAS-free materials and respective technologies for the battery industry within the currently suggested derogation period. The data that we have collected in our 30 years of extensive experience with the commercialization of EV, ESS and other industrial batteries compels the conclusion that **it will take at least 40 years to achieve a stable commercialization of PFAS-free EV batteries;**

④ Even those 40 years may however not be sufficient to verify cell performance and reliability. **An insufficient verification of cell performance and reliability for EV due to time constraints would risk user's safety**;

⑤ The proposed restriction creates **extreme market uncertainties, leading to a halt in EU investments across the entire supply chain and hindering the achievement of the EU's Carbon Neutrality target.**

⑥ Including batteries in the PFAS restriction strongly contradicts the EU's general policy on batteries, especially the new EU Battery Regulation which emphasize **the core importance of batteries for the EU's sustainability/climate/green mobility goals**.

Given these facts, the only reasonable option is to **exclude EV, ESS and other industrial batteries from the PFAS restrictions or have an unlimited derogation period.** A derogation period, even one of 40 years, would endanger urgently needed industry investments and render

a systematic manufacture planning impossible. **The exclusion of the 'Battery Industry' from the PFAS Restrictions is crucial to preserving the supply chain of lithium-ion batteries in the EU, supporting the realization of the EU's circular economy and a more sustainable eco-friendly environment**.

I. Introduction

The Korean battery industry and LGES, Samsung SDI, and SK on have been the pioneer of the battery manufacturing sector since the beginning.

We embarked on our first battery development research in 1992 and has been dedicated to creating unparalleled material technologies and next-generation batteries ever since. With outstanding technological capabilities in the fields of Advanced Automotive, Mobility & IT, and ESS batteries, we are actively pursuing new product developments and securing a world-class battery production capacity while expanding the next-generation energy market.

We have been bringing forward major investment in building manufacturing facilities in the EU. LGES, Samsung SDI, and SK on's local production facilities in Poland, Hungary will significantly contribute to job creation in the EU and function as an essential part of the EU battery industry, the latter playing a pivotal role in the global battery supply chain.

We have been recognized as the most environmentally cautious companies globally. For many decades, environmental concern and sustainable growth have been a high priority for us. Our aims to lead ESG management with the understanding that the consistent growth of the battery industry is the basis of the increasing use of green energy, contributing to a sustainable future for humanity. In particular, our aims to achieve carbon neutrality of its value chain by 2050. Ultimately, we strive to go beyond carbon neutrality with the goal of being carbon negative.

From our over 30 years of experience, we know that **the currently suggested 13.5/6.5-year derogation period to replace PFAS materials in the battery industry is unrealistic and not achievable.**

The new EU Battery Regulation creates a well-structured framework that addresses and eliminates potential health and environmental risks of end-of-life batteries. The new EU Battery Regulation is a cornerstone of the European Green Deal and aims to improve the circular economy, resource use and efficiency, and the life cycle of batteries in terms of climate neutrality and environmental protection.

II. Reasons why the complete exclusion from the PFAS ban is required

1. Environmental Perspective

1) Overly extensive scope of the restriction: inclusion of PFAS not proven to be harmful

The scope of proposed restriction is excessively broad, encompassing PFAS substances that have not been proven to be harmful, leading to their placement on the prohibited use list. As per Annex XVII to REACH, restrictions are intended to ban the use of substances that have been confirmed to be harmful through the rigorous REACH process of registration and evaluation. PFAS types such as PFOA (Perfluorooctanoic acid), PFOS (Perfluorooctanesulfonic acid), and PFHxS (perfluorohexane 1 Sulphonic Acid), which have been confirmed to be harmful, are appropriately restricted under Annex XVII.

However, it is extremely vital to ensure that **only additional PFAS substances that have been conclusively demonstrated to be harmful are selectively made subject to restrictions**. A targeted and evidence-based approach is required to strike the right balance between environmental protection and allowing for legitimate and safe uses of PFAS substances in various applications.

2) Rechargeable batteries release minimal amounts of PFAS into the environment and provide little to no exposure to the human body throughout their life cycle. [1]

It is essential to emphasize that rechargeable batteries release minimal amounts of PFAS into the environment and provide little to no exposure to the human body throughout their life cycle. PFAS substances are contained solely inside the battery and do not escape into the environment. **At each stage of the battery life cycle – production, usage, collection, and disposal – there in no significant or non-controlled risk of exposure to humans or the environment.**

The only moments of potential exposure during battery collection are effectively regulated and resolved through the **EU Battery Regulation**. The EU Battery Regulation mandates the collection/recovery and recycling of used batteries with increased target rates over time, particularly for EV, by 2030**.** By enforcing this Regulation, any – potential – exposure to PFAS during the collection/recycling and disposal stages is tightly controlled. Consequently, for the battery industry, the current proposed PFAS restriction appears excessive as it restricts the use of crucial materials despite the ability to manage potential negative effects effectively through other regulation.

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[1] See RECHARGE's dossier submission to ECHA for detailed description.

2-1) Rechargeable batteries release minimal amounts of PFAS into the environment

Slide 24 from the 5 April 2023 ECHA webinar[2] on the PFAS restriction highlights that the energy sector represents between 0 and 1% of the total emissions of PFAS. Nevertheless, we present a detailed analysis of these emissions over the battery life cycle. Studies performed by Desotec demonstrate that all sources of emissions (not just PFAS) during the entire battery life cycle are tracked and controlled.[3]

2-2) In each stage of the battery's life cycle there is no significant risk of exposure to humans or the environment

(1) Battery Manufacturing Stage

There are no unintended or uncontrolled emissions of PFAS during the battery manufacturing process. During the battery manufacturing stage, PFAS handling facilities (input/mixer) are equipped with local exhaust systems, effectively preventing any scattering into the environment or the atmosphere. The use of sealed pipes during material transfer further minimizes exposure to the human body and the environment. Additionally, it is mandatory for workers handling PFAS substances to wear protective equipment, such as protective clothing, goggles, hats, and dust masks, ensuring their safety in the event of minimal emissions.

All battery manufacturing operations are conducted in facilities abiding by applicable permission requirements of the respective (EU Member) State, where any release of emissions is controlled and must be below regulation threshold limits. These include the limits of the Industrial Emissions Directive[4] ("IED"), aiming to prevent and limit levels of pollution. Under the EU Green Deal ("EGD"), the IED is in the process of being amended with a revision proposal released last year[5]. The proposed IED revision not only addresses PFAS limits but also clarifies requirements for reviewing and updating permits to comply with environmental quality standards, measures under the water legislation permits as well as reducing emissions of pollutants and greenhouse gas emissions. The proposed IED also specifically addresses the importance of the sustainable growth of batteries outlining all EU legislations in alignment to

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[2] Restriction of PFAS under REACH, ECHA webinar of 5 April 2023, available at: https://echa.europa.eu/-/restriction-of-per-and-polyfluoroalkyl-substances-pfass-under-reach.

[3] *Kirchhoff*, M./*Reichert*, D.: Emission Compliance in Battery Manufacturing and Recycling. Presentation slides of Desotec Activated Carbon, available at: www.desotec.com.

[4] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control).

[5] Proposal for a Directive of the European Parliament and of the Council amending Directive 2010/75/EU and Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste (COM(2022) 156 final).

make this happen. In addition, the Chemicals Strategy for Sustainability Towards a Toxic-Free Environment[6] directly addresses the production of safe and sustainable chemicals for batteries.

(2) Battery Use Stage

During battery manufacturing, active substances, binders (like PTFE and PVDF), and additives are embedded in a mechanical substrate to form electrodes. These electrodes are then further assembled with other battery components such as separator, electrolyte, connectors, gaskets, washers, and casing to obtain a finished battery. Lithium batteries are sealed by design and do not have any openings. Some alkaline batteries may need to have water additions during their working life and therefore may be equipped with a valve opening system. Although gasses can be emitted during the working life of these batteries, the valves are designed to prevent any PFAS liquids or solids emissions leakage**. There are no PFAS emissions from any type of battery during normal use of the battery.**

(3) Waste Battery Collection Stage

The Batteries Directive 2006/66/EU, as amended by Directive 2013/56/EU, banned the disposal to landfill or incineration of automotive batteries and industrial batteries. Instead, **all automotive batteries and industrial batteries that become waste in the EU are collected and recycled in closed loop systems which minimize emissions.** The new EU Battery Regulation[7] states that all waste starting, lighting and ignition ("SLI") batteries, waste industrial batteries and waste EV batteries should be collected.

For this purpose, the producers of these batteries "*should be required to accept and take back free of charge, all waste batteries for their respective category from end-users*". Detailed reporting obligations should be established for all producers, waste management operators and waste holders involved in the collection of waste SLI batteries, waste industrial batteries and waste EV batteries (paragraph 112, page 70). The EU Commission Batteries FAQ[8] states that "***nearly 100% of automotive batteries and industrial batteries are already being collected***" and notes that the economic value of batteries motivates collection by professionals.

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[6] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Chemical Strategy for Sustainability Towards a Toxic-Free Environment, 14 October 2020.

[7] Regulation of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC.

[8] https://environment.ec.europa.eu/topics/waste-and-recycling/batteries-and-accumulat.

The European association of national collection schemes for batteries (Eucobat)[9] estimates that 19% of portable batteries placed on the EU market are exported in second hand or waste electrical products and therefore are not available for collection and recycling in the EU. Eucobat highlights that achieving a 65% collection and recycling target based on the quantity of batteries placed on the market is equivalent to achieving a 80% collection and recycling target based on the quantity of batteries that are available for collection.

In the meantime, Art. 59 sec. 3 EU Battery Regulation requires the industry to achieve the following collection and recycling targets based on the quantity of portable batteries placed on the market:

- 45% by 31 December 2023;
- 63% by 31 December 2027;
- 73% by 31 December 2030.

Achieving these targets will move the collection and recycling of portable batteries towards a closed loop system which minimizes emissions.

Increasing collection and recycling rates of portable batteries will also help with the large amounts of batteries stored by consumers. Surveys have shown that consumers tend to hoard electronic products that are old, broken, obsolete, or are no longer in use for different reasons. These waste portable batteries from consumer electronic products stored at home are currently not available for collection and recycling.

Once collected, the Waste Electrical and Electronic Equipment (WEEE) Directive[10] aims to achieve a separate recycling of Electrical and Electronic Equipment (EEE) and the batteries included in them. Art. 8 sec. 2 WEEE requires that the WEEE recycling process shall remove batteries from any separately collected WEEE, if possible. The removed batteries can then be recycled.

However, not all batteries can be removed from WEEE. Many electronic products include small batteries on the printed circuit boards to provide back-up power to clock functions and memory functions. The WEEE Directive requires (*inter alia*) the removal of printed circuit boards of mobile phones generally. These printed circuit boards are often sent for metal smelting including any batteries contained on the boards. The smelting of batteries at 1,600℃ destroys the PFAS entirely and does not result in any PFAS emissions. This explains why a large proportion of waste portable batteries in consumer electronic products are not available

[9] https://www.eucobat.eu/downloads/position-paper-collection-target-waste-batteries.

[10] Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE).

for collection and battery recycling because they are not separately removed during the WEEE recycling process.

(4) Waste Battery Recycling Stage

The new EU Battery Regulation aims "*to make all batteries placed on the EU market more sustainable, circular and **safe***"[11] to achieve the EU circular economy and decarbonization ambitions from the sourcing of materials all the way through to battery collection, recycling, and repurposing. Once it enters into force, sustainability requirements such as disclosure of batteries' environmental footprint and recycled content will be introduced starting in 2024.

Batteries are recycled using pyrometallurgical processes and/or hydrometallurgical processes. All types of PFAS used in batteries are fully dissociated into fluorine compounds at these high temperatures. PVDF rapidly decomposes in the temperature range 400 – 510 ℃, followed by gradual decomposition between 510 – 700 ℃. The most stable PFAS, perfluoromethane (CF4), needs a temperature of 1380 ℃ to be dissociated. The temperature of the smelting reduction stage results in complete destruction of all these types of PFAS. **As the materials are smelted at between 1400℃ and 1600℃ during the pyrometallurgical process, there are no PFAS emissions from the pyrometallurgical process.**

All battery recycling operations are conducted in facilities which are permitted by the competent authority within each EU Member State, where any release of emissions is controlled and must be below regulation threshold limits. These limits include those set by the Industrial Emissions Directive[12] which sets limits on preventing and limiting levels of pollution.

2-3) By enforcing the new EU Battery Regulation, exposure to PFAS during the collection/recycling and the disposal stages can be tightly controlled.

The new EU Battery Regulation creates a well-structured framework that addresses and eliminates potential health and environmental risks of end-of-life batteries. The new EU Battery Regulation is a cornerstone of the European Green Deal and aims to improve the circular economy, resource use and efficiency, and the life cycle of batteries in terms of climate neutrality and environmental protection.

Regarding portable batteries – as the kind of batteries mainly used in EEE – it tightens the requirements for removability and sets new requirements to ensure replaceability. A battery will be considered

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[11] https://ec.europa.eu/commission/presscorner/detail/en/ip_22_7588.

[12] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control).

removable if it can be removed and replaced with a comparable battery without affecting the device. Such batteries in the future have to be removed and replaced, with the old battery requiring recycling under the new EU Battery Regulation. The enforcement of these new provisions will drastically decrease the number of EEEE-batteries being discarded by consumers and ensure their safe collection and professional recycling. This will significantly reduce the risk of improper treatment of end-of-life batteries which could potentially lead to PFAS exposure.

2. Technical Perspective

1) From our 30 years of extensive experience with the commercialization of EV, ESS, and other industrial batteries, we know that it would take at least 40 years to achieve a stable commercialization of PFAS-free EV batteries, and that the **currently suggested 13.5/6.5-year derogation period to replace PFAS materials in the battery industry is unrealistic and not achievable.**

The data that we have collected in the last 30 years of development of materials, optimization of the entire battery manufacturing process and supply chain **compels the conclusion that it would take at least 40 years to achieve a stable commercialization of PFAS-free EV batteries**.

This is especially due to the following reasons:

(1) Currently **no alternative cathode binder material**[13] **for PFAS (for example PVDF or PTFE) exists that simultaneously satisfies all required characteristics**, such as high voltage stability, thermal and chemical stability, mechanical properties, and processability. **The alternative material development period alone is predicted to be longer than 10 years at minimum.**

(2) After the alternative material is developed**,** it will **take at least 30 years to evaluate its commercialization,** which includes a new development and optimization of the entire battery manufacturing process as well as of the required facilities and equipment.

(3) The abovementioned minimum 40 years may not be sufficient to verify cell performance and reliability. **An insufficient verification of cell performance and reliability for EV due to time constraints would risk user's safety**.

(4) An **increased battery price** due to a decreased yield of battery manufacturing, an investment in mass production facilities/equipment, and binder supply shortage **will be an obstacle for the swift transition to carbon free EVs in the EU.**

At this point, it is unclear if and when a PFAS alternative for EV batteries can be found.

[13] The cathode binder indicates either the binder inside cathode itself or the binder added between the electrode and separator for adhesion during stacking or winding processes.

Even in the most positive scenario assuming that it will be found within reasonable time, the **total estimated time for the development and commercialization of PFAS-free EV batteries is at least 40 years**. It is however likely that no alternative exists or that processes will take significantly longer, especially to ensure safety for consumers. Therefore, any derogation period for EV batteries would have to be unlimited.

Given these facts, the only reasonable option is to exclude EV, ESS, and other industrial batteries from the PFAS restriction or have an unlimited derogation period. A derogation period, even one of 40 years, would endanger urgently needed industry investments and render a systematic manufacture planning impossible.

The battery manufacturers in Korea are consistently conducting technical reviews on alternatives for PVDF but have not found a material as good as PVDF in terms of productivity, quality, performance, and stability.

Recent academic research highlights materials such as polyimide, polyurethane, polyolefin, polyester, and epoxy, but as discussed in this report, none of these satisfies the desired processability, stability, and environmental aspects in the current lithium-ion battery design.

Some binders, for example, may seem feasible on a research level, but the actual commercialization involves various aspects not discussed in academic papers. This includes the productivity, quality, performance, safety, reliability, testing, and development, which will take at least 30 years based on our past experience.

In addition, in case the components of the lithium-ion battery need to be changed when the new binder is applied, the equipment, facility, and new material need to be developed and verified. This will further extend replacement times.

Also, the hazards of the newly introduced materials may be higher than those of PVDF and previous materials.

It therefore has to be concluded that replacing PFAS is practically impossible and that any replacement will likely be an inferior solution. **Therefore, the battery industry needs to be excluded entirely from the PFAS restrictions.**

1-1) No commercialized alternative candidate in the current market satisfies the most important characteristics of a cathode binder and it will take at least 10 years to develop an appropriate alternative.

There is **no commercialized alternative candidate** in the current market that satisfies the **following most important characteristics as a cathode binder, which need to be met simultaneously**: ① high chemical stability, ② electrochemical stability, ③ high thermal stability, ④ high mechanical properties, and ⑤ good processability.*14*

- **Minimum Requirements for Normal Lithium-Ion Battery Binders**

The primary function of a binder for lithium-ion battery is to provide mechanical strength and electrode stability. Cathode binders, for example, limit volume expansion during the lithium-ion battery intercalation process to maintain structural stability, while performing as a buffer during delithiation to support return to its original structure.

The bare minimum requirements for cathode binders in lithium-ion batteries are discussed below. These properties need to be considered in various perspectives, such as mechanical stability, electrochemical stability, and processability.

(1) Mechanical Stability

Carbonate electrolytes used in a lithium-ion battery are of high polarity. A binder must maintain its function and work as an adhesive and not dissolve in the electrolyte.

Without an appropriate binder, repeated expansion/contraction caused by charging and discharging can lead to structural deformation, meaning ohmic resistance induced by a weakened bond between active materials and conductive additives, which could lead to an overall decline of battery capacity. Even electrode dropout can happen, which could result in a serious safety issue.

Thermal resistance and flame retardancy are also required for a binder since the drying process of electrodes generally happens at around 200℃. Only a limited group of polymer substances qualifies for such requirements.

(2) Electrochemical Stability

Oxidation resistance is also required with respect to the generation of active oxygen in an overcharging state of metal oxide, such as cathode materials. Furthermore, a binder should have a lithium-ion conductivity without any side reaction while it is soaked in electrolyte. High-molecular substances that qualify for such requirements cannot be specified.

For example, compared to organic electrolytes such as ethylene

[14] The details regarding each property can be referred to Section 2.1.1 of RECHARGE 2nd draft.

carbonate(EC) (-12.46 eV) and propylene carbonate(PC) (-12.33eV), fluorine-based materials such as PVDF (-14.08 eV) and PTFE (-15.47 eV) have a comparative advantage in terms of oxidation potential.

(3) Processability

A. Homogeneity

A binder should uniformly paste/adhere with either active materials, conductive agents, or additives, while ensuring certain properties such as stable coating.

B. Contamination

A binder should not experience problems such as detaching from collector during the slitting and notching processes.

C. Viscosity

A binder with adequate viscosity is required to apply high shear force to mix the slurry uniformly.

D. Environment

Residue and solubility should be considered so that solvent can be recovered and reused.

E. Fibrillation (Dry electrode process)

A binder with enough fibrillation ability is required to paste/adhere with either active materials, conductive agents or additives uniformly in dry mixing condition.

- **No "alternative candidate material" satisfies the most important characteristics that have to be fulfilled simultaneously by a cathode binder.**

The materials most mentioned as cathode binder alternatives can be classified as aqueous and non-aqueous binders:

(1) Aqueous Binder

According to our research, the Ni-based cathode active material is easily degradable with only a minimum amount of moisture (several hundred ppm)[15], which consequently leads to battery performance degradation. It has been confirmed that the use of aqueous binder leads to a drastic decrease of the battery lifespan. This cannot be avoided by controlling/adjusting the aqueous binder type, content, configuration. It was also confirmed that **it is practically impossible to produce an electrode on an aqueous base.**

Therefore, the use of PFAS is inevitable for cathode binder.

(2) Non-Aqueous Binder

Both battery makers and researchers have made enormous efforts to develop binder for non-aqueous solvent application to replace PVDF over the past 30 years, but none have been commercially successful.

The use of PVDF is dominant in non-aqueous and commercialized cathodes in lithium-ion batteries, and numerous studies have been conducted to replace fluorine-based polymers in industries. The candidates for alternatives however have critical flaws that bar their commercialization and the currently available candidates cannot be utilized.

A. Polyimide: while showing good adhesion and thermal resistance, the imide bond is not suitable for the required characteristics.

B. Polyolefin (PE, PP): electrochemically not suitable due to high HOMO energy level (i.e. the oxidation potential value is too low).

C. Polyester: while showing good adhesion and thermal resistance, the ester bond is not suitable for the required characteristics.

D. Epoxy: time needed to induce curing is too long in processing perspective.

- **The unique property of PVDF is suitable for lithium-ion batteries and the recycling of the non-aqueous solvent is well established, which is environmentally desirable.**

(1) Processability

PVDF has a low crystallinity as a polymer, allowing it to have relatively

[15] Particularly, the extent of degradation becomes more severe as the content of Ni increases in the cathode material.

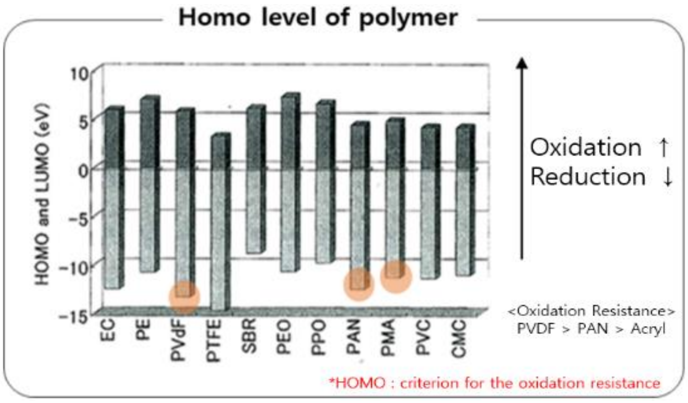
high solubility and great processability. The viscosity range is highly controllable, which is important in deciding the slurry viscosity suitable for the specific ratio of the active material. It is advantageous for coating quality and the adhesion to the electron collector is decent. In addition, the slurry made with PVDF exhibits appropriate flexibility and stiffness when pressed making it suitable for a high density pressing.

(2) Stability

PVDF, compared to other polymers, has an unusually high dielectric constant and exhibits an excellent lithium-ion conductivity ($10^{-6} \sim 10^{-5}$ S/cm) when swollen by electrolyte. Also, the strong bond between carbon and fluorine within the polymer makes it resistant to chemical changes under almost all carbonate electrolytes. Thus, PVDF satisfies all necessary properties as a cathode binder in lithium-ion batteries.

(3) Oxidation Resistance

During charging, the cathode is under a strongly oxidizing environment. Oxidation resistant properties are mandatory for a cathode binder. The oxidation resistant properties become better as the Highest Occupied Molecular Orbital (HOMO) energy level decreases, and the low HOMO energy can be achieved by introducing an electron acceptor. The fluorine-based functional group (-F, -CF2) is one of the strongest electron acceptors, and there is no polymer found that exhibits oxidation resistant levels that are similar to PVDF or PTFE, which are composed purely of the aforementioned functional group.



(4) Environment

PVDF, which is synthesized by polymerization, uses NMP as solvent and the solvent has an ignition temperature of 346°C, making it highly stable.

Also, the solvent recycling and reuse are well established and easier compared to other solvents. In addition, **PVDF exhibits relatively low toxicity compared to other aqueous alternatives suggested by RECHARGE.** [16] Overall, the toxicity and persistence – ECHA's main concerns – of PVDF are not much different from that of the alternatives.

Contents	PVDF	PTFE	SBR	CMC	polyacrylic acid
CAS No.	24937-79-9	9002-84-0	9003-55-8	9004-32-4	9003-01-4
H	- Skin irritation category2 - Eye irritation category2 - Specific target organ toxicity, single exposure category3	- Skin irritation category2 - Eye irritation category2 - Specific target organ toxicity, single exposure category3 - Aquatic chronic category4 - Specific target organ toxicity, repeated exposure category1	- Carcinogenicity category1A - Mutagenicity category1B - Skin sensitization category1 - Eye irritation category2 - Aquatic chronic category3 - Specific target organ toxicity, single exposure category3	- Skin irritation category2 - Eye irritation category2 - Aquatic chronic category3 - Acute toxic category4 - Specific target organ toxicity, repeated exposure category1	- Carcinogenicity category1A - Mutagenicity category1B - Skin irritation category2 - Skin corrosion category1B - Eye damage category1 - Eye irritation category2 - Acute toxic category4 - Aquatic acute

[16] See RECHARGE's dossier submission to ECHA for detailed description.

					category1 - Aquatic chronic category2 - Specific target organ toxicity, single exposure category3

Although it depends largely on the processing control during lithium-ion battery manufacturing, the solvent recycling is generally easier for non-aqueous solvents with lower flash point, i.e. more volatile, compared to water that has strong bonds and less volatility. Thus, the use of **PVDF requires less energy for solvent recycling and reuse, resulting in lower Global Warming Potential ("GWP") and is therefore more eco-friendly**.

Meanwhile, the dry process in which no solvent is utilized during the electrode manufacturing process also requires the use of a different type of fluorine-based polymer material, PTFE, as a key component. The fibrilization property along with the aforementioned requirements such as thermal, chemical, and mechanical properties, makes PTFE an irreplaceable material for dry processing. **PTFE also exhibits relatively low toxicity compared to other aqueous alternatives suggested by RECHARGE**[17].

1-2) Even if an alternative binder for PVDF is developed, the actual commercialization will take at least 30 years.

Replacing PVDF is not equivalent to merely replacing one material with another. Rather, the entire process including the binder dissolution, slurry preparation and transfer, electrode manufacture, and cell assembly is affected in a complicated way by changing the binder, and **a great deal of time and cost must be invested to verify the manufactured cells**. In other words, **it is not only difficult to replace the binder but doing so will also largely affect the entire battery manufacturing process and cell performance**.

In our experience, the required development of new processes, equipment, and large-scale

[17] See RECHARGE's dossier submission to ECHA for detailed description.

facilities and the optimization of commercialization cannot be accomplished in less than 30 years. In addition, it will take decades to thoroughly evaluate the biological hazard and working environment safety, especially if the alternative has not already been evaluated for biohazard effects over generations.

It is also important to note that the 30 years period which was required for the first-time development of batteries did not even include the material development period. The battery industry has always utilized PFAS materials as key materials from the very initial stage of its development.

Thus, replacing PVDF with a new binder requires that all processes including the binder dissolution process, slurry preparation, electrode coating, drying, and electrolyte wetting are reviewed. During the 30 years of research for our current EV batteries, we have solved various problems of the electrode process and as a result, we have succeeded in the commercialization of EV batteries. A replacement of PVDF with a new binder would render these mass production experiences and efforts to base zero. We would also have to repeat endless trouble shooting for processing issues and require several decades to successfully commercialize again.

When the processes listed below return to base zero, a minimum of 30 to 35 years will be required to rebuild them. Building equipment for each process, developing the process recipe, and verifying the semi-product are mandatory. Also, each step needs to be verified in lab-scale, then proceed to scale-up and pilot, followed by mass production. Realistically, the processes listed below cannot be validated simultaneously; each needs to be validated on a step-by-step basis because each step will have a significant influence on the following step. Also, the resources such as human resources, cost, infrastructure etc. are limited for the below contents to be carried out at the same time in the process.

Based on this, the **minimum estimated time required to verify each process** is as follows:

- at least 2 years for binder dissolution equipment;
- at least 3 years for main mixer disperser;
- at least 4 years for coater;
- at least 3 years for pressing equipment;
- at least 3 years for notching equipment.

Thus, the total time required for the process development alone is a minimum of 15 years. After development, the following steps are required:

- at least 4 years to verify the assembly processability and cell performance, which are needed in the 4M processes for customers;
- at least 10 years to build a plant to expand to mass production;

- at least 3 years to stabilize the yield, overall equipment efficiency, and quality.

Therefore, the total time required for a transition is minimum 30 years, but likely more. It should also be noted that **if the newly developed alternative turns out to be hard to handle in processing, these time estimations might not be enough to stabilize mass production at the same level as currently PVDF**.

The following describes **typical past experiences of battery manufacturers where development/commercialization times took much longer than anticipated** due to difficulties of developing at each step of the process:

(1) Binder Dissolution

When manufacturing the cathode slurry, a process of pre-dissolving the PVDF binder is required to uniformly disperse the binder. At this stage, the state of the binder greatly affects the raw material storage, weighing, dissolution vessel type, selection of process equipment, and condition setting. If the new substitution binder is in the form of a bale such as rubber, there may be great difficulties in preparing the process including cutting and quantitative weighing, and a new facility investment for these may be inevitable. In addition, the bale form has a low specific surface area, so it may take more time and cost more energy to dissolve it sufficiently.

If the new alternative binder is in the form of a solution, a dissolution process would not be required, but the additional mass of the solvent needs to be reflected in the transportation cost and there is a high risk of binder property being compromised due to the high temperature when passing through the equator. In addition, the solution type requires a large storage space, and the existing dissolution facilities are likely to become unused facilities.

If it is a powder type such as PVDF, it is highly likely that the new substitution binder has a higher molecular weight to compensate for lower physical properties compared to PVDF, a more complex structure such as a copolymer, or a composite of one or more polymers. In this case too, in order to sufficiently dissolve the binder, more thermal energy and process time as well as a solvent change, additional dissolution equipment, and the like may be required.

(2) Cathode Mixing

When manufacturing a cathode slurry, the binder uniformly disperses the active material and the conductive material, thus contributing to appropriate rheological properties. However, if the binder is changed, there is a high possibility that both the existing solvent and the mixing process equipment themselves need to be changed for the slurry to have an equal or better processability. Asides from the dispersibility of the cathode slurry, the phase stability of the slurry is important as well and the viscosity of the slurry should not rapidly increase or decrease before coating or drying. PVDF has been developed and improved to obtain the slurry properties that are optimized to assure the desired slurry stability in a non-aqueous solvent through a long period of research and development, including the development of recycling technology for reuse of the solvent.

(3) Cathode Slurry Transfer

In addition, one of the factors that is easily overlooked is the slurry transfer step, which is directly related to productivity in manufacturing. In the case of applying a new alternative binder replacing PVDF, if the slurry viscosity is significantly increased, the entire transfer system of the pipeline may need to be replaced.

This change includes increasing the transfer pump power according to the physical properties, readjusting the line of balance, and evaluating a full review of new facility investment.

(4) Electrode Production

From the viewpoint of electrode production, the slurry must have appropriate rheological properties, which are also greatly affected by the binder. The binder change causes a large change in the flow and thermal properties of the slurry (particularly, it affects the drying temperature and drying time), and is highly likely to cause electrode quality problems in the coating and drying process after slurry preparation.

In addition, certain binders are likely to require the introduction of an additional process different from the existing process for coating/drying. For example, a high temperature curing process of 300°C or higher may be required to improve the performance of the binder. In this case, it is necessary to develop a new temperature control process and related process equipment that can ensure the uniformity of the electrode, not to mention the need to build a new facility for the large-scale and high temperature that uses much more thermal energy.

(5) Cell Assembly

The binder greatly affects the physical properties of the electrode such as electrode adhesion force and flexibility. If the adhesion force is lower than that of PVDF, it cannot easily proceed to the subsequent process stage due to electrode detachment and even if the cell is manufactured, the capacity and cycle performance are inevitably degraded. In addition, if a design change such as an increase in binder is made to make-up the insufficient adhesion force, the electrode may become stiffer and lose flexibility. For the mass production of electrodes, the electrodes are wound and unwound in the form of rolls, and at this stage, the electrodes with low flexibility and brittleness cause additional problems of being easily broken and detached.

(6) Electrolyte Wetting

Once produced, the electrode undergoes an electrolyte wetting process where the degree of wetting is greatly affected by the affinity of the binder and the electrolyte. If an electrolyte-friendly functional group is additionally introduced into the binder, it may be helpful to solve this problem, but mechanical properties of the binder may be compromised. Thus, other problems such as a decrease in electrode adhesion force or a decrease in cell life may be the result.

(7) Cell Verification

When changing the binder, the cell needs to be verified for its safety and life span. This process takes a very long time and is high cost. For EV cells, it has been taking decades to obtain data from field tests regarding cell safety upon sudden temperature change and impact. It is obvious that a newly introduced binder will have to go through the same verification steps as PVDF did, which will take just as long. For example, in the case of EV and ESS cells, life verification of 3,000 cycles or more is required to guarantee at least 10 years of lifespan, but it takes more than 2 years for the verification of one condition. This applies for the case of continuous charge/discharge, and the actual field test will take more than 10 years because charge/discharge will not be continuous.

2) The abovementioned minimum 40 years may not be sufficient to verify cell performance and reliability. **An insufficient verification of cell performance and reliability for EV due to time constraints would risk user's safety**.

In the beginning of the commercialization of batteries, there have been multiple fire incidents. The battery industry has invested around 30 years of research and development to ensure the reliability and safety of the batteries, and the EV and ESS industries are now blossoming due to the improved battery quality. **To assure the long-term reliability of EV and ESS, field test data under high temperature, low temperature, vibration, and impact was collected over 20 years through the Battery Management System ("BMS") embedded in the battery pack.** The battery industry has worked very hard to achieve the current level of reliability. The effort, time, and cost invested are valuable assets to the industry that cannot be calculated through a simple arithmetic. **If an alternative binder was applied without such extensive long-term verification, tremendous safety risks for end-users would be the consequence.**

3) Comprehensive exclusion from the ban is required for the entire battery industry

As it has been emphasized, developing viable alternative PFAS substances and their manufacturing technologies used in the battery industry within the currently suggested derogation periods is not feasible.

The proposed PFAS restrictions **not only affect the manufacturing of current cell materials, pack parts (used for electric vehicles and ESS), and electric/electronic devices but also hampers the development of key essential materials for the development of next-generation batteries.** Examples of these indispensable materials include "PVDF" and "PVDF Copolymer" utilized as cathode binders and separator binders, "PTFE" used as binders for dry process, and O-rings and gaskets employed in the top cap of cylindrical batteries.

These materials cannot be substituted with existing technologies or alternative materials. Over the course of more than three decades, the battery industry has dedicated extensive research and development efforts to optimize the performance and stability of these materials. **Replacing them with non-PFAS materials would inevitably impact the performance, stability, and – most importantly – the safety of the materials achieved through decades of innovation efforts.** The unique properties of PFAS substances played a crucial role in maximizing and ensuring the structural integrity, reliability, stability, and performance of lithium-ion batteries, making them suitable for EV applications. Korea's experience strongly suggests that without PFAS substances, the performance, reliability, and safety of EV batteries will be drastically compromised, hindering the growth of the EV industry, and impeding the progress towards the realization of the EU's long-term eco-friendly strategies and goals.

In particular, the development of alternative materials for lithium-ion battery binders is an intricate task that requires substantial time and resources. The current restriction proposal suggests derogation periods of 6.5 years or 13.5 years. Even when assuming the existence of alternative materials, considering the time required for the development period of alternative substances, sample testing, facility modification, etc., it is impossible to develop viable substitutes for PFAS substances that meet the stringent performance and safety requirements demanded by lithium-ion batteries within these extremely short time lines. The introduction of alternative PFAS substances without extensive evaluation will most likely have a negative impact on battery performance and lifespan, potentially hindering the progress of the EU's "Green Mobility" plans and impeding a successful transition towards EVs.

3. Socio-Economic Perspective

1) Problems linked to the time required to build a new supply chain, price increases, and supply shortage of EV, ESS, and other industrial batteries during the transition.

Even if a new alternative binder could be found, an entirely new binder supply chain would have to be established. In the meantime, PVDF usage has already been minimized to increase energy density. Even if it is assumed that the replacement is carried out only to the minimum required amount, securing the raw materials for a new binder, developing the commercially viable polymerization process, selecting the binder supplier capable of producing the required amount, investing for mass production, **and establishing a stable new supply chain requires an enormous amount of time and financial investment**.

2) The proposed PFAS restriction creates significant market uncertainties which prevent EU investments throughout the entire supply chain.

This situation poses a considerable obstruction to achieving the EU's long-term strategies, including the "Green Deal Industrial Plan for the Net-Zero Age", "Net Zero Industry Act", and "Green Mobility".

In a world where global attention is focused on expanding the EV market, a PFAS restriction would set unachievable requirements for the battery industry, thereby slowing down and even preventing battery and EV production. The consequence will be substantial losses not only for the companies of the EU's battery and EV supply chains, but also for the broader EU economy. Many other EU industries actively promoting green policies, such as the "2030 carbon neutrality" goal, would also be affected.

As of 2022, the EU EV battery market stands at 2.4 million units. However, to meet the EU's target of 100% of new vehicles sold being zero-emission by 2035, there is a need for a 250% increase in the battery market until 2027, and a 550% increase by 2034.

Unfortunately, the uncertain market conditions caused by the proposed PFAS restriction have led material companies to be hesitant to expand their investments. Such difficult investment climate makes it challenging to meet the rapidly growing demand for EV batteries, which must expand by 2 or 3 times the current size within the next 5 years to achieve the EU goals. Material companies usually plan new investments 4 to 5 years in advance, but due to the uncertainty brought on by the PFAS restriction proposal, these companies are currently delaying their investment plans.

3) The huge costs incurred to develop commercially suitable materials and relevant application processes will challenge a swift transition of the EV industry.

In addition, if the PFAS restriction is passed as currently discussed, companies making fluorine-based binders will most likely stop their investments into capacity expansion immediately. In the short term, especially given that currently there is not even a suitable candidate as an alternative, this will most likely to lead to a rapid increase in battery and EV prices as well as a battery supply shortage.

Finally, the financial investment required to develop a commercially suitable material, new mass production facilities, manufacturing processes, and cell verification is estimated to be multi-billion USD. The investment for new mass production facilities for the new alternative material alone is expected to reach more than 1 billion USD/10GWh. **These costs will be reflected in the price of EV batteries. As a result, the burden on EU consumers will increase, and the EV industry itself may be challenged.** This further exacerbates the challenges faced in meeting the ambitious EU targets.

4. Regulatory Perspective

1) Strong contradiction with the new EU Battery Regulation

Including PFAS in batteries in the PFAS restriction strongly contradicts the EU's general policy on batteries, as most recently expressed in the new EU Battery Regulation.

On several occasions, the Recitals to the new EU Battery Regulation emphasize the core importance of batteries for the EU's sustainability/climate/green mobility goals. The Recitals deliver strong arguments making it clear that an exclusion of the battery sector from the planned PFAS restriction is required:[18]

- The transition to e-mobility is indispensable for the EU to reach its 2050 climate goals;
- Batteries will make this transition possible;
- The EU expects the EV-battery market to grow "massively" in the next years due to increased e-mobility demand;
- Batteries have strategic importance;
- It is required to provide legal certainty to all operators on the battery market and to avoid discrimination and barriers to trade;
- Rules for battery performance and safety are required.

Against the background, including the battery sector in the PFAS restriction would strongly contradict the explicit wording and policy considerations of the new EU Battery Regulation.

2) Lack of basis for enforcement and compliance checks of PFAS restriction

Companies in the development/mass production stages typically check for hazardous substances to adhere to relevant regulations. However, the proposed PFAS restriction lacks specific CAS numbers for prohibited substances, making it challenging to identify their presence in the materials.

Furthermore, adequate assessment methods for detecting PFAS substances in most cases have not been established. As a result, besides the material manufacturers, no downstream users can confidently confirm the absence of PFAS substances in their products. To facilitate compliance with proposed regulations, it is imperative to develop methodologies for testing PFAS content in materials and revise relevant laws and regulations prior to incorporating PFAS into the Safety Data Sheet ("SDS") as part of foundation for companies to comply.

III. Conclusion

Based on the aforementioned it has to be concluded that replacing PFAS is practically impossible and that any replacement will likely be an inferior solution. **Therefore, PFAS used by the 'Battery Industry' need to be completely excluded from the restriction.** We sincerely hope that ECHA realizes the magnitude of the abovementioned issues and takes a more practical approach in agreeing with the battery industry that a permanent exclusion from the PFAS restriction for the Battery Industry as a whole is really what is required at this point in time.

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[18] See Recital (2) to the new EU Battery Regulation.

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NMMA National Marine Manufacturers Association   MRAA MARINE RETAILERS ASSOCIATION OF THE AMERICAS   wsia WATER SPORTS INDUSTRY ASSOCIATION

March 1, 2024

Commissioner Katrina Kessler
Minnesota Pollution Control Agency
520 Lafayette Rd, St Paul, MN 55155

Dear Commissioner Kessler,

I hope this letter finds you well. I am writing on behalf of the National Marine Manufacturers Association (NMMA), the Marine Retailers Association of the Americas (MRAA), and the Water Sports Industry Association (WSIA) to comment on unavoidable use in PFAS products, specifically in relation to Minnesota Session Law - 2023, Chapter 60, H.F. No. 2310.

NMMA is the trade association for the U.S. recreational boating industry, representing nearly 1,500 marine businesses, including recreational boat, marine engine, and accessory manufacturers. Our members are often U.S.-based small businesses, many of which are family owned. NMMA members collectively manufacture more than 85 percent of the marine products sold in the U.S. Furthermore, the recreational boating industry has a $230 billion impact on the nation's economy and in communities across the country, with nearly 700,000 American jobs across 35,000 U.S.-based marine businesses.

MRAA is the leading trade association of North American small businesses that sell and service new and used recreational boats and operate marinas, boatyards, and accessory stores. MRAA represents more than 1,300 individual member retail locations and conducts advocacy efforts on their behalf.

WSIA is the towed watersports industry's leading advocate, working to strengthen, grow boating and protect the interests of its member companies and recreational boaters across the country. The WSIA develops best practices, maintains waterway access rights, educates participants, and promotes safety on the water, including when participating in towed watersports. WSIA represents over 440 member companies, including boat, marine engine, and accessory manufacturers, as well as marine dealers.

Boating is big business in Minnesota, with an estimated annual economic impact of $6.9 billion, supporting over 25,000 jobs and 700 businesses. Moreover, we acknowledge the crucial work carried out by the Minnesota Pollution Control Agency (MPCA) in addressing environmental concerns and implementing necessary regulations.

Our members, most of whom are small businesses, face specific challenges in complying with Minnesota's PFAS reporting requirements. While we share the common goal of safeguarding the environment and human health, we believe that collaborative efforts are essential to strike a balance between regulatory demands and the economic feasibility of our industry.

In this letter, we aim to provide extensive insights and recommendations regarding the implementation of PFAS reporting requirements. We believe that collaborative efforts between the MPCA and stakeholders in the marine industry are crucial to achieving a balance between regulatory demands and the economic feasibility of our sector.

Our associations propose the following considerations for the implementation of PFAS reporting requirements, with a focus on a risk-based approach that addresses the unique considerations of small businesses, cost considerations, and the duration of Unavoidable Use determinations:

1. **Define Criteria for "essential for health, safety, or the functioning of society" based on a risk-based approach:** To ensure effective protection of human health and the environment, we request that the regulations adopt a risk-based approach. By focusing on actual environmental, health, and safety risks associated with PFAS chemistries, Minnesota can ensure that its regulatory efforts focus first on its highest priorities. To enhance the efficacy of this approach, we suggest incorporating a thorough evaluation of both hazard and exposure, considering the specific properties and uses of individual PFAS compounds.

   In addition, providing clear and reasonable timelines, coupled with extensive notices to stakeholders, is crucial to facilitate compliance without causing undue disruptions to supply chains and business continuity. The marine industry, with its complex and global supply chains, requires sufficient time for phaseouts and alternative analyses. Therefore, we urge the MPCA to establish realistic timelines, considering the intricate nature of our industry.

2. **Make unique considerations for Minnesota's small marine businesses:** Small businesses in the marine industry, many of which are based in Minnesota, play a vital role in assembling complex components, such as recreational marine engines, boats, trailers, and accessories. They face significant challenges in complying with the precise identification requirements outlined in Session Law - 2023, Chapter 60. For example, a typical 20-foot boat consists of more than 1,000 distinct stock keeping units (SKUs), making it impractical to identify 12,000 potential PFAS chemicals within each purchased component and subassembly. By and large, marine manufacturers are not actually responsible for directly manufacturing products that include PFAS, instead, during the manufacturing process, essential components that contain PFAS are assembled by the marine manufacture to create the final product.

   Moreover, the global and multi-tiered supply chain in the marine industry adds another layer of complexity. Minnesota marine dealers and manufacturers represent a minute fraction of the sales by their international importers and distributors who may be unaware of the ultimate destination of their products. Our members, who manufacture only a few of the components they use in their products, find themselves financially and logistically hard-pressed to acquire the information demanded by the proposed statute.

   Considering these challenges, we strongly urge that the MPCA view small marine businesses through a different lens when making unavoidable use determinations. Recreational boat building is generally driven by small businesses that assemble various purchased components that require a long useful life under harsh conditions. Recognizing the practical limitations faced by these businesses will contribute to a more realistic and feasible regulatory framework.

3. **Consider the costs of PFAS alternatives and develop a reasonable cost threshold:** we recommend the development of a reasonable cost threshold to prevent undue financial burdens on existing and developing marine businesses. The costs associated with developing chemical substitutions and identifying chemicals in a complex, global, multi-tiered supply chain will place an undue financial burden on marine businesses. It is essential that the regulations preserve industry sustainability, innovative capacity, and product diversity. We request that regulatory bodies protect these foundations of business and recognize the already-existing safe, durable, and essential products within the marine industry. A balanced approach that considers the economic

implications of PFAS alternatives will contribute to the long-term success of both environmental protection and the marine industry. Moreover, this approach aligns with international and federal precedents.

4. **Ensure CCU determinations remain in effect for the lifetime of each exempted product category:** Adding complexity to an already daunting task, the Environmental Protection Agency's (EPA) PFAS Master List encompasses over 12,000 potential chemicals falling within the reporting requirements. To address concerns over the ever-expanding PFAS master list, we propose that all Unavoidable Use determinations for a specific product category remain in effect for the lifetime of the product. Avoiding re-evaluation of unavoidable use products will provide much-needed stability for retailers and manufacturers facing substantial challenges in meeting the reporting requirements.

5. **Please share what uses and products you may submit a request for in the future and briefly why?**

   PFAS chemical entities assume a pivotal purpose in the maritime sector, including but not limited to paint, wiring harnesses, monitors, displays, seals, and lubricants. PFAS imparts unmatched thermal protection, water resistance, corrosion prevention, lubrication, and safety to specified marine equipment. Presently, there are notably scant viable alternatives to PFAS in these critical applications and efforts to develop alternatives for them have yielded suboptimal results. Our suppliers report that the substitutes they are testing degrade far quicker, require more frequent maintenance, and compromise the functionality, reliability, and safety of marine equipment. This underscores the importance of PFAS in upholding the integrity of marine equipment.

   For example, components integral to fuel systems, such as gaskets, O-rings, seals, and high-voltage battery cables commonly integrate fluoroelastomer (FKM). FKM is an essential additive and allows these core components to meet stringent design requirements, adhere to low-permeation evaporative emissions standards stipulated by the EPA and CARB, and provide the durability, chemical resistance, and heat resistance these products must have. FKM stands as a superior solution for many marine products, including primer bulbs. The multi-layered design of primer bulbs incorporates an internal FKM component to perpetuate compliance with both EPA and CARB evaporative emissions requirements established in 2010. These bulbs have manifested exceptional durability, reliability, and safety in daily use. Achieving the low permeability required by federal laws. While FKM as a fluoroelastomer may contain small amounts of PFAS chemicals used in its production, there are currently no available alternatives to the FKM component. Moreover, significant time and appropriate deadlines will be needed to allow manufacturers to complete rigorous validation and certification testing to ensure that the substitutes comply with required safety, performance standards.

   In consideration of FKM and its associated safe PFAS chemicals, manufacturers likely will apply for unavoidable use exemptions for a variety of marine equipment, such as marine engines and motors (HTS 8501.31.4000) and navigation gear (HTS 9014.80.4000). These applications will encompass a range of marine engine types, including outboard, inboard, stern drive, gas- and diesel-powered, and electric trolling motors. Manufacturers also foresee applying exemptions for indispensable navigation tools such as sonar, radar, electronic charts, tracking computers, compasses, and fish finders that provide indispensable functions that are integral to maritime operations. Notably, radar systems and electronic charts are essential to Public Safety and Rescue Operations. They must deliver precision and reliability under adverse conditions and require minimal maintenance during search and rescue missions and emergency scenarios. Marine engines and navigational tools play a pivotal role in environmental and marine research. For recreational use, these products propel Minnesota's recreational fishing economy, which boasts an annual economic impact of $10 billion. Furthermore, life jackets, also referred to as personal flotation devices (PFDs), throwable boat cushions, and boating survival gear are mandated by the United States Coast Guard and the International Maritime Organization (IMO) to meet certain harsh conditions and specifications. These products have a very long useful life and must remain intact and functional under robust conditions. The U.S. Coast Guard has statutory authority under Title 46, U.S. Code, Sections 3306(a) and (b), 4102(b), 4302(a) and (c), and 4502(a) and (c)(2)(B), to prescribe regulations for the design, construction, performance, testing, carriage, use, and inspection of lifesaving equipment on commercial and recreational vessels.

We request that the MPCA closely collaborate with Minnesota's marine businesses to ensure a pragmatic and feasible procedure for applying and gaining approval of unavoidable use exemptions. We believe together government and the marine industry can strike a balance that protects the environment and the economic sustainability of Minnesota's marine industry. We are confident that these regulations can be written to address the unique challenges faced by small businesses if they implement a risk-based approach, consider the costs of alternatives, and ensure stability in regulatory determinations, Even environmentally focused states, such as California, with its decades of experience regulating chemical classes, have minimized PFAS reporting mandates due to the massive scale and cost associated with such compliance.

In closing, we appreciate your consideration of these recommendations. We hope to have the opportunity to collaborate in their implementation for the betterment of both environmental protection and the economic sustainability of our industry.

Sincerely,

Chad Tokowicz

Government Relations Manager
Marine Retailers Association of the Americas

Jesse McArdell

State Policy & Engagement Manager Midwest
National Marine Manufacturers Association

Ethan Hellier

Midwest Government Affairs Manager
Water Sports Industry Association

Laurent Davis Attachment
RECEIVED
By: OAH on 3/1/2024

wilo®

WILO USA LLC – W66 N1253 Forward Way, Cedarburg, WI 53012

Date: March 1st, 2024

To: Minnesota Pollution Control Agency

RE: Request for Comments: Planned new Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID number R-4837.

Wilo USA LLC stands firmly behind efforts to minimize the presence of Per- and Polyfluorinated Substances (PFAS) in the environment. However, we express concern regarding the potential economic, social, and health ramifications of current PFAS restrictions. It's important to acknowledge that PFAS play a vital role in ensuring product functionality in critical applications in order to meet stringent safety standards. Major end markets and applications served are as follows:

- Building Services Pumping Equipment, Systems & Accessories for Plumbing and HVAC in commercial and residential buildings.
- Water Management Pumping Equipment, Systems & Accessories for municipal water supply and wastewater handling treatment.
- Agricultural & Groundwater Pumping Equipment for irrigation, fertilization, weed and pest control, flood management.

In line with our commitment to finding balanced solutions, we have worked through our industry associations: Hydraulic Institute, Fluid Sealing Association, Valve Manufacturers Association, the Water and Wastewater Manufacturers Association (a.k.a. the Flow Control Coalition) which have developed a comprehensive Currently Unavoidable Uses (CUU) proposal, that is being submitted to the states of Maine and Minnesota. This proposal is founded upon expert knowledge of the design of critical processes, and incorporates valuable insights gathered from diverse stakeholders including design engineers, end-users and manufacturers of critical system components.

By engaging engineers and experts from the various segments of the fluid handling industry, the Associations have applied a collaborative, systems level approach to this complex issue. Highly corrosive materials, high temperatures, harsh environments, accessibility and life-cycle considerations along with intended, efficient sustainable performance, are all part of the design criteria of the industrial and other process systems which currently require PFAS as there are no viable alternatives to handle toxic substances, prevent hazardous leaks and fugitive emissions, ensure clean air and water, etc.

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Wilo USA LLC actively participated in the consultation process and supports the Flow Control Coalition's submission. We believe that their proposal represents a thoughtful and pragmatic approach to managing PFAS and ensuring that critical functions of industry and society continue while at the same time, mitigating adverse impacts on businesses, communities, and public health.

Laurent Davis
VP Product Management & Marketing

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RECEIVED
By: OAH on 3/1/2024
Jacob Carter Attachment

WINDOW & DOOR MANUFACTURERS ASSOCIATION
WDMA

March 1, 2024

Commissioner Katrina Kessler
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, Minnesota 55155

Re: Planned New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

Dear Commissioner Kessler:

The Window and Door Manufacturers Association (WDMA) is a national trade association representing the leading producers of commercial and residential doors, windows, and skylights for domestic and export markets. Our members sell to distributors, dealers, builders, remodelers, homeowners, architects, contractors, and other specifiers in the residential, commercial, and institutional construction markets. WDMA members manufacture high-quality products designed and constructed to performance-based standards that provide improved safety, comfort, and energy efficiency in residential and commercial buildings.

Last year, the Minnesota legislature passed a law banning products containing intentionally added PFAS that are sold, offered for sale, or distributed in the state beginning January 1, 2032 unless the MPCA determines by rule that the use(s) of PFAS they contain are currently unavoidable uses. We are writing in response to the Minnesota Pollution Control Agency's (MPCA) request for comment related to its planned new rules governing "Currently Unavoidable Use" (CUU) determinations about products containing per-and polyfluoroalkyl substances (PFAS).

Under the law, CUU determinations can be accepted for product uses that are deemed essential for health, safety, or the functioning of society. Windows, doors and skylights play a vital role in the functioning of society and these products should be recognized as essential, warranting special consideration for regulatory exemptions by the MPCA.

Windows, doors, and skylights are indispensable components of buildings and critical infrastructure, necessary for the safety, security, and functionality of homes, businesses, hospitals, and other facilities. These products provide not only protection from external elements but also provide natural light, ventilation, and emergency egress routes, contributing significantly to public health, safety, and the functioning of society. They serve multifaceted functions that are integral to the well-being and operation of commercial and residential communities. Any regulatory measures that impede the production or availability of these

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essential building products could have far-reaching consequences, including disruptions in construction projects, increased costs of housing for consumers, and compromised safety standards.

Notably, historical precedent clearly establishes that windows, doors and skylights are essential for health, safety, and the functioning of society. During the COVID-19 pandemic, when lockdowns and stay-at-home orders were in place, access to safe and secure shelter became even more crucial. Construction and maintenance activities, including the manufacture, installation, repair, and replacement of windows, doors and skylights, were allowed to continue to ensure the integrity and safety of buildings. The designation of window, door and skylight manufacturers as essential during the COVID-19 pandemic was based on the recognition of their critical role in supporting public health, safety, infrastructure, and the economy, ensuring that essential services and functions could continue despite the challenging circumstances.

Windows, doors and skylights also adhere to stringent safety and energy codes mandated by the state of Minnesota that provide reliable structural performance and reduced emissions using components that rely on PFAS chemicals to meet existing regulations.

Please note that WDMA is responding to MPCA's request for comment based on its current assessment, recognizing that its manufacturer members are in the early stages of gathering and analyzing information from suppliers that will enable a more detailed analysis. We would welcome the opportunity to provide supplementary comments as WDMA member companies learn more from its suppliers.

As such, WDMA is submitting comments as MPCA develops the PFAS in Products Currently Unavoidable Use Rule. MPCA requested specific feedback on the following questions:

1. **Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?**

   It is imperative that MPCA establishes criteria defining "essential for health, safety, or the functioning of society" when making determinations for CUU exemptions. Clarity with CUU exemptions is critical to orderly compliance and administration of a law with such broad societal impact.

   In developing this criteria, MPCA should recognize that a foundational aspect of a functioning society is shelter, and further recognize that windows, doors, and skylights are component parts of Minnesotans' homes that are essential for the functioning of society. MPCA should also consider relevant guidance from the state of Maine for PFAS CUU exemptions, which released criteria for "essential for the functioning of society" that includes construction materials and critical infrastructure.

To be considered necessary for "the functioning of society," products with PFAS should satisfy an equally critical policy objective such as: security, sustainability, energy efficiency, availability of housing, and ease of use for all people, such as disabled and aging populations in Minnesota that rely on products with properties provided by PFAS that lessen the operating force of windows, doors and skylights. WDMA's members' products provide these societal needs, and thus windows, doors, and skylights should be deemed necessary for the functioning of society and receive a CUU determination.

A balanced approach is necessary, even with legislation aimed at safety. MPCA should focus criteria on other equally critical needs satisfied by the products at issue. For example, during the COVID-19 pandemic, many manufacturers, like WDMA's members, were deemed essential workers critical to the functioning of society. Those same considerations that were used to draw lines during COVID safety protocol can guide the MPCA here. WDMA's members were critical workers during the pandemic for the same reason that their products are necessary for the functioning of society.

Here, there a number of critical needs and policy objectives aided by the window and door products containing PFAS. For example, the use of PFAS increases durability, and durable products inherently generate less waste, aiding sustainability efforts. Many of our member companies have product warranties of ten years or longer. PFAS removes friction points in WDMA's members' products because PFAS lowers the necessary operating force. This is more than a marketing pitch. The ease with which individuals can operate their home furnishings like windows, doors, and skylights allows disabled and aging Minnesotans to vibrantly remain independent and in their homes. For this segment of the community, PFAS continues to provide autonomy. Removing their options from the market may have a disparate impact on disabled and aging populations.

Further, in the state of Minnesota, adherence to specific performance and energy standards for windows, doors, and skylights is mandated by the Minnesota State Building Codes. These regulations are in place to ensure that Minnesota's commercial and residential buildings meet rigorous criteria for energy efficiency, sustainability, and performance standards. The Minnesota State Building Codes are based on national model codes developed by the International Code Council (ICC) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). The codes provide specific criteria for the design, energy-efficiency and installation of windows, doors and skylights to ensure they meet safety and functionality standards.

Windows, doors, and skylights play a pivotal role in the overall thermal performance of structures, influencing heating, cooling, and lighting demands. The energy codes stipulate stringent requirements for factors such as U-factor, solar heat gain, air tightness, and overall energy efficiency ratings. By establishing and enforcing these standards, the state aims to enhance energy conservation, reduce environmental impact, and promote the construction of buildings that contribute to the overall well-being of residents and the broader community in Minnesota. These are all criteria that MPCA should recognize as "essential for health, safety, or the functioning of society."

WDMA member companies manufacture products that contain thousands of various components that are essential for commercial and residential construction. There are many components that go into producing high-quality windows and doors to meet the energy and safety standards mandated by the state of Minnesota, including coatings and sealants that are integral for sealing out weather and protecting homes from harsh environmental conditions and serve to block dust, sound, and heat transmission. Prohibiting the use of PFAS in adhering to these standards will be immediately detrimental to the commercial and residential construction markets in Minnesota. Coatings and sealants that contain PFAS offer unique properties that enhance the performance of windows, doors and skylights that contribute to their durability, resistance to environmental elements, and overall performance.

For the reasons mentioned above, MPCA should determine that existing building safety and energy codes appropriately regulate windows, doors and skylights and that these products are "essential for health, safety, or the functioning of society."

2. **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.**

WDMA assumes MPCA will accept representative samples similar to other environmental programs like ENERGY STAR. Products manufactured by WDMA members are highly customized with literally millions of product combinations due to size, shapes, wall depth, building construction type, glass package, material types and other considerations. The parts that go into such products accordingly vary. Because of customization, feasibly, WDMA members will seek hundreds of thousands of requests for CUU determinations. The massive number of product iterations will certainly cause a backlog to the MCPA and delay the ability of Minnesotans to purchase windows, doors, and skylights that are needed for home repair projects, remodeling, and larger scale residential and commercial developments.

MPCA should also recognize that windows, doors, and skylights achieve high-performance and energy efficiency standards mandated by the state of Minnesota using PFAS-containing components, such as coatings and sealants, that currently have no reasonable alternative. These components are essential to the overall performance of commercial and residential structures using window, door and skylight products that must meet various energy efficiency ratings. Window, door and skylight manufacturers will seek numerous CUU determinations for fenestration products that must adhere to rigorous standards mandated by the Minnesota State Building Codes.

3. **Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?**

   Yes, the law expressly allows specific products or product categories to receive a CUU determination. WDMA believes this authority from lawmakers to exempt specific products and product categories is part of the necessary recognition that there are critical, essential services, like housing, that cannot be unduly burdened, despite the utility of the law. Further, the fact that the law disallows exemptions for the products listed in the statute underscores that exemptions for products or product categories is feasible and appropriate when the products are outside the ambit of human consumption.

   MPCA should prioritize CUU determinations for product categories that pose low risks to personal health, such as products that are disconnected from human ingestion, and that are not in constant and close contact with the human body. Compare windows, doors and skylights to the prohibited items listed in the law and it is apparent that our members' products do not belong. Windows, doors and skylights are not single-use products, and they are not ingested nor applied to human skin.

   The immediacy of the PFAS reporting requirements and the total ban on products with PFAS additives will severely and adversely impact the ability of our members to conduct business in the state of Minnesota and will have material consequences for both consumers and the commercial and residential construction industries that rely on our products. This warrants a CUU determination that exempts windows, doors and skylights with PFAS from being banned in Minnesota.

Thank you for your consideration of these comments. WDMA recognizes that there will be an obligation to report information on products containing PFAS beginning January 1, 2026. Our members are working diligently to comply with these obligations and look forward to being a collaborative partner with MPCA as these regulations are implemented. For any questions, please contact WDMA's Director of Government Affairs Jacob Carter at jcarter@wdma.com.

Sincerely,

Michael P. O'Brien, CAE
President & CEO
Window & Door Manufacturers Association

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INTERNAL

February 29, 2024

Submitted via the Minnesota Office of Administrative Hearings eComments Website

Katrina Kessler
Commissioner
Minnesota Pollution Control Agency
520 Lafayette Road N
St. Paul, MN 55155-4194

Re: **<u>Georg Fischer Piping Systems Americas Comments on MPCA's Planned Rulemakings for PFAS-Containing Products</u>**

Dear Commissioner Kessler:

On behalf of Georg Fischer Piping Systems Americas, we write to offer comments on the proposed regulations on per- and polyfluoroalkyl substances (PFAS) being developed by the Minnesota Pollution Control Agency (MPCA or the Agency), as authorized in Minn. St. § 116.943 (Section 116.943). These comments discuss the MPCA's planned rules governing currently unavoidable use determinations about products containing PFAS.

Georg Fischer (GF) is a global corporation, founded in 1802, and headquartered in Switzerland, with a presence in more than 34 countries distributed across more than 80 facilities. GF employes over 15,000 employees worldwide and generated sales of 3,998 million CHF in 2022. GF is divided into three divisions, which includes its largest division, Piping Systems.
GF Piping Systems Americas (GFPS) is a leading provider of high-quality piping system products. GFPS employes approximately 2250 employees and has sales of $750 Million. GFPS Americas serves a wide range of industries and applications including Data Centers, Microelectronics, Life Sciences, Food and Beverage, Water & Gas Distribution, Water Treatment, Energy, Chemical Processing, Mining, Agriculture, Aquaculture and others.

GF globally is committed to sustainability and considers this to be an essential pillar of its business framework. GF was recognized by the Wall Street Journal (2020) as the 9th most sustainable company, lending credence to our commitment to our sustainability practices Swiss ingenuity and responsible business processes. While GF supports the goal of limiting the release of PFAS into the environment and reducing Minnesotans' exposure to PFAS, we are concerned about the potential scope and reach of these regulations as well as their incompatibility with the Minnesota's own economic interests.

GFPS does not sell direct-to-consumer based products, as our primary focus is on industrial users, most of which produce products that do not contain PFAS. We believe it is important for MPCA to understand that a prohibition of our broad prohibition of PFAS will impact many industries, including:

- Semiconductor and microelectronics manufacturing
- Industrial chemical processing
- Energy production and energy-related applications
- Marine
- Mining

- Drinking water and wastewater treatment
- Food and beverage production
- Pharmaceutical manufacturing
- Life science industries

Accordingly, GFPS would like to offer its recommendations below to help inform future rule drafting in a way that would avoid negatively impacting the quality of life and the economic prospects of Minnesotans.

1. FLUOROPOLYMERS ARE UNIQUE AMONG PFAS

GFPS must stress that fluoropolymers as a class of substances are significantly different than other PFAS. The lack of such differentiation in Minn. St. § 116.943 is misguided as it will ban substances simply for their similarity to some substances that have been shown to pose a risk to human health and the environment. Although we would prefer to see a full exemption of fluoropolymers from the ban on PFAS in products, we hope that at the very least MPCA will consider the tremendous difference between fluoropolymers and other PFAS when evaluating CUU designations.

Fluoropolymers (covering fluoroplastics such as PVDF, ECTFE, FEP, PFA, PTFE, etc., as well as fluoroelastomers, such as FKM, FFKM, etc.) have unique properties that distinguish them from other PFASs, and they do not have the same environmental and toxicological profiles associated with some substances in this class of chemicals that are of concern.

Fluoropolymers are durable, stable, and mechanically strong in harsh conditions in a variety of sectors including but not limited to automotive, aerospace, chemical processing, environmental controls, energy production and storage, and electronics. They are also stable in air, water, sunlight, chemicals, and microbes, and chemically inert, meeting the requirements for low levels of contaminants and particulates in manufacturing environments critical for the food and beverage, pharmaceutical, medical, and semiconductor industries.

Finally, fluoropolymers are biocompatible, non-wetting, non-stick, and highly resistant to temperature, fire, and weather. These unique characteristics make them a critical material for a broad range of industries and sectors, playing a diverse and crucial role for society, with few, if any, viable alternatives, and making them essential in numerous technologies, industrial processes, and everyday products.

Beyond their socio-economic value for industry, their unique stability means that they are low-risk polymers for human health and their environment.[1,2] Trying to replace them in their many applications would lead to substitution with alternatives (when available) that do not provide the same advanced performance and safety as fluoropolymers. Furthermore, any alternative that may be suggested to replace fluoropolymers will need to perform at least at some degree (even if at lower levels) of chemical

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[1]Henry, B.J., Carlin, J.P., Hammerschmidt, J.A., Buck, R.C., Buxton, L.W., Fiedler, H., Seed, J. and Hernandez, O. (2018), A critical review of the application of polymer of low concern and regulatory criteria to fluoropolymers. Integr Environ Assess Manag, 14: 316-334, https://doi.org/10.1002/ieam.4035.

[2]Korzeniowski, S.H., Buck, R.C., Newkold, R.M., El kassmi, A., Leganis, E., Matsuoka, Y., Dinelli, B., Beauchet, S., Adamsky, F., Weilandt, K., Soni, V.K., Kapoor, D., Gunasekar, P., Malvasi, M., Brinati, G. and Musio, S. (2022), A critical review of the application of polymer of low concern regulatory criteria to fluoropolymers II: Fluoroplastics and fluoroelastomers. Integr Environ Assess Manag, https://doi.org/10.1002/ieam.4646.

and temperature resistance, which means that such alternatives will likely be persistent materials like fluoropolymers.

Since fluoropolymers are different from the other families of PFAS, there is no scientific, economic, or social basis to justify regulating them in the same way as all other PFAS. We hope that MPCA will consider these facts in their CUU determinations, as well as in future rulemaking.

2. WITHOUT CAREFUL DRAFTING, THE RULES WILL DAMAGE CRITICAL INDUSTRIES AND THE HIGH-TECH ECONOMY

a. Fluoropolymers are Essential to the Semiconductor Industry

Below we provide an example of the importance of fluoropolymers to just one of the industries we serve, semiconductor manufacturing. A similar case can be made for each of the industries in which our products are used, and we look forward to an opportunity to do so in the future with more detail.

Fluoropolymers (FPs) are essential to the semiconductor industry because of their low surface tension, high heat and chemical resistance, high thermal stability, radiation stability, electrical characteristics, compatibility with other chemicals, and other unique properties. These properties enable FPs to fulfill the purity criteria required for semiconductor manufacturing. FPs are used by the industry to meet many needs within the manufacturing process and can be found in various equipment, materials, and other critical components, including in the following:

- Control and distribution systems (pipes, pumps, valves, etc.)
- Various components in a wide range of processing tools and sensors
- Ancillary articles (such as tubing, gaskets, containers, and filters)
- Facility systems in semiconductor manufacturing factories such as water and chemical distribution, waste removal systems, and exhaust systems

In short, the semiconductor manufacturing process is enormously dependent on fluoropolymers, the majority of which currently have no viable alternatives. In fact, GFPS sells a large variety of non-fluoropolymer materials, both in this application and elsewhere. Typically, products and solutions containing PFAS are being used for their performance characteristics in order to satisfy industry requirements. Our experience is that the industry requirements drive the choice of material rather than cost, as non-PFAS alternatives are generally less costly.

3. RESPONSES TO QUESTIONS FROM MPCA REGARDING CUU DETERMINATION PROCESS

i. Should criteria be defined for “essential for health, safety, or the functioning of society”? If so, what should those criteria be?

GFPS suggests that the MPCA should promulgate objective standards regarding the determination of whether uses of PFAS in products are currently unavoidable and that such standards should interpreted flexibly and broadly. We are providing the following background information on uses of PFAS in our products that we believe is currently unavoidable and “essential to health, safety, and the functioning of society” in the hopes that it will help inform MPCA’s decision making as to what these terms should include.

Fluoropolymers in GFPS products are primarily in industrial applications including semiconductor manufacturing, life sciences, pharmaceuticals, and chemical manufacturing. These products are not end-use articles sold to consumers, but rather components used in large, complex industrial systems. As previously stated, the use of products containing PFAS is generally driven by industry and process requirements. In many cases the use of non-PFAS known alternatives may be available but would result in lower performance capabilities, for example, more frequent maintenance requirements. Increased maintenance frequency could result in more frequent exposure to other chemicals and hazardous conditions as well as an increase in the risk of unintended releases of dangerous chemicals in the environment. The performance capabilities of our fluoropolymer-based products is a large part of why our customers choose these materials, as they have the proper functional characteristics to ensure safer, long-term operation.

In the case of semiconductor manufacturing, the impact of a PFAS ban on the semiconductor industry cannot be overstated, as semiconductors simply cannot be made without PFAS materials. The devices are made with the help of our products are used in computers, data centers, mobile phones, automobiles (300 to 1000 per vehicle), aerospace (airplane components), process control systems, medical devices (pacemakers, insulin pumps), to name just a few applications. Our society has come to be dependent on these items in our daily lives, and it is quite clear that they are essential to health, safety, and the functioning of society. We hope that this example illustrates to MPCA the importance of ensuring that all products and process required in the supply chain to produce “essential” end products are also deemed “essential” themselves.

ii. Should costs of PFAS alternatives be considered in the definition of “reasonably available”? What is a “reasonable” cost threshold?

In the case of GFPS products, PFAS-based materials are not used because of cost but for their functionality. In fact, PFAS materials are far more expensive than currently available non-PFAS potential alternatives (which don’t have the same functionality). Current “alternatives” would at best significantly reduce service life and production yield, in situations where they are usable at all.

Besides simply comparing costs, potential alternatives must be commercially available and demonstrated to be usable in practice, beyond theoretical and academic assertions that they exist.

To provide a specific example, a valve used in a sulfuric acid peroxide mixture should use FFKM o-rings. FKM o-rings will work to some extent, but they will have a much shorter service life (< 6 months vs > 3 years for FFKM). The FFKM version of this product is 10X the cost of FKM, ($25.00 vs $2.5) yet customers still use FFKM to ensure system uptime and product quality.

Another example is the use of stainless steel pipes in lithium mining operations. PVDF pipes cost 10X as much as stainless steel, but last >5 years, compared to 6 months for steel pipes. In this case, the cost is measured in up-time, replacement costs, and reduced maintenance versus simply material costs. This

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example should also serve to illustrate the environmental ramifications of banning such long-lived materials, requiring alternatives that must constantly be manufactured and disposed of.

iii. Should unique considerations be made for small businesses with regards to economic feasibility?

Yes. The cost to develop alternatives is beyond the ability of small businesses to absorb. Even if a larger company could provide a new material, it would take significant effort to test and qualify a new material in a component (article). Most small businesses are not equipped to do this testing, nor can they afford to have it done. For example, testing the impact on a process would require having at least a pilot scale process available, which is not practical for most small businesses.

iv. What criteria should be used to determine the safety of potential PFAS alternatives?

It is difficult to recommend criteria for hazard evaluations of potential alternatives when no such criteria have been applied to the PFAS substance(s) being banned. In the case of fluoropolymers, significant evidence (discussed in section 1 of this document) exists that indicates they are "polymers of low concern" in terms of their risk to human health or the environment. If such substances are to be prohibited, certainly their alternatives must demonstrate extraordinary safety profiles.

Additionally, evaluation of the safety of potential alternatives should not only consider their toxicological profile as a substance, but also the safety impact of replacing currently used substances with said alternative. For example, hydrofluoric acid (HF), which is essential to the semiconductor manufacturing process, is highly hazardous to workers. If the materials used to handle HF are substituted with less resistant/shorter service-life alternatives that must be frequently replaced, the resulting increase in worker exposure to HF will have a tremendous negative impact on worker safety.

v. How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

Arbitrary timeframes for CUU determinations do not reflect the reality of research and development time necessary to identify and commercialize an alternative material. For applications such as ski wax or raincoats, a new material can be identified and produced to fill the need for PFAS-based products relatively quickly.

However, for applications that require extreme precision, such as semiconductor manufacturing, or those that have significant safety implications like aerospace components, simply declaring that in 15 years an alternative substance must be used does not manifest such a material into existence.

Additionally, even in the best case where alternatives are rapidly identified or developed, qualification and commercialization of new substances in such fields can easily take a decade itself. For example, the

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semiconductor manufacturing process consists of nearly 1400 steps, with each having a number of variables that can impact the entire process. Evaluating the impact of a potential new material on this entire process requires controlled, step-by-step experimentation that takes years to conduct.

Rather than providing a suggesting for arbitrary timeframes for CUU determinations, we recommend the following: Uses of PFAS determined to be currently unavoidable should not be prohibited until a commercially viable alternative has been demonstrated to exist.

vi. How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA?

Of the approximately 100,000 unique product numbers that GF offers, we sell approximately 5000 unique PFAS-containing or entirely PFAS-based products. To provide an example, for PVDF piping systems, we offer 16 different sizes of product with 9 of those having 2 designs, resulting in 25 different product categories. Each of these ranges has about 50 different components, meaning that we offer 1250 products simply for piping systems made from this one material alone. For this reason, we believe that MPCA should group such products by broad use categories, rather than evaluating CUU proposals by individual materials/products.

Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?

If so, they should be required to demonstrate that either a practical, commercialized alternative exists on the market, or that the use does not benefit health, safety, or the functioning of society.

vii. In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

Our company sells piping systems that consist of pipes, fittings, valves, seals, gaskets, and sensors. There is tremendous variety in the sizes, shapes, and configurations of these systems based on the needs of individual customers. However, all of the PFAS-containing products we sell fall under these categories, and they are all made from fluoropolymers, including PVDF, ECTFE, FKM, FFKM, and PTFE.

GF intends to seek currently unavoidable use determinations for all of its products containing PFAS. As stated above, even where we have non-PFAS products available, these products do not necessarily constitute a commercially feasible alternative for our customers.

Our products are relatively similar across industries, but their applications are highly diverse. The following table presents most of the industry sectors for which we intend to seek CUU designations and their specific sub-uses.

Industrial Sector	Specific Application
Energy	Production of green hydrogen by electrolysis
	Automobile battery production Metal working/Steel manufacturing Chlor-alkali electrolysis Gasoline
	Cleaning and etching of metal surfaces Purifying metals Rocket fuel
	Metal pickling Glass etching and cleaning Oil refining Uranium fuel production for nuclear reactors
	Fracking process Oil production Metal pickling
Chemical processing	Chlor-alkali electrolysis Intermediates for fertilizers Gasoline Paper bleaching Cellulose fibers Coloring agents Sulfonation agents Amino acid intermediates
	Fertilizer production Organic dyes and lacquers Fungicides Household cleaning products
	Steel pickling Leather tanning process Manufacturing of PVC Production of household cleaners

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Microelectronics	Manufacture of semiconductor wafers, flat panel displays, and solar photovoltaic cells: -Production/transport of ultrapure water -Handling sulfuric acid/hydrogen peroxide solution
	Microelectronics industry: - to clean photoresist or organic material residue from silicon wafers - wet etching of wafers in the semiconductor fabrication process.
Drinking- and industrial waste water treatment	Drinking water treatment plants Large disinfection plants for industrial wastewater Disinfection plants for public infrastructure (hospitals, hotels, schools, swimming pools, ships, etc.)
Food & beverage	Primary, secondary and tertiary food processing Beverage manufacture and transport
	Additive dosing for food industry Salt purification Bleaching agent handling
Pharmaceuticals	Reverse osmosis (RO/DI) water
	Production of pharmaceuticals
	Synthesis of chemical active ingredients of API drugs Virucide Fungicide
	Production of pharmaceuticals
Life Science	Reverse osmosis (RO/DI) water
	Handling Laboratory Waste

viii. Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

Georg Fischer requests that MPCA make a currently unavoidable use designation for all industrial uses of fluoropolymer materials and systems in the manufacturing processes and supply chains of semiconductor manufacturing, energy industry, water treatment, agriculture/aquaculture, industrial chemical processing, food and beverage production, mining, marine, pharmaceutical manufacture, life sciences, and other more niche markets. Until MPCA has the time and resources to fully evaluate and understand the complex value chains and processes that make up these sectors, industrial uses of fluoropolymers therein should be considered currently unavoidable.

4. COMMENTS ON FACILITATING PRODUCTIVE ENGAGEMENT WITH INDUSTRY

Georg Fischer appreciates MPCA's proactive outreach to the regulated community in advance of issuing draft rules and encourages the agency to maintain this approach going forward. Engaging interested stakeholders from the early stages of the rulemaking process through listening sessions, webinars, and other venues will afford them the opportunity to inform the MPCA's rulemaking activities in a way that empowers the agency to meet its regulatory mandates while more effectively ensuring the long-term viability and competitiveness of the affected industries.

Building on these early-stage engagement activities, Georg Fischer recommends that the MPCA institutionalize the communication stream between itself and its regulated industries. One way to accomplish this would be through the creation of a workgroup, comprised of stakeholder representatives, which would inform the drafting and implementation of the planned rules, further examine affected products, and identify ways to ease administrative burdens without sacrificing the public health and environmental imperatives that prompted passage of Section 116.943 in the first place.

5. CONCLUSION

GFPS is committed to balancing the need for environmental protection and the sustainability of all the industries and applications referenced in this document. GFPS supports the responsible use of these materials in applications where the specific material characteristics are required. We welcome the opportunity to engage with MPCA to better explain the critical role that these substances have in the sectors and industries our company serves.

GFPS is grateful for the opportunity to engage with MPCA on planned rulemakings and is available to meet at your convenience to further elaborate on the issues discussed in these comments. If you have any questions or would like to discuss our positions, please do not hesitate to contact us.

Sincerely,

DocuSigned by:
James Jackson
FAB3773D45D14C7...

James Jackson
Head of Business Unit Americas
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LEECH LAKE BAND OF OJIBWE
DIVISION OF RESOURCE MANAGEMENT

Via Web Submission:
Katrina Kessler
Commissioner, Minnesota Pollution Control Agency
520 Lafayette Road N St. Paul, MN 55155-4194

March 1, 2024

RE: Proposed New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS), Revisor's ID Number R-4837

OAH Docket No. 71-9003-39667

Dear Commissioner Kessler,

As a sovereign Tribal government located in Northern Minnesota, the Leech Lake Band of Ojibwe (LLBO) is taking this opportunity to comment on proposed new rules governing how MPCA determines Currently Unavoidable Uses of PFAS. This proposed rule, and the legislation which has prompted its creation, is of great importance to the Leech Lake Band of Ojibwe.

The continued production, use, and distribution of PFAS are an immediate and grave threat to the Leech Lake Band of Ojibwe, our treaty-guaranteed rights to hunt, fish, and gather, our lifeways, and our health, and the health of the environment and all people. PFAS have been found in the drinking water of our Tribal school, in our lakes, and in the fish we eat, and are surely present and continue to be introduced to other parts of the environment we have not yet analyzed. As long as PFAS continue to be manufactured and used, our bodies and environment will continue to be poisoned for decades to come.

The PFAS contamination present on our Reservation is the result of countless small sources, such as airborne deposition, product wear, and improper disposal of small quantities of household waste containing PFAS. There are no manufacturers or other facilities using, producing, or discharging PFAS within the Reservation. The uses this rule will allow are the very reason that Leech Lake Reservation is contaminated by PFAS today, and how it will continue to be polluted.

This proposed rule will outline the means of determining which products will continue to be sold with PFAS "intentionally added" to them. For the purposes of this rule, the terms "intentionally added," "product," and "product component" should be understood as broadly as possible in order to limit the use of PFAS to essential uses only. Contamination of water or soil by PFAS is harmful to human health at extremely low levels, and the intentional use of manufacturing, storage, or distribution processes which may introduce any amount of PFAS to a product, such as material transfer by Teflon (PTFE) coated hoses, will contribute PFAS compounds to products.

The below paragraphs will address the bolded questions MPCA requested:

Should criteria be defined for “essential for health, safety, or the functioning of society”? If so, what should those criteria be?

The phrase “essential for health, safety, or the functioning of society” should be narrowly defined to ensure that PFAS is only used when it is actually essential. Defining “essential” to include uses of PFAS intended to reduce maintenance, lengthen product life, or provide other perceived benefits when ANY alternative exists would be a mistake. Claims that a use of PFAS is “essential for health, safety, or the functioning of society” should be weighed against the value of clean air, water, and food for “health, safety, or the functioning of society.”

Should costs of PFAS alternatives be considered in the definition of “reasonably available”?

The cost of PFAS alternatives should not be considered when defining “reasonably available.” The harms caused by PFAS to the environment and human health, and the associated costs with remediating PFAS contamination, in the cases it is possible, are so great that any cost increase from a safe PFAS alternative will be cheaper than continuing to pollute our environment and ourselves.

Should unique considerations be made for small businesses with regards to economic feasibility?

Small businesses should not be given unique considerations, as any accounting of continued PFAS use which considers the negative externalities borne by society would show PFAS are never economically feasible. Additionally, because small businesses are the majority of businesses, such an exception would dramatically increase the allowed future PFAS pollution.

What criteria should be used to determine the safety of potential PFAS alternatives?

The safety of PFAS alternatives should be determined prior to their introduction to the market and use. Criteria to be considered should be their effects on human health and the environment, the ability of alternatives to disperse in the environment, and how readily they can be removed from the environment if they are found to be harmful in the future. Any safety determination should also consider by-products created during the production of alternatives and any product decomposition.

How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?

Currently unavoidable use determinations for PFAS should be valid for a period of one (1) year. If MPCA chooses to set a longer period for currently unavoidable use determinations, the period should be as short as possible, and should absolutely be no longer than three (3) years. A short determination period will ensure that the determinations are actually current and will encourage the competition and development of PFAS alternatives and research of PFAS. Any significant changes in available information about alternatives and/or new impacts should trigger a re-evaluation of currently unavoidable use determinations.

What information should be submitted in support of currently unavoidable use determination requests?

Requests to determine a PFAS use as currently unavoidable should include all potential alternatives, and should include a “no use” alternative. For example, an application describing the use of a PFAS coating in a nozzle to prevent clogging would be required to include a “no use” alternative in which the nozzle is mechanically cleaned or an alternative coating is used. Members of the public should also be able to request a currently unavoidable use determination be denied or revoked based on new information or technology. Manufacturer applications for a currently unavoidable use determination should include the specific PFAS(s) to be used, the environmental fate of the PFAS, estimated amount of PFAS to be used/sold during the reporting period, known environmental and health effects of specific PFAS, specific use of PFAS in the product, and justification of need for that specific product.

Should currently unavoidable use determinations be made for individual products or for product categories?

Currently unavoidable use determinations should only be made for specific products. The review period for all determinations based on product category must be shorter than for individual products. If entire categories of products are determined to have currently unavoidable uses of PFAS, the state will be giving free rein to industry to continue using these toxic chemicals without pressure to identify and implement alternatives.

Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?

No initial determinations of currently unavoidable use should be made as part of this rulemaking. If MPCA makes currently unavoidable use determinations as part of this rulemaking, that will greatly undermine the market incentives and pressure on industry to develop and implement safe alternatives.

Our environment and our bodies are being already being harmed by PFAS. Continued use of PFAS-containing products will exponentially increase this harm. Any exceptions to Minnesota's ban on the continued use of PFAS should be for the rare circumstances where their use is truly unavoidable and there is a genuine need for that specific product and use and that use can be measured and limited. If **any** PFAS alternative exists for a specific use or product, MPCA should determine that the use is **avoidable**.

LLBO would like to thank MPCA for the review and consideration of our comments on the Proposed New Rules Governing Currently Unavoidable Use Determinations about Products Containing Per-and polyfluoroalkyl substances (PFAS) (Revisor's ID Number R-4837) and would like to reemphasize that coordination between MPCA and Tribes is paramount in achieving sound environmental policy and should be as extensive as necessary to address issues of concern that exist among all involved parties. We look forward to continued communication on this important matter and the inclusion of our input in the proposed rule.

If you have any questions or require clarification please do not hesitate to contact my Deputy, Craig Tangren, at (218) 335-7429 or at craig.tangren@llojibwe.net.

Regards,

Brandy Toft (Mar 1, 2024 14:55 CST)

Brandy Toft
Interim Division of Resource Management Co-Director and Environmental Director

LLBO PFAS Currently Unavoidable Use Comments 3.1.2024

Final Audit Report 2024-03-01

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Appendix 1

Functions of PFAS, the uses and substitutions of Specialist Equipment

Appendix 1-1 The characteristics and functions of PFAS

This document is the appendix 1 of the general comment to the Restriction report on Per- and polyfluoroalkyl substances (PFAS) from

Japan Electric Measuring Instruments Manufacturers' Association (JEMIMA)

submitted on February 29, 2024

Table of content

The characteristics and functions of PFAS

Summary

PFASs have many functions. The characteristics and functions of PFAS which are mainly used in Specialist equipment are described in this section.

PFAS has excellent properties such as, chemical resistance, electric insulation, heat resistance, repellency from water and oil, non-adhesion, weatherability, and others. PFASs are used where multiple of these properties are required simultaneously. We recognize that the ability to provide these various properties in a single material is the most important property of PFAS, and at present we do not have information on any other substance with this function other than PFAS.

Chemical resistance

Fluoropolymers compared to other general-purpose resins

	ETFE	FEP/TFE/FPA	FLPE	FLPP	HDPE	LDPE	PC	PETG	PP	PVC	TPE***
Acids, Dilute or Weak	E	E	E	E	E	E	E	G	E	E	G
Acids, **Strong/Concentrated	E	E	G	G	G	G	G	N	G	G	F
Alcohols, Aliphatic	E	E	E	E	E	E	G	G	E	G	E
Aldehydes	E	E	G	G	G	G	G	G	G	G	G
Bases/Alkali	E	E	F	E	E	E	N	N	E	E	F
Esters	G	E	G	G	G	G	N	G	G	N	N
Hydrocarbons, Aliphatic	E	E	E	G	G	F	G	G	G	G	E
Hydrocarbons, Aromatic	G	E	E	N	N	N	N	N	N	N	N
Hydrocarbons, Halogenated	G	E	G	F	N	N	N	N	N	N	F
Ketones, Aromatic	G	E	G	G	N	N	N	N	N	F	N
Oxidizing Agents, Strong	E	E	F	F	F	F	F	F	F	G	N

*Not for tubing chemical resistance (except PVC) **Except for oxidizing acids (See oxidizing agents, strong) ***TPE gaskets

Table 1 Classes of Substances at 20° C, Chemical Compatibility Chart - LDPE, HDPE, PP, Teflon Resistance (calpaclab.com)

* Not for tubing chemical resistance (except PVC) ** Except for oxidizing acids (See oxidizing agents, strong) *** TPE gaskets

Excellent: 30 days of constant exposure causes no damage. Plastic may tolerate for 30 years.
Good: Little or no damage after 30 days of constant exposure for the regent
Fair: Some effect after 7 days of constant exposure to the reagent. The effect may be crazing, cracking, loss of strength or discoloration.
Not recommended: Immediate damage may occur. Depending on the plastic, the effect may be severe crazing, cracking, loss of strength or dis coloration, deformation, dissolution or permeation loss.

Type / Properties	Fluoroelastomer	Silicon rubber	Acrylic rubber	Nitrile rubber	Ethylene propylene rubber
	FKM	MQ, VMQ	ACM	NBR	EPDM
Specific gravity	1.8~2.0	1.0	1.0	1.0	0.9
Heat resistance	◎	◎	○	△	○
Low temperature resistance	△	◎	○	◎	◎
Electrical properties	○	○	△	△	◎
Solvent resistance	◎	◎	○	△	○
Flame resistance	◎	○	▲	▲	▲
Ozone resistance	◎	◎	◎	×	◎
Steam resistance	◎	○	×	△	○
Acid resistance	◎	○	△	○	◎
Alkaline resistance	◎	◎	△	○	◎
Oil resistance	◎	△	○	○	×
Permeability resistance	◎	▲	○	○	△

Table 2 Property Comparison of Fluoro elastomers (FKM) with Other Rubbers[1]

◎ : Excellent ○ : Good △ : Fair ▲ : Marginal × : Poor

"Cleanliness" is defined as the fact that fluoropolymers are not easily eluted by acids, alkalis, or solvents (chemical resistance), do not contain other materials such as plasticizers in the molding process, and do not contain products that would thermally decompose during the material molding process.

Ozone resistance

Ozone is known to degrade plastic materials in two ways:

A: Substances with double bonds (C=C) in their structures (such as natural rubber, chloroprene rubber, butadiene rubber, etc.) undergo decomposition in which ozone reacts with the double bonds to produce ketones, when they come into contact with ozone.

B: When ozone exists in water, peroxy radicals are generated. Non-fluorine materials (eg polyethylene, polypropylene, etc.) deteriorate even if they do not have double bonds.

Fluoropolymers does not have decomposition pathways such as A and B even if it comes into contact with ozone, so it can be used for a long time without deterioration.

1 https://www.daikinchemicals.com/library/pb_common/pdf/catalog/RC-1L.pdf translated from the document in Japanese. Last accessed on 14 July, 2023

Thermoplastic resin		Ozon Resistance
Soft vinyl chloride	PVC	○
Rigid vinyl chloride	PVC	○
Vinylidene chloride resin	PVdC	◎
ABS	ABS	△
Polyethylene	PE	△
Nylon	N	×
Acrylic resin	PMMA	△
Fluoropolymer resin	PTFE	◎
Phenolic resin	PF	△
Melamine resin	PVC	○
Furan resin	FF	○
Epoxy resin	EP	△
Unsaturated polyester resin	UP	×

Table 3 Comparison of ozone resistance properties of plastics

Repellency from water and oil / non-adhesion

Since the fluoropolymers have a small polarizability, the intermolecular force is small. Because of its characteristics, fluoropolymers have repellency and non-adhere properties on the surface. In general, the repellency from various liquids is evaluated by the contact angle, and the larger the contact angle, the higher the repellency.

Contact angle θ

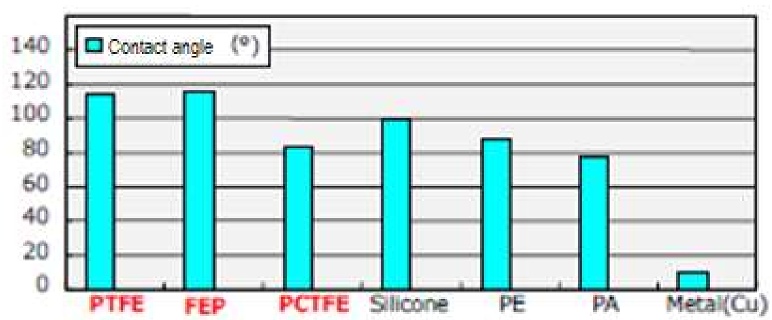


Figure 1 Contact angles with water

Adhesion energy refers to the amount of work required to pull a liquid contacting a solid away from the solid. The larger the contact angle, the smaller the adhesion energy. It means that a liquid in contact with a small adhesion energy solid easy to separate from the solid.[2]

Material name	Contact angle with water (°)	Adhesion energy (dyn/cm)
PTFE	114	43.1
FEP	115	42.0
Silicone resin	90~110	47.8~72.7
Paraffin	105~106	52.7~53.8
PE	88	75.2
PCTFE	83	-
PA	77	97.7
Phenolic resin	60	109.0
Copper(electropolishing)	9.6	144.2
Aluminium(electropolishing)	4.6	145.0

Table 4 Surface properties of various plastics and metals

This characteristic is sometimes called "mold releasability". It can also be expressed as antifouling because it does not easy to adhere.

Heat resistance

Fluoropolymers have high heat resistance as follows. They have higher heat resistance compared to other general-use resins

	Fluoropolymers						Other general-use resins	
Heat resistance : maximum operating temperature (C)	PTFE	PFA	FEP	ETFE	PCTFA	PVdF	PP	PVC
	260	260	205	150	120	120	100	60

Table 5 The heat resistance of Fluoropolymer [3]

Electric insulation

When the dielectric constant is low, the insulation in electrical components can be made thinner, leading to downsizing and weight reduction of the equipment. In applications where downsizing and weight reduction are necessary, it is an essential feature

[2] Japan Fluoropolymers Industry Association(2020), ふっ素樹脂ハンドブック, 14th edition. Page 34 Translated from Japanese.

[3] DAIKIN INDUSTRIES, LTD. (2009) ダイキン フッ素樹脂ハンドブック, Page 4

	Fluoropolymer				Fluorine rubber	
	PTFE	FEP	PFA	ETFE	FKM	FEPM
Dielectric constant	◎ 2.1			○ 2.3～2.8	△ 3～4	△～○ 2.5～3.5
	Non-fluoropolymer				Non-fluorine rubber	
	PVC	PEEK	TPI (Thermoplastic Polyimide)	Polyolefin	Silicone rubber	EPDM
Dielectric constant	△ 4～6	△ 3.2～4.5	△ 2.8～3.2	△～○ 2.3～4	△ 3.2～10	△ 2.5～3.5

Table 6　The dielectric constants of various resins

Low friction, self lubrication

Friction coefficient of fluorine resin is lower than that of other resins. It is because polarizability (Mobility of electrons in an electric field) of C-F bonding is low (0.68) and the intermolecular force is weak. (Reference: polarizability of C-Cl bonding is 2.59) [4]

Types of plastic	Plastic / Plastic	Plastic / Steel	Steel / Plastic
PTFE	0.04	0.04	0.10
PE	0.10	0.15	0.20
PS	0.50 *)	0.30	0.35
PMMA	0.80 *)	0.50 *)	0.45 *)

*) indicates occurrence of stick-slip motion.
Measurement condition: Bowden-Laden type measurement equipment, load: 9.8-39.2N, sliding speed: 0.01cm/s
Plastic/Steel indicates sample material/pin material
PE: polyethylene PS: polystyrene PMMA: polymethylmethacrylate

Table 7　Comparison of friction coefficient among PTFE and other materials[5]

As an example of low friction, Table8 shows friction coefficient of PTFE.

Type	ASTM test method	Measurement condition		Unit	PFA	PTEF	FEP
Coefficient of static friction	-	Against polished steel		-	0.05	0.02	0.05

Table 8 Comparison of static friction coefficient among PFA, PTFE and FEP[6]

One of the characteristics related to friction is “self lubrication”. The molecules of PTFE separate from molding of PTFE due to friction. The molecules in crystals of PTFE separate easily because intermolecular forces are weak. PTFE moves and attaches to the friction mating surface and generates friction between them. It lowers friction coefficient. [7]

4 Japan Fluoropolymers Industry Association(2020), ふっ素樹脂ハンドブック, 14th edition. Page 9 Translated from Japanese.

5 Japan Fluoropolymers Industry Association(2020), ふっ素樹脂ハンドブック, 14th edition. Page 24 Translated from Japanese.

6 DAIKIN INDUSTRIES, LTD. (2009) ダイキン フッ素樹脂ハンドブック, Page 53

7 Japan Fluoropolymers Industry Association(2020), ふっ素樹脂ハンドブック, 14th edition. Page 24 Translated

Gas barrier properties/Gas permeation properties

Fluoropolymer film are less steam permeability.

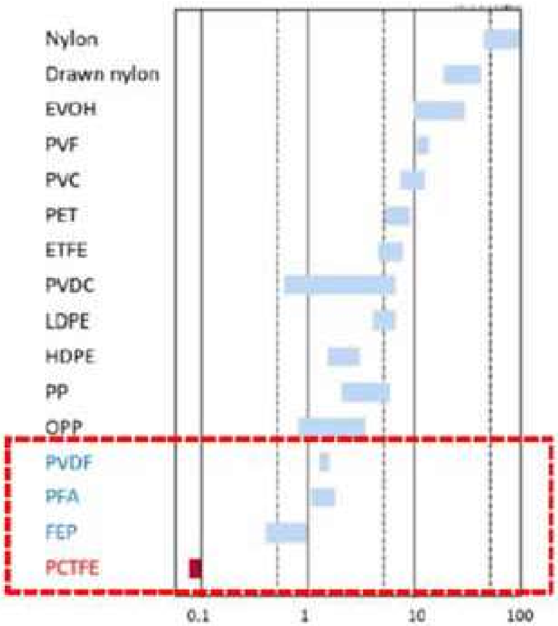


Figure 2 The degree of steam permeability [8]

steam permeability (g/m²/d)

from Japanese.

[8] DAIKIN INDUSTRIES, LTD. (2009) Daikin Fluoropolymers Handbook, Page 109

Fluorine elastomers are less atmospheric (nitrogen, oxygen) permeability.

Material	Temperature degree Celsius	He	H_2	O_2	N_2	CO_2	CH_4	C_2H_2	C_3H_8
Vinyl methyl silicone rubber (VMQ)	25	N/A	400	400	200	1600	N/A	N/A	10000 or more
	50		570	500	280	1550			
Ethylene propylene rubber (EPDM)	25	N/A	N/A	16.5	5.90	79.2	N/A	N/A	91.2
	50			46.6	13.7	183			246
Perfluoro-elastomer (FFKM)	25	10.3	8.25	2.5	8.1	28.7	3.3	N/A	N/A
Styrene butadiene rubber (SBR)	25	17.5	30.5	13	4.8	94	N/A	N/A	N/A
	50	42	74	34.5	14.5	195			
Vinylidene fluoride fluororubber (binary FKM)	25	2.95	4.6	1.0	0.8	3.9	0.6	N/A	N/A
Vinylidene fluoride fluororubber (Ternary FKM)	25	2.64	4.13	1.7	0.7	1.6	0.4	N/A	N/A
Chloroprene Rubber (CR)	25	N/A	10.3	3.0	0.89	19.5	2.5	N/A	N/A
	50		28.5	10.1	3.55	56.5	9.8		
nitril-butadiene rubber (Mid-high NBR)	25	9.32	12.1	2.94	0.81	23.5	N/A	18.9	26.9
	50	23.4	33.7	10.5	3.58	67.9		68.3	78.3
nitril-butadiene rubber (High NBR)	25	5.2	5.42	0.73	0.18	5.67	N/A	8.25	11.2
	50	14.2	17.0	3.5	1.08	22.4		19.8	33.1
butyl rubber (IIR)	25	6.4	5.5	0.99	0.25	3.94	0.6	1.28	N/A
	50	17.3	17.2	4.03	1.27	14.3	3.2	5.82	

(×10^{-8} cc,cm/cm^2,sec,atm)

Table 9 Comparison of gas permeability of elastomer[9]

Property of Gas Permeability

Property			Standard Test method	Unit	FEP film
Gas Permeability	Gas permeability coefficient	N_2	ASTM D1434	cm³・cm/cm²・s・atm	120×10^{-10}
		O_2			370×10^{-10}
		H_2			1,080×10^{-10}
		CO_2			970×10^{-10}
		CH_4			66×10^{-10}
		C_2H_4			44×10^{-10}
	Water-vapor permeability		JIS Z0208	g/m²・24h	1.6
	Water Absorption		ASTM D570	%・24h	<0.01

Table 10 Gas Permeability of FEP film[10]

9 DAIKIN INDUSTRIES, LTD. (2009) Daikin Fluoropolymers Handbook, Page 78

10 DAIKIN INDUSTRIES, LTD. (2009) Daikin Fluoropolymers Handbook, Page 78

Fluoropolymers permeate small molecular gases, such as oxygen and nitrogen, conversely, large molecular gases do not permeate. Fluoropolymer properties are used in permeate membranes for measurement and analysis.

Gas	Gas Permeability		
	FEP	PTFE	Low Density Polyethylene
N_2	1.2×10^{-8}	1.1×10^{-8}	0.74×10^{-8}
O_2	3.7×10^{-8}	3.2×10^{-8}	2.2×10^{-8}
CO_2	9.7×10^{-8}	8.9×10^{-8}	9.6×10^{-8}
CH_4	0.66×10^{-8}	—	2.2×10^{-8}
CH_3	0.66×10^{-8}	—	5.2×10^{-8}
C_3H_8	0.11×10^{-8}	—	7.2×10^{-8}
C_2H_4	0.48×10^{-8}	—	—

Temperature: 25 degree Celsius(77° F) Units: cm^3 (ST P) cm/cm^2・atm

Table 11 Comparison of gas permeability of various materials[11]

Low refractive index

Amorphous fluoropolymer resin has high transmittance. This is utilized for optical components and optical fibres.

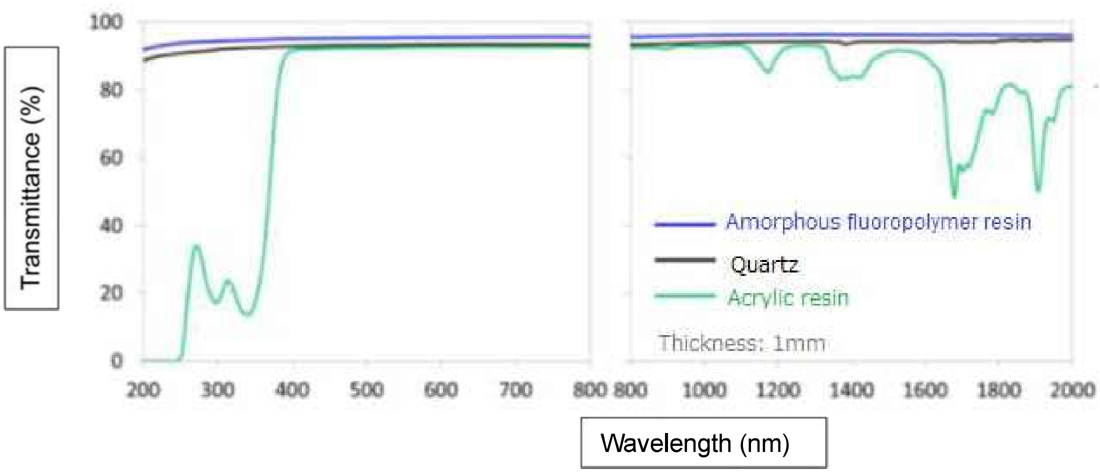


Figure 3 Comparison of transmittance

Weatherability

Fluoropolymer resin has high weatherability and can be used outdoors. It does not react to sunlight such as ultraviolet rays. It is not susceptible to oxidizing effects of atmospheric oxygen and other substances (see "chemical resistance"). It can be used in a wide temperature range from low to high (see "heat resistance"). It has high water repellency and does not absorb water, so it is not affected by humidity changes. It can be said that fluoropolymer resin has high weather resistance because it has the above points.

[11] DAIKIN INDUSTRIES, LTD. (2009) Daikin Fluoropolymers Handbook, Page 80

	Fluoropolymer resin						General resin	
	PTFE	PFA	FEP	ETFE	PCTFE	PVdF	PP	PVC
Weatherability	◎	◎	◎	◎	◎	◎	×	×

◎ Excellent, ○ Good △ Not very good ▲ Needs attention × Not good

Table 12 Fluoropolymer resin weatherability comparison [12]

Regarding the graph below, it can be seen from the accelerated weatherability test with the Sunshine Weather Meter that the gloss retention rate decreases by no more than 10% even after 4000 hours of exposure. [13]

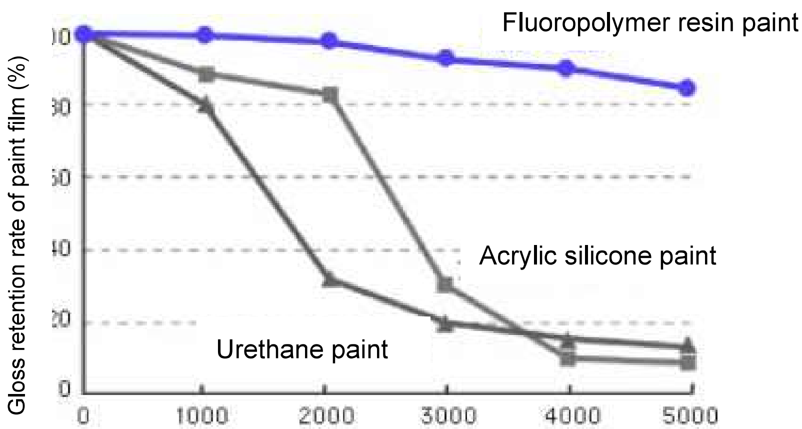
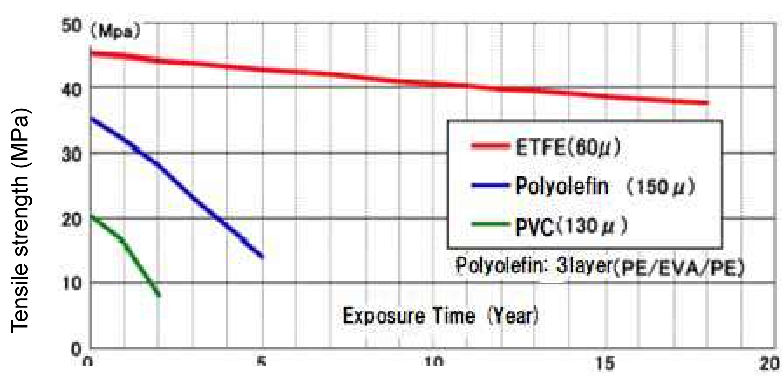


Figure 4 Accelerated weatherability test of paint



Exposure time by weather meter(h)

Figure 5 Outdoor exposure test Comparison of tensile strength between ETFE and other materials [14]

[12] DAIKIN INDUSTRIES, LTD. (2009) ダイキン フッ素樹脂ハンドブック, Page 4

[13] https://www.kyoeishoji.co.jp/business/chemical/fusso_toryo.html translated from the document in Japanese. Last accessed on 21 July, 2023

[14] https://www.taiyokogyo.co.jp/feature/etfe_film.html translated from the document in Japanese. Last accessed on 21 July, 2023

Durability

It means that it can be used for a long time. Due to its high chemical resistance and high weatherability, PFAS can achieve high durability.

Resistance to creep / Compression set

When a constant load is applied to a polymeric material, creep occurs, in which deformation progresses over time. Similarly, compression set occurs where the deformation does not recover when the force is removed. Both properties are known to be correlated. When rubber materials are used in elastic applications such as packings or diaphragms, it is required to minimize the effects of both properties.

Experimental examples of "30% creep time (Hour)" for major rubber materials are shown below. Creep is known to be worse at higher temperatures, Experiments have shown that FKM and silicon exhibit good properties.

	50 degree Celsius	70 degree Celsius	100 degree Celsius	120 degree Celsius	150 degree Celsius
NR	190	103	3.8	—	—
SBR	1250	203	14	—	—
CR	4200	550	45	7.4	—
NBR	3900	380	41	12.2	—
IIR	—	—	2.7	—	—
FKM	—	—	1650	305	180
Silicon	—	—	—	1550	190

Table 13

Quoted from the journal of “the Society of Rubber Science and Technology, Japan”, 1960(Vol33), P882-892, “Stress relaxation and creep properties of various vulcanized rubbers”.

Examples of compression set test results are shown below. In general, it is difficult to quantitatively compare materials because the measured values differ depending on the compounding and hardness of the rubber. Here, the compression set of the materials was compared by comparing the minimum value of each material in the database. FKM and silicon showed relatively good properties, showing the same tendency as creep.

	Compression set JISK6301 100 degree Celsius×70h
NR	—
SBR	Min 20%
CR	Min 23%
NBR	Min 9%
IIR	—
EPDM	Min 23%
FKM	Min 11%
Silicon	Min 6%

Table 14

The minimum value of each material was quoted from the data described in "Material Database / Organic Materials" (1989), The Nikkan Kogyo Shimbun”.

Appendix 1

Functions of PFAS, the uses and substitutions of Specialist Equipment

Appendix 1-2　Uses of PFAS in Specialist Equipment

This document is the appendix 1 of the general comment to the Restriction report on Per- and polyfluoroalkyl substances (PFAS) from

Japan Electric Measuring Instruments Manufacturers' Association (JEMIMA)

submitted on February 29, 2024

Table of content

Uses of PFAS in Specialist Equipment

Summary

PFAS are a very important group of substances for Specialist Equipment, which depends on these uses to maintain safety, as they are highly effective in chemical resistance, Repellency from water and oil, and electric insulation.

PFAS polymer resins are two to ten times more expensive than other commodity plastics. There is no use other than where the equipment does not work without the use of PFAS.

General electronics components are not covered in this document. However, since our equipment also uses common electronic circuit parts, we also use parts common to information equipment and general consumer EEE. For usage and non-substitutable information for such parts, please refer to Japan 4EE Input to Submission Requirements on Currently Unavoidable Uses (CUUs) under Maine law 38 M.R.S. §1614. Semiconductors are also used in our products. Many PFASs are used in semiconductors and semiconductor manufacturing equipment. Comments on most of the items in this section have been submitted by industry associations that specialize in the respective items. We hope that dossier submitters consider the manufacturer's opinions.

In this chapter, the use of PFAS in components and materials are explained. Then the some examples of the uses follows. These examples are not exhaustive.

Electric wires and insulation

An electric wire is a linear member for transmitting electricity. Metal, which is a good conductor, is used for the part that transmits electricity, and plastic resin that has electric insulation is used around the wire in order to block the influence on anything other than the transmission destination of electricity.

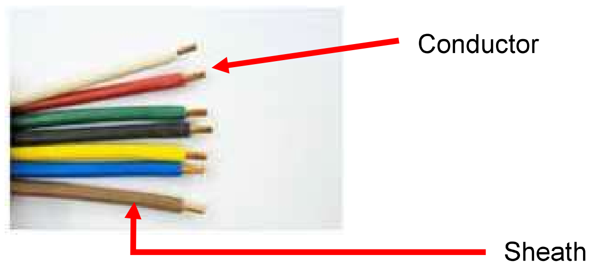


Figure 1

Polyvinyl chloride is generally used for covering parts where plastic resin is used, which is called as sheath, but PTFE, PFA, FTPE, etc. are selected depending on the suitability of use and electric insulation requirements. Since these are more expensive than polyvinyl chloride, they are used only when it is difficult to use other materials such as polyvinyl chloride.

PFAS functions required by PFAS wires and availability of alternatives.

Wires using PFAS for coating have high electrical insulation when the coating is thin (100 μm or less). PFAS also has a high heat resistance of 150-200°C. In addition, PFAS wires can be used even when there are chemicals around the device because PFAS has chemical resistance.

Examples of devices equipped with electric wire and insulation

<u>Cables for Sapphire Capacitance Diaphragm Gauge</u>

The components use electric insulation with PFAS.

・Temperature sensor for control

・Heater board connection cable and thermistor

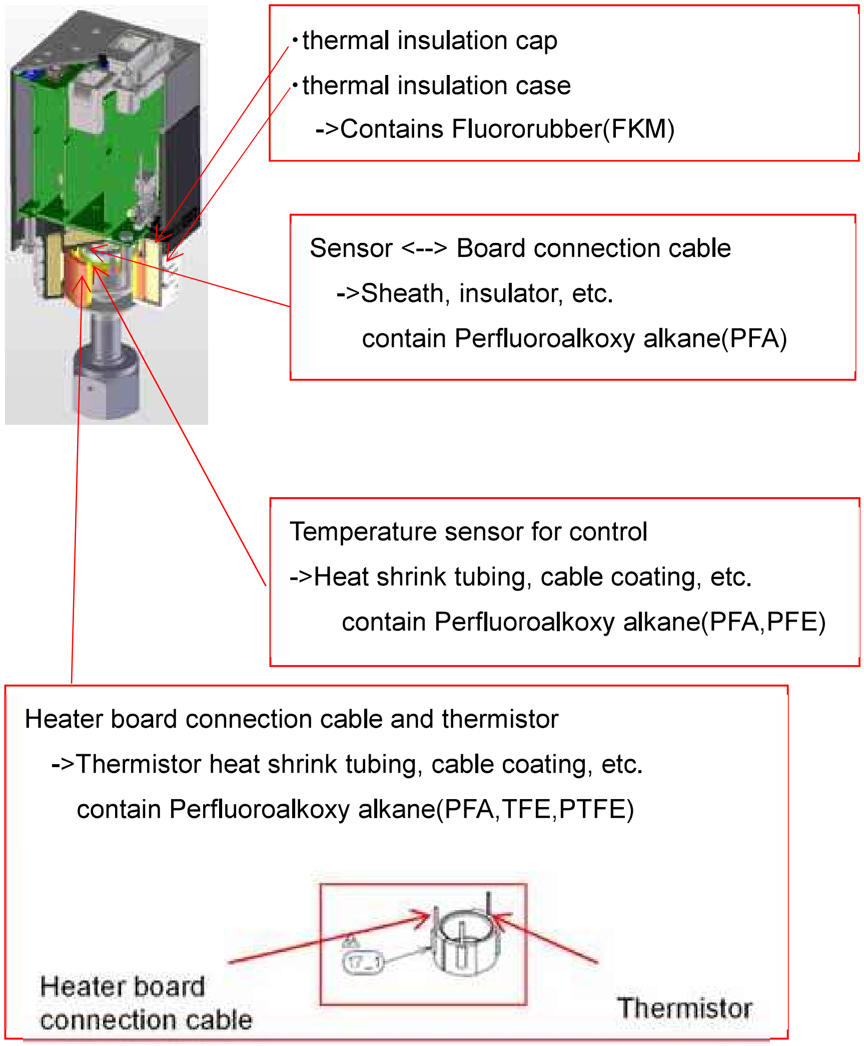


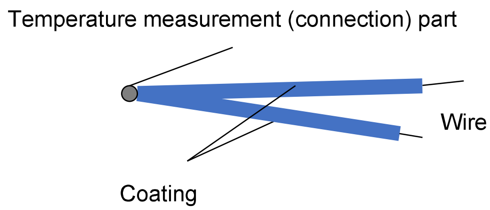
Figure 2

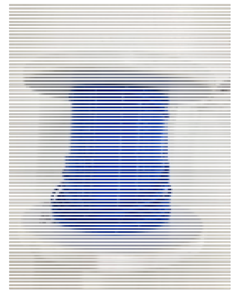
There is no fluorine-free material with equivalent heat resistance.

<u>Temperature sensor (thermocouple)</u>

A thermocouple is a temperature sensor that measures using the principle that a thermoelectromotive force is generated by connecting the tip of a metal wire made of different materials and the temperature difference between the tip and the other end.

Temperature sensors can measure a wide range of objects, including acids, alkalis, and organic solvents, and can also measure a wide range of temperatures, including applications that measure chemicals at 100°C or higher. The thermocouple wires are coated with FEP and PFA to ensure accurate measurement without negative effects from chemicals or high temperatures. There is no material other than fluoropolymers that combines chemical resistance and heat resistance to realize such applications, and it is difficult to replace them.





Coated temperature sensor wire

Figure 3 thermocouple

Heat shrink tubing

By putting a thin and long object to be covered in a tube, heating it, and shrinking the tube, the object is covered. It prevents parts from coming off or falling off, and strengthens the covered part. Fluoropolymer resin heat-shrink tubing is thin but has high electric insulation performance. PTFE and PFA are used as fluoropolymer resins.

Functions of PFAS required by heat-shrinkable tubing and availability of alternatives

Fluoropolymer resin heat-shrink tubing is thin but has high electric insulation performance. It can be used in applications where there is not enough space for electric insulation, and there is no alternative material available for applications that require tight spaces.

Examples of the products which incorporate heat shrinking tubes

<u>Thermistor protection for Sapphire Capacitance Diaphragm Gauge</u>

Components corresponding to a heater operating temperature of MAX 250°C

For the picture of this products, please see the explanation in electric wires and insulation.

Fluoropolymer resin is used in the heat-shrinkable tube to protect the thermistor

There is no fluorine-free material with equivalent heat resistance.

Sealing materials

Parts description

- Packings, gaskets, and O-rings

Packings and gaskets exist to connect and seal by placing/placing them between parts. As an example, they are used in piping and pipe connections. Gases and liquids that pass through pipes leak out through the smallest gaps, and packing gaskets exist to prevent this. Packing in the narrow sense is used for power system parts, and those used for non-moving parts are called gaskets. Various innovations have been made in molding and realizing functions, such as spiral

gaskets made of alternating layers of thin metal strips and PTFE sheets, and wrapped gaskets made of 0.4~0.8 mm hot PTFE, covering gaskets of metal or other materials.
Those with a circular/round cross section are called O-rings.
In addition to PTFE, fluoropolymer rubbers such as FKM and FFKM are also used for this application.

Figure 4 Packings, gaskets, O-rings

- Bearings

A bearing reduces friction between two parts to make movement smoother. Bearings are classified into radial bearings, thrust bearings, and linear bearings, depending on whether rotational or linear motion is involved. A bush is also a type of bearing.
Fluoropolymer bearings such as PTFE have a low coefficient of friction and can maintain a constant torque within various tolerances, while minimizing rattling and noise. In particular, PTFE must be used for bearings near chemical fluids such as acids, alkalis, organic solvents, and ozone, and for food contact applications, where oil is not preferred.

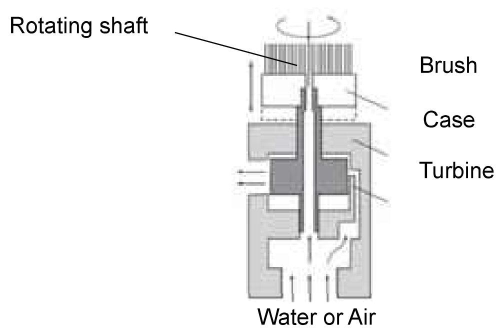


Figure 5 Bearing used for the rotating shaft sliding part of the sensor cleaning brush

- Sealing tape

Sealing tape, made of PTFE material, is an adhesive tape used to secure parts within equipment. It is employed to fasten parts that could pose safety risks if dislodged, as well as to seal mounting parts. Additionally, the tape serves as a filler to address gaps in the joints or connections of pipes for flowing liquids or gases, such as water pipes, air pipes, and hydraulic pipes. Notably, the tape can establish liquid- or gas-tight connections with tapered pipe threads by directly filling the voids between the threads.

Figure 6

The functions of sealing materials of PFAS and alternatives

Functions of PFAS Required by Sealing Materials and the Feasibility of Alternatives to PFAS

- Required Functions for Sealing Materials

Liquids and gases flowing in pipes, or near parts, often consist of strong acids, alkalis, or organic solvents. Therefore, the sealing materials used must be resistant to these chemicals. Fluoropolymer is highly resistant to such chemicals, and additionally, it is ozone-resistant, making it an ideal choice when ozone is present in the piping.

If the liquid or gas in the piping, or the equipment itself, operates at high temperatures, PTFE or PFA are good options due to their high heat resistance of up to 260°C, a limit higher than other resins. FFKM and FKM rubbers also exhibit high heat resistance, withstanding temperatures up to 250-300°C.

For applications where sealing materials, such as gaskets, are used on sliding surfaces, where lubricating oil is unsuitable (particularly in contact with food), or where play and noise must be avoided, sealing materials must also possess low friction and self-lubrication properties.

In the restriction report on seal tape, paste-like sealing materials are mentioned as alternative materials. However, if these sealing materials contain hydrocarbon substances, reactive functional groups may decompose. This could pose a risk of contamination in the surrounding area due to the produced decomposition products. For sealing tape used for equipment operating in clean environments, where such contamination is unacceptable, paste-like sealing materials cannot be used as alternatives.

As a sealing material that combines outstanding chemical resistance, ozone resistance, heat resistance, water and oil repellency, low friction, self-lubrication, and cleanliness, there is no substitute for fluoropolymers. The substitution of fluoropolymers with other materials poses a significant challenge. Non fluorine elastomers might be considered as potential replacements for fluorine rubbers like FKM rubber. However, their heat resistance, low friction, and chemical resistance do not measure up to those of fluorine-rubbers like FKM rubber. Therefore, substituting fluorine -rubbers with non-fluorine elastomers is unfeasible.

Examples of the products which uses sealing materials

Pressure Transmitter

Pressure transmitters are measuring instruments mainly used in factories and plants. It measures pressure for process fluids such as liquids, gases and steam and outputs analog or digital signals corresponding to the measurement results. It is also used to measure flow rate and liquid level based on measured pressure.

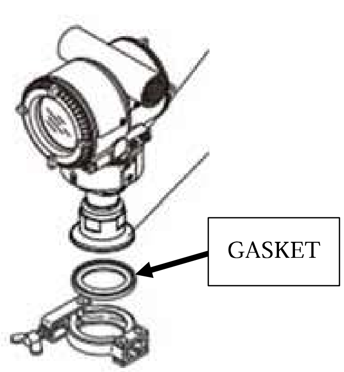
The process fluid to be measured has various characteristics such as temperature, pressure, and properties. If the sealing performance is not maintained, not only correct measurement results not be obtained, but the factory or plant may stop. In addition, if the process fluid is high temperature, extremely low temperature, or toxic or corrosive, the outflow of the fluid may cause great damage to the surrounding environment and workers, so the sealing performance is very important.

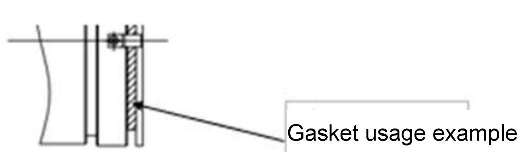
Many sealing materials that use PFAS materials have excellent heat resistance and chemical resistance, and it is considered difficult to replace them when considering the above safety assurance.

- O-R
  - It is used for sealing the mating part of the product.

Figure 7 Wetted O-RING

- Gasket
  - Seal a product and pipe fittings. Fluid leak prevention.





Collar

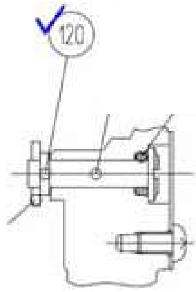


Figure 8

Junction unit for vacuum environment / O-ring for seal for air and vacuum environment

Optical Junction unit for vacuum environment is used for a photoelectric sensor that enables detection inside a vacuum chamber by transmitting light from a fiber amplifier through a fiber unit.

The optical coupler is provided with sealing ability to pass the detection light through the wall of the vacuum device.

The O-ring for sealing are made of fluorine rubber to keep high temperature, high seal and high cleanliness

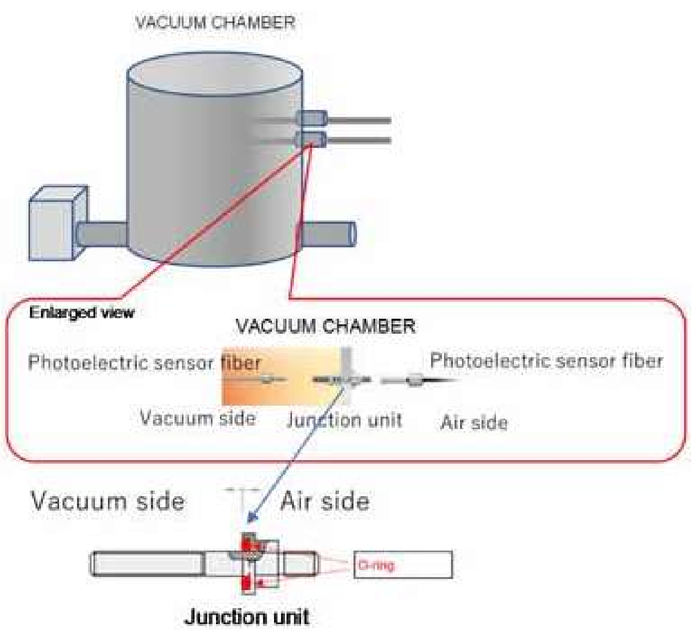


Figure 9

To keep high temperature, high seal, and high cleanliness in a vacuum environment, materials other than fluorocarbon rubber are not appropriate.
O-rings are used as sealing parts to prevent external leakage at joints between different parts.

Mass Flow Controller / Mass Flow Meter

O-rings are used as sealing parts to prevent external leakage at joints between different parts.

<Mass flow controller usage example>

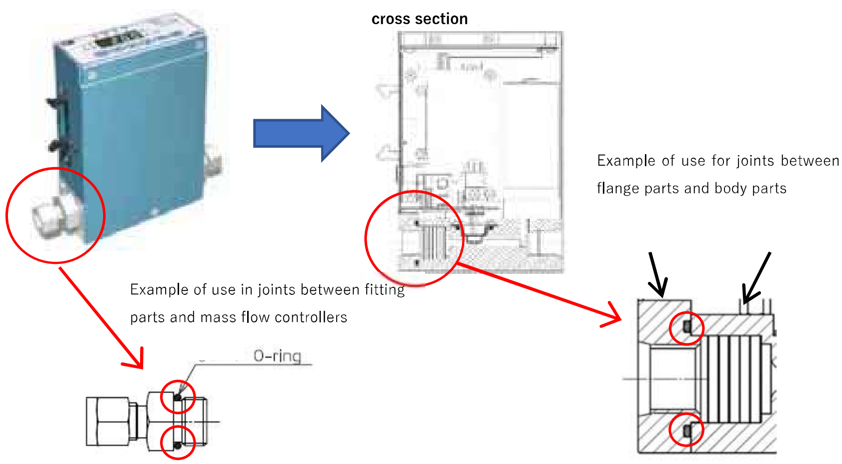


Figure 10

FKM is used for various gases with excellent heat resistance, chemical resistance, ozone resistance, etc., especially when using flammable oxygen gas, it is used due to its high heat resistance and ozone resistance, and the alternative product is a special rubber material, but it becomes a fluorine-based rubber material and the use of fluorine-based substances is unavoidable.
If fluorine-based materials are not used, safety is significantly impaired.

Plumbing
Plumbing is any system that convey fluids or energy for any application. Pipes, tubes, joints, fittings, are used for plumbing. Fluoropolymer resins, such as, PTFE, PFA, PVDF, are used. Some international standards mention uses of fluoropolymer resins for plumbing. [1]

- Tubes (not heat shrink tubes)
  Tubes are used for convey fluids to the places.

[1] Example of international standards: ISO 12039:2019 mentions that the sampling line shall be made of PTFE, PFA.

Figure 11

- Joints / fittings
  Joints / fittings are components to connect tubes to units and/or tubes to tubes.

Figure 12

The functions and alternatives which plumbing requires:

The material of plumbing is determined by the types of fluids flowing through tubes. Fluoropolymers can be used as piping for fluids in the temperature range of -10°C to 200°C (PTFE) and about -40°C to 160°C (PFA), including acids, alkalis, organic solvents, ozone, and oils. Fluoropolymers (PTFE, PFA, PVDF) are the only plumbing materials that can be used when the fluids of flowing the tubes meets one or more of these characteristics.

Fluoropolymer resins are the only materials that can simultaneously provide and express multiple functions required for the proper functioning of chemical resistance/ cleanliness, repellency from water and oil, and heat resistance.

Examples of the products which incorporate plumbing

<u>Magnetic Flowmeter</u>

An Electromagnetic Flowmeter is a type of flow meter that applies a magnetic field in the perpendicular direction to the flow of the measured fluid. As a result of the flow and the magnetic field, an electromotive force is generated in directions perpendicular to both the flow and the magnetic field. This electromotive force is extracted by a pair of electrodes, and the output signal is sent to a converter. The electromagnetic flow meter is a flow meter that applies Faraday's law of electromagnetic induction to moving objects.

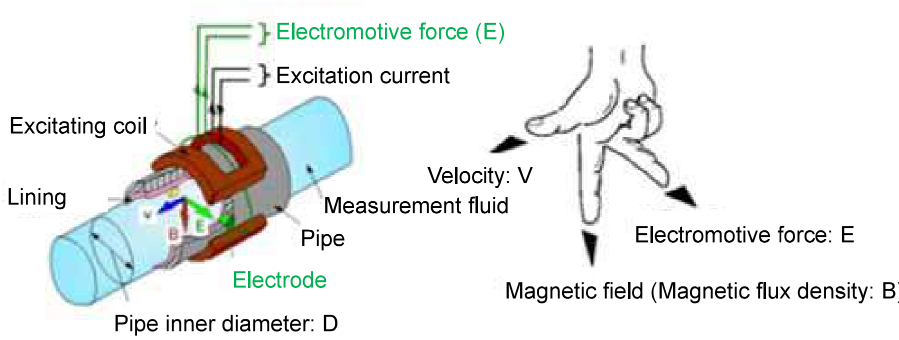


Figure 13

The resin lining, known as lining, is applied to pipes (metal piping), and materials such as PFA and PTFE are used.

The purposes of this lining are as follows:

Electrical insulation: The lining ensures electrical insulation between the measured fluid and the electrodes or the pipe, preventing electrical short-circuiting of the signal electromotive force.

Chemical resistance: The lining provides resistance to chemical substances such as acids and alkalis when the measured fluid contains them. This prevents corrosion and degradation caused by the fluid's characteristics and the environment, thereby improving the accuracy and reliability of the measurement.

Wear protection: The lining plays a role in protecting the pipe from internal friction and impacts. It reduces wear and damage caused by solid particles and abrasives in the fluid, maintaining measurement performance over an extended period of use.

Heat resistance: The lining exhibits stable performance even in high-temperature environments. It resists degradation when exposed to high-temperature fluids and environments, ensuring consistency and reliability in the measurements.

NOx measuring equipment

For accurate measurement, dehumidify the sample with a dryer unit before measuring. It is dehumidified by the Flemion tube of the dryer unit, but it is necessary to purge dry gas around the Flemion tube. Cover the Flemion tube with a PFA tube, purging dry gas in between.

Also, PFA tubes are used to connect the dryer unit and piping.

Since NOx is highly adsorbable, PTFE, which does not easily adsorb, is used as a sampling tube.

Used to connect flow sensor and PTFE tube.

Micro flow rate liquid flow meter

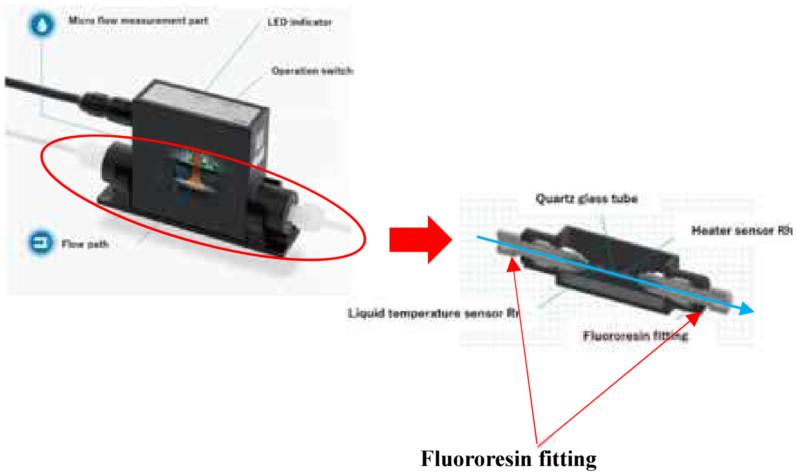


Figure 14

◆Characteristics of PFA,PTFE

・Inert to many chemicals

・Resistance to aging

・Less additives

・Soft

・Easy to process

◆Benefits of using PFA,PTFE

Semiconductor manufacturing process is required high level chemical controls, due to chemical contamination makes negative influences on quality of products. PTFE and PFA which are inert to various chemicals and also include low additives, are suitable materials for flow paths in semiconductor manufacturing process.

◆Impact of prohibition using PFA,PTFE

It will be impossible to keep miniaturization technology used in current semiconductor manufacturing process.

To avoid this problem would require a great deal of effort and technical innovation.

Fuel Cell Performance Testing Equipment

Fuel cells generate electricity and heat through a chemical reaction between hydrogen and oxygen. Fuel cell performance testing equipment evaluates the performance and durability of fuel cells. Fuel cells contribute to carbon neutrality by improving energy efficiency and reducing CO2 emissions.

The following characteristics are required for the piping of the fuel cell performance testing equipment.

- The piping serves as a flow path for alkaline substances used as materials for hydrogen and acidic substances produced as a result of the reaction. (Chemical resistance)
- Since the polymer membrane used in the fuel cells requires wet condition, water vapor is added to the hydrogen. The flow path is heated to approximately 150°C to prevent condensation of water vapor in the piping. (Heat resistance)
- Hydrogen in the exhaust gas after the reaction may be reused, which requires an additional supply of hydrogen, resulting in large pressure changes inside the piping. Therefore, the piping needs to be strong. (Durability).

In case of condensation in the piping, the concentration of water vapor added to hydrogen cannot be maintained at the required level and normal operation will be disturbed. In addition, a transparent pipe with chemical resistance may be used as a liquid level gauge to check the liquid level in the tank where the alkali solution is stored.

For these reasons, the fuel cell performance testing equipment needs to be made of transparent, chemical (acid, alkali) resistant, heat resistant, and durable materials. Currently, PTFE and PFA are the only such materials available, and they are difficult to replace.

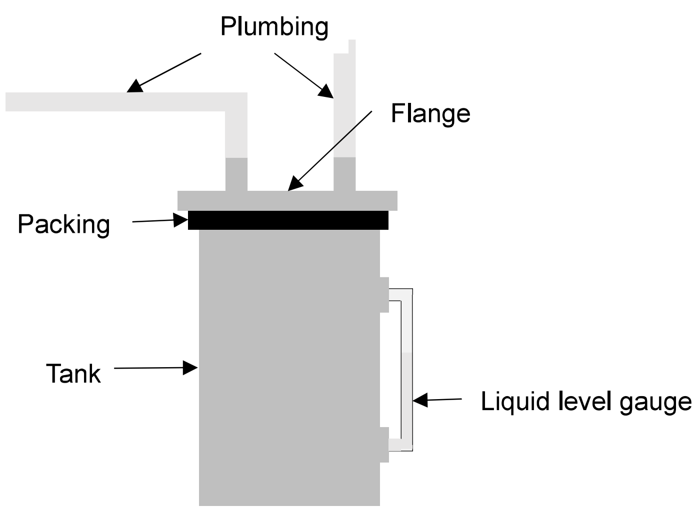


Figure 15

Valves

Valves are general for equipment with a movable mechanism that can open and close flow paths in order to go through, stop, and control the flow of fluids.

They are used in a wide variety of products, from relatively small devices with flow paths and valves to large-scale manufacturing processes and chemical plants. There are many types of valves. Some valves, which are often incorporated in specialist equipment, are discussed. They are not exhaustive.

The functions and alternatives which valves require:
The chemical resistance against acids, alkalis, organic solvents oils, and ozone, which flows through valves, is essentially required. Valves, which opens and close frequently required the property of low friction, repellency from water and oils, non-adhesion. Any failure of valves can cause serious accidents. Therefore, the durability of fluoropolymer resin is required for valves PTFE and other fluoropolymer resins are frequently used. Fluoropolymer resins, such as, PTFE are the only materials that can simultaneously provide and express multiple functions required for the proper functioning of valves.

- Solenoid valve

A solenoid valve is electromehanically operated. One of the operations is to open and close a valve using the principle that when an electric current is applied to an electromagnet (solenoid), an iron piece called a plunger is attracted and released when the electric current is cut off. Diaphragms divide into a valve compartment that opens and closes flow paths and a functioning compartment that drives. Fluoropolymer resins, such as, PTFE, FKM, FFKM, and FEPM, are frequently used for flow paths, diaphragms, and sealing materials in solenoid valves. Solenoid valves have wide variety of types, such as, liner action, pilot operated, the combination of liner action and pilot operated.

- Ball valves

A ball valve opens and closes a flow path by rotating a hollow ball. In automatic valves, an electric motor is used to rotate the ball. A large cross-sectional area of the flow path can be obtained, and the resistance of the path can be kept low. Fluoropolymer resins, such as, PTFE, are frequently used

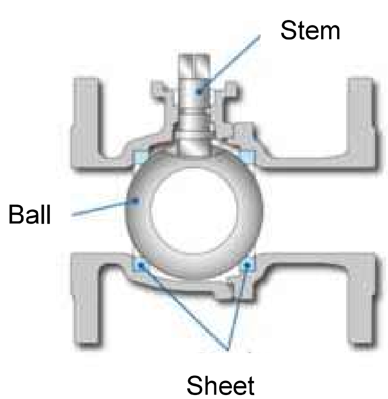


Figure 16

- Check valve

A check valve is installed on gas or liquid piping where the fluid back pressure closes the valve plug to prevent reverse flow. A check valve is called as non-return valve, reflux valve, retention valve, foot valve, or one-way valve There are disc check valves that blocks backflow by closing the O-ring valve with a disc and duckbill check valves that uses a valve plug shaped like a duck's beak.　Fluorinated materials such as PTFE, FKM, FFKM and FEPM are used for the valve plug and the sealing materials of the housing.

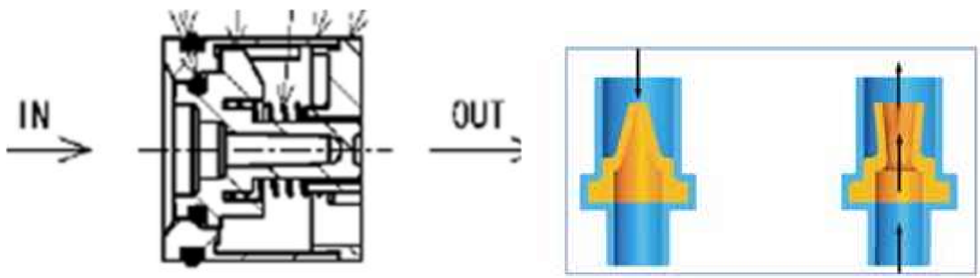


Figure 17

- Relief valves/safety valves

A relief valve is a valve that automatically releases pressure when excessive pressure occurs in the pipes. A spring keeps the valve plug such as O-rings or diaphragms closed, and it opens (released) when a pressure exceeding the spring force occurs.
Fluorinated materials such as PTFE, FKM, FFKM and FEPM are used for the valve plug and the sealing materials of the housing.

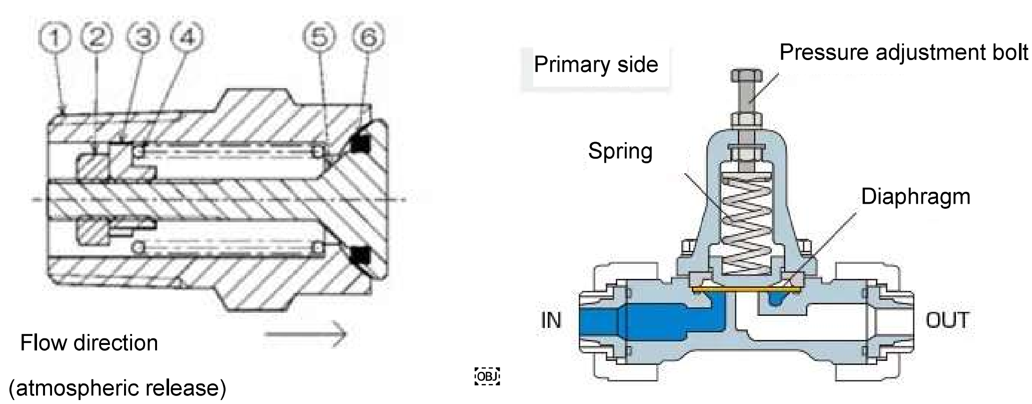


Figure 18

Examples of the products which incorporates valves

Control valve of mass Flow Controller

Mass flow controllers are used for flow control of various industrial gases.

PTFE is used as the material of the valve body of the flow control valve of mass flow controller.

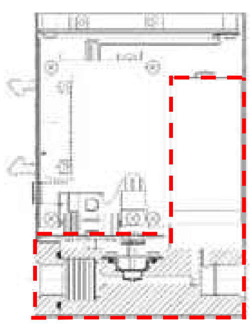
See part (10) in the figure24 below (the right is a partial enlarged view).

Performance requirements for materials.

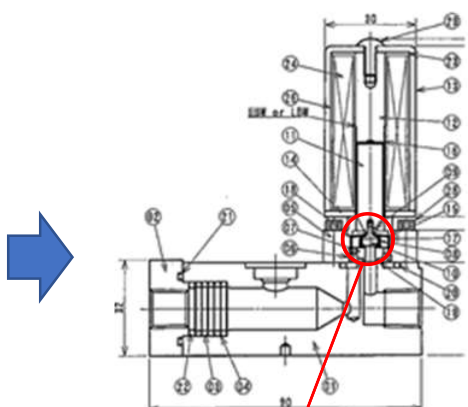
・Heat resistant to withstand operation from -10°C to +60°C.

・Chemical resistance to withstand components contained in combustible gases.

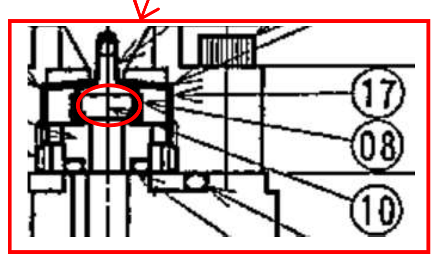
・Resistant to ozone gas.



Cross-sectional view of the product



Cross-sectional view of the valve



Enlarged vie

Figure 19

Mass flow controller for semiconductor manufacturing

Mass flow controller for semiconductor manufacturing

PFA coating is applied to the valve that functions to accurately supply the amount of etching gas in the etching equipment for semiconductor manufacturing. When the valve is closed, it must be tightly closed and impermeable to gas. Low friction is necessary because it must not wear out even with the impact of continuous opening and closing of the valve.

The friction ecoefficiency of silicone is low, and silicone cannot be used for this application.

Fluoride ion measuring equipment

This equipment is mainly used to measure the concentration of fluoride ions in factory wastewater. Fluoride ions are detected by an ion electrode, and the concentration can be monitored continuously by sending the sample to the flow cell holding the ion electrode with a liquid sending pump. The sample water is an aqueous solution such as factory wastewater. Various ionic components and insoluble solids are included depending on the type of production.

Used as a switching valve for the solution feed channel

The valve is used as a switching valve for the solution feeding flow path, and the body and diaphragm valve are PTFE solenoid valves.

NOx measuring equipment

NOx meter utilizes chemiluminescence generated in the process that NO and ozone react to produce NO2. Since the emission intensity is proportionally related to NO concentration, NO concentration is obtained by measuring the emission intensity. Since NO2 does not emit light, it is converted into NO by a converter, and NOx(NO+NO2) is measured, and then NO2 concentration is obtained from the difference between NOx density and NO density. So the NOx meter requires switching between the NO measurement line and the NOx measurement line. Also, during calibration, it is necessary to switch between the sample line and the calibration line. Since NOx has high adsorptivity, PTFE is required for NOx passing part, and therefore, a solenoid valve is used for switching.

The NOx meter requires switching between the NO measurement line and the NO2 measurement line. Also, during calibration, it is necessary to switch between the sample line and the calibration line. A solenoid valve is used for switching.

Control valves

Control valves are used in a variety of different markets that controls fluid flows in plumbing installed in air conditioning system of building, and Industrial plants, for example petrochemical and power plant.

Examples of control valve products

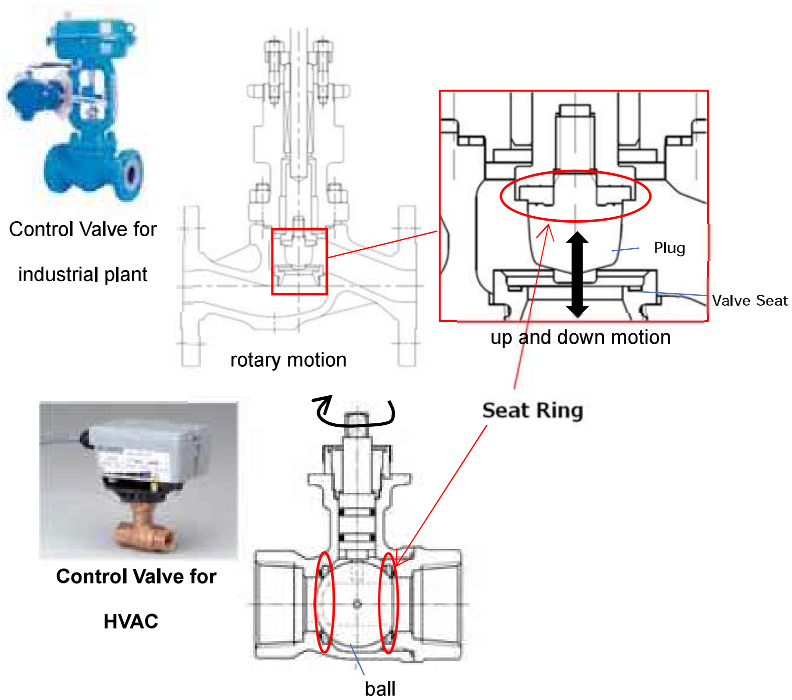


Figure 20

PTFE seat ring is a component of control valves that has a function of stopping the flow by contacting with the plug when it is fully closed.

In general, the friction coefficient of PTFE (0.1 or less) is approximately 1/5 that of metal (approximately 0.5), and the torque required to rotate the plug is approximately 1/5 in proportion to the friction coefficient.

Add that, corrosive and high temperature fluid flows through control valves. So, excellent chemical and heat resistance are required to control valves. PTFE fills all of characteristics aforementioned. Furthermore, it has proven track record of long-term use in various fields.

<u>Material for scraper rings in industrial control valves</u>

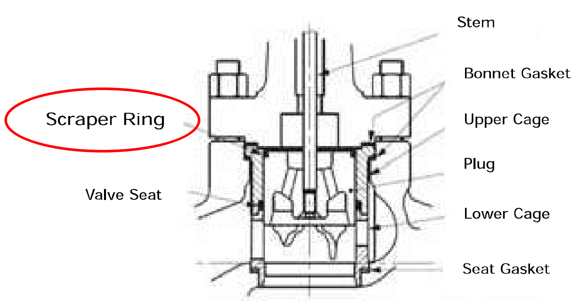


Figure 21

The PTFE scraper ring scrapes off the fluid adhering to the cage of the control valve and prevents sticking of the plug and cage.
Industrial control valves are used to control corrosive fluids such as chemicals, and are required to have performance that can withstand the control of corrosive fluids.
On the other hand, in identifying corrosive fluids, there are many fluids that are difficult to determine physical properties such as intermediates of chemical substances, and materials that have a wide range of chemical resistance are required.

In order to control corrosive fluids with industrial control valves, scraper rings made of PTFE are required in the flow passages where corrosive fluids come into contact.
Other polymer materials, such as rubber and resin, might be able to substitute for PTFE as the material of scraper rings. However, it is considered that the alternative materials are not suitable, because they do not have enough resistance to various chemicals of chemical plants.

Lining and throttling mechanism materials for industrial control valves

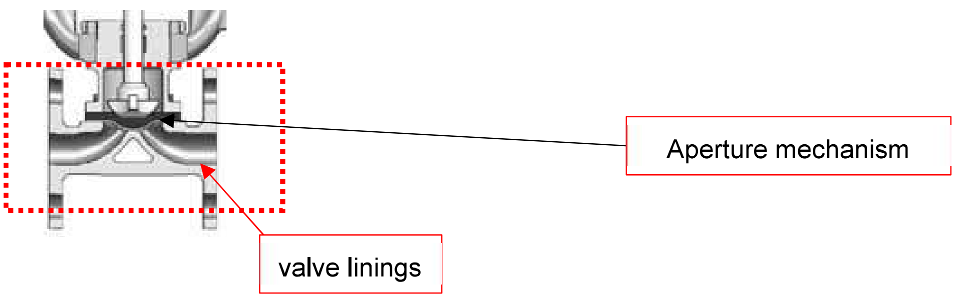


Figure 22

Industrial control valves are installed in pipes of various industrial plants, that are used to control flow of fluids. Industrial control valves are used to control corrosive fluids such as chemicals.

Industrial control valves are required to be able to withstand the control of corrosive fluids at high temperatures (approximately 140°C).

In order to control corrosive fluids with industrial control valves, main body linings and throttle mechanisms made of PFA, ETFE and PTFE are required in the flow passages where corrosive fluids come into contact.

Depending on the fluid used, PFA and ETFE are used in the body lining, and PTFE is used in the throttle mechanism.

- It is possible that other polymer materials such as rubber and resin can be used as alternative materials for body lining and throttle mechanism using PFA, ETFE, and PTFE. However, alternative materials have poor resistance to a wide variety of chemicals in industrial chemical plants and cannot withstand corrosive fluids.

-
- If it is assumed that metal materials such as chromium and nickel alloys will be substituted, it is necessary to periodically stop the equipment and check the corrosion status of the control valves connected to the pipes. When corrosion occurs, fluid control becomes impossible, so it is necessary to replace the industrial control valve itself.

Pumps

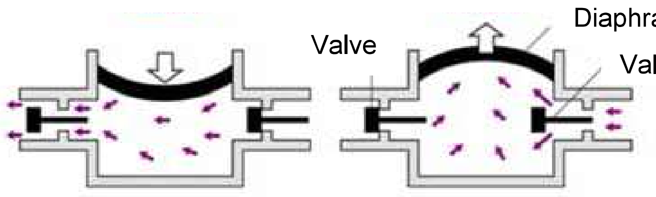


Figure 23 Explanation on Pumps [2]

A pump is a device that transfers, pumps, and stirs liquids and gases under the action of pressure. It is divided into two types according to the difference in structure: non-positive displacement pumps and positive displacement pumps. Non-positive displacement pumps are pumps that impart energy to liquids by rotating impellers, and include centrifugal pumps, propeller pumps, and viscous pumps. A positive displacement pump is a pump that pressurizes and energizes a liquid that is within a certain volume, and there are plunger pumps, diaphragm pumps, gear pumps, etc. In pumps, fluorine rubber such as FKM, FFKM, and FEPM is used for the sealing members and diaphragms of the housing. PTFE is used for the impeller bearings.

PFAS functions which pumps require and alternatives

Pumps used to transfer fluids such as acids, alkalis, organic solvents, oils, and ozone require high chemical resistance for each member in contact with the fluid. Especially in the case of diaphragms, durability that can withstand repeated bending are also required. Fluorine materials such as FKM, FFKM, and FEPM are used as materials to satisfy these requirements, and it is difficult to replace them with other materials.
In the case of bearings, low friction, self-lubrication, and wear resistance are also required. Fluorine materials such as PTFE are used as materials to satisfy these requirements, and it is difficult to replace them with other materials.

[2] https://www.monotaro.com/note/cocomite/525/

Coating/Lining

Part Description

A surface treatment in which the surface or inner surface of a base material is covered with a fluoropolymer is called a coating or lining. A relatively thick covering is often referred to as a lining, while a thin covering is often referred to as a coating. There are various methods such as molding, bonding a sheet to the base material, bonding powder, or covering with a liquid. Fluoropolymers used include PTFE, PFA, PCTFE, FEP, and ETFE.
Metal plating and surface treatment containing fluoropolymer resins are used to adhere to metals. Coatings and linings are applied to parts in contact with fluids. The parts include the inner surface of the piping and parts in contact with the fluid. Coatings may be applied to areas where water repellency to water and oil, low friction, self-lubrication, and non-adhesion are desired.

Examples of coating / lining

Piping inner surface

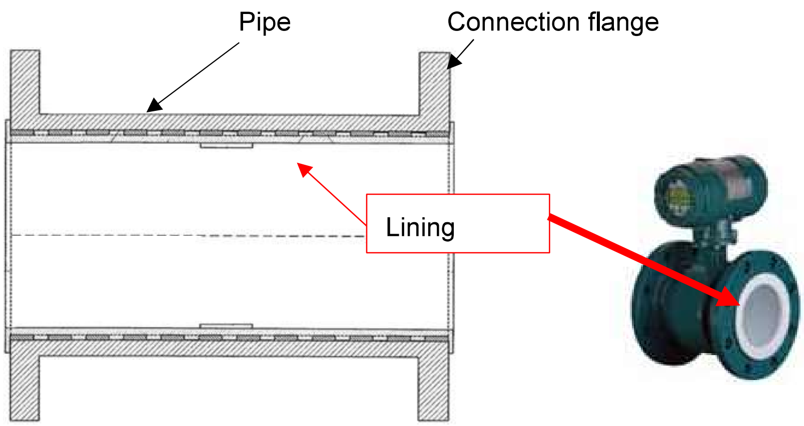


Figure 24

Coating and lining section of parts (diaphragm) in contact with fluid

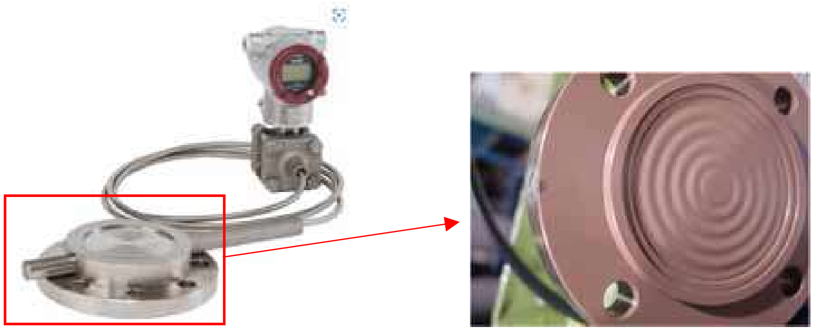


Figure 25

PFAS functionality required by coating/lining and possible substitutions

By covering the surface with a fluoropolymer, PFAS gains chemical resistance/cleanliness and mold-releasing properties that the base material does not have. Coatings and linings in contact with fluids can withstand corrosion and operate stably without maintenance for long periods of time (10 years). For example, fluorine coatings and linings on low-hardness rubber materials provide both high flexibility and chemical resistance. When the fluid is a powder, it is difficult for the fluid to adhere to the coating/lining area due to non-adhesion of fluoropolymers.

Coatings for instruments and tools for analysis and measurement
Analysis and measuring instruments are required to have chemical resistance because they may analyze and measure any kinds of chemical substances, including strong acids, strong alkalis, organic solvents, and oils, as samples. For correct analysis and measurement, no specimens or reference materials should remain in instruments or pipettes, tubes, etc. If residues remain, subsequent analysis and measurement will not be accurate. In order to prevent residues from remaining, coating should be applied to the areas where the specimens and reference materials are likely to remain. The fluoropolymer resins have the functions, such as, repellency from water and oils, and non-adhesion. These functions can prevent residues from remaining, which resulting in accurate analysis and measurement.

Examples of Parts and Equipment Using Lining and Coating
There are a great many devices that coat base materials that come in contact with fluids.

Lining for fluid contact parts of electromagnetic flowmeters and pressure transmitters

Equipment around piping such as electromagnetic flowmeters and pressure transmitters cannot maintain their performance without fluoropolymer resin linings and coatings in order to withstand various fluids such as acids and alkalis.
Linings using ETFE or PFA can operate stably for 10 years without maintenance.
Accidents may occur if the equipment continues to operate with the fluid flowing through the piping without noticing that it has been corroded by the fluid.
In order to maintain the work environment and safety management, it is necessary to use fluoropolymers that can be safely used for a long period of time without replacement for devices that pass corrosive fluids.

Environment-resistant photoelectric switch with built-in amplifier

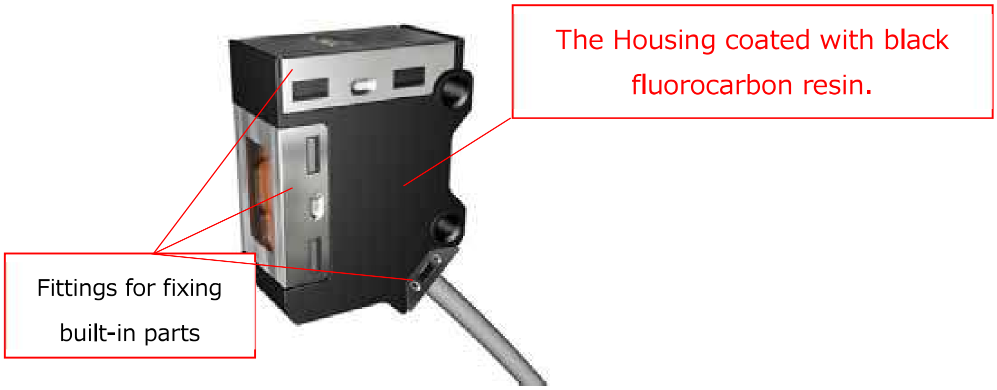


Figure 26 External View/ Detection of work piece seating in machine tool

Improved corrosion resistance of housing

The housing of Environment-resistant photoelectric switch is made of zinc die-cast. Zinc die-casting has advantages such as high fluidity, easy dimensional accuracy, low molding temperature, and long service life of metal mold, but it has low chemical resistance.

Therefore, it cannot be used in machine tools and automobile parts machining lines, which are users of this switch, unless corrosion resistance is improved by painting and plating. Water-soluble coolant (basic) is often used in machine tools and automobile parts machining lines, and zinc die-cast housing is highly likely to be corroded unless surface treatment such as painting is performed (Figure 26).

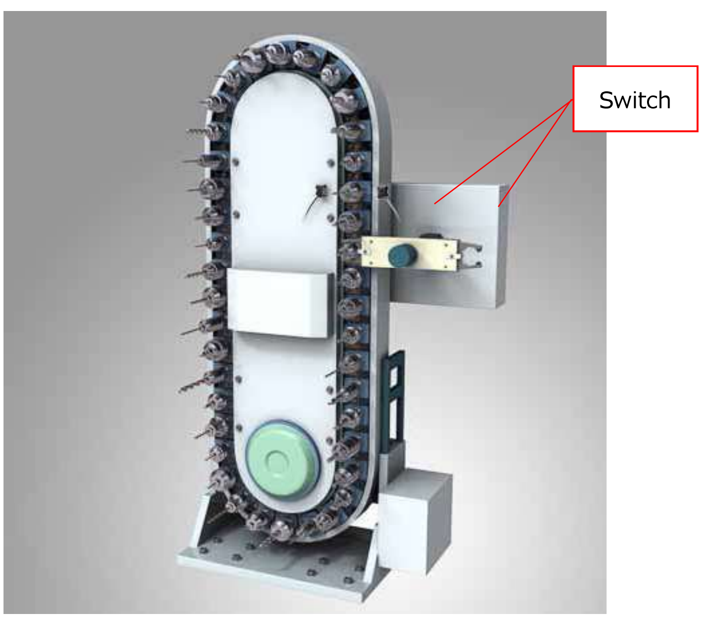


Figure 27 Confirmation of Existence of Tool in Machine Tool

Prevention of crevice corrosion and dissimilar metal contact corrosion

The H2B housing is assembled with a metal stopper (SUS plate (zinc plated)) (Figure 26) and attached to an accessory SUS bracket or the mounting surface of the user side (metal, resin, etc., materials cannot be specified) (Figure 27). Therefore, it is necessary that the metal surface of the housing is not exposed in order to prevent electrolytic corrosion due to gap corrosion and contact between different metals.

The former model number of this switch had adopted acrylic coating, but it was changed to fluorine coating due to low resistance to water-soluble coolant. The surface of the housing must be free from exposed metal. Therefore, coating by coating is necessary instead of plating. For the same reason, coating is necessary even if the housing is changed to a highly chemical resistant metal material such as SUS.

There are concerns about the following impacts due to the unavailability of this technology

・ Affects machining with machine tools that use water-soluble coolant and parts machining and production on automotive parts production lines

・ There is no alternative technology. When a switch without fluorine coating is used, corrosion of the switch causes contamination of corrosion products (foreign matter) into parts, generation of rust in processed parts, and increase of stoppage period of machine tools and production lines due to increase of sensor replacement frequency.

For the above-mentioned reasons, the prohibition of coatings with fluorine-based paints should be exempted indefinitely from this restriction because of the economic burden due to the increased frequency of replacement and the serious degradation to the finished product.

In terms of disposal, restrictions should not be applied as coatings by fluorinated paints generally lead to a reduction in waste.

Spatter-guarded proximity switch

Part of the housing of the spatter-guarded proximity switch used in a welding environment.

Cap：Fluoropolymer resin PFA sensing surface

Housing：Coated with fluoropolymer resin.

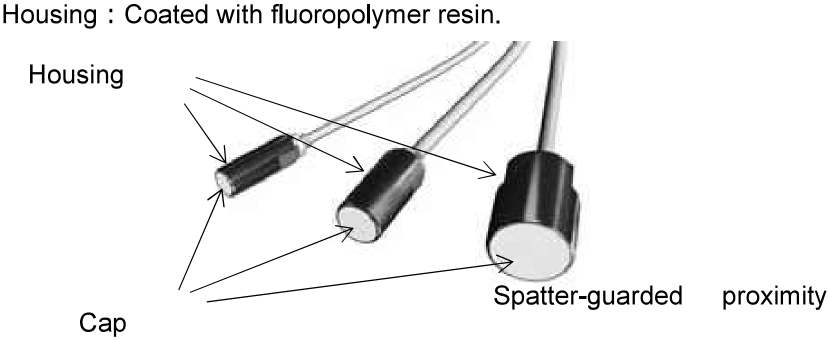


Figure 28

The following features can be obtained by using Fluoropolymer resin.

Cap：It can withstand the heat of welding spatter. It is difficult for spatter to stick.

Housing：It is difficult for spatter to stick.

Flame arrestor (sintered metal) surface

Figure 29

Sintered metal flame arrestor is used to prevent the internal gas sensor element from becoming an ignition source. Surrounding gas reaches the sensor element through fine gaps in the sintered metal, but when water is adsorbed on the sintered metal, the flow path of the gas narrows. Therefore, in order to prevent water adsorption and corrosion on sintered metal, a fluorine coating is applied for the purpose of adding repellency from water and chemical resistance.

- Inside the metal nipple

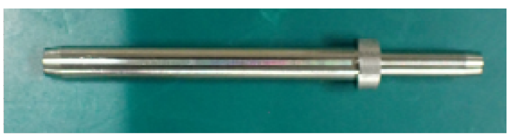


Figure 30

Fluorine coating is applied to the inside of the metal nipple which is part of the gas flow path for the purpose of adding non adhesion in order to prevent the gas concentration from decreasing due to the adsorption of highly adsorptive gases.

Repellency from water

The flame arrester (sintered metal) is given water repellency by applying a fluorine coating to prevent clogging due to water adsorption and corrosion.

Non-adhesion

Fluorine coating is applied to parts of metal pipes that cannot be used due to insufficient strength of fluoropolymer resin pipes, such as when it is necessary to cut threads to fix them.

Chemical resistance

Fluorine coating is applied to the parts used in the gas flow path to provide chemical resistance. Fluorine coating can be used in acids, alkalis, organic solvents, ozone, and oils.

Fuel cell performance testing equipment: Coating of tank

Fuel cells generate electricity and heat through a chemical reaction between hydrogen and oxygen. Fuel cell performance testing equipment evaluates the performance and durability of fuel cells. Fuel cells contribute to carbon neutrality by improving energy efficiency and reducing CO2 emissions.

The Fuel cell performance testing equipment supplies hydrogen obtained from an alkaline substance to the fuel cell. It stores the alkaline liquid to obtain hydrogen in a stainless steel tank, which cannot be used for a long period of time because the stainless steel is corroded by the alkali. Therefore, the tank surface is protected by coating with PTFE. Moreover, hydrogen gas used for fuel cell is necessary to add water vapor. The tanks for to control the dew point of the added water vapor can reach temperatures above 150°C. Thus the coating material must be heat resistant. So far, PTFE is the only material which has both chemical and heat resistance.

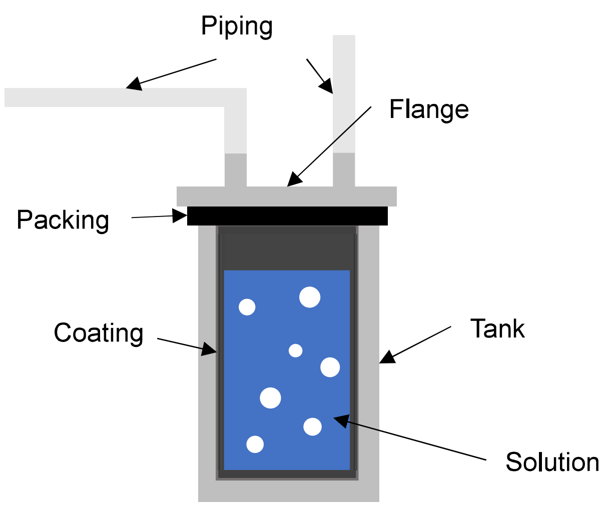


Figure 31

Temperature sensor

Contact type temperature sensors can measure temperature by contacting the object to be measured and reaching to the same temperature. The sensor measures the temperature using the element itself or an element inserted into a protective tube for strength.

Temperature sensors can measure a wide range of objects, including acids, alkalis, and organic solvents, and can also measure a wide range of temperatures, including applications that measure chemicals at 100°C or higher. Therefore, sensor elements, wires themselves, and protective tubes are coated with FEP or PFA to eliminate the adverse effects of chemicals and high temperatures and realize accurate measurement.

There is no material other than fluoropolymers that combines chemical resistance and heat resistance to realize such applications, and it is difficult to replace them.

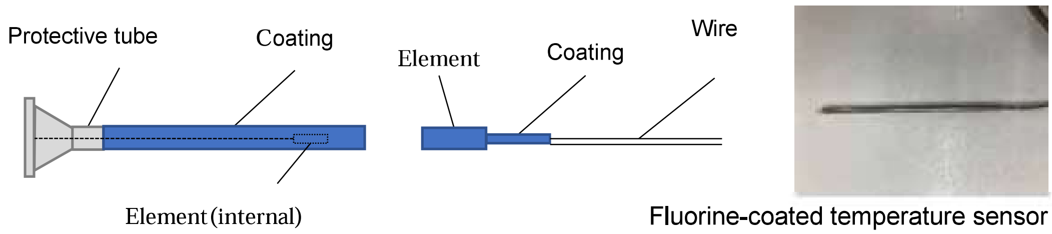


Figure 32

<u>Coatings/linings for tools for analysis and measurement</u>

Analysis and measuring instruments are required to have chemical resistance because they may analyse and measure any kinds of chemical substances, including strong acids, strong alkalis, organic solvents, and oils, as samples. For correct analysis and measurement, no specimens or reference materials should remain in instruments or pipettes, tubes, etc. If residues remain, subsequent analysis and measurement will not be accurate. In order to prevent residues from remaining, coating should be applied to the areas where the specimens and reference materials are likely to remain. The fluoropolymer resins have the functions, such as, repellency from water and oils, and non adhesion. These functions can prevent residues from remaining, which resulting in accurate analysis and measurement.

<u>Coatings for the interior of X-ray analysis detector</u>

Fluorescence X-ray analysis (XRF) is designed to analyze elements by measuring the X-ray fluorescence produced after each element is excited by X-rays. X-rays generated from components close to the sensor are also detected, so that X-rays of fluorescence generated from sources other than the sample being measured interfere with accurate analysis.

The lower the atomic number, the lower the energy of the X-ray fluorescence. Conversely, elements with higher atomic numbers tend to absorb X-rays more easily.

Therefore, metallic materials such as Nickel, which are the internal components of the detector, are coated with a metal with a lower atomic number, such as Aluminum (Al), and then coated with a fluoropolymer resin less than 100 μm thick to absorb the fluorescent X-rays generated from Al. Fluoropolymers also emit fluorescent X-rays, but their low energy has no effect on the analysis.

If coatings other than fluoropolymers are used, epoxy resins and carbon coatings are available. But these have a lower X-ray absorption than fluoropolymers. For the same absorption capacity, a coating three times thicker for graphite (C) and seven times thicker for polypropylene (C_3H_6) is required to absorb the fluorescence X-ray from Al (See the figure38). The thicker coating interferes with the sensor, reducing detection sensitivity and increasing analysis time.

For accurate X-ray fluorescence analysis, it is difficult to use anything other than fluoropolymers for the internal coating of the detector.

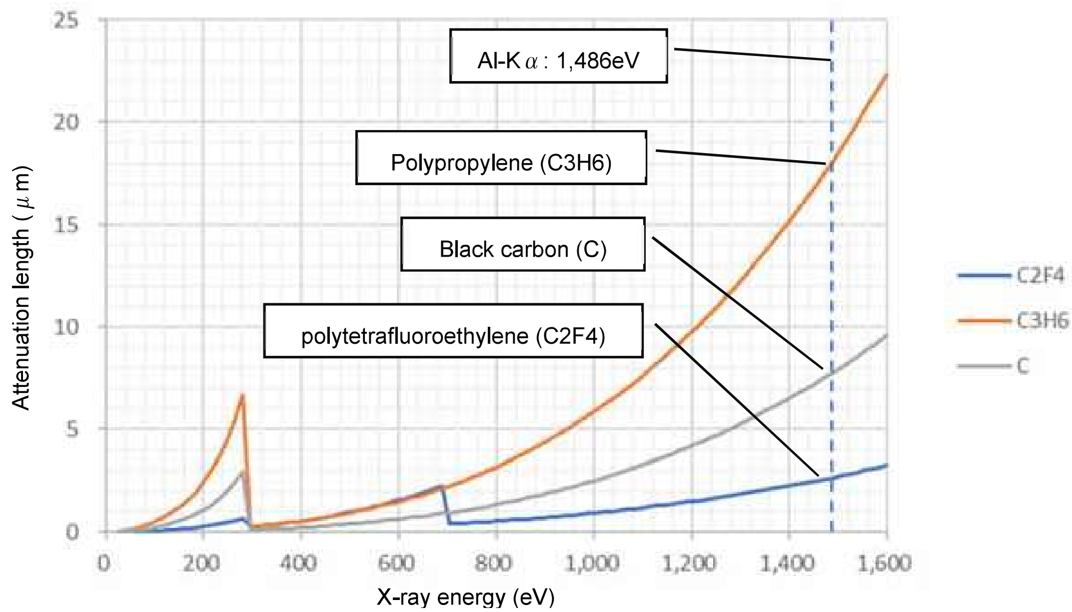


Figure 33 X-ray attenuation lengths from Aluminum [3]

Membrane filters

Membrane filters are to remove and separate specific substances or objects from fluids. A wide variety of materials are used. If fluorine compounds are necessary, PTFE, FEP, ETPE and PFA are frequently used.

Membrane

Dissolved oxygen electrode

Electrolyte

Electrochemical gas sensor

Figure 34

[3] It is calculated with CXRO X-Ray Interactions With Matter, https://henke.lbl.gov/optical_constants/ accessed on 25 August 2023

Measurement method of pH meter and diagram of membrane filter

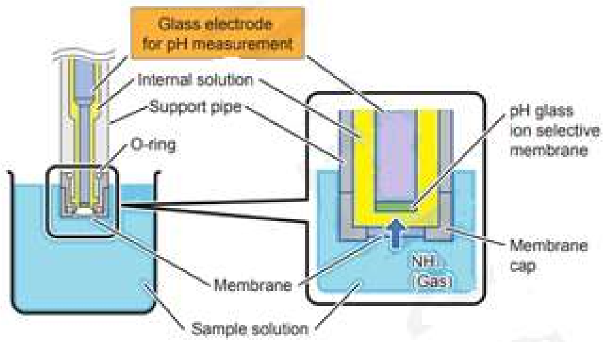


Figure 35

1. Gas components in the sample are go into the electrode through the membrane.
2. The pH of the internal solution changes according to the amount of the gas taken in, and the change of pH is read by a glass pH electrode.
3. The pH change of the internal solution is converted to gas concentration in the sample.

The following properties are required for the membrane used in this application.
There is currently no other material that possesses these properties at a level that can be used in products.

・Gas permeability
Membrane must have sufficient gas permeability even under conditions of no pressure.
・Chemical resistance
Membrane must have sufficient chemical resistance that will not deteriorate after immersion in various samples.
・Repellency from water
Repellency from water is required in order not to permeable water.

PVC, glass and PEEK are too high much gas barrier property to separate gases. PE is weak for acids. Glass is melt down by hydrogen fluoride and some gases. Fluorine compounds such as PFAS are the only materials that can simultaneously provide and express multiple functions required for the proper functioning of membrane filters.

PTFE filter used in the ozone decomposition catalyst unit of NOx measuring equipment
A NOx meter needs to generate ozone to measure NOx by the chemiluminescence method. For accurate measurements, ozone is generated in excess of NOx in the sample. An ozone decomposition catalyst is used to decompose ozone remaining after NOx measurement, and a PTFE filter is used to remove the catalyst powder.

PTFE filter is a filter with little adsorption and decomposition. Use is recommended in the Environmental Air Constant Monitoring Practices Promotion Manual. It also has better ozone-resistance than PVC and PE and is less priced than PEEK.

PTFE porous membrane electrochemical gas sensor

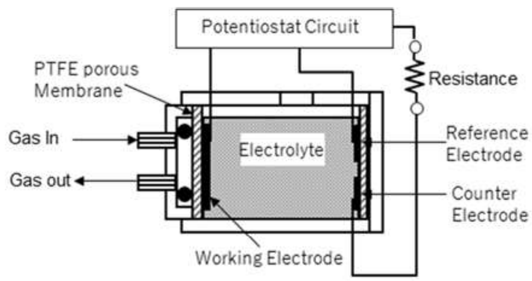


Figure 36

1. Electrochemical gas sensor is constituted by a working electrode formed on a PTFE porous membrane, a reference electrode, a counter electrode, electrolyte and a housing which is holding other components.
2. Every electrode is connected to a potentiostat circuit and the working electrode is implied fixed potential to that of the reference electrode.
3. The PTFE porous membrane is in contact with atmosphere which may contain intended gas to be detected.
4. The gas to be detected goes through by diffusion in the membrane and reaches the interface of the working electrode and the electrolyte.
5. The gas is electrochemically oxidized or reduced.
6. The oxidized or reduced reaction involves transfer of electrons between chemical species and the working electrode, hence current flows in the circuit.
7. The current is measured to determine the concentration of the gas to be detected

The following properties are required for the membrane used in this application.

There is currently no other material that possesses these properties at a level that can be used in products.

・Gas permeability

The membrane must have gas permeability at atmospheric pressure.

・Water resistance

The membrane must have sufficient water resistance not to leak electrolyte.

・Corrosion resistance

The membrane must have corrosion resistance. Examples of corrosive gases are NOx, SOx, halogen and halogen halide.

・Chemical resistance

・Heat resistance

The membrane must have sufficient heat resistance over 150 degree Celsius to coat electro catalyst.

・Non-adsorptive

The membrane must have sufficient non-adsorptive. If the gas to be detected is adsorbed on the membrane, the gas can’t go through the membrane, or it takes time to go through the membrane.

Galvanic oxygen sensor

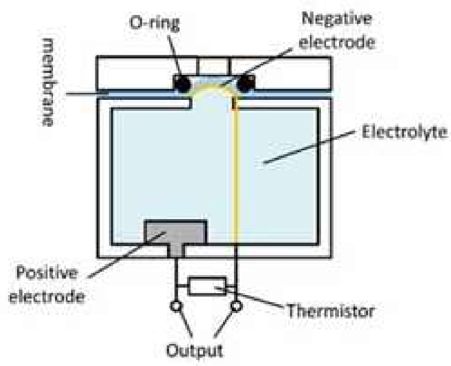


Figure 37

1. Oxygen gas in the sample reaches through the membrane into the sensor.
2. The oxygen gas taken in is reductively decomposed at the cathode. A current flows according to the oxygen amount taken in.
3. The current is read as a voltage through a resistor such as a thermistor.

The following properties are required for the diaphragm used in this application.

Gas permeability

The gas to be measured is taken into the electrode. This measurement is not possible without sufficient oxygen permeability even under conditions of no pressure. Among fluorine compounds, FEP has superior oxygen permeability compared to other polymer membranes.

Chemical Resistance

FEP is used in environments where it is in constant contact with various gases (acids, alkalis, organic solvents, etc.). The membrane filter does not deteriorate in these environments, does not elute components of the membrane filter when in contact with any sample, and must be resistant to chemicals.

Water repellency and water resistance

The membrane filter must be hydrophobic and water resistant to prevent water from permeating into the electrode.

The material must not change after 10 years of exposure test as a material.

Electrode

-Parts in contact with liquid other than electrodes in electrode structure (of instrument that measures the physical quantity of a liquid by electrical means)-

The electrode in a measuring instrument is a part to be electrically contacted with an object and to measure for the purpose of measuring the electrical signal of the measurement object.

The instrument to measure the physical quantity of a liquid by electrical means is equipped the electrode(s).

In that type of instrument, the purpose of the electrodes is to detect the electrical potential or charge at limited area in the liquid. Therefore,

(In the electrode and surrounding structure,) parts in contact with liquid other than electrodes must be non-conducting.

For non-conducting material, high hardness materials such as glass or ceramics can be used only very limited usage. because these high-hardness materials are inferior in workability and impact resistance.

Therefore, in many cases, resin is used for parts in contact with liquid other than electrodes.

And there is no resin material other than PFAS that can withstand the temperature and corrosiveness of liquids.

Examples of the products which incorporates electrodes

Internal junction and filers in electrodes for pH liquid measurement

Internal solution determines the standard of electric potential for pH liquid measurement. Small amount of internal solution is diffused in the sample. It is necessary to reduce the amount of diffusion of the internal solution to reducing the impact to samples, and stable measurement. Fluoropolymer gels and porous resins which impregnant fluoro-monomer internal solution minimise the amount of the diffusion.

Samples could be strong acids, alkalis, organic solvents, and others. The liquid junction of electrodes requires chemical resistance. PFASs are chosen for internal solutions, gels and porous resins in the liquid junction for pH measurement. PFASs have repellency from water and oils, which resulting in less stains in the electrodes. This is particularly useful for continuous operations. Internal junctions require PFASs which have the function of chemical resistance and repellency from water and oils for accurate and stable measurement.

Optical coating

A water-repellent coating layer which contains Perfluoroalkyl or perfluoropolyether compounds is formed with a thickness of less than tens of nm on the outermost surface of coating layers of the ophthalmic lens surfaces.

The water repellent coating provides superior properties such as water repellency, oil repellency, lubricity, smoothness and chemical resistance to the ophthalmic lens. These properties improve prevention of water discoloration on anti-reflection coatings, scratch resistance, ease of wiping off stains (fingerprints, sebum, etc.) on the lens surface and maintainability. As the results, these high performances enable to extend substantially the product life of lenses.

And the water-repellent coating layer is coated on anti-reflection coating layers to eliminate the ghost and flare phenomena in lens optical systems.

The one of valuable features is having both properties of low refractive index (n<=1.40) and high transparency of the coating layer which composed of perfluoroalkyl or perfluoropolyether compounds.

*1 Ghosting/flare: Reflected light generated on the lens surface is repeatedly reflected in complex ways, resulting in the appearance of light images that are not actually there. The higher the reflectivity of the lens surface, the more likely it is to appear.

*2 Anti-reflection coating: A film with a function to reduce reflected light. In ophthalmic lenses, reflection is reduced by alternately layering materials with different refractive indices to utilize light interference.

*3 Low refractive index: Since the lower the refractive index of the film of the top surface layer of an antireflection coating, the greater the effect of reducing reflections from the lens surface, a film material with a lower refractive index is required. The refractive index of general glass is 1.52, and the refractive index of base materials for eyeglass lenses is 1.50~1.90 (including plastic and glass).

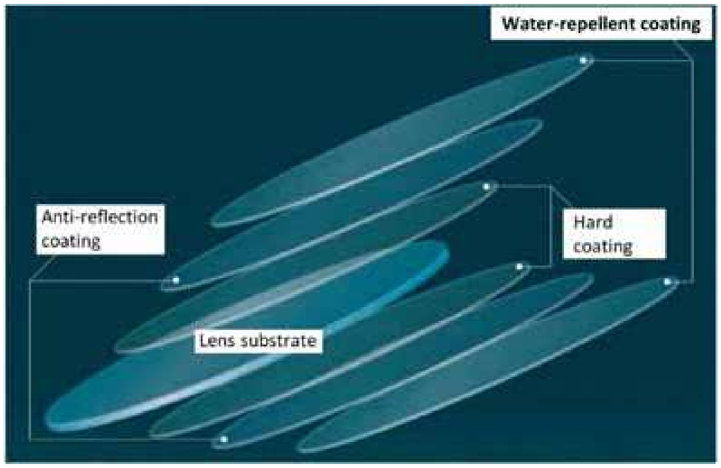


Figure 38

Functions of PFAS that required for lens coating and their alternatives.

Ophthalmic lenses

Ophthalmic lenses are daily exposed to sunlight, rain, sweat, and washed with detergents. So, high level repellency from water and oil are required for the coating of ophthalmic lenses. PFAS-based coatings are widely used because of their excellent weatherability, low friction, and repellency from water and oil. The water-repellent coatings have been developed since the 1980s, but it is still very difficult to achieve the target performances with non-fluorine compounds. Even after more than 30 years effort, no coating without PFAS, which can pass abrasion resistance, chemical resistance, and weather resistance tests assuming everyday use, has been developed yet.

As the proposal alternatives, silicone-based water repellents are representative material, though they can achieve fluorine-based equivalents in terms of contact angle to water, they have not been able to achieve fluorine-based equivalents in terms of contact angle to oil, chemical resistance, and low refractive index.

<Test results>

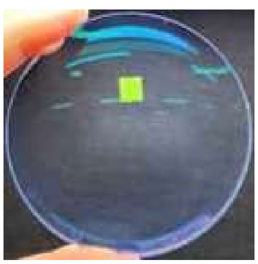
Performance comparison of fluorine-based perfluorinated polyether water-repellent coating and silicone-based polydimethylsiloxane water-repellent coating

		Perfluorinated polyether	Polydimethylsiloxane
Contact angle	To water (H_2O)	108°	104°
	To oil (Oleic acid $C_{18}H_{34}O_2$)	80°	52°
Scratch resistance	Steel wool load 500g 50 round-trip	Good	Bad
Chemical resistance	After 6hr dipping in alkali（NaOH aq. pH:11）	Good	Bad
	After 6hr dipping in acid（HNO_3 aq. pH:1）	Good	Bad

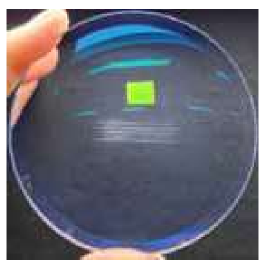
Table 1

＜Details＞

Pictures of appearance after scratch test



perfluorinated polyether



polydimethylsiloxane

Contact angle change in chemical resistance test

		Alkali		Acid	
		Water	Oleic acid	Water	Oleic acid
Perfluorinated polyether	Before	108°	80°	108°	80°
	After	105°	70°	104°	70°
Polydimethylsiloxane	Before	105°	52°	105°	52°
	After	42°	40°	48°	31°

Table 2

Water repellent effect by coating

Without coating With Coating

Figure 39 Difference among lens with coating and without coating [4]

Period required for replacement: About 1.5 to 2 years, if a non-fluorine material with PFAS-equivalent performance is produced.

Volume of PFAS to be placed on the EU market : car camera 0.32μg/year

Amount of PFAS entering in the EU as water-repellent coating materials on ophthalmic lenses

The amount of PFAS entering the EU as water-repellent coatings on ophthalmic lenses is estimated to be 300 kg/year*1. The amount of PFAS entering the EU through water coating*2 is much smaller (1 ppm to 2 ppm) than the total amount of PFAS entering the EU through all applications (140,000 to 310,000 ton/year).

<Explanation for estimating the amount of PFAS entering the EU as water-repellent coating materials of ophthalmic lenses>.

The amount of PFAS entered in the EU as ophthalmic lenses was calculated from the product of the annual sales volume of eyeglass lenses in the EU and the amount of PFAS coated as hydrophobic coating film per lens.

[4] Cannon optron https://optron.canon/ja/evaporation/pickup01.html accessed on 31 May 2023.

1. Hypothesis

・Assume that all vision corrective spectacle lenses sold in the EU have a hydrophobic coating on both sides.

2. Estimate

1) Annual sales volume of eyeglass lenses in the EU

200,000,000 pcs/year (200 million pcs/year) *1,*2

2) Amount of PFAS per lens (both sides) **

1.5 x 10-3 g/pcs

3) Amount of PFAS entering the EU through spectacle lenses

1) × 2) = 300 kg/year

4) Total amount of PFAS entering the EU

140,000 to 310,000 tons/year *3

5) PFAS content ratio by spectacle lens

9.7E-07～2.1E-06 (1ppm～2ppm)

**The net PFAS amount is the solid content coated as the water-repellent coatings on both sides of the lens, excluding the solvent. Assuming that the total amount a is deposited on the total number of lenses b that are put in. The amount of PFAS per lens is calculated as a/b.

Therefore, The PFASs amount entering in EU countries as water-repellent coating materials for ophthalmic lenses is much smaller than that entered in EU as other industrial application.

3. Reference

*1 WORLD LENS AND FRAME DEMAND STUDY 2022, SWV
https://www.ewintelligence.com/world-lens-and-frame-demand-study-2022/98489.article

*2 Spectacle Lenses – Europe
https://www.statista.com/outlook/cmo/eyewear/spectacle-lenses/europe

*3 ANNEX XV RESTRICTION REPORT PROPOSAL FOR A RESTRICTION, P.22/224, Socio-economic analysis, “For the EU, this resulted in an estimated amount of 140 000 to 310 000 t of PFASs introduced to the market in 2020,"
https://echa.europa.eu/documents/10162/f605d4b5-7c17-7414-8823-b49b9fd43aea

Examples of devices with lenses

PFAS is mainly used for outdoor sensors, lenses of surveillance cameras, etc., and protective panels on the surface of smartphones and other devices.

Without the use of PFAS, it would not be possible to meet the required specification of water contact angle (100° or more). As a result, the visibility of the image will be poor, and the function of the sensor or surveillance camera will not be established.

Examples

Fiber unit for Measurement use

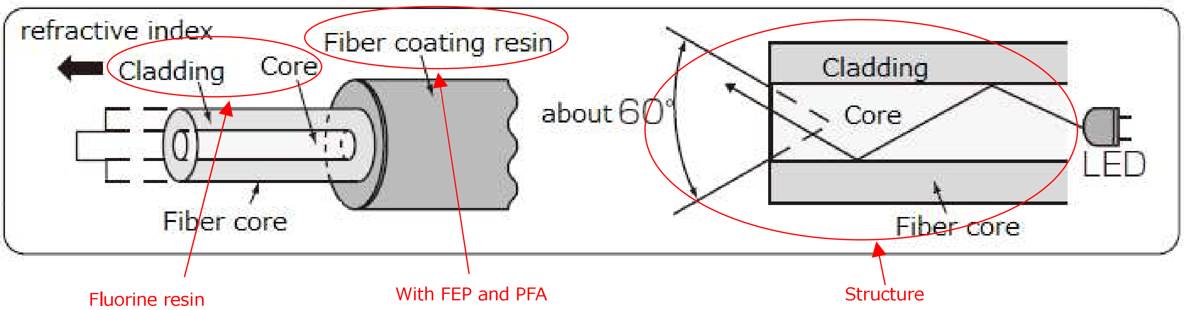
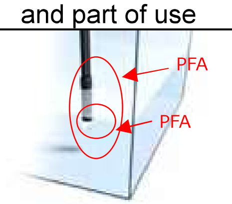
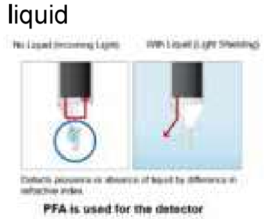


Figure 40

・This is a step index type multimode fiber (using the refractive index difference between core and clad). Fluorine resin is used for the clad. No alternative material has been proposed by the manufacturer at present. In this type of fiber, the basic optical characteristics of the fiber are determined by the refractive index difference between core material and clad material, and the material is selected by the manufacturer in consideration of the manufacturing method. Users use commercially available fiber. FEP is used for the clad and jacket, and PFA is used for the jacket and outer coating.

	Detection method and part of use	Purpose and materials used	Principle using PFA characteristics
Liquid level detection		The tip detection part is made of PFA, and the tube material which may come into contact with liquid is also covered with PFA, a material which is easily fused with the tip. In order to make the tip small and non-electric, a commercially available plastic optical fiber cable is used for guiding the detection light, and fluorine resin (specific material is not disclosed by the manufacturer) is also used as the clad material.	Use refractive index difference between PFA and liquid  It uses the difference in refractive index between liquid and liquid. Detection principle ・ It utilizes the return light difference due to the refractive index difference (hereinafter referred to as n) between the material of

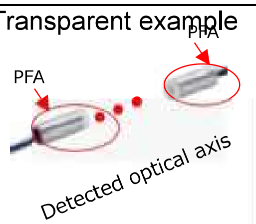
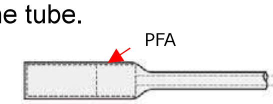
			the tip cone and the external contact material. ・ Without liquid : In a state of lower refractive index than PFA (n ≒ 1.35) (air n ≒ 1), most of the light emitted from the projection is reflected by the inner surface of the cone and returns to the light receiving portion to enter. ・ Liquid : The liquid has a large refractive index equal to or higher than that of PFA (water n ≒ 1.33, ethyl alcohol n ≒ 1.36), and the amount of light that is substantially transmitted through the conical surface and returns to the light receiving portion decreases. ・ The presence or absence of liquid is determined by this light amount difference.
Leak detection		The detection head and cable, which may come into contact with liquid, are covered with PFA.	Use refractive index difference between PFA and liquid  Detection principle is the same as "liquid level detection"
Chemical resistance	Transparent example 	The detection head and cable, which may come into contact with liquid, are covered with PFA.	Sealing performance is ensured by fusing the tip of the PFA detection head and the tube. 

Figure 41

Due to the housing made of PFA resin, this fiber unit has higher stability against organic solvents than other products.

・The following characteristics can be obtained by using PFA resin for the fiber unit.

- This fiber unit functions stably for the detection of organic solvents.
- There is no alternative to this function

・This leakage sensor is used for the following applications.

- Liquid leakage detection in semiconductor wafer cleaning and developing processes
- Detection of tank leakage

・There are concerns about the following effects due to the unavailability of this technology :

- Cleaning and development of a semiconductor wafer using an organic solvent cannot be carried out safely.

・For the above reasons, the prohibition of PFA resin in leakage sensors affects safety and should be exempted from this restriction indefinitely.

Heat medium

Refrigerators, compressors, centrifuges

Refrigerators are used for the units require temperature control, and pretreatment for measurement and analysis. Fluorinated gases are the only materials that can simultaneously provide and express multiple functions required for the proper functioning of refrigerators, such as, thermodynamic efficiency, surface tension, electrical insulation, inactivity, heat conductivity, and a wide range of operating temperature.

HFCs as F-gas will be restricted by the EU F-gas regulation and international treaties. HFCs will be replaced by organic fluorine compounds that their GWP are smaller than carbon dioxide. In that case, the substituted organic fluorine compounds (GWP>1) will be further substituted.

A succession of substitutions in a short period shortens the lifetime of specialist equipment, which is originally long-life. Refrigerators, compressors, centrifuges are used as units of specialist equipment, the derogation as spare parts should be considered. Specialist equipment cannot be repaired, it will be discarded, and its lifetime will be shortened.

Refrigerants must not leak from the unit, the units that uses refrigerants such as refrigerators, compressors, and centrifuges require the sealing materials mentioned in this document.

5(f), (g), and (h) of proposal wordings are written in Annex A of the restriction report. Specialist equipment with a long lifetime cannot be sufficient grace periods. The grace periods should be examined.

Example of a product using a refrigerator:

<u>Compressor calorimeter</u>

A Compressor calorimeter is an equipment that measures the performance of compressors, which is the heart of air conditioner. It is used by compressor manufacturers for development and quality control, and contributes to the development of compressors that are compatible with natural refrigerants and more efficient energy-saving compressors.

Figure 42 Compressor calorimeter

Some of equipment such as calorimeters are equipped with a temperature chamber to maintain a constant environmental temperature for measuring EUT, and refrigeration units using CFC refrigerant (HFC, HFO) are used to cool the temperature chamber. Compressor endurance testing equipment, system performance test equipment, environmental test chambers, and other equipment are also equipped with a refrigerator for the same purpose.
Natural refrigerants such as ammonia and CO_2 are candidates to replace CFC refrigerants, but they have the following problems.

・When natural refrigerants are used, the refrigerator becomes too large and cannot be replaced.
・The system cannot be configured because there is no option of peripheral equipment for refrigeration equipment that is compatible with natural refrigerants.
・Many natural refrigerants are flammable, toxic, and unsafe. Especially for CO2, the use of CO2 is more hazardous due to its high pressure.
For these reasons, CFC refrigerants are difficult to replace.

Lubricating oil

Lubricating oil is used to control friction and wear of metal contacting parts when machines are combined to rotate, reciprocate, or otherwise operate. In addition to suppressing friction and wear, this oil also suppresses corrosion and frictional heat, and its sealing and cleaning properties allow the machine to operate smoothly.

Lubricating oil formulated with PFAS have the following characteristics

・Low friction: Reduces the adverse effects of friction on the lifetime and performance of components.

・Heat resistance: Resistance to chemical changes even when used in high-temperature environments. Resistance to ignition.

・Weatherability: Excellent oxidation stability and resistance to adverse effects of oxygen. Not decomposed by moisture.

・Chemical resistance: Resistant to chemicals such as acids and alkalis.

・Chemical resistance/cleanliness: Almost no deterioration of rubber and plastic materials.

There is no other lubricant besides fluorinated synthetic lubricants that can satisfy all of the above characteristics.

Lubricant oils in the products.

<u>Mass Flow Controller / Mass Flow Meter</u>

Mass flow controllers and mass flow meters are used for flow control and flow measurement of various industrial gases.

Lubricating oil is applied to joint screws and O-rings to prevent screw galling and improve the assembly of O-rings.

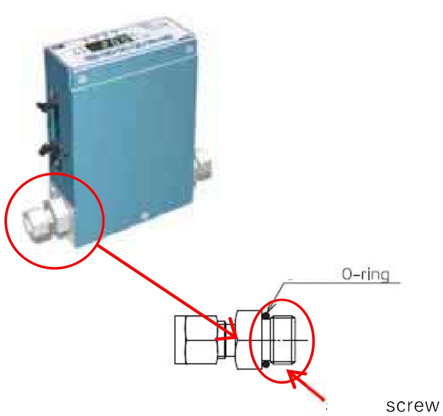


Figure 43

Ordinary grease and oil cannot be used because they may become a source of ignition when flammable oxygen gas is used, so their safety is significantly impaired.

<u>Pressure Transmitter</u>

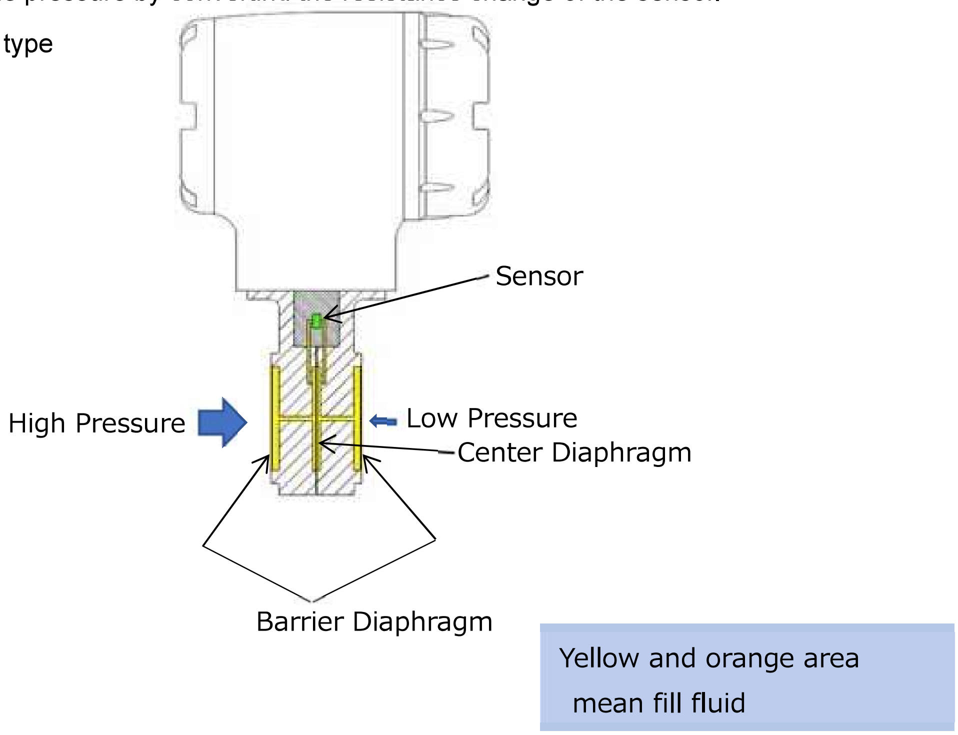
Measuring Principal

A pressure transmitter consists of a barrier diaphragm that contacts the process pressure, a center diaphragm that protects the sensor, and a sensor that detects the pressure.

If there is a difference in pressure on each barrier diaphragm, the fill fluid that carries the pressure creates a pressure difference on either side of the sensor, which distorts the sensor and changes its resistance.

Measure the pressure by converting the resistance change of the sensor.

Standard type



Remote type

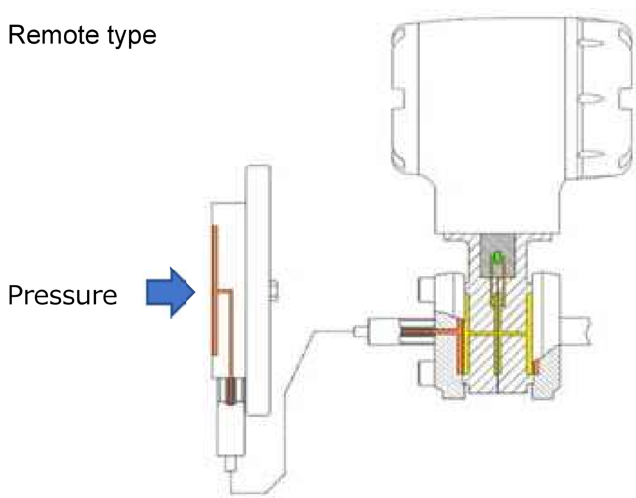


Figure 44

In addition to the following items, the properties required for the fill fluid include fluidity even at low temperatures, low viscosity, and non-flammability. The only fill fluid that offers all of these is the fluorinated fill fluid, and there is no alternative.
The diaphragms that come into contact with process fluids may be damaged due to corrosion or abrasion during use. When broken, the fill fluid comes into direct contact with the process fluid, but otherwise does not leak into the environment.　This product is a WEEE target model and is in a controlled state for disposal.
Shipping volume information：Less than 1000kg par year
Since the fill fluid is in direct contact with the sensor, high electrical insulation performance is required.
PCTFE can use up to 120 degree Celsius, Perfluoropolytrimethyleneoxide can use up to 260 degree Celsius.
Stable against strong corrosive acids and alkalis.
Does not react with chlorine and oxygen even under high temperature and pressure.
Surface tension:26～28mN/m
Silicon oil: Most likely fill fluid but reacts with chlorine and oxygen at high temperatures and pressures, and in the worst cases explodes.

Coding for sliding rubber parts of industrial controllers

A PTFE-coated lubricant is applied to the outer circumference of the packing to make it easier to separate the front bezel from the case.　Since the housing is made of resin, there is a risk of solvent cracking, and grease cannot be used.

Figure 45 Overall product

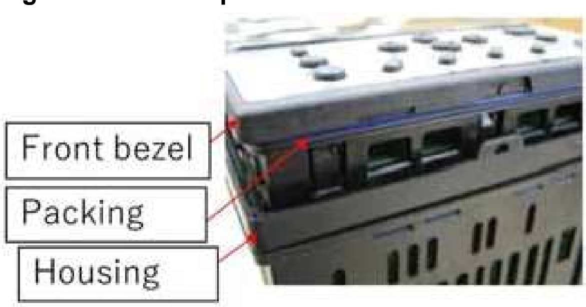


Figure 46 Packing installation explanatory diagram

Others

Solvent for oil content analyzer

Solvent for oil content analyzer is chlorotrifluoroethylene (CAS RN 9002-83-9). (hereinafter "specific chlorotrifluoroethylene solvent")

Solvent extraction-nondispersive infrared absorption method is used for oil content measurement. The light from the light source enters the cell filled with the oil-extracted solvent. After that, an interference filter introduces only the absorption wavelength range (3.4 to 3.5 μm) attributed to stretching vibration between carbon-hydrogen bonds (C-H) into a detector (pyrosensor). As the oil content in the oil extracting solvent increases, the light transmitted through the cell is decreased, and the current value generated by the pyroelectric effect decreases. The oil content can be calculated using this current value.

Infrared absorption method for oil content analysis is standardized in ASTM standard D7066-4.

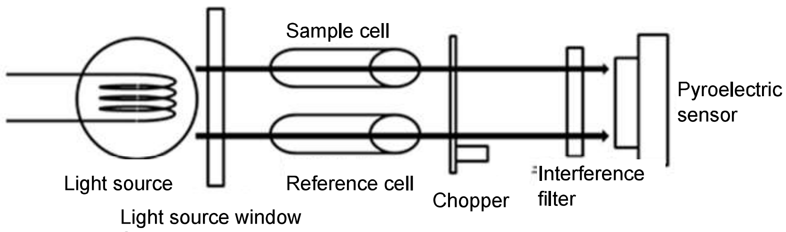


Figure 47 Oil content analyzer bench structure

Extraction of oil from solid samples is performed by immersion as shown in the figure below.

Figure 48 Method for extracting oil from solid samples

Functions of PFAS required by solvent for oil content analyzer and substitutability.

The oil content is quantified by Beer-Lambert law using absorption attributed to carbon-hydrogen stretching vibration at 3.4 to 3.5 μm (2941 to 2857 cm^{-1}). Therefore, the extraction solvent must not have absorption in this wavelength range. Chlorotrifluoroethylene has no carbon-hydrogen bond (C-H) in its molecular structure and has no absorption at 3.4 to 3.5 μm, so it is suitable as a solvent for oil content measurement using the solvent extraction-nondispersive infrared absorption method.

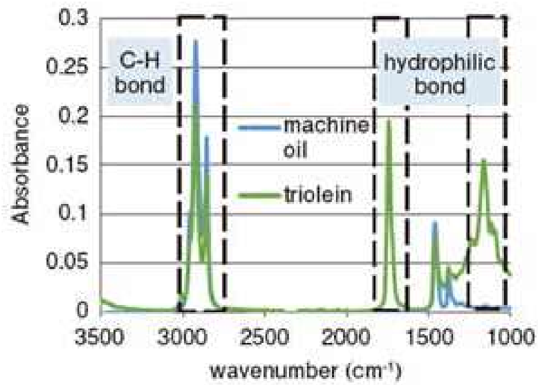


Figure 49 IR spectrum of oil

Existing solvents used for cleaning parts and general reagents that do not have carbon-hydrogen bond (C-H) in their molecular structures were verified, but it could not be adopted because it did not meet the following performance requirements.

- Influence of infrared absorption
  From the principle of the analyzer, it is necessary to have no absorption higher than that of the specific chlorotrifluoroethylene solvent in the wavelength range of 3.4 to 3.5 μm (2941 to 2857 cm^{-1}).
- Safety
  The specific chlorotrifluoroethylene solvent is not listed in the Montreal Protocol and the Kigali Amendment and are not classified in the EU CLP Regulation Hazard Classification.
  With a boiling point of 134°C and a vapor pressure of 1.33 (kPa), it does not easily volatilize during use, so it can be used with normal ventilated environment. Similar safety and operability are required for alternative material.

- Analyzer performance cannot be achieved
  The measurement range of the oil content analyzer is 0-200 mg/L. The light source and the detector are designed and adjusted to achieve the specified performance in the range of 0-200 mg/L when measured using the specific chlorotrifluoroethylene solvent.
  Therefore, as with the influence of infrared absorption, a low absorption rate equivalent to that of the specific chlorotrifluoroethylene solvent is required for measurement in the analyzer range of 0-200 mg/L

Composition	Specific Chloro trifluoro ethylene	1-bromo propane + stabilizer	aliphatic hydro carbon + ester	Decane	Undecane	1-bromo propane	Trichloro-ethylene	tetrachloro-ethylene
Name	Chloro-trifluoro-ethylene polymer			Decane	Undecane	1-bromo-propane	Trichloro-ethylene	tetrachloro-ethylene
(CAS RN)	9002-83-9	106-94-5 stabilizer: unknown	unknown	124-18-5	1120-21-4	106-94-5	79-01-6	127-18-4
Boiling point (degree Celsius)	134	48	174	172	196	71	87	121
Classification of EU CLP Regulation	Not Classified			Not Classified	Not Classified	Flam. Liq. 2 Skin Irrit. 2 Eye Irrit. 2 STOT SE 3 STOT SE 3 STOT RE 2 Repr. 1B	Skin Irrit. 2 Eye Irrit. 2 STOT SE 3 Muta. 2 Carc. 1B Aquatic Chronic 3	Carc. 2 Aquatic Chronic 2
Montreal Protocol and Kigali Amendment	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Absorption around 3.4-3.5 μm	Small	Large	Large	Large	Large	Large	Large	Middle
KB value	31	13	-	-	-	121	130	90
400 mg oil solubility	Possible	-		-	-		Possible	Possible
Alternative?	-	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable	Unsuitable

Table 3 comparison of solvents

Solvent PFAS Release Risk

Using: With a boiling point of 134°C and a vapor pressure of 1.33 (kPa), it does not easily volatilize during use. And the specific chlorotrifluoroethylene solvent is not listed in the Montreal Protocol and the Kigali Amendment and are not classified in the EU CLP Regulation Hazard Classification, so safe to use.

After use: Only the oil can be removed from used specific chlorotrifluoroethylene solvent with a dedicated equipment and can be reused

Existence and Possibility of Alternatives: There is no alternative solvent that can ensure the same performance and safety as the current one.

Period required for substitution when a substitute material is developed: 4-5 years

Solvent: There is no alternative solvent that can ensure the same performance and safety as the current one.

Limit switch button, housing and rubber seal

1. Internal switch button
2. Painting the housing
3. Used for each rubber seal of limit switch

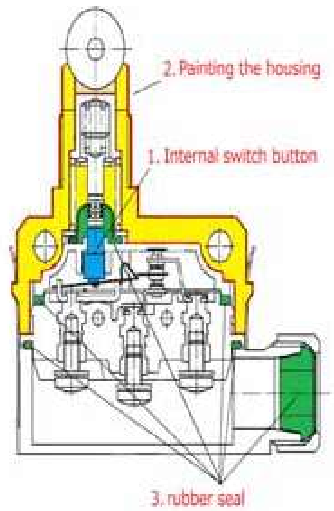


Figure 50

Although the exterior coating can be changed to other coatings, fluorine is the lowest and most suitable for internal sliding properties.

Sliding : plunger and housing

Sliding: internal switch button and internal switch cover

Addition of fluorine improves slidability.

	Fluoropolymer	Resin	
	PTFE	PE	POM
Dynamic friction coefficient (ud)	0.09	0.13	0.18
Heat-resistant(degree Celsius)	260	70-110	80-120

Table 4 [5]

The retention of seals at high temperatures is superior to other rubbers.

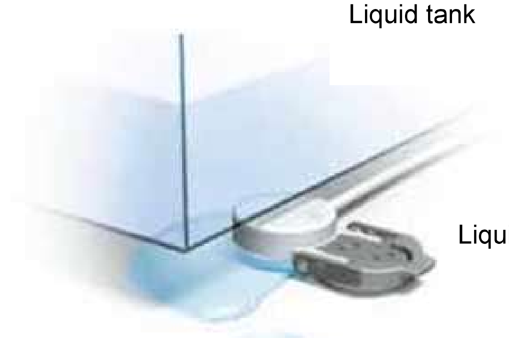
Switching to silicone rubber is difficult to adopt because of the risk of contact failure.

In addition, it is often used for applications such as cutting fluid that damage silicon rubber, so it cannot be used.

[5] https://www.y-skt.co.jp/magazine/coating/lowfriction/

Liquid leak sensor

Liquid tank



Liquid leak sensor

The sensor housing is made of PFA resin.

Figure 51

Schematic diagram of sensor structure
The sensor housing cover, case and tube are made of PFA resin.

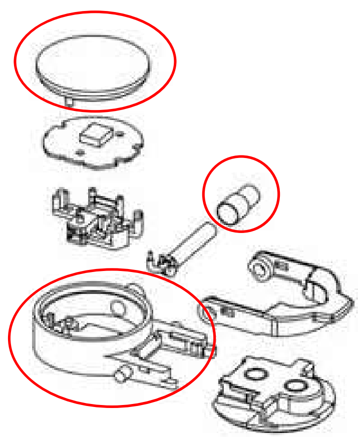


Figure 52

Due to the housing made of PFA resin, this leakage sensor has higher stability against organic solvents than other products.

・The following characteristics can be obtained by using PFA resin for the leakage sensor.

- This leakage sensor functions stably for the detection of organic solvents.

・This leakage sensor is used for the following applications.

- Liquid leakage detection in semiconductor wafer cleaning and developing processes
- Detection of tank leakage

・There are concerns about the following effects due to the unavailability of this technology :

- Cleaning and development of a semiconductor wafer using an organic solvent cannot be carried out safely.

Cutting parts

(Example of finished products: diaphragm galvanic oxygen sensors, oxygen detectors)

It is a part manufactured by cutting a block of resin. Because it is a small-lot production product, it is produced by cutting that does not require mold costs. Another reason for cutting is that there are places where sealing properties are required.

Here, I will touch on the machined parts used in the casing of the galvanic oxygen sensor. There are various materials, but we will describe the case where PTFE and PFA, which have higher chemical resistance, are used.

Figure 53 Example of Fluoroplastic Cutting Parts

Please see “Membrane filters” for galvanic oxygen sensors

Fluoropolymer casing are required when parts require chemical resistance. There is a need to measure oxygen concentration even in places where acids, alkalis, and organic solvents are always present. In this application, it is necessary to have chemical resistance such that it does not deteriorate even when it comes into contact with various gases (acids, alkalis, organic solvents), does not elute components even when it comes in contact with any sample.

Also, as a material, it is necessary to have weather resistance properties such as not changing in a 10-year exposure test and not softening or deforming in the surrounding environment of -40 to 70 °C.

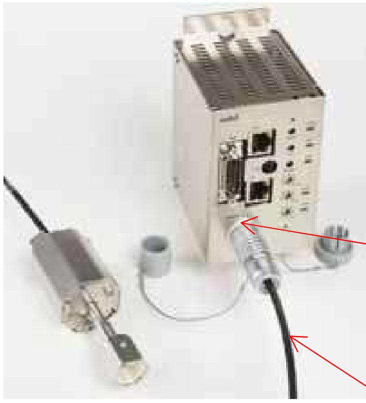
If you try to perform the same function with other materials, for example, phenolic resins and polyamide resins can be mentioned as resins that are resistant to acetone as a general organic solvent, but phenolic resins are resistant to strong alkalis. Polyamide-based resins cannot be used as a substitute because they do not have durability against strong acids.

Sapphire Capacitance Diaphragm Gauge

Components corresponding to a heater operating temperature of MAX 250°C

For the picture of this products, please see the explanation in electric wires and insulation.

Components compatible with gauge head operating temperature of MAX 250°C



LEMO connector ⇔
Board connection cable
→
Cable jacket and dielectric
contain Perfluoroalkoxy alkane(PFA)

Sensor, Temperature sensor for control ⇔ Board connection cable
→ Sheath, insulator, etc.
contain Perfluoroalkoxy alkane(PFA)

Figure 54

Humidity element for humidity sensor and dew point temperature sensor

Sector "Electronics and semiconductors (Annex E.2.11.)" "Construction products (E.2.13.)"

Sub uses :Monitoring and control instruments Heating, Ventilation and Air Conditioning(HVAC)

Polymeric PFAS /Fluorinated polyimide

Generic name for the final product: Humidity sensor, Dew point temperature sensor

Common name for application parts: Humidity element

Detailed application description:

The humidity sensor chip used for a humidity sensor and a dew point temperature sensor measures humidity by capacitance change between electrodes sandwiching the moisture sensitive film. The thickness of the moisture sensitive film is several μm.

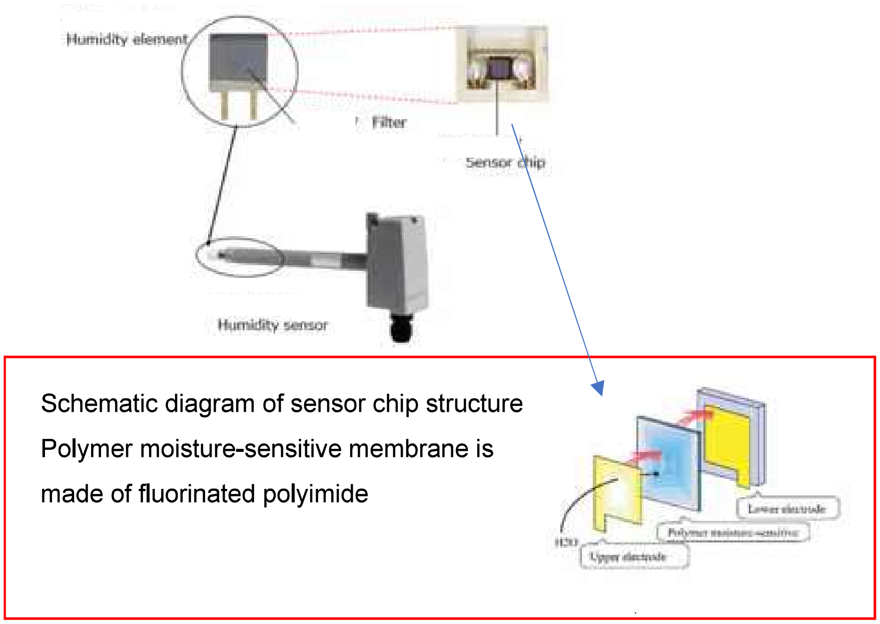


Figure 55

・This humidity sensor is used for the following purposes

・Humidity sensor installed in an environment in which condensation appears on the sensor itself, such as inside the HVAC duct and the outside air intake section.

The following features can be obtained by using fluoride polyimide for humidity sensor

・The humidity sensor works stably for a long period in an environment where the sensor is condensed (100% humidity).

・Nothing to replace this function.

The humidity sensor has higher stability under high temperature, high humidity and condensation than other products due to the humidity sensitive membrane using fluorinated polyimide.

・The prohibition of this technology is concerned about the following effects.

・It won't be able to properly measure and control humidity on HVAC system in an environment in which condensation appears on the sensor itself.

・Other polymer materials such as methyl methacrylate resin (PMMA), polyimide, polysulfone, etc. can be candidates as alternative technologies and materials.

・However alternative technology requires replacement of the sensor every time condensation occurs. For example, it is known that condensation appears on a humidity sensor which is inserted into an outside air intake duct several times a year depending on the weather. Humidity sensors without moisture sensitive membrane using fluorinated polyimide for this application will require replacement at least once a year. Moisture sensitive membranes using fluorinated polyimide can withstand at least 8 years of use.

Performance requirements for materials (PFAS)

Heat-resistant: 180 degree Celsius as a humidity sensitive element

Repellency from water: Electrical insulation in condensing environments

Chemical resistance: Resistant to organic solvent atmosphere

Alternative Considerations: No substitute material

Required derogation period: 13.5 years or more

Valve for air volume and room pressure control

Materials for ensuring sliding, corrosion resistance, chemical resistance, and solvent resistance for air volume valves.

Use sector: "Medical devices (Annex E.2.9.)", "Construction products (E.2.13.)"

sub-uses: Control valve, Heating, Ventilation and Air Conditioning(HVAC)

PFA：26655-00-5

PTFE：9002-84-0

PVDF：24937-79-9

ETFE：25038-71-5

Generic name for the final product: Valve for air volume and room pressure control

Common name for application parts: Body, Pivot arm, S-link, Shaft, Spring, Cone, Brackets, Seal), Tap, e-crip), Bush, Slider, Sleeve, Cap, Bolt

Detailed application description

The two main applications of valves are below.

(1) To be installed as a local exhaust ventilation system to prevent workers from being exposed to substances harmful to the human body, such as in chemical manufacturers and biotechnology research laboratories.

For example, when a worker opens or closes the door of the local exhaust device (red dotted frame in Figure 56), the differential pressure across the valve suddenly changes, but by taking advantage of the good sliding property, the valve can be instantly changed to the appropriate valve opening position to maintain exhaust at a constant air volume.

In addition, since valves must control fluids containing various chemicals and solvents, they must be resistant to corrosion, chemicals, and solvents.

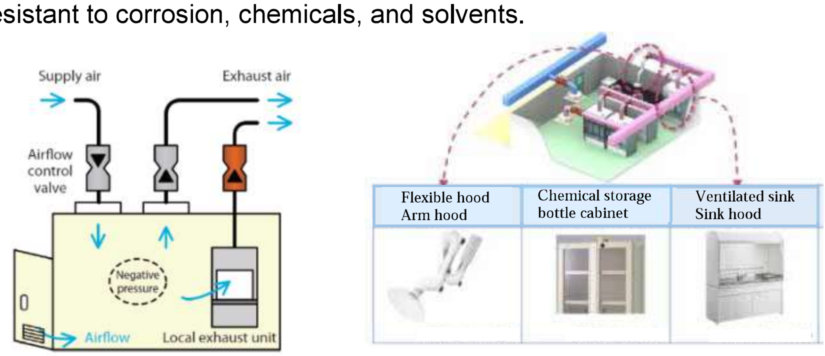


Figure 56 Example of air volume control in a chemical/ Other exhaust applications

(2) The device is installed in hospital rooms and wards as a negative-positive pressure control device to secure hospital beds for patients with infectious diseases and to protect healthcare workers from infection risk.

Even when the differential pressure across the valve suddenly changes due to the opening and closing of the hospital room entrance door, etc., the air supply and exhaust valves respond instantly by taking advantage of their good sliding characteristics and change to the appropriate opening position, thereby always maintaining the pressure difference between the room and outside.

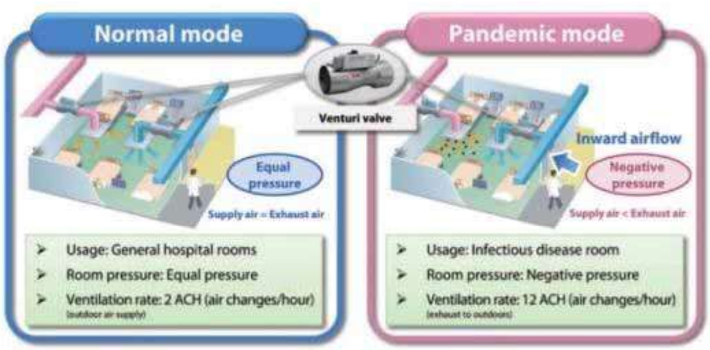


Figure 57 Image of negative and positive pressure control in a hospital room

The parts used in valves that include candidates for regulation are below.

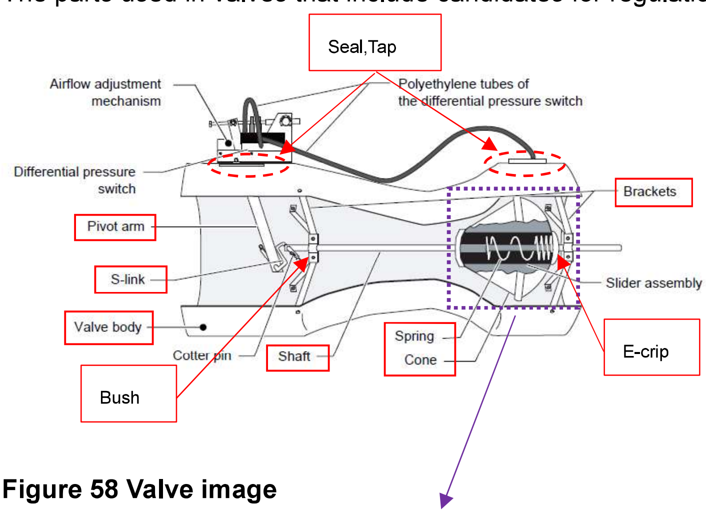


Figure 58 Valve image

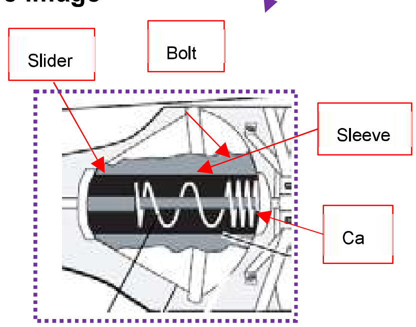


Figure 59 Slider assembly

(1) For valves that do not require corrosion resistance, chemical resistance, or solvent resistance, parts (Slider, Sleeve, Cap) containing PTFE should be used to ensure sliding properties.

(2)Valves that require corrosion resistance, chemical resistance, and solvent resistance use the following parts to ensure the above three functions and sliding properties.
・Parts containing PTFE (Slider, Sleeve, Cap, Bush, Seal, Tap)
・Parts containing PFA (Shaft, Spring)
・Parts containing PVDF or ETFE (Body, Pivot arm, S-link, Cone, E-crip, Bolt)

Technical Description of Essential Uses
As mentioned above in “Detailed application description”, valves must have the sliding property required to respond instantly to sudden disturbances, and the corrosion, chemical, and solvent resistance required to control fluids containing various chemicals and solvents.
Therefore, it is necessary to place parts containing PTFE, PFA, PVDF, and ETFE for mechanisms that need to ensure sliding properties and for channel parts that are in contact with the control fluid.
(1) Ensure sliding properties
Other polymeric materials may be used as an alternative to PTFE for ensuring sliding properties. However, since there is no material with lower sliding resistance than PTFE, the sliding resistance force will increase and the sliding performance required for valves cannot be ensured.
(2) Ensure sliding properties, corrosion resistance, chemical resistance, and solvent resistance
Other polymeric materials, such as rubber and resin, may be used as alternatives to PFA, PTFE, PVDF, and ETFE for the purpose of ensuring the above four functions.
However, the alternative materials cannot ensure the sliding properties, corrosion resistance, chemical resistance, and solvent resistance required for valves due to the deterioration of sliding properties as described in (1) and the lack of resistance to various chemicals and solvents.
The following effects are feared as a result of the unavailability of these technologies.
The inability to use PFA, PTFE, PVDF, and ETFE for valves will make it impossible to carry out normal operations at chemical manufacturers, biotechnology research facilities, hospitals, and other facilities.
This will have a profound impact on the production and supply of medicines, the progress of research in biotechnology, and isolated medical treatment, including coronas.

For the above reasons, the prohibition of the use of parts containing PFA, PTFE, PVDF, and ETFE in valves should be exempted from this restriction in terms of ensuring safety for the human body.

In terms of disposal, the restriction should not be applied to valves containing PFA, PTFE, PVDF, and ETFE, since these components can be used until the product reaches its original service life, leading to a reduction of waste in general.

Performance requirements for materials (PFAS)
Heat-resistant: Heat-resistant max93 degree Celsius
Chemical resistance: Resistant to chemicals, solvents and corrosive fluids
Sliding performance: Wear resistance due to sliding, sliding performance
Non-adhesion: Non-adhesion of foreign matter

Mechanical parts for sliding or releasing applications used in "Specialist equipment"

Fluoropolymers with excellent low friction, and self-lubrication and mon-adhesion. Properties are often used in mechanisms that require sliding with plastic and metal parts or releasing from sticky materials.. The following common characteristics are related to the reason why fluoropolymers are particularly selected for "Specialist equipment".

1) Some final products handled by "Specialist equipment" require use in special environments. For example, in facility environments where foods, liquids, powders, etc. are handled, consideration must be given to high temperature, high humidity, generation of dust, or hygiene management.
2) Equipment used in social infrastructure such as factories is required to have performance such as automatic operation, trouble-free operation, easy preparation and setup changes. This enables us to provide society with high-quality, low-cost products and services.
3) When handling products with equipment, it is required to minimize the impact on product quality, such as damage or adhesion of foreign matter.

From the above, the mechanical parts for sliding applications used in "Specialist equipment" are required to have the following properties.
・Repellency from water and oil / non-adhesion
・Low friction, self-lubrication
・Heat resistance
・Chemical resistance (Acid resistance, Alkali resistance, Oil resistance, Ozon resistance)

Table 5 summarizes the performance of major alternative materials with respect to the required performance.

Material		PTFE	POM	HDPE	PA66
Material or Coating		Material/ Coating	Material	Material/ Coating	Material/ Coating
Low friction	Coefficient of friction	0.04	0.2~0.3	0.2~0.3	0.18~0.4
Repellency from water and oil	Contact angle of water [deg]	114	(Equivalent to PA66)	88	77
	adhesion energy [dyne/cm]	43.1		75.2	97.7
Oil resistance	Contained in food	◎	○	◎	◎
Acid resistance	Contained in food	◎	×	◎~○	△~×
Alkali resistance	Contained in detergents, etc.	◎	×	◎	◎
Ozon resistance	Special cleaning	◎		△	×
Heat resistance	Hot food	◎	△	△~×	△

Table 5

* Non-adhesion and Repellency from water and oil are according to the above-mentioned property table. Others are summarized by the author of this section based on multiple documents.

Appropriate materials are selected and used according to the required performance that varies depending on the work environment and target product. From the table, PFAS shows good properties with respect to water/oil repellency and heat resistance. Cases where PFAS is used as an irreplaceable material include, for example, use in environments where food and liquids are handled, as well as guide parts or blade surface coatings where adhesion is undesirable.

Instrument example (Packaging machine for food industries)


Heating pressure bar with knife of packaging machine (with PTFE Coating)

Figure 60

Food Contact Parts of Measuring Instruments

The following performances are required for the food contact parts of measuring instruments for pre-packaging food.

1) Conformity with (EC) No 1935/2004, (EU) No 10/2011, etc. is required for safety when materials used are exposed to the body through food.
2) For the purpose of reducing food waste and cleaning burden, and ensuring supply by automating production, it is required that food does not adhere easily.

There are two technical approaches to the anti-adhesion performance of 2). The first is "a) reducing the contact area with food" and the other is "b) using water- and oil-repellent, non-adhesive materials." The Table 6 summarizes the performance of the main means currently in practical use considering the operating environment conditions. Each means is provided in the form of material or coating.

Technical approach		(1)contact area	(2) water- and oil-repellent, non-adhesive materials		
Means		Stainless steel embossed structure	PFAS(PTFE,PFA)	Ceramic	HDPE
Material or Coating		Material	Material/Coating	Coating	Material
Repellency from water and oil	Does not adhere to water or oil	× Oil hardens and accumulates.	◎	◎~〇	〇
Non-adhesion (for hard foods)	Food does not remain on equipment.	◎~〇	◎	〇~△	〇
Non-adhesion (for soft foods)		△~×	◎	〇~△	〇
Oil resistance	Contained in food	◎	◎	◎	◎
Acid resistance	Contained in food	◎	◎	◎	◎~〇
Alkali resistance	Contained in detergents, etc.	◎	◎	〇	◎
Ozon resistance	Special cleaning	◎	◎	◎	△
Heat resistance	Hot food	◎	◎	◎	〇
Durability	Hard to wear	◎	△	〇	△

Table 6

*PFAS and PE are according to the above-mentioned property table. SUS and ceramics are summarized by the author of this section based on multiple documents.

In terms of technology in the practical stage, PFAS is superior in all items except durability. Since the required performance differs depending on the type of food and the factory environment, means other than PFAS may be selected. However, it is clear from the above table that substitution is not possible in all cases, which is the reason why exclusion is necessary. Also, the determination of substitutability must be tried in all cases using actual food in a real working environment, which is why the substitution period is necessary.

Instrument example (Weigher for food industries)

Example of oil accumulation (Food contact part is a flat stainless steel without coating)

Example of stainless steel embossed structure

Figure 61

RECEIVED
By: OAH on 3/1/2024 at 4:33pm

Edith Nagy Attachment 2

Coalition of Manufacturers of Complex Products

March 1, 2024

Katrina Kessler, Commissioner
Minnesota Pollution Control Agency
520 Lafayette Rd. N.
St. Paul, MN 55155-4194

Via eComment at https://minnesotaoah.granicusideas.com/

Re: Planned New Rules in Minnesota Governing Currently Unavoidable Use Determinations About Products Containing Per- and Polyfluoroalkyl Substances, Revisor's ID No. R-4837

Dear Commissioner Kessler:

The Coalition of Manufacturers of Complex Products (Coalition) appreciates the opportunity to respond to the Minnesota Pollution Control Agency's (MPCA) request for comments regarding the planned new rules for the MPCA's determination of currently unavoidable uses (CUU) of per- and polyfluoroalkyl substances (PFAS) in products. Additionally, the Coalition submits requests a CUU determination for complex consumer and durable goods, their components and replacement parts, as part of this rulemaking.

Coalition members manufacture equipment and products by assembling tens to hundreds or thousands of parts, components, and raw materials to provide, in many cases, critical services to society. These include commercial and consumer products such as appliances, vehicles, vessels, motors, heating, ventilation, air conditioning, refrigeration, and water heating equipment (HVACR- WH), electronics, and their replacement parts. Coalition members serve and support nearly every major sector in the nation, providing critical products and services for government agencies, the military, law enforcement, first responders, and public safety, food and agriculture (including commercial fishing and sea farming), energy, transportation and logistics (including for commuting and for island residents), public works and infrastructure support services, critical manufacturing, the defense industrial base, conservation, and life-saving climate control and ventilation in homes, hospitals, schools, and eldercare facilities, or food preservation and processing and for critical health and life sciences. Services dependent on refrigeration include everything from the prevention of dangerous food spoilage to life-giving medicines, vaccines, proteomics, therapeutics, blood plasma, and other temperature-dependent elements in the life sciences and pharmaceutical sectors. Collectively these products and services constitute a vital part of the economy, at all levels, including for public safety..

A ban on the use of complex consumer and durable goods in Minnesota would significantly disrupt the safety, health, and functioning of society in Minnesota, national security, and critical infrastructure. The Coalition is pleased to provide additional input below, in response to MPCA's questions listed in the request for comments. In addition to our responses, the Coalition is including comments submitted on establishing currently unavoidable use exemptions in Maine (Attachment 1). Please note that the information there was developed with both Maine and Minnesota's programs in mind.

1. **Should criteria be defined for "essential for health, safety, or the functioning of society"? If so, what should those criteria be?**

In Section 1 of Attachment 1, the Coalition provides the definition for "complex consumer and durable goods." In Section 2 of Attachment 1, the Coalition explains the criteria by which complex consumer and durable goods are essential to the safety and functioning of critical domestic infrastructures such as national defense, transportation, communications, and construction, and are used in security systems, safety lighting, and life-saving medical devices.

2. **Should costs of PFAS alternatives be considered in the definition of "reasonably available"? What is a "reasonable" cost threshold?**

The Coalition submits that MPCA should not only consider the costs of PFAS alternatives, but all associated costs, such as the costs that companies incur over the time it takes to implement alternatives across the complex supply chains for these products. In Section 4 of Attachment 1 the Coalition describes the length of time it takes to identify and implement alternatives across complex supply chains.

3. **Should unique considerations be made for small businesses with regards to economic feasibility?**

The Coalition supports taking small business considerations into account in providing exemptions from reporting and the law's product ban.

4. **What criteria should be used to determine the safety of potential PFAS alternatives?**

In determining the safety of potential PFAS alternatives, the Coalition supports a risk-based approach, as described in Section 3 of Attachment 1.

5. **How long should PFAS currently unavoidable use determinations be good for? How should the length of the currently unavoidable use determination be decided. Should significant changes in available information about alternatives trigger a re-evaluation?**

The Coalition supports CUU determinations that are not time limited. As described in Section 4 of Attachment 1, identification of and transition to safer feasible alternatives for PFAS in complex consumer and durable goods takes many years. The variety of ways in which PFAS components are used and the myriad of products does not align with a single transition period.

6. **How should stakeholders request to have a PFAS use be considered for currently unavoidable use determination by the MPCA? Conversely, could stakeholders request a PFAS use not be determined to be currently unavoidable? What information should be submitted in support of such requests?**

The Coalition supports exemptions by product category. The Coalition does not support redirecting limited state resources to requests for not unavoidable determinations. Product manufacturers are in the best position to know their products and whether alternatives are feasible. The Coalition supports having the same criteria that Maine requires for CUU exemptions.[1]

7. **In order to get a sense of what type of and how many products may seek a currently unavoidable uses determination, please share what uses and products you may**

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[1] Maine Department of Environmental Protection, *PFAS in Products: Currently Unavoidable Uses* (Last visited February 29, 2024).

submit a request for in the future and briefly why. There will be a future opportunity to present your full argument and supporting information for a possible currently unavoidable uses determination.

The Coalition respectfully requests that MPCA grant an exemption for the product category of complex consumer and durable goods, as defined in Section 1 of Attachment 1. The Coalition believes that this product category fulfills all of the requirements for a CUU determination.

8. **Should MPCA make some initial currently unavoidable use determinations as part of this rulemaking using the proposed criteria?**

Yes. Due to the essential nature of and the additional time needed to find alternatives, CUU determinations should be part of the proposed rule. We ask that complex consumer and durable goods be included. To avoid uncertainty around the extremely negative socio-economic consequences of a ban on complex consumer and durable goods, CUU determinations should be made as soon as possible. The proposed rule should include a process for requesting additional exemptions.

9. **Other questions or comments relating to defining currently unavoidable use criteria and the process MPCA uses to make currently unavoidable use determination.**

The Coalition believes that a CUU exemption should apply to the 2032 ban and the reporting requirement, set to become effective in Minnesota as of January 1, 2026.

* * *

The Coalition would welcome an opportunity to discuss these comments with you and answer any questions. The Coalition respectfully requests that MPCA grant our request to provide a currently unavoidable use exemption in proposed and final regulations for complex consumer and durable goods, their components and replacement parts. For further information about these comments, please do not hesitate to contact Martha Marrapese, Partner at Wiley Rein LLP, at (202) 719-7156 or mmarrapese@wiley.law.

Enclosure

GPC Code List Submitted on February 29, 2024
Japan Electric Measuring Instruments Manufacturers' Association (JEMIMA)

SegmentCode	SegmentTitle	SegmentDefinition	FamilyCode	FamilyTitle	FamilyDefinition	ClassCode	ClassTitle	ClassDefinition	BrickCode	BrickTitle	BrickDefinition_Includes	BrickDefinition_Excludes	AttributeCode	AttributeTitle	AttributeDefinition	AttributeValueCode	AttributeValueTitle	AttributeValueDefinition
65000000	Computing		65010000	Computers /Video Games		65010100	Computer/ Video Game Accessories		10001112	Computer Tools/Tool Kits	Includes any products that can be described/observed as a collection of tools specifically designed to be used with computer equipment.	Excludes products such as DIY Toolkits.						
65000000	Computing		65010000	Computers /Video Games		65010100	Computer/ Video Game Accessories		10001115	Card Readers	Includes any products that can be described/observed as a compact portable device that allows for fast viewing, sharing, transferring and e-mailing of various data, such as pictures.	Excludes products such as Computer Drives and Cards.	20002649	Type of Card		30007885	MEMORY CARD	
65000000	Computing		65010000	Computers /Video Games		65010200	Computer Components		10001118	Computer Components - Replacement Parts/Accessories	Includes any products that can be described/observed as replacement parts and accessories that can be applied to various computer components.	Excludes all other products currently catered for within Computers segment.						
65000000	Computing		65010000	Computers /Video Games		65010200	Computer Components		10001119	Computer Components Other	Includes any products that can be described/observed as a Computer Component, where the user of the schema is not able to classify the products in existing bricks within the schema.	Excludes all currently classified Computer Components.						
65000000	Computing		65010000	Computers /Video Games		65010200	Computer Components		10001120	Computer Components Variety Packs	Includes any products that can be described/observed as two or more distinct Computer Component products sold together which exist within the schema but belong to different bricks, that is two or more products contained within the same pack which cross bricks within the Computer Components class. Includes products such as Computer Memory and Computer Motherboards sold together. Items that are received free with purchases should be removed from the classification decision-making process.	Excludes products such as Computer Processors sold individually.						
65000000	Computing		65010000	Computers /Video Games		65010200	Computer Components		10001123	Computer Motherboards	Includes any products that can be described/observed as the primary printed circuit board in a PC, which contains all of the basic circuitry and components required for a PC to function. The motherboard typically contains the system bus, processor and coprocessor sockets, memory sockets, serial and parallel ports, expansion slots and peripheral controllers but can be sold with or without these components attached.	Excludes products such as Peripherals.	20001709	Target Use/Application	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the target use and/or application.	30007587	DESKTOP	
65000000	Computing		65010000	Computers /Video Games		65010200	Computer Components		10005683	Computer/ Video Games Mass Storage	Includes any products that can be described/observed as a mass storage device on which data is held and from which data can be retrieved. Includes devices such as tapes, cartridges and disks specifically for use with computers and video consoles. Includes products such as ZIP and JAZZ disks.	Excludes products such as random access memory (RAM).	20002579	Storage Medium/Device	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of device used for storage.	30013000	DATA CARTRIDGE/TAPE	
65000000	Computing		65010000	Computers /Video Games		65010300	Computer Drives		10001133	Hard Disc Drives	Includes any products that can be described/observed as a storage device that uses a set of rotating, magnetically coated discs called platters to store data or programs, hermetically sealed to prevent airborne contaminants from entering and interfering with these close tolerances.	Excludes products such as Floppy Disc Drives and CD/DVD Drives.	20002710	If Multimedia	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether the product uses a combination of text, audio, still images, animation, and video.	30002960	NO	

65000000	Computing		65010000	Computers /Video Games		65010400	Computer/ Video Game Software		10001138	Computer Software (Non Games)	Includes any products that can be described/observed as a program that instructs a computer how to process data and documentation and that explains how these programs should be used. Includes products such as Word Processing Software, Spreadsheet Software, Presentation Software and Desktop Publishing Software.	Excludes products such as Computer Games.	20000045	Consumer Lifestage	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the period or stage in the consumer's life during which the product is considered to be suitable.	30000147	ADULT	
65000000	Computing		65010000	Computers /Video Games		65010400	Computer/ Video Game Software		10006236	Computer Software (Non Games) - Digital	Includes any products that can be described/observed as a programme which is downloaded or streamed that instructs a computer how to process data along with documentation that explains how these programs should be used. Includes products such as Word Processing Software, Spreadsheet Software, Presentation Software, Fonts, and Desktop Publishing Software.	Excludes products such as Computer Games and Digital Mobile Apps.						
65000000	Computing		65010000	Computers /Video Games		65010500	Computers		10001141	Computers - Replacement Parts/Accessories	Includes any products that can be described/observed as replacement parts and accessories that can be applied to various computer products.	Excludes all other products currently catered for within the Computers/Video Games segment.						
65000000	Computing		65010000	Computers /Video Games		65010500	Computers		10001142	Computers Other	Includes any products that can be described/observed as a Computer article, where the user of the schema is not able to classify the products in existing bricks within the schema.	Excludes all currently classified Computers as well as articles to be found within the Communication segment.						
65000000	Computing		65010000	Computers /Video Games		65010500	Computers		10001147	Servers	Includes any products that can be described/observed as a computer in a network that provides access to other computers in the network to programs, web pages, data, or other files and services, such as printer access or communications access.	Excludes products such as Personal Computers not specifically designed for use as Servers as well as servers for home automation or smart devices.	20001709	Target Use/Application	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the target use and/or application.	30007678	DATABASE SERVER	
65000000	Computing		65010000	Computers /Video Games		65010600	Computer/ Video Game Control/Input Devices		10001152	Computer/ Video Game Control/Input Devices - Replacement Parts/Accessories	Includes any products that can be described/observed as replacement parts and accessories that can be applied to various Computer/Video Game Console Control and Input Devices.	Excludes products classified in other bricks of Computer/Video Game Console Control and Input Devices class.						
65000000	Computing		65010000	Computers /Video Games		65010700	Computer/ Video Game Peripherals		10001155	Computer/ Video Game Peripherals - Replacement Parts/Accessories	Includes any products that can be described/observed as replacement parts and accessories that can be applied to various Computer/Video Game Peripherals.	Excludes products classified in other bricks of the Compute/Video Game Peripherals class.						
65000000	Computing		65010000	Computers /Video Games		65010700	Computer/ Video Game Peripherals		10001156	Printer Consumables	Includes any products that can be described/observed as being specifically designed to periodically replace/refill components of a printer that have been depleted or worn out by use, such as ink cartridges. These products also includes refills such as ink, which is just added to the original cartridge in order to refill it rather than replace it. Cartridges may contain only black ink or one to five colours of ink. The products include Photo Ink Cartridges that contain special lighter Cyan and Magenta Inks, which help re-create more lifelike flesh tones.	Excludes products such as Printers, Type Writer and Fax Machine Consumables.	20002605	Dedicated Usage	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the application/usage to which the product is dedicated.	30000720	COMBINATION	

65000000	Computing		65010000	Computers /Video Games		65010700	Computer/ Video Game Peripherals		10001156	Printer Consumables	Includes any products that can be described/observed as being specifically designed to periodically replace/refill components of a printer that have been depleted or worn out by use, such as ink cartridges. These products also includes refills such as ink, which is just added to the original cartridge in order to refill it rather than replace it. Cartridges may contain only black ink or one to five colours of ink. The products include Photo Ink Cartridges that contain special lighter Cyan and Magenta Inks, which help re-create more lifelike flesh tones.	Excludes products such as Printers, Type Writer and Fax Machine Consumables.	20002605	Dedicated Usage	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the application/usage to which the product is dedicated.	30007730	PRINTER	
65000000	Computing		65010000	Computers /Video Games		65010700	Computer/ Video Game Peripherals		10001158	Printers	Includes any products that can be described/observed as a computer/games console printer that produces hard copies. Includes products such as photo printers and video games printers.	Excludes products such as multifunctional devices that include a printer and which are classified with office machinery, as well as any other computer peripherals.	20002615	If Photo Printer	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether the product is a photo printer.	30002960	NO	
65000000	Computing		65010000	Computers /Video Games		65010700	Computer/ Video Game Peripherals		10001158	Printers	Includes any products that can be described/observed as a computer/games console printer that produces hard copies. Includes products such as photo printers and video games printers.	Excludes products such as multifunctional devices that include a printer and which are classified with office machinery, as well as any other computer peripherals.	20001080	Type of Printer	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of printer.	30002518	UNIDENTIFIED	This term is used to describe those product attributes that are unidentifiable given existing or available product information.
65000000	Computing		65010000	Computers /Video Games		65010800	Computer Networking Equipment		10001163	Gateways	Includes any products that can be described/observed as a device that enables two dissimilar systems that have similar functions to communicate with each other.	Excludes products such as Switches, Hubs, Routers and Firewalls.						
65000000	Computing		65010000	Computers /Video Games		65010800	Computer Networking Equipment		10001168	Network Routers	Includes any products that can be described/observed as a device that determines the next network point to which a data packet should be forwarded enroute toward its destination.	Excludes products such as Hubs, Switches and Gateways.	20002061	If With Modem	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether or not the product is supplied with a modem.	30002960	NO	
65000000	Computing		65010000	Computers /Video Games		65010800	Computer Networking Equipment		10001168	Network Routers	Includes any products that can be described/observed as a device that determines the next network point to which a data packet should be forwarded enroute toward its destination.	Excludes products such as Hubs, Switches and Gateways.	20001092	Type of Network Router	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of network router.	30007770	DYNAMIC ROUTER	
65000000	Computing		65010000	Computers /Video Games		65010800	Computer Networking Equipment		10001168	Network Routers	Includes any products that can be described/observed as a device that determines the next network point to which a data packet should be forwarded enroute toward its destination.	Excludes products such as Hubs, Switches and Gateways.	20001092	Type of Network Router	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of network router.	30007771	STATIC ROUTER	
65000000	Computing		65010000	Computers /Video Games		65010800	Computer Networking Equipment		10001168	Network Routers	Includes any products that can be described/observed as a device that determines the next network point to which a data packet should be forwarded enroute toward its destination.	Excludes products such as Hubs, Switches and Gateways.	20001092	Type of Network Router	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of network router.	30002515	UNCLASSIFIED	This term is used to describe those product attributes that are unable to be classified within their specific market; e.g. goat's cheese - goat's cheeses is often generically labelled and cannot be further classified.
65000000	Computing		65010000	Computers /Video Games		65010800	Computer Networking Equipment		10001168	Network Routers	Includes any products that can be described/observed as a device that determines the next network point to which a data packet should be forwarded enroute toward its destination.	Excludes products such as Hubs, Switches and Gateways.	20001092	Type of Network Router	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of network router.	30002518	UNIDENTIFIED	This term is used to describe those product attributes that are unidentifiable given existing or available product information.
65000000	Computing		65010000	Computers /Video Games		65010800	Computer Networking Equipment		10001169	Network Switches	Includes any products that can be described/observed as a computer networking device that filters information/data between network segments.	Excludes products such as Hubs, Routers and Gateways.						
65000000	Computing		65010000	Computers /Video Games		65010800	Computer Networking Equipment		10001170	Computer Networking Equipment Other	Includes any products that can be described/observed as Computer Network Equipment, where the user of the schema is not able to classify the products in existing bricks within the schema.	Excludes all currently classified Computer Network Equipment.						

65000000	Computing		65010000	Computers /Video Games		65010800	Computer Networking Equipment		10001171	Computer Networking Equipment Variety Packs	Includes any products that can be described/observed as two or more distinct Computer Networking Equipment products sold together which exist within the schema but belong to different bricks, that is two or more products contained within the same pack which cross bricks within the Computer Networking Equipment class. Includes products such as Computer Firewalls and Gateways sold together. Items that are received free with purchases should be removed from the classification decision-making process.	Excludes products such as Network Access Points sold individually.						
65000000	Computing		65010000	Computers /Video Games		65010800	Computer Networking Equipment		10001172	Computer Networking Equipment - Replacement Parts/Accessories	Includes any products that can be described/observed as replacement parts and accessories that can be applied to various Computer Networking Equipment.	Excludes all other products currently catered for within Computers segment.						
66000000	Communications		66010000	Communications		66010100	Communication Accessories		10001379	Communication Accessories Other	Includes any products that may be described/observed as Communication Accessories products, where the user of the schema is not able to classify the products in existing bricks within the schema. Includes all products (e.g. military, emergency service, industrial or other special specifications) which fit the product definition.	Excludes all currently classified Communication Accessories products.						
66000000	Communications		66010000	Communications		66010200	Fixed Communication Devices		10001383	Fixed Communication Devices Other	Includes any products that may be described/observed as a Fixed Communication Device, where the user of the schema is not able to classify the products in existing bricks within the schema.	Excludes all currently classified Fixed Communication Devices.						
66000000	Communications		66010000	Communications		66010200	Fixed Communication Devices		10001384	Fixed Communication Devices Variety Packs	Includes any products that may be described/observed as two or more distinct Fixed Communication Device products sold together, which exist within the schema belonging to different bricks but to the same class, that is two or more products contained within the same pack which cross bricks within the Fixed Communication Devices class. Includes products such as a Telephone sold with a separate Answering Machine. Items that are received free with purchases should be removed from the classification decision-making process.	Excludes products such as a Telephone sold with a Caller ID Display.						
66000000	Communications		66010000	Communications		66010300	Mobile Communication Devices/Services		10001385	Mobile Communication Devices/Services Other	Includes any products that may be described/observed as Mobile Communication Devices and Services products, where the user of the schema is not able to classify the products in existing bricks within the schema.	Excludes all currently classified Mobile Communication Devices and Services products.						
68000000	Audio Visual/Photography		68020000	Photography/Optics		68020100	Photography		10001487	Digital Cameras	Includes any products that can be described/observed as a digital device specifically designed for taking photographs that are stored on either an internal memory or memory cards/chips. Images taken on a digital camera can be viewed on products such as televisions or computers. Unwanted images can be erased from the memory.	Excludes products such as Analogue Cameras.	20003040	Can Directly Print Photos	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether or not the product can produce pictures from the camera.	30002960	NO	
68000000	Audio Visual/Photography		68020000	Photography/Optics		68020200	Optics		10001505	Optics - Replacement Parts/Accessories	Includes any products that can be described/observed as a replacement part or an accessory for products within the Optics class.	Excludes products such as Batteries and all Optics Products currently catered for in the Optics class.						

68000000	Audio Visual/Photography		68020000	Photography/Optics		68020200	Optics		10001506	Optics Other	Includes any products that can be described/observed as Optics products, where the user of the schema is not able to classify the products in any existing bricks within the schema.	Excludes all currently classified Optics products as well as Interchangeable Lenses to be found in the photography class.						
68000000	Audio Visual/Photography		68040000	Audio Visual Media		68040200	Recordable Media		10001452	Memory Cards	Includes any products that can be described/observed as a computer chip on which electronic information can be stored and accessed quickly. Memory cards may be installed in equipment such as phones or cameras. These products can hold various capacities of data and can transfer this data at various speeds to or from an external device. Includes products such as Games Console Memory Cards as well as Universal SD, and Smart Media Cards, which can be used with a number of electronic products.	Excludes products such as Computer/Video Mass Storage and USB Flash Drives/Thumb Drives.	20002598	Storage Capacity	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the storage capacity.	30016034	<1 GIGABYTE	
68000000	Audio Visual/Photography		68040000	Audio Visual Media		68040200	Recordable Media		10001456	Floppy Discs	Includes any products that can be described as a flat circular device, usually stored in a square plastic case, which has a magnetic covering and is used for storing computer information.	Excludes products such as recordable DVDs or CDs.						
68000000	Audio Visual/Photography		68040000	Audio Visual Media		68040200	Recordable Media		10001457	Recordable Media Variety Packs	Includes any products that can be described/observed as two or more distinct Recordable Media products sold together, which exist within the schema belonging to different bricks but to the same class, that is two or more products contained within the same pack which cross bricks within the Recordable Media class. Includes products such as Recordable CD's and Recordable DVD's sold together. Items that are received free with purchases should be removed from the classification decision-making process.	Excludes products such as Camcorder and Blank Video Cassettes Variety Packs.						
68000000	Audio Visual/Photography		68040000	Audio Visual Media		68040200	Recordable Media		10001458	Recordable Media Other	Includes any products that can be described/observed as Recordable Media products, where the user of the schema is not able to classify the products in existing bricks within the schema.	Excludes all currently classified Recordable Media Products.						
68000000	Audio Visual/Photography		68040000	Audio Visual Media		68040200	Recordable Media		10006398	USB Flash Drives/Thumb Drives	Includes any products that can be described/observed a solid state device with a computer chip on which electronic information can be stored and accessed quickly. A USB flash drive(also called a thumb drive) is a data storage device that includes flash memory with an integrated Universal Serial Bus (USB) interface. These products are typically removable and rewritable and can be linked to a computer's USB port. These products can hold various capacities of data and can transfer this data at various speeds to or from another device.	Excludes products such as Computer/Video Mass Storage and other memory cards.	20002598	Storage Capacity	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the storage capacity.	30016049	< 2 GIGABYTES	
72000000	Home Appliances		72020000	Small Domestic Appliances		72020600	Portable Air Control Appliances		10005317	Air Conditioners - Portable	Includes any products that may be described/observed as a portable device for controlling, especially lowering, the temperature and humidity of an enclosed space.	Excludes stationary air conditioners.	20001638	If With Integral Timer	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify if the product has an integral timer.	30002960	NO	
73000000	Kitchenware and Tableware		73040000	Kitchenware		73040300	Food Measuring Equipment		10002140	Food Thermometers	Includes any products that can be described/observed as an instrument for measuring temperature of food while cooking. Includes products such as digital thermometers, manually operated dial food thermometers, disposable temperature indicators designed for particular foods and pop-ups that are inserted into the food and pop-up when the desired temperature is reached.	Excludes products such as thermometers not specifically designed for measuring food temperature.	20001679	Type of Food Thermometer	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of food thermometer.	30009656	DIGITAL FOOD THERMOMETER	

73000000	Kitchenware and Tableware		73040000	Kitchenware		73040300	Food Measuring Equipment		10002141	Food Measuring Equipment Variety Packs	Includes any products than can be described/observed as two or more distinct kitchen measuring tools sold together, which exist within the schema belonging to different bricks but to the same class, that is two or more products contained within the same pack which cross bricks within the Food Measuring Equipment class. Includes products such as a cooking timer and thermometer sold together. Items that are received free with purchases should be removed from the classification decision-making process.	Excludes products such as a kitchen scale and kitchen utensils variety pack.						
73000000	Kitchenware and Tableware		73040000	Kitchenware		73040300	Food Measuring Equipment		10002142	Food Measuring Equipment Other	Includes any products that can be described/observed as food measuring equipment, where the user of the schema is not able to classify the products in existing bricks within the schema.	Excludes all currently classified Food Measuring Equipment as well as products such as personal scales classified in Healthcare.						
78000000	Electrical Supplies		78020000	Electrical Connection/Distribution		78020500	Electrical Connection		10005573	Connectors (Electrical)	Includes any products that can be described/observed as a coupling device for joining conductors of one electrical circuit together with those of another circuit. Connectors may facilitate a connection that can be easy established and separated or be a permanent fixture. Typically these products are either female or male, or in some case may comprise of both female and male parts.	Specifically excludes plugs, sockets connected to the mains/live electricity supply and terminal blocks/strips. Excludes products such as Conduit Connectors, Splitters, Extension Cables/Reels, Switches Transformers and Fuses.	20002566	Automatic/Mechanical	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether the product makes a connection automatically or through mechanical operation.	30006875	AUTOMATIC	The product manufacturer identifies that the product is operated automatically.
78000000	Electrical Supplies		78020000	Electrical Connection/Distribution		78020600	Electrical Distribution		10000547	Converters/Transformers	Includes any products that can be described/observed as an electrical apparatus designed to alter, convert, stabilise, regulate or transform an electric power supply characteristic, such as the voltage, current or phase. Includes products such as signal converters, power regulators and distribution power transformers.	Excludes products such as adaptors, switches and splitters.	20000658	If Waterproof	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify if the product is waterproof.	30002960	NO	
78000000	Electrical Supplies		78020000	Electrical Connection/Distribution		78020600	Electrical Distribution		10005568	Splitters	Includes any product that can be described/observed as a device that separates an electronic signal into two or more smaller and approximately equal signals and distributes them to a number of receivers simultaneously. Includes products such as power splitters, RF (radio frequency) signal splitters and microphone splitters.	Excludes products such as electrical adaptors, busways and cable splicing tools.	20002536	Type of Splitter	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of splitter.	30012961	DATA NETWORK SPLITTER	
78000000	Electrical Supplies		78020000	Electrical Connection/Distribution		78020600	Electrical Distribution		10005570	Relays/Contactors	Includes any products that can be described/observed as an electrical switching device that opens and closes under control of another electrical circuit. Relays are designed for switching loads on or off, whereas contactors are designed to "break" a high current load and are commonly fitted with overload protection. Includes products such as power relays, socket relays and alternating voltage relays, as well as vacuum contactors.	Excludes products such as switches, transformers and circuit breakers.	20002538	Type of Relay/Contactor	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of electrical relay or contactor.	30012788	ALTERNATING VOLTAGE RELAY	
78000000	Electrical Supplies		78020000	Electrical Connection/Distribution		78020600	Electrical Distribution		10005577	Electrical Distribution Accessories/Fittings	Includes any products that can be described/observed as an accessory or fitting used to assist or enhance the installation of electrical distribution products. Includes products such as wire terminal kits, terminal block covers and terminal block separators.	Excludes products such as pliers classified with hand tools and wall plates.	20002531	Type of Electrical Distribution Accessory/Fitting	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of electrical distribution accessory or fitting.	30012919	CEILING BOX FLANGE	

78000000	Electrical Supplies		78020000	Electrical Connection/Distribution		78020600	Electrical Distribution		10005585	Surge Suppressors/Protectors	Includes any products that can be described/observed as a device used to protect electrical appliances and electronic equipment. Surge protectors regulate the voltage supplied to an electric device by either blocking, or shorting to ground, voltage above a safe threshold. Includes products such as external surge suppressors, which are installed on the electrical panel to protect home appliances such as refrigerators and washing machines, or point-of-use surge suppressors, which are connected to individual pieces of home electronic equipment such as computers and televisions.	Excludes products such as circuit breakers and fuses.	20002542	External/Point-of-use	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether the product is installed externally where all electricity enters the home, or at point-of-use where connection is made to an individual piece of electronic equipment.	30007610	EXTERNAL	
78000000	Electrical Supplies		78020000	Electrical Connection/Distribution		78020600	Electrical Distribution		10005586	Switches	Includes any products that can be described/observed as a circuit interruption device used to control the flow of electricity to electrical lights, appliances, and outlets. The flow is controlled by either turning the electricity on or off or by changing the path along which it flows and can be managed mechanically, electronically by remote control or via an app (smarthome).	Excludes products such as dimmers classified with electrical lighting, relays and circuit breakers.	20001353	Installation Type	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify how/where the product is installed.	30012932	PANEL MOUNTED	
78000000	Electrical Supplies		78020000	Electrical Connection/Distribution		78020600	Electrical Distribution		10005586	Switches	Includes any products that can be described/observed as a circuit interruption device used to control the flow of electricity to electrical lights, appliances, and outlets. The flow is controlled by either turning the electricity on or off or by changing the path along which it flows and can be managed mechanically, electronically by remote control or via an app (smarthome).	Excludes products such as dimmers classified with electrical lighting, relays and circuit breakers.	20002537	Type of Switch	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of switch.	30012771	FLOW SWITCH	
78000000	Electrical Supplies		78020000	Electrical Connection/Distribution		78020600	Electrical Distribution		10005586	Switches	Includes any products that can be described/observed as a circuit interruption device used to control the flow of electricity to electrical lights, appliances, and outlets. The flow is controlled by either turning the electricity on or off or by changing the path along which it flows and can be managed mechanically, electronically by remote control or via an app (smarthome).	Excludes products such as dimmers classified with electrical lighting, relays and circuit breakers.	20002537	Type of Switch	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of switch.	30012779	LEVEL/FLOAT SWITCH	
78000000	Electrical Supplies		78020000	Electrical Connection/Distribution		78020600	Electrical Distribution		10005586	Switches	Includes any products that can be described/observed as a circuit interruption device used to control the flow of electricity to electrical lights, appliances, and outlets. The flow is controlled by either turning the electricity on or off or by changing the path along which it flows and can be managed mechanically, electronically by remote control or via an app (smarthome).	Excludes products such as dimmers classified with electrical lighting, relays and circuit breakers.	20002537	Type of Switch	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of switch.	30012766	LIMIT SWITCH	
78000000	Electrical Supplies		78020000	Electrical Connection/Distribution		78020600	Electrical Distribution		10005682	Multi-use/Universal Electrical Timers/Controllers	Includes any products that can be described/observed as an electrical device that automates/controls the operational timing of a number of different home systems such as electrical lighting, central heating, water heating, security systems and audio visual equipment. Includes products with a plug-in connection as well as wireless digital, programmable switches and touch pads.	Excludes products such as cooking timers, clocks and control systems intended for a single application such as thermostats and audio visual remote controls.						

78000000	Electrical Supplies		78020000	Electrical Connection/Distribution		78021100	Batteries/Chargers		10000546	Batteries	Includes any products that can be described/observed as small electro-chemical cells specifically designed to produce an electrical current that can act as a conveniently sized portable power source for a range of electronic devices. Includes products such as rechargeable and non-rechargeable Battery Cells that come in different sizes dependent on power output.	Excludes products such as Battery Chargers, Transformers and Car Batteries.	20000664	Battery Constituent	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify a particular type of battery constituent.	30004177	ACID	
78000000	Electrical Supplies		78020000	Electrical Connection/Distribution		78021200	Electrical Generation		10008390	Inverters	Includes any products that can be described/observed as an electronic device that converts direct current (DC) electricity into alternating current (AC) electricity. In renewable energy systems, inverters are commonly used to convert the DC electricity produced by solar panels or wind turbines into AC electricity that can be used to power homes and businesses. Inverters are essential for renewable energy systems, as most electrical devices require AC power to function. In addition to converting DC to AC, inverters may also perform other functions, such as regulating the voltage and frequency of the AC output, providing grid-tie capabilities, and managing power quality.	Excludes products such as converters, charge/voltage regulators and transformers.						
78000000	Electrical Supplies		78030000	Electrical Lighting		78030400	Portable Electric Lighting		10005642	Electric Torches/Flashlights	Includes any products that can be described/observed as a hand-held or head mounted portable electric spotlight. Typically a torch/flashlight consists of a small electric lightbulb powered by electric batteries or rechargeable electric cell. The components are mounted in a housing that contains the necessary electric circuit and provides ease of handling, a means of access to the batteries for replacement, and a clear covering over the lightbulb for its protection. Includes products such as headlamps, which have elasticised straps and can be worn around the head leaving the hands free.	Excludes products such as all Lanterns, Lightbulbs/Tubes, Freestanding Lamps and Lighting Fixtures.	20002572	Type of Torch/Flashlight	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of torch or flashlight.	30002518	UNIDENTIFIED	This term is used to describe those product attributes that are unidentifiable given existing or available product information.
78000000	Electrical Supplies		78040000	Electrical Cabling/Wiring		78040100	Cabling/Wiring Management/Control		10005647	Cable/Wire Conduit/Ducting/Raceways	Includes any products that can be described/observed as an enclosure for wires and cables, generally formed with hard/solid materials. Includes products such as a surface raceway, a floor moulding wire track, a cable conduit, a wire duct, a cable tray and a strut channel. In the office, cord organisers and routers are particularly useful for the orderly realignment and consolidation of tangling wires, which exist with most electronic equipment.	Excludes products such as protective wrapping for wires and cables, conduit fittings, electrical busways and ducting used in the ventilation and plumbing of a building.	20002512	Type of Cable/Wire Conduit/Ducting/Raceway	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of cable or wire conduit, ducting or raceway.	30012950	CABLE LADDER	
78000000	Electrical Supplies		78040000	Electrical Cabling/Wiring		78040100	Cabling/Wiring Management/Control		10005650	Cabling/Wiring Protection/Wrapping	Includes any products that can be described/observed as a protective sheath or tube, generally formed with soft materials. These products are normally made of a protective material that offers safety properties such as heat, flame and abrasion resistance and in certain circumstances could also claim to be waterproof. Includes products such as spiral wrap, corrugated loom tubing and expandable sleeving and heat shrink tubing.	Excludes products such as insulation tape and cable conduit, ducting or raceways.	20000987	Safety Features	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the product safety features.	30009601	ABRASION RESISTANT	

78000000	Electrical Supplies		78040000	Electrical Cabling/Wiring		78040100	Cabling/Wiring Management/Control		10005660	Cable Conduit Fittings	Includes any products that can be described/observed as a fitting specifically designed for use with electrical conduit. Includes products such as conduit couplings, expansion fittings, locknuts and cable boxes.	Excludes products such as electrical wiring and cabling connectors and cable clips, grommets and ties, and light bulb fittings.	20002540	If Watertight	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether or not the product is watertight.	30002960	NO	
78000000	Electrical Supplies		78040000	Electrical Cabling/Wiring		78040300	Electrical Cables		10005758	Telecommunication Cables	Includes any products that can be described/observed as wires or optical fibres bound or twisted together into a single piece of cable that is used to carry an electrical current, audio and visual data to and from telecommunication equipment. These products may or may not have a protective jacket or sheath for insulation. Includes products such as telephone cables and fax/modem cables.	Specifically excludes all single stranded wires and all construction/building cables. Excludes products such as computer cables, audio visual cables and satellite installation cables.	20002660	Type of Telecommunication Cable	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of telecommunication cable.	30013529	FAX/MODEM CABLE	
78000000	Electrical Supplies		78040000	Electrical Cabling/Wiring		78040400	Electrical Wiring		10005541	Electrical Wires	Includes any products that can be described/observed as a conducting wire, made from one or more cylindrical strands/threads of elongated or drawn out metal. These products are used to carry an electrical current from one location to another. These products may or may not have a protective jacket or sheath for insulation, and can range in length from a short piece of wire used in fuses, to wire that is many meters long. Includes products such as bare wire and insulated copper wire.	Specifically excludes computer cables, telecommunication cables, audio visual cables, non-conducting and gardening wires. Excludes products such as Capacitors, Fuses, Wire Connectors, and Wire/Cable Sleeving.	20002508	If Insulated	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether or not the product has an insulating cover/wrapping.	30002960	NO	
78000000	Electrical Supplies		78050000	Electronic Communication Components		78050100	Electronic Communication Components		10005661	Circuit Assemblies/Integrated Circuits	Includes any products that can be described/observed as an assembly of electronic components containing many circuits built into a single device capable of many functions such as the controlling, processing and distribution of information and the conversion and distribution of electric power. Includes analogue and digital circuits.	Excludes electrical distribution boards and circuit breakers.	20001145	Analog/Digital	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether the product is analog or digital.	30007712	ANALOG	
78000000	Electrical Supplies		78050000	Electronic Communication Components		78050100	Electronic Communication Components		10005661	Circuit Assemblies/Integrated Circuits	Includes any products that can be described/observed as an assembly of electronic components containing many circuits built into a single device capable of many functions such as the controlling, processing and distribution of information and the conversion and distribution of electric power. Includes analogue and digital circuits.	Excludes electrical distribution boards and circuit breakers.	20001145	Analog/Digital	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether the product is analog or digital.	30006049	BOTH	
78000000	Electrical Supplies		78050000	Electronic Communication Components		78050100	Electronic Communication Components		10005661	Circuit Assemblies/Integrated Circuits	Includes any products that can be described/observed as an assembly of electronic components containing many circuits built into a single device capable of many functions such as the controlling, processing and distribution of information and the conversion and distribution of electric power. Includes analogue and digital circuits.	Excludes electrical distribution boards and circuit breakers.	20001145	Analog/Digital	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether the product is analog or digital.	30005480	DIGITAL	
78000000	Electrical Supplies		78060000	General Electrical Hardware		78060100	General Electrical Hardware		10005599	Voltmeters/Multimeters	Includes any products that can be described/observed as a measuring instrument, used to measure electrical currents, voltage (potential difference between two points) or to measure currents, voltage and resistance. Typically these products are used for basic fault finding in electrical circuits. Includes products that use digital and analogue displays.	Excludes other electric measuring equipments.	20001145	Analog/Digital	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether the product is analog or digital.	30007712	ANALOG	

78000000	Electrical Supplies		78060000	General Electrical Hardware		78060100	General Electrical Hardware		10005599	Voltmeters/Multimeters	Includes any products that can be described/observed as a measuring instrument, used to measure electrical currents, voltage (potential difference between two points) or to measure currents, voltage and resistance. Typically these products are used for basic fault finding in electrical circuits. Includes products that use digital and analogue displays.	Excludes other electric measuring equipments.	20001145	Analog/Digital	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether the product is analog or digital.	30012965	ANALOGUE/DIGITAL	
78000000	Electrical Supplies		78060000	General Electrical Hardware		78060100	General Electrical Hardware		10008363	Monitors/Screens	Includes any products that can be described/observed as a monitor/screen in which images or text are displayed that provides guidance and monitoring about the specific appliance to the user. Includes products that use digital and analogue displays.	Excludes products such as Multimeters and Voltmeters.						
79000000	Plumbing/Heating/Ventilation/Air Conditioning		79010000	Plumbing/Heating/Ventilation/Air Conditioning		79010600	Air Conditioning/Cooling/Ventilation Equipment		10003982	Air Conditioners/Coolers - Fixed	Includes any products that can be described/observed as a fixed or installed device for controlling, especially lowering, the temperature and humidity of an enclosed space.	Excludes portable air conditioners, air dehumidifiers and air purifiers.	20002283	If with Adjustable/Rotating Louvres	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether the item is equipped with adjustable and/or rotating louvres.	30002960	NO	
79000000	Plumbing/Heating/Ventilation/Air Conditioning		79010000	Plumbing/Heating/Ventilation/Air Conditioning		79010600	Air Conditioning/Cooling/Ventilation Equipment		10003984	Air Conditioning/Cooling/Ventilation Equipment Replacement Parts/Accessories	Includes any products that can be described/observed as a replacement part or accessory for an installed air conditioning system. Includes products such as air filters for an air conditioner or a wall bracket to hold a ventilator.	Excludes products such as a complete air conditioning system.						
79000000	Plumbing/Heating/Ventilation/Air Conditioning		79010000	Plumbing/Heating/Ventilation/Air Conditioning		79010600	Air Conditioning/Cooling/Ventilation Equipment		10004063	Air Conditioning Equipment - Multifunction - Fixed	Includes any products that can be described/observed as a fixed or installed unit that combines the work of several appliances such as, for example, air conditioner, dehumidifier and fan.	Excludes portable multifunction air controlling appliances.	20001531	Function	Indicates with reference to the product branding, labelling or packaging, the descriptive term that is used by the manufacturer to identify the intended usage of the appliance.	30011944	CHILLER/DEHUMIDIFIER	
91000000	Safety/Security/Surveillance		91030000	Home/Business Safety/Security/Surveillance		91030400	Home/Business Surveillance Equipment		10005412	Light/Motion/Sound Sensors	Includes any products that can be described/observed as an automatic light controller with sound and/or motion activation to detect intruders. A motion sensor detects "warm" infrared movement and a sound sensor detects voices several metres away. Includes products such as sensors with adjustable sound and motion lights, manual and automatic options and weather resistant casings.	Excludes products such as surveillance cameras and security lights that remain on during the night.	20002339	Automatic/Manual	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether the product is operated automatically or manually.	30006875	AUTOMATIC	The product manufacturer identifies that the product is operated automatically.
91000000	Safety/Security/Surveillance		91030000	Home/Business Safety/Security/Surveillance		91030400	Home/Business Surveillance Equipment		10005413	Security Lights	Includes any products that can be described/observed as an exterior light, which illuminates the building exterior and property thus acting as a deterrent to intruders. Includes products such as low energy lights that can be left burning all night as well as floodlights that are more often used on business premises.	Excludes products such as motion and sound sensor lights and personal safety lights.	20000651	If With Remote Control	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether or not the product comes with a remote control device.	30002960	NO	
91000000	Safety/Security/Surveillance		91030000	Home/Business Safety/Security/Surveillance		91030400	Home/Business Surveillance Equipment		10005415	Home/Business Surveillance Equipment Variety Packs	Includes any products that can be described/observed as two or more distinct combinations of home/business surveillance products sold together, which exist within the schema belonging to different bricks but to the same class, that is two or more products contained within the same pack which cross bricks within the Home/Business Surveillance Equipment class. Includes products such as a light motion sensor sold with a floodlight. Items that are received free with purchases should be removed from the classification decision-making process.	Excludes products such as surveillance camera and door intercom variety packs.						

91000000	Safety/Security/Surveillance		91030000	Home/Business Safety/Security/Surveillance		91030600	Home/Business Safety/Security/Surveillance Variety Packs		10005417	Home/Business Safety/Security/Surveillance Variety Packs	Includes any products than can be described/observed as two or more distinct home or business safety/security/surveillance products sold together which exist within the schema but belong to different classes that is two or more products contained within the same pack which cross classes within the Home/Business Safety/Security/Surveillance family. Includes products such as burglar alarm and security lights variety packs. Items that are received free with purchases should be removed from the classification decision-making process.	Excludes products such as fire retardant and fire blanket variety packs.						
79000000	Plumbing/Heating/Ventilation/Air Conditioning		79010000	Plumbing/Heating/Ventilation/Air Conditioning		79010600	Air Conditioning/Cooling/Ventilation Equipment		10003985	Air Conditioning/Cooling/Ventilation Equipment Variety Packs	Includes any products that can be described/observed as two or more distinct air conditioning/cooling/ventilation products sold together, which exist within the schema belonging to different bricks but to the same class, that is two or more products contained within the same pack which cross bricks within the Air Conditioning/Cooling/Ventilation Equipment class. Includes products such as an air ventilation system sold with ducting and ducting boosters. Items that are received free with purchases should be removed from the classification decision-making process.	Excludes products such as extractor fan and stove variety packs.						
79000000	Plumbing/Heating/Ventilation/Air Conditioning		79010000	Plumbing/Heating/Ventilation/Air Conditioning		79010500	Heating Equipment		10002660	Central Heating Replacement Parts/Accessories	Includes any products that can be described/observed as a replacement part or an accessory for central heating products. Includes products such as replacement temperature pressure relief valves for boilers, radiator valves, gas connectors and accessories such as radiator covers and water heater blankets.	Excludes products such as complete central heating products.	20002475	Type of Central Heating Replacement Part/Accessory	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of central heating replacement part or accessory.	30013276	CHIMNEY BRUSH	
79000000	Plumbing/Heating/Ventilation/Air Conditioning		79010000	Plumbing/Heating/Ventilation/Air Conditioning		79010500	Heating Equipment		10005478	Fireplaces/Fireplace Surrounds/Mantels	Includes any products that can be described/observed as an appliance built into a home, consisting of a space designed to contain an open fire, generally for heating but sometimes also for cooking. A chimney or other vent allows gas and particulate exhaust to escape the building and a fireplace will normally be surrounded by decorative panels and a mantelshelf. Includes products such as wood/coal-burning fireplaces with a chimney and gas fires installed with a gas flue, as well as installed electric fires.	Excludes freestanding, portable fires or heaters that do not require installation.	20002004	Fuel Type	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of fuel that powers the product.	30004553	COAL	
79000000	Plumbing/Heating/Ventilation/Air Conditioning		79010000	Plumbing/Heating/Ventilation/Air Conditioning		79010500	Heating Equipment		10002653	Heating System Controls	Includes any products that can be described/observed as a mechanical or electronic device that controls a heating system within a building. It is capable of increasing comfort for personnel while delivering real cost savings through the use of a programmed time switch and thermostat. Time and temperature can be set according to building and user needs.Includes products that have control options for heating only, ventilation only, frost protection, seven-day programming, three on/off periods per day, holiday mode and overtime mode.	Excludes products such as the components of the heating system itself, such as pipes and the boiler as well as Smart Home/Home Automation Equipment - Temperature Regulation Appliances.	20002470	Manual/Digital	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether the product is controlled by manual or digital operation.	30005480	DIGITAL	

79000000	Plumbing/ Heating/Ventilation/Air Conditioning		79010000	Plumbing/ Heating/Ventilation/Air Conditioning		79010500	Heating Equipment		10004002	Thermostats	Includes any products that can be described/observed as a device that automatically regulates temperature in a room or building by cutting off and restoring the supply of heat from the central heating system. Includes mechanical thermostats and digital thermostats that can be remotely controlled by a home automation system.	Excludes products such as thermostats not intended for the control of a building's central heating system.	20002478	Mechanical/Digital	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether the product is operated mechanically or digitally.	30005480	DIGITAL	
79000000	Plumbing/ Heating/Ventilation/Air Conditioning		79010000	Plumbing/ Heating/Ventilation/Air Conditioning		79010800	Water/Gas Supply/Central Heating		10008010	Connectors Accessories/Replacement Parts - Water, Gas, Central Heating	Includes any products that may be described/observed as an accessory or replacement part for connectors. Includes products such as closing plugs, sealing wires, pinch nuts, cutting rings and gradient sets.	Excludes: Valves/Fitting accessories/replacement parts. Specifically Excludes Air Conduits/Air Conduit Fittings.						
79000000	Plumbing/ Heating/Ventilation/Air Conditioning		79010000	Plumbing/ Heating/Ventilation/Air Conditioning		79010800	Water/Gas Supply/Central Heating		10004057	Pipes/Tubing - Accessories/Replacement Parts	Includes any products that can be described/observed as an accessory/replacement part for Water/Gas Supply products. Includes products such as pipe hangers and clips, tubing brackets, rosettes and saddles.	Excludes products such Valves, Pipes/Tubing, Connectors, Hose Clamps and Pumps.	20002150	Type of Accessory/Replacement Part	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of accessory or replacement part.	30008043	BRACKET	
79000000	Plumbing/ Heating/Ventilation/Air Conditioning		79010000	Plumbing/ Heating/Ventilation/Air Conditioning		79010800	Water/Gas Supply/Central Heating		10005867	Pipes/Tubing Flanges	Includes any product that can be described/observed as an external or internal rib or rim, used to connect to another pipe or flange; to close a pipe; to add strength to a pipe or to hold a pipe in place. Includes products such as closet flanges, orifice flanges, long weld necks and reducing flanges.	Excludes products such as connectors.	20002733	Raised/Flat	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify whether the product is raised from the surface or flat.	30014602	FLAT/RING TYPE JOINT (RTJ)	
79000000	Plumbing/ Heating/Ventilation/Air Conditioning		79010000	Plumbing/ Heating/Ventilation/Air Conditioning		79010800	Water/Gas Supply/Central Heating		10004024	Valves/Fittings - Water and Gas	Includes any products that can be described/observed as a valve or fitting that regulates the flow of water and/or gas (i.e. propane; pneumatics; etc.) by opening, closing or partially obstructing the passageway within a water/gas supply system.	Specifically excludes Faucet/Tap and Shower Valves. Excludes products such as Pumps, Connectors, Pipe Accessories, Pipes and Tubing.	20002942	Type of Usage		30000720	COMBINATION	
79000000	Plumbing/ Heating/Ventilation/Air Conditioning		79010000	Plumbing/ Heating/Ventilation/Air Conditioning		79010800	Water/Gas Supply/Central Heating		10008011	Valves/Fittings Accessories/Replacement Parts - Water and Gas	Includes any products that may be described/observed as an accessory or replacement part for valves and fittings. Includes products such as drains for water and gas.	Excludes: Connectors Accessories/Replacement Parts						
91000000	Safety/Security/Surveillance		91030000	Home/Business Safety/Security/Surveillance		91030200	Door/Window/Perimeter Security Products		10005398	Access Control Security Systems	Includes any products that can be described/observed as an electronic system situated at the entry door or gate of a property that identifies the person through the use of a security code, business related personnel information or personal recognition factors such as a fingerprint or the iris of the eye. Includes products such as keypad entry that requires a security code, swipe card control that incorporates personnel information and biometric scan-in access control that recognises fingerprints.	Excludes products such as door intercoms, door viewers and computer access security control systems.	20002328	Type of Access Control Security System	Indicates, with reference to the product branding, labelling or packaging, the descriptive term that is used by the product manufacturer to identify the type of access control that is incorporated in the security system.	30012058	BIOMETRIC READER	
	Vehicle		77010000	Automotive Accessories and Maintenance		77014300	Automotive Electrical		10006846	Automotive Instruments and Measurement Systems	Includes any products that can be described/observed as automotive instrument systems or measurement systems.		20003008	Type of Automotive Instruments/Measurement Systems	Indicates with reference to the product branding, labelling or packaging, the descriptive term that is used by the manufacturer to identify the type of automotive instruments/measurement system.	30002515	UNCLASSIFIED	This term is used to describe those product attributes that are unable to be classified within their specific market; e.g. goat's cheese - goat's cheeses is often generically labelled and cannot be further classified.
	Vehicle		77010000	Automotive Accessories and Maintenance		77014300	Automotive Electrical		10006846	Automotive Instruments and Measurement Systems	Includes any products that can be described/observed as automotive instrument systems or measurement systems.		20003008	Type of Automotive Instruments/Measurement Systems	Indicates with reference to the product branding, labelling or packaging, the descriptive term that is used by the manufacturer to identify the type of automotive instruments/measurement system.	30002518	UNIDENTIFIED	This term is used to describe those product attributes that are unidentifiable given existing or available product information.

HTS Number	Indent	HTS Description(EN)
2903.78.00	0	Other perhalogenated derivatives
4016.93	2	Gaskets, washers and other seals:
4016.93.50	3	Other
4016.93.50.10	4	O-Rings
4016.93.50.20	4	Oil seals
4016.93.50.50	4	Other
7318.15	2	Other screws and bolts, whether or not with their nuts or washers:
7318.15.20	3	Bolts and bolts and their nuts or washers entered or exported in the same shipment
7318.15.20.10	4	Having shanks or threads with a diameter of less than <il>6 mm</il>
7318.15.20.20	5	Track bolts
7318.15.20.30	5	Structural bolts
	5	Bent bolts:
7318.15.20.41	6	Right-angle anchor bolts
7318.15.20.46	6	Other
	5	Other:
	6	With round heads:
7318.15.20.51	7	Of stainless steel
7318.15.20.55	7	Other
	6	With hexagonal heads:
7318.15.20.61	7	Of stainless steel
7318.15.20.65	7	Other
	6	Other:
7318.15.20.91	7	Of stainless steel
7318.15.20.95	7	Other
7318.15.40.00	3	Machine screws <il>9.5 mm</il> or more in length and <il>3.2 mm</il> or more in diameter (not including cap screws)
7318.15.50	3	Studs
7318.15.50.30	4	Of stainless steel
	4	Other:
	5	Continuously threaded rod:
7318.15.50.51	6	Of alloy steel
7318.15.50.56	6	Other
7318.15.50.90	5	Other
	3	Other:
7318.15.60	4	Having shanks or threads with a diameter of less than <il>6 mm</il>
	5	Socket screws:
7318.15.60.10	6	Of stainless steel
7318.15.60.40	6	Other
	5	Other:
7318.15.60.70	6	Of stainless steel
7318.15.60.80	6	Other
7318.15.80	4	Having shanks or threads with a diameter of <il>6 mm</il> or more
7318.15.80.20	5	Set screws
	5	Other:

	6	Socket screws:
7318.15.80.30	7	Of stainless steel
7318.15.80.45	7	Other
	6	Other:
	7	With hexagonal heads:
7318.15.80.55	8	Of stainless steel
	8	Other:
7318.15.80.66	9	Cap screws
7318.15.80.69	9	Other
	7	Other:
7318.15.80.82	8	Of stainless steel
7318.15.80.85	8	Other
7318.16.00	2	Nuts
	3	Lugnuts:
7318.16.00.15	4	Non-locking chrome-plated
7318.16.00.30	4	Locking
7318.16.00.45	4	Other
	3	Other:
7318.16.00.60	4	Of stainless steel
7318.16.00.85	4	Other
7318.22.00.00	2	Other washers
8405.10.00.00	1	Producer gas or water gas generators, with or without their purifiers; acetylene gas generators and similar water process gas generators, with or without their purifiers
8413.20.00.00	1	Hand pumps, other than those of subheading 8413.11 or 8413.19
8413.50.00.50	2	Diaphragm pumps
8413.60.00	1	Other rotary positive displacement pumps
	2	Hydraulic fluid power pumps:
8413.7	1	Other centrifugal pumps:
8413.81.00	2	Pumps
8413.91	2	Of pumps:
8414	0	Air or vacuum pumps, air or other gas compressors and fans; ventilating or recycling hoods incorporating a fan, whether or not fitted with filters; gas-tight biological safety cabinets, whether or not fitted with filters; parts thereof:
8414.10.00.00	1	Vacuum pumps
8414.30.40.00	2	Not exceeding 1/4 horsepower
8414.40.00.00	1	Air compressors mounted on a wheeled chassis for towing
	1	Fans:
8414.51	2	Table, floor, wall, window, ceiling or roof fans, with a self-contained electric motor of an output not exceeding 125 W:

8414.59.15.00	3	Fans of a kind used solely or principally for cooling microprocessors, telecommunications apparatus, automatic data processing machines or units of automatic data processing machines
8414.70.00.00	1	Gas-tight biological safety cabinets
	2	Air compressors:
8414.80.05.00	3	Turbochargers and superchargers
8414.80.16.05	6	Not exceeding <il>746 W</il>
8414.90.10	2	Of fans (including blowers) and ventilating or recycling hoods
8415	0	Air conditioning machines, comprising a motor-driven fan and elements for changing the temperature and humidity, including those machines in which the humidity cannot be separately regulated; parts thereof:
8418	0	Refrigerators, freezers and other refrigerating or freezing equipment, electric or other; heat pumps, other than the air conditioning machines of heading 8415; parts thereof:
	2	Compression type:
8418.10.00.10	3	Having a refrigerated volume of under <il>184 liters</il>
8418.21.00.10	3	Having a refrigerated volume of under <il>184 liters</il>
8418.21.00.20	3	Having a refrigerated volume of <il>184 liters</il> and over but under <il>269 liters</il>
8418.99.40.00	3	Door assemblies incorporating more than one of the following: inner panel; outer panel; insulation; hinges; handles
8421	0	Centrifuges, including centrifugal dryers; filtering or purifying machinery and apparatus, for liquids or gases; parts thereof:
	1	Centrifuges, including centrifugal dryers:
8421.29.00.05	3	Refrigerant recovery and recycling units
8421.39.01.15	4	Other
8421.91	2	Of centrifuges, including centrifugal dryers:
8443.32	2	Other, capable of connecting to an automatic data processing machine or to a network:
8443.32.10	3	Printer units
	4	Laser:
8443.32.10.20	5	Other
8443.32.10.40	4	Ink jet
8443.32.10.80	4	Dot matrix
8443.32.10.90	4	Other
8443.32.50.00	3	Other

8443.39	2	Other:
8443.91	2	Parts and accessories of printing machinery used for printing by means of plates, cylinders and other printing components of heading 8442:
8443.91.10.00	3	Machines for uses ancillary to printing
8470.21.00.00	1	Other electronic calculating machines:
8471.41.01	1	Other automatic data processing machines:
8471.41.01.10	2	Comprising in the same housing at least a central processing unit and an input and output unit, whether or not combined
8471.49.00.00	3	Other
8471.90.00.00	3	Other
	0	Parts and accessories (other than covers, carrying cases and the like) suitable for use solely or principally with machines of headings 8470 to 8472:
8473.21.00.00	1	Parts and accessories of the machines of heading 8470:
8473.3	2	Other
	1	Parts and accessories of the machines of heading 8471:
8473.30.11	2	Not incorporating a cathode ray tube:
8473.30.11.40	3	Printed circuit assemblies
8473.30.11.80	4	Memory modules suitable for use solely or principally with machines of heading 8471
8473.30.20.00	4	Other
8473.30.51.00	3	Parts and accessories, including face plates and lock latches, of printed circuit assemblies
8473.30.91.00	3	Other
	2	Other:
8481.8	1	Safety or relief valves
8481.80.10	2	Hand operated:
	3	Of copper
8481.80.10.20	4	Having a pressure rating under <il>850 kPa:</il>
8481.80.10.50	5	Supply stops
	5	Other
8481.80.10.60	4	Having a pressure rating of <il>850 kPa</il> or over:
8481.80.10.70	5	Gate type
8481.80.10.75	5	Globe type
8481.80.10.85	5	Plug type
8481.80.10.90	5	Ball type
8481.80.10.95	5	Butterfly type
8481.80.30	5	Other
	3	Of iron or steel
8481.80.30.10	4	Of iron:
8481.80.30.15	5	Gate type
8481.80.30.20	5	Globe type

8481.80.30.25	5	Plug type
8481.80.30.30	5	Ball type
8481.80.30.40	5	Butterfly type
	5	Other
8481.80.30.55	4	Of steel:
8481.80.30.60	5	Gate type
8481.80.30.65	5	Globe type
8481.80.30.70	5	Plug type
8481.80.30.75	5	Ball type
8481.80.30.90	5	Butterfly type
8481.80.50	5	Other
8481.80.50.40	3	Of other materials
8481.80.50.60	4	Pressure spray can valves
8481.80.90	4	Other
8481.80.90.05	2	Other
8481.80.90.10	3	Solenoid valves
8481.80.90.15	3	Ballcock mechanisms
	3	Regulator valves, self-operating, for controlling variables such as temperature, pressure, flow and liquid level
	3	Other:
8481.80.90.20	4	With electrical or electro-hydraulic actuators:
8481.80.90.25	5	Control valves designed for proportional operation by a signal from a control device
8481.80.90.30	5	Other
	4	With hydraulic actuators
8481.80.90.35	4	With pneumatic actuators:
8481.80.90.40	5	Control valves designed for proportional operation by a signal from a control device
8481.80.90.45	5	Other
8481.80.90.50	4	With thermostatic actuators
8481.9	4	Other
	1	Parts:
8481.90.10.00	2	Of hand operated and check appliances:
8481.90.30.00	3	Of copper
8481.90.50.00	3	Of iron or steel
8481.90.90	3	Of other materials
	2	Other
8481.90.90.20	3	Of valves of subheading 8481.20:
8481.90.90.40	4	Valve bodies
	4	Other
8481.90.90.60	3	Other:
	4	Valve bodies
8481.90.90.81	4	Other:
8481.90.90.85	5	Steel forgings

8484.10.00.00	0	Gaskets and similar joints of metal sheeting combined with other material or of two or more layers of metal; sets or assortments of gaskets and similar joints, dissimilar in composition, put up in pouches, envelopes or similar packings; mechanical seals:
8486.90.00.00	2	For lifting, handling, loading or unloading of boules, wafers, semiconductor devices, electronic integrated circuits and flat panel displays
8501	0	Electric motors and generators (excluding generating sets):
8501.1	1	Motors of an output not exceeding 37.5 W:
	2	Of under 18.65 W:
8501.10.20.00	3	Synchronous, valued not over $4 each
8501.10.40	3	Other
8501.10.40.20	4	AC
	4	DC:
8501.10.40.40	5	Brushless
8501.10.40.60	5	Other
8501.10.40.80	4	Other
8501.10.60	2	Of 18.65 W or more but not exceeding 37.5 W
8501.10.60.20	3	AC
	3	DC:
8501.10.60.40	4	Brushless
8501.10.60.60	4	Other
8501.10.60.80	3	Other
8501.4	1	Other AC motors, single-phase:
8501.40.20	2	Of an output exceeding 37.5 W but not exceeding <il>74.6 W</il>
8504	0	Electrical transformers, static converters (for example, rectifiers) and inductors; parts thereof:
8504.10.00.00	1	Ballasts for discharge lamps or tubes
8504.32.00.00	2	Having a power handling capacity exceeding <il>1 kVA</il> but not exceeding <il>16 kVA</il>
8504.4	1	Static converters:
8504.40.40.00	2	Speed drive controllers for electric motors
8504.9	1	Parts:
8517.62.00	2	Machines for the reception, conversion and transmission or regeneration of voice, images or other data, including switching and routing apparatus:
8517.62.00.10	3	Modems, of a kind used with data processing machines of heading 8471
8517.62.00.20	3	Switching and routing apparatus
8517.62.00.90	3	Other
8525.89	2	Other:
8531.10.00	1	Burglar or fire alarms and similar apparatus

8533.9	1	Parts:
8534.00.00	0	Printed circuits
8536.41.00	2	For a voltage not exceeding 60 V
8536.41.00.05	3	Automotive signaling flashers
	3	Other:
	4	With contacts rated at less than 10 A:
8536.41.00.20	5	Electromechanical
8536.41.00.30	5	Other
	4	Other:
8536.41.00.45	5	Contactors
	5	Other:
8536.41.00.50	6	Electromechanical
8536.41.00.60	6	Other
8536.50.40.00	2	Motor starters
	2	Other:
8536.50.70.00	3	Electronic AC switches consisting of optically coupled input and output circuits (insulated thyristor AC switches); electronic switches, including temperature protected switches, consisting of a transistor and a logic chip (chip-on-chip technology); electromechanical snap-action switches for a current not exceeding 11 amps
8536.50.90	3	Other
	4	Rotary:
8536.50.90.20	5	Rated at not over 5 A
8536.50.90.25	5	Rated at over 5 A
	4	Push-button:
	5	Rated at not over 5 A
8536.50.90.31	6	Momentary contact
8536.50.90.32	6	Other, gang switches
8536.50.90.33	6	Other
8536.50.90.35	5	Rated at over 5 A
8536.50.90.40	4	Snap-action, other than limit
8536.50.90.45	4	Knife
8536.50.90.50	4	Slide
8536.50.90.55	4	Limit
8536.50.90.65	4	Other
	1	Lamp-holders, plugs and sockets:
8536.90.85.10	3	Electrical distribution ducts
8537.1	1	For a voltage not exceeding <il>1,000 V</il>:
8538.9	1	Other:
	2	Printed circuit assemblies:
8538.90.10.00	3	Of an article of heading 8537 for one of the articles described in additional U.S. note 11 to chapter 85
8538.90.30.00	3	Other

8538.90.40.00	2	Other, for the articles of subheading 8535.90.40, 8536.30.40 or 8536.50.40, of ceramic or metallic materials, electrically or mechanically reactive to changes in temperature
	2	Other:
8538.90.60.00	3	Molded parts
8538.90.81	3	Other
8538.90.81.20	4	Of automatic circuit breakers
	4	Other:
8538.90.81.40	5	Metal contacts
8538.90.81.60	5	Other parts of switchgear, switchboards, panel boards and distribution boards
8538.90.81.80	5	Other
8543.20.00.00	1	Signal generators
8543.7	1	Other machines and apparatus:
8543.70.98.20	5	Special effects pedals for use with musical instruments
8544.42	2	Fitted with connectors:
8544.42.10.00	3	Fitted with modular telephone connectors
	3	Other:
8544.42.20.00	4	Of a kind used for telecommunications
8544.42.90	4	Other
8544.42.90.10	5	Extension cords as defined in statistical note 6 to this chapter
8544.42.90.90	5	Other
9001	0	Optical fibers and optical fiber bundles; optical fiber cables other than those of heading 8544; sheets and plates of polarizing material; lenses (including contact lenses), prisms, mirrors and other optical elements, of any material, unmounted, other than such elements of glass not optically worked:
9001.10.00	1	Optical fibers, optical fiber bundles and cables
	2	Optical fibers:
9002.19.00.00	2	Other
9011.80.00.00	1	Other microscopes
9013.20.00.00	1	Lasers, other than laser diodes
9013.80.91.00	2	Other
9016	0	Balances of a sensitivity of 5 cg or better, with or without weights; parts and accessories thereof:
9022.19.00.00	2	For other uses
9025.19	2	Other:
9025.19.80	3	Other
9025.19.80.10	5	Infrared thermometers of a kind described in statistical note 2 of this chapter
9025.19.80.60	5	Infrared thermometers
9025.8	1	Other instruments:

9025.80.10.00	2	Electrical
	2	Other:
9025.80.15.00	3	Barometers, not combined with other instruments
9025.80.20.00	3	Hydrometers and similar floating instruments, whether or not incorporating a thermometer, non-recording
9025.80.35.00	3	Hygrometers and psychrometers, non-recording
9025.80.40.00	3	Thermographs, barographs, hygrographs and other recording instruments
9025.80.50.00	3	Other
9025.90.06.00	1	Parts and accessories
9026	0	Instruments and apparatus for measuring or checking the flow, level, pressure or other variables of liquids or gases (for example, flow meters, level gauges, manometers, heat meters), excluding instruments and apparatus of heading 9014, 9015, 9028 or 9032; parts and accessories thereof:
9026.1	1	For measuring or checking the flow or level of liquids:
9026.10.20	2	Electrical
9026.10.20.40	3	Flow meters
9026.10.20.80	3	Other
	2	Other:
9026.10.40.00	3	Flow meters
9026.10.60.00	3	Other
9026.2	1	For measuring or checking pressure:
9026.20.40.00	2	Electrical
9026.20.80.00	2	Other
9026.8	1	Other instruments and apparatus:
9026.9	1	Parts and accessories:
9026.90.20.00	2	Of electrical instruments and apparatus
	2	Other:
9026.90.40.00	3	Of flow meters, heat meters incorporating liquid supply meters and anemometers
9026.90.60.00	3	Other
9027	0	Instruments and apparatus for physical or chemical analysis (for example, polarimeters, refractometers, spectrometers, gas or smoke analysis apparatus); instruments and apparatus for measuring or checking viscosity, porosity, expansion, surface tension or the like; instruments and apparatus for measuring or checking quantities of heat, sound or light (including exposure meters); microtomes; parts and accessories thereof:
9027.1	1	Gas or smoke analysis apparatus:

9027.10.20.00	2	Electrical
	2	Other:
9027.10.40.00	3	Optical instruments and apparatus
9027.10.60.00	3	Other
9027.2	1	Chromatographs and electrophoresis instruments:
9027.20.50	2	Electrical
9027.20.50.30	3	Electrophoresis instruments
9027.20.50.50	3	Gas chromatographs
9027.20.50.60	3	Liquid chromatographs
9027.20.50.80	3	Other
9027.20.80	2	Other
9027.20.80.30	3	Gas chromatographs
9027.20.80.60	3	Liquid chromatographs
9027.20.80.90	3	Other
9027.3	1	Spectrometers, spectrophotometers and spectrographs using optical radiations (ultraviolet, visible, infrared):
9027.30.40	2	Electrical
9027.30.40.40	3	Spectrophotometers
9027.30.40.80	3	Other
9027.30.80	2	Other
9027.30.80.20	3	Spectroscopes
9027.30.80.80	3	Other
9027.5	1	Other instruments and apparatus using optical radiations (ultraviolet, visible, infrared):
9027.50.10.00	2	Exposure meters
	2	Other:
9027.50.40	3	Electrical
9027.50.40.15	4	Chemical analysis instruments and apparatus
9027.50.40.20	4	Thermal analysis instruments and apparatus
9027.50.40.50	4	Photometers
9027.50.40.60	4	Other
9027.50.80	3	Other
9027.50.80.15	4	Chemical analysis instruments and apparatus
9027.50.80.20	4	Thermal analysis instruments and apparatus
9027.50.80.60	4	Other
	1	Other instruments and apparatus:
9027.81.00.00	2	Mass spectrometers
9027.89	2	Other:
9027.89.45	4	Electrical
9027.89.45.30	5	Chemical analysis instruments and apparatus
9027.89.80.30	5	Chemical analysis instruments and apparatus
9027.9	1	Microtomes; parts and accessories:

	2	Parts and accessories:
	3	Of electrical instruments and apparatus:
9027.90.45.00	4	Printed circuit assemblies for the goods of subheading 9027.81 or 9027.89
	4	Of optical instruments and apparatus:
9027.90.64.00	5	Of instruments and apparatus of subheading 9027.20, 9027.30, 9027.50, 9027.81 or 9027.89
9027.90.68.00	5	Other
	4	Other:
9027.90.84.00	5	Of instruments and apparatus of subheading 9027.20, 9027.30, 9027.50, 9027.81 or 9027.89
9027.90.88.00	5	Other
9028	0	Gas, liquid or electricity supply or production meters, including calibrating meters thereof; parts and accessories thereof:
9028.20.00.00	1	Liquid meters
9029.2	1	Speedometers and tachometers; stroboscopes:
9030	0	Oscilloscopes, spectrum analyzers and other instruments and apparatus for measuring or checking electrical quantities, excluding meters of heading 9028; instruments and apparatus for measuring or detecting alpha, beta, gamma, X-ray, cosmic or other ionizing radiations; parts and accessories thereof:
9030.10.00.00	1	Instruments and apparatus for measuring or detecting ionizing radiations
9030.2	1	Oscilloscopes and oscillographs:
9030.20.05.00	2	Specially designed for telecommunications
9030.20.10.00	2	Other oscilloscopes and oscillographs
	1	Other instruments and apparatus, for measuring or checking voltage, current, resistance or power (other than those for measuring or checking semiconductor wafers or devices):
9030.31.00.00	2	Multimeters, without a recording device
9030.32.00.00	2	Multimeters, with a recording device
9030.33	2	Other, without a recording device:
9030.33.34.00	3	Resistance measuring instruments
9030.33.38.00	3	Other
9030.39.01.00	2	Other, with a recording device
9030.40.00.00	1	Other instruments and apparatus, specially designed for telecommunications (for example, cross-talk meters, gain measuring instruments, distortion factor meters, psophometers)
9030.84.00.00	2	Other, with a recording device

9030.89.01.00	2	Other
9030.9	1	Parts and accessories:
	2	For articles of subheading 9030.10:
9030.90.25.00	3	Printed circuit assemblies
9030.90.46.00	3	Other
9030.90.89.61	5	Other
9031	0	Measuring or checking instruments, appliances and machines, not specified or included elsewhere in this chapter; profile projectors; parts and accessories thereof:
9031.41.00	2	For inspecting semiconductor wafers or devices (including integrated circuits) or for inspecting photomasks or reticles used in manufacturing semiconductor devices (including integrated circuits)
9031.41.00.20	3	For inspecting photomasks or reticles used in manufacturing semiconductor devices
	3	For inspecting semiconductor wafers or devices:
9031.49	2	Other:
9031.49.90.00	3	Other
9031.8	1	Other instruments, appliances and machines:
9031.80.80	2	Other
9031.80.80.60	4	For testing electrical characteristics
9031.80.80.70	4	Other
9031.80.80.85	3	Other
9031.9	1	Parts and accessories:
	2	Of other optical instruments and appliances, other than test benches:
9031.90.59.00	3	Other
	2	Other:
9032	0	Automatic regulating or controlling instruments and apparatus; parts and accessories thereof:
9032.10.00	1	Thermostats
	2	For air conditioning, refrigeration or heating systems:
9032.10.00.30	3	Designed for wall mounting
9032.10.00.60	3	Other
9032.10.00.90	2	Other
9032.20.00.00	1	Manostats
	1	Other instruments and apparatus:
9032.81.00	2	Hydraulic and pneumatic
	3	Industrial process control instruments and apparatus:
9032.81.00.20	4	Hydraulic
9032.81.00.60	4	Pneumatic
9032.81.00.80	3	Other
9032.89	2	Other:

	3	Automatic voltage and voltage-current regulators:
9032.89.20.00	4	Designed for use in a 6, 12 or 24 V system
9032.89.40.00	4	Other
9032.89.60	3	Other
	4	Control instruments for air conditioning, refrigeration or heating systems:
9032.89.60.15	5	Complete systems
9032.89.60.25	5	Other
	4	Process control instruments and apparatus:
9032.89.60.30	5	Complete systems
	5	Other:
9032.89.60.40	6	Temperature control instruments
9032.89.60.50	6	Pressure and draft control instruments
9032.89.60.60	6	Flow and liquid level control instruments
9032.89.60.70	6	Humidity control instruments
9032.89.60.75	6	Other
9032.89.60.85	4	Other
9032.9	1	Parts and accessories:
	2	Of automatic voltage and voltage-current regulators:
9032.90.21.00	3	Designed for use in a 6, 12 or 24 V system
9032.90.41.00	3	Other
9032.90.61	2	Other
9032.90.61.20	3	Of thermostats
9032.90.61.40	3	Of manostats
9032.90.61.60	3	Of instruments and apparatus of subheading 9032.81
9032.90.61.80	3	Other
9033	0	Parts and accessories (not specified or included elsewhere in this chapter) for machines, appliances, instruments or apparatus of chapter 90:
9033.00.90.00	1	Other

Alex Gordon (Semiconductor Industry Association) Attachment

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Annex A - Table A.49. Uses and properties of PFASs in the semiconductor industry identified by stakeholders - Updated since the Call for Evidence/Royal Haskoning studies and initial uploads to the ECHA portal for the Annex XV public consultation
Semiconductor Manufacturing

Use Category	Sub-Use	Properties	Examples of PFAS	Estimated Timeframe To Substitute with Non-PFAS Alternatives (Timeline commences after an invention is identified)	Element
Photolithography	Photoacid generators	- Strong electronegativity of F atom in the complex resist/chemical matrix allows for controlled generation of strong acid upon exposure to UV light	Fluorinated salts	25+ years	Process Chemistries
Photolithography	Antireflection coatings	- Low dielectric constant - Low refractive index - Good thermal stability - Good barrier properties	Acrylate and methacrylate-based copolymers	15-20+ years	Process Chemistries
Photolithography	Topcoats and Embedded Immersion Barriers Layers	- Hydrophobicity	Fluoropolymers	25+ years	Process Chemistries
Photolithography	Surfactants	- Uniformity in coating with minimal effect on properties provided by other critical resist/chemical ingredients (i.e., without impact to refractive indexes)	Non-polymeric PFASs (non-ionic)	15-20+ years	Process Chemistries
Photolithography	Dielectric Polymers (PBO/PI)	- Hydrophobicity - Electrical non-conductivity - Thermal resistance	Water-insoluble C1 PFAS polymers	15-20+ years	Process Chemistries Semiconductor Device
Photolithography	Filters	- Chemical resistance ' - Low extractables against solvents	Fluoropolymers	15+ years	Process Chemistries
Nanoimprint Lithography		- Low surface adherence	Fluoropolymers	15-20+ years	Process Chemistries
Photoresist	Epoxy, case masking	- Resistance to fire, grease, stain, etc.	Fluorotelomer-related compounds	15-20+ years	Process Chemistries Semiconductor Device
Colour Filter photoresist for imaging semiconductor components "photopatterning"					
Plasma [Dry] Etch and Wafer Cleaning		- Anisotrophic etching capabilities	PFC, HFC and HFO gases	15+ years	Process Chemistries
Vapour deposition chamber	Cleaning	Less shedding	PFC, HFC and HFO gases	10+ years	Process Chemistries
Wet surface modification chemistries (e.g. Wafer)	Wet etch	- Wetting agents - Selective metal oxide removal	Fluorinated organic acids	3-15+ years	Process Chemistries
Advanced Semiconductor Packaging	Flux	- High-temperature thermal stability (>160 C)	Surfactants	5 years	Process Chemistries
Development of necessary chemistries and their packaging to be used for manufacturing of process recipes (Photo Acids, Polymer with Fluorine Groups, Monomers/prepolymers, Surfactants, Dyes etc.)	Semiconductor manufacturing - process chemistries				Process Chemistries
The use of fluoropolymers in process chemistry manufacturing equipment (Filtration system e.g. PTFE filters, Pump, etc.), production infrastructure (Blending Kettles, Piping, Valves, etc.) and evaluation tools (coating, exposure and development tools, NMR, IR, ICP/MS, Titrator, etc.)	Semiconductor manufacturing - process chemistries				Process Chemistries
The use of Consumable Materials for process chemistry development and manufacturing (air and wet chemical filters, seals/o-rings, piping/tubing, embedded lubricants (oils, greases, solids), non-process chemicals, replacement parts, release film for mold process etc.)	Semiconductor manufacturing	High temperature stability up to 180°C Low Young's modulus Low tensile strength (i.e. high stretchability with low tearing risk) Low adhesion strength Chemical inertness	Fluoropolymer		Semiconductor Manufacturing Equipment Semiconductor Manufacturing Infrastructure Semiconductor Manufacturing Support Equipment Process Chemistries
Articles to store, handle, and deliver liquid process chemicals (Bottle Cap Seals, PTFE inner, PTFE tape, Dip tube, O-ring, Packing, Connector, Valve etc.)	Semiconductor manufacturing				Process Chemistries
MEMS wafer process	Vapor HF Sacrificial Etch: Tool Parts, Seals, Fittings etc.	Chemical resistance to HF vapor, low particle generation	Fluoropolymer	at least 20+ years	Process Chemistries Semiconductor Manufacturing Equipment
Semiconductor Manufacturing Equipment (photolithography coaters, scanners and developers, dry etch, ion implant, deposition, CMP, assembly test, metrology, pumps, point of use abatement equipment, spare parts, equipment repair, maintenance of articles and mixtures used etc.)					Semiconductor Manufacturing Equipment
Semiconductor Manufacturing Equipment & Infrastructure - Enabling Uses of Fluoropolymer Articles (raw materials including precursors, fluoropolymer parts embedded within manufacturing equipment, spare parts, equipment repair, maintenance of articles and infrastructure, filters, piping, tubing, gaskets, cables etc.)	Data, Power & Fluid Delivery and Interconnects, sealants/piping, waste removal used in semiconductor manufacturing	- Chemical resistance - Low volatility/high stability - Thermal resistance - Cleanliness - UV resistance - Flame resistance - Inertness - Purity - Low flammability - Temperature stability - Resistance to chemical permeation - Low coefficient of friction - Optical properties - Low dielectric constant - Low dissipation factor - low outgassing factor - Stable electrical performance over high temperature	Fluoropolymers (i.e., Teflon ™, Viton ™, PTFE, PFA, FEP, ETFE, PVDF, FFKM, etc)	15+ years	Semiconductor Manufacturing Equipment Semiconductor Manufacturing Infrastructure
Plasma Etch and Wafer Cleaning	Filters Ozone functionalized water	Chemical resistance Thermal durability High retention and high flow Low extractables	Fluoropolymers		Semiconductor Manufacturing Equipment
Plasma Etch and Wafer Cleaning	Thermal insulation for wet solution	Low thermal conductivity Chemical resistance Thermal durability Less shedding Less gas	Fluoropolymers		Semiconductor Manufacturing Equipment
Wafer	Wet etch & clean filters	Chemical resistance Temperature resistance Low extractables	Fluoropolymers		Semiconductor Manufacturing Equipment

Heat Transfer Fluids	Equipment Chillers	- High precision temperature control imparted by thermal stability - Viscosity vs temperature characteristics - Specific heat - Electrical conductivity characteristics	Hydrofluoroethers, perfluoropolyethers (including PFPMIE), and other fully fluorinated liquids (perfluorinated amines and perfluoroalkylmorpholines, PFPE, Butane, 1-ethoxy-1,1,2,2,3,3,4,4,4-nonafluoro-, 2,3,3,4,4-pentafluoro-5-methoxy-2,5-bis[1,2,2,2-tetrafluoro-1-(trifluoromethyl)ethyl]tetrahydrofuran, Perfluamine, 1,1,1,2,2,4,5,5,5-nonafluoro-4-(trifluoromethyl)-3-pentanone PFCs HFCs HFOs	8-14+ years	Semiconductor Manufacturing Equipment Semiconductor Manufacturing Infrastructure
Thermal Testing of Semiconductor Devices (in-line and end of line)	Equipment Chillers	- High precision temperature control imparted by thermal stability - Viscosity vs temperature characteristics, - Specific heat and electrical non-conductivity characteristics - High boiling point - Low pour point - Non-flammability	Hydrofluoroethers, perfluoropolyethers (including PFPMIE), and other fully fluorinated liquids (perfluorinated amines and perfluoroalkylmorpholines, Reaction mass of 1,1,2,2,3,3,4,4,4-nonafluoro-N,Nbis(nonafluorobutyl)butan-1-amine and 1,1,2,2,3,3,4,4,4-nonafluoro-N-[1,1,2,3,3-hexafluoro-2-(trifluoromethyl)propyl]-N-(1,1,2,2,3,3,4,4,4-nonafluorobutyl)butan-1-amine	8-14+ years	Semiconductor Manufacturing Equipment
Vacuum pump	Vacuum fluid	- Thermally stable - Non-flammable and insoluble in water, acids, bases and most organic solvents - Inertness - Low off-gassing and particle generation	Fluorocarbon ether polymers of polyhexafluoropropylene oxide,	10+ years	Semiconductor Manufacturing Equipment
Plastics such as PC/ABS		- Flame retardancy	Perfluoroalkane sulfonic acids (PFSA), their salts and esters	15+ years	Semiconductor Manufacturing Equipment
Fluoroelastomers, polymers including polyimides, polyamides, polyesters, polycarbonate etc.		- Cross linking agent for fluoroelastomers, monomer, high temperature composites and electronic materials	Bisphenol AF and its salts	15-20+ years	
Adhesive, coating, lubricant		Solvability	Perfluoroalkylethers	10+ years	
Lubricants		- Inertness - Low off-gassing and particle generation	PFPE Fluorosilicone PCTFE PTFE	10+ years	Semiconductor Manufacturing Equipment Semiconductor Manufacturing Infrastructure
Semiconductor Manufacturing Equipment & Infrastructure - the design, manufacture and delivery of semiconductor manufacturing equipment	Semiconductor manufacturing	- Chemical resistance - Low volatility/high stability - Thermal resistance - Cleanliness - UV resistance - Flame resistance - Inertness - Purity - Low flammability - Temperature stability - Resistance to chemical permeation - Low coefficient of friction - Optical properties	Fluoropolymers (i.e., Teflon ™, Viton ™, PTFE, PFA, FEP, ETFE, PVDF, FFKM, etc)	15+ years	Semiconductor Manufacturing Equipment Semiconductor Manufacturing Infrastructure
Reticle and pellicle manufacturing and all of its required chemicals, materials and tooling etc.	Semiconductor manufacturing - photolithography				Semiconductor Manufacturing Equipment
Consumable Materials in semiconductor manufacturing equipment (air and wet chemical filters, seals/o-rings, piping/tubing, embedded lubricants (oils, greases, solids), non-process chemicals, replacement parts etc.)	Semiconductor manufacturing				Semiconductor Manufacturing Equipment Semiconductor Manufacturing Infrastructure
Development of semiconductor manufacturing equipment (fluoropolymers, PFAS in mixtures etc.)	Production of semiconductor manufacturing equipment				Semiconductor Manufacturing Equipment Semiconductor Manufacturing Infrastructure
The use of fluoropolymers and PFAS in mixtures in the production of semiconductor manufacturing	Production of semiconductor manufacturing equipment				Semiconductor Manufacturing Equipment
Semiconductor Manufacturing infrastructure (production and storage, high purity water manufacturing/delivery systems, high purity chemical & gas delivery systems, air filtration systems, bulk chemical delivery systems treatment and distribution, planar chemical delivery systems, liquid waste collection system, abatement systems, semiconductor wastewater treatment and HVAC including corrosive exhaust ducting and treatment, facilities systems controls, gaskets for pipelines, etc.)	Support of semiconductor manufacturing (Chemical transportation, air cleaning, waste removal, waste treatment, etc.)	- Inertness (no outgassing) - Chemical resistance - Mechanical stability - Low pressure drop (filters) - Low volatility/high stability - Purity - Low flammability - Temperature stability - Resistance to chemical permeation	Fluoropolymers (PVDF, PTFE, etc.)	15+ years	Semiconductor Manufacturing Infrastructure
Plasma Etch and Wafer Cleaning	Thermal insulation for gas supply and exhaust in Plasma Etch	Low thermal conductivity Chemical resistance Thermal durability Less shedding Less gas	Fluoropolymers		Semiconductor manufacturing Infrastructure
Vapour deposition chamber	Thermal insulation for gas supply and exhaust in Plasma Etch	Low thermal conductivity Chemical resistance Thermal durability Less shedding Less gas	Fluoropolymers		Semiconductor Manufacturing Infrastructure
Consumable Materials in semiconductor manufacturing infrastructure (air and wet chemical filters, seals/o-rings, piping/tubing, embedded lubricants (oils, greases, solids), non-process chemicals, replacement parts etc.)	Semiconductor manufacturing				Semiconductor Manufacturing Infrastructure
Development of semiconductor manufacturing infrastructure equipment (fluoropolymers, PFAS in mixtures etc.)	Semiconductor manufacturing				Semiconductor Manufacturing Infrastructure
Support equipment for SM Processes	Protection Equipment for Maintenance/Firefighting	Special requirements when F-containing gases come into play	Viton™ gloves, personal protective equipment for firefighters etc.	Not known	Semiconductor Manufacturing Infrastructure

Semiconductor Manufacturing Support Equipment (Automated Material Handling Systems, lab equipment such as Die yield/Failure Analysis, Pathfinding/R&D, Chemical evaluation, associated abatement systems etc.)	Support of semiconductor manufacturing				Semiconductor support equipment
Consumable Materials in semiconductor manufacturing support equipment (air and wet chemical filters, seals/o-rings, piping/tubing, embedded lubricants (oils, greases, solids), non-process chemicals, replacement parts etc)	Semiconductor manufacturing				Semiconductor support equipment
Development of semiconductor manufacturing support equipment (fluoropolymers, PFAS in mixtures etc.)	Semiconductor manufacturing				Semiconductor support equipment
Wafer processing and transportation semiconductor manufacturing support systems - cassettes from front end to back end	FOUPs - Front Opening Unified Pod/Front Opening Universal Pod	High airflow and low particle penetration Low outgassing Low particle emission Water spray washing resistance	Fluoropolymers		Semiconductor support equipment
Advanced Semiconductor Packaging	Encapsulants (epoxy underfills, mold compounds etc.)	Temperature resistance Beneficial material flow Wetting, degassing and composite homogeneity Electrical non-conductivity	Fluoropolymers	13 years	Semiconductor Device
Advanced Semiconductor Packaging	Thermal Interface Materials	High thermal conductivity/heat resistance Tear resistance High tensile strength Incorporation of various fillers into different resin systems - High-temperature thermal stability (>160 C) - Low surface tension	Fluoropolymers	20+ years	Semiconductor Device
Advanced Semiconductor Packaging	Adhesives	- Solubility in organic solvents, low dielectric constants, and high thermal and thermo-oxidative stability	Fluorinated Tetracarboxylic acid anhydride derivatives, aromatic diamines, acrylate and methacrylate-based copolymers	20+ years	Semiconductor Device
Advanced Semiconductor Packaging	Hydrophobic coating/hermetic seal packages	- Unique hydrophobicity	Fluoropolymers	10+ years	Semiconductor Device
Advanced Semiconductor Packaging	Substrates including buildup/dielectric material	- High-temperature thermal stability (>160 C) - Electrical non-conductivity/low dielectric constant - Surface roughness/adhesion - Low coefficient of thermal expansion	Fluoropolymers	10+ years	Semiconductor Device
Advanced Semiconductor Packaging	MEMS anti-stiction layer/coating	- Low coefficient of friction - Low surface energy - High thermal stability - chemical inertness - mechanical durability, - electrical insulation - low particle generation	Fluoropolymers Fluoroalkyl Silanes	15-20+ years	Semiconductor Device
Advanced Semiconductor Packaging	Die for chiplets				
Advanced Semiconductor Packaging	Release sheet for thermocompression bonding process of semiconductor chips	- Heat-resistant - Releasability - Flexibility - Tensile strength	PTFE	10+ years	Semiconductor Device
Advanced Semiconductor Packaging	Packaging (bump, test, sort & assembly)				Semiconductor Device
Advanced Semiconductor Packaging	Sintering of semiconductor chips to a heatsink	- Anti-stiction - High thermal stability (>280°C) - Contamination protection - Compensation of topology	Fluoropolymers	10+ years	Process Chemistries
Advanced Semiconductor Packaging	Vapour phase soldering	- High boiling point (>235°C) - Long term thermal stability - No reactivity to semiconductor under these conditions	PFPE	15+ years	Process Chemistries
MEMS sensor packaging	Passivation gels and coating materials	Unique property: simultaneous high chemical stability against polar, unipolar and oxidative agents and acids Low Young's modulus that is constant over very wide operational temperature range (-50°C to 175°C) High thermal stability No significant aging over product lifetime (up to 15 years)	Fluoropolymers	10+ years	Semiconductor Device
MEMS sensor packaging	Chemically robust adhesives for chip and package component attach	Unique property: simultaneous high chemical stability against polar, unpolar and oxidative agents and acids Low Young's modulus that is constant over very wide operational temperature range (-50°C to 175°C) High thermal stability No significant ageing over product lifetime (up to 15 years)	Fluoropolymers	10+ years	Semiconductor Device
MEMS sensor packaging	Soft adhesives for chip attach	Intermediate Young's modulus that is constant over very wide operational temperature range (-50 to 175°C) High thermal stability No significant aging over product lifetime (up to 15 years)	Fluoropolymers	7+ years	Semiconductor Device
MEMS sensor packaging	Air-permeable membranes, protective meshes, and their hydrophobic and oleophobic coatings	Unique property: simultaneous high chemical stability against polar, unpolar and oxidative agents and acids Unique property: simultaneous hydrophobicity and oleophobicity High thermal stability up to reflow solder temperature (>260°C)	Fluoropolymers	at least 20+ years	Semiconductor Device

Bruce Calder (Claigan Environmental) Attachment

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CUU	Currently Unavoidable Use (CUU)	Products	HS Codes	Example Products	Essential Use of Product	Essential Use of PFAS	Comparison of Alternatives	PFOA	Alternatives Tab
1	Fluoropolymer and perfluoropolyether (PFPE) release agents used in manufacturing processes of plastic, rubber, and pressed wooden parts including foam.	Widespread use Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory, Building Products, and Security & Defence.	HS Code Chapters - 32, 39, 40, 56 83, 84, 85, 86, 87, 88, 89, and 90	Gaskets (401693), o-rings (401693), and molded rubber parts in electronics (40), pumps (841381), medical devices (9018), door locks (830140), pressed wood pallets (441520)	Widespread use. Used in the majority of manufactured products on the market.	Release agents are required to release rubber parts from their molds	Superior to other release agents. May be replaceable in the future by silicone. Wide verification and validation required. Silicone has higher friction and adhesion than fluoropolymer based release agents.	None	Release agent
2	PTFE used as an additive drip agent in plastics to meet flammability safety requirements	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 39, 40, 48, 49, 76 83, 84, 85, 86, 87, 88, 89, and 90	Electronics with plastic components (85). Examples- vacuum cleaners (850860), computers (847130), fans (841490), food processing equipment (843880), and electric cars (870380).	Widespread use. Used in the vast majority of complex electronics on the market to meet flame retardancy standards such as UL 94 and IEC 60695-11.	Provide required anti-drip flame retardancy required by fire regulation and standards. Currently no effective replacements for PTFE as an anti-drip additive. Virtually all electronics use PTFE anti-drip agents in one or more parts. Restriction of PTFE anti-drip agents would create a significant safety risk for electronics and require the redesign and re-qualification of safety of virtually every electronic product on the US market	Only additive widely approved for use to meet strict anti-drip flame retardancy requirements in plastics	None	Anti-Drip
3	PTFE, ETFE, PFA, PVDF, and FEP as a wire insulator.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 83, 84, 85, 86, 87, 88, 89, and 90	Laptops (847130), medical endoscopes (901890), mass spectrometers (902781), car ignition (8708), tablets (847160), Pumps (8414), Data Machines (8517), Printers (8544), Analytical Instruments (9026), Photometers/Instruments (9027)	Widespread use. >100M products per year Used in the majority of complex higher performance electronics on the market.	Provide temperature and chemical resistance in combination with electrical insulation	Other materials do not have sufficient temperature and corrosive resistance, feasibility in dense electronics (too thick), and electrical insulation	None except PFA. PFA can be manufactured without residual PFOA but time will be required for conversion.	Wiring
4	Fluoropolymers (PTFE, ETFE, FEP, and PFA) used for electrical insulation purposes except wiring.	Hoses, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 83, 84, 85, 86, 87, 88, 89, and 90	Coaxial cables (854420), audio ports (853669), chemical hoses (3917), antennas (852910), electrical transformers (850431), electric switches (853630)	Widespread use. >10M products per year. Common in most RF applications. Necessary for many radio frequency applications Also common to general electrical insulation, static dissipative hoses, and fire suppression.	Fluoropolymers have the best in class dielectric constants / electrical insulation while maintaining flexibility. This includes both electrical isolation but also in static dissipation and related safety activities.	Other polymers do not provide sufficient electrical insulation (poorer dielectric constants). Ceramics can provide sufficient dielectric constants for some RF applications, but do not have the flexibility required for most applications.	None except PFA. PFA can be manufactured without residual PFOA but time will be required for conversion.	Dielectric
5	Fluorosilicone, amorphous fluoro resins, and fluoroelastomers (including perfluoroelastomers) for electrical insulation purposes except wiring.	Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 83, 84, 85, 86, 87, 88, 89, and 90; and HS Code 3917.	High voltage cables (854460), electric vehicles (870380), hoses (3917), (853340) electrical resistors (including rheostats and potentiometers) and industrial machinery (843890).	High voltage applications would be difficult without fluoroelastomers	Specialized uses requiring electrical isolation in a rubber	No other material has equivalent dielectric constant / electrical insulation capability with flexibility Fluoroelastomer use is more specialized and lower volume than PTFE and ETFE for the same purpose.	None	Insulator
6	Fluoropolymers in invasive, implantable, fluid, and gas contacting applications in medical devices.	Medical	HS Code Chapter - 90	Endoscopes (901890), surgical instruments (9018), surgical tubing, and pacemakers (902150), electrical components (854370)	Widespread medical use. Necessary for most invasive procedures	Low friction, flexibility, and high biocompatibility are essential for internal procedures	Alternatives do not have equivalent low friction, flexibility, and/or biocompatibility. Some polymers, such as silicone and polyurethane, have applications in invasive medical devices but not in situations requiring low friction or thin material. Silicone also contains over 100X higher concentrations of forever chemicals (D4, D5, and D6) than PFA fluoropolymer.	Yes. However PFOA presence is strongly linked to flexibility and will take time and validation to phase out.	Medical
7	PTFE as an additive up to 25% in plastics for the purpose of reduced friction and wear	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 28, 32, 38, 39, 40, 49, 73, 74, 82, 83, 84, 85, 86, 87, 88, 89, and 90	Bearings (848210), medical devices, drills (846721), manufacturing equipment, food processing equipment (820830), industrial vehicles and instruments for analysis (9027).	Widespread use. Very common in longer life products with moving parts. Without these products, there would be no more automation or automated assistance.	PTFE additive provides greatly reduced friction and wear in plastic parts. This property greatly extends their lifetime and time before replacement.	Alternatives do not have equivalent low friction or compatibility as an additive. No other additives are as effective in safely reducing the coefficient of friction of plastics. Restriction of PTFE additives in plastics for friction reduction would reduce the lifetime of many products, resulting in products going to waste or landfall sooner and more often. In addition, PTFE added plastics extend product life/service intervals thereby reducing potential fluid and gas releases/exposures. They also reduce power consumption compared to non-PTFE added counterparts.	No	Friction
8	PTFE, ETFE, and PCTFE for professional, industrial, or high temperature applications (>150C) requiring reduced friction, or chemical inertness.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 32, 39, 40, 83, 84, 85, 86, 87, 88, 89, and 90.	Chemical reactors (841989), breathing appliances (9020), chemical processing, oil and gas (847989), laboratory equipment, engines, electrical transformers (850450), and industrial equipment.	Widespread professional and industrial use. Requirement for industrial and laboratory machinery. Working at high temperatures or harsh environments would no longer be possible.	Fluoropolymers have tremendous chemical and temperature resistance combined with low friction. All three are essential for the operation and safety in industrial environments.	No other materials have the same low friction and chemical inertness properties as PTFE, ETFE and PCTFE at regular temperatures and at high temperature (150C). PTFE and PCTFE extend product life/service intervals thereby reducing potential chemical releases/exposures. They also can reduce power consumption compared to non-PTFE/PCTFE counterparts.	No	Harsh Env.
9	Fluoroacrylic coatings necessary for chemical or fire safety for fabrics including applications requiring extreme water repellancy for professional use.	Textiles	HS Code Chapters - 39, 42, 56, 62, and 63	Chemical aprons (6210), Splash shields (392690), motorcycle racing jacket (420310), and hazardous environment clothing (621010)	Safety clothing is necessary for worker safety in hazardous environments.	Fluoroacrylics provide adhesion to the fabric and protection from acid, water, and oil.	Alternatives do not have the combination of acid, water, temperature, and oil resistance sufficient for hazardous environments while maintaining permeability to air (breathability).	Yes from the fracturing of the C-O-C bond in the fluoroacrylic coatings. But in low concentration.	Fabric Coating
10	Fluoroacrylic coatings on fabrics necessary for the protection or storage of portable medical devices or laboratory equipment.	Textiles, Medical, Laboratory	HS Code Chapter - 84 and 90	Water resistance cases for pumps (841370), dialysis equipment (901890), CPAPs and other sensitive medical or laboratory devices (901920).	Water resistance provided by the carrying case is necessary for sensitive medical and laboratory requirement.	Fluoroacrylics provide adhesion to the fabric and significant protection from acid, water, and oil. The safety of the laboratory or medical device is dependant on their proper care from the environment.	Alternatives do not have the combination of acid, water, and oil resistance sufficient for complete protection of the sensitive equipment or medical devices.	Yes from the fracturing of the C-O-C bond in the fluoroacrylic coatings. But in low concentration.	Fabric Coating

11	PTFE, PFA, FKM, and PVDF membranes for gas and aqueous filtration, or particle retention.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 38, 39, 73, 84, 85, 86, 87, 88, 89, and 90.	Medical filtration membrane (901819), laboratory filtration membranes (8414), water purification / food processing equipment filtration membranes (842121), and drinking water filtration and laboratory membranes (9020)	PTFE, PVDF, FPA, and FKM membranes are hydro- (water) and oleo- (oil) phobic while still allowing air to pass. These membranes provide the ability to extract air components from liquids and solids in specialized environments. Fluoropolymer membranes perform well under pressure and are stable over time and resistant to corrosive cleaning reagents.	PTFE, PVDF, PFA, and FKM membranes are the only material with best in class air porousness and resistance to water and oils.	No other material has the same gas permeability while being hydrophobic, oleophobic, acid resistant, and alkali resistant. Fluoropolymer membranes also have the advantage of maintaining their performance characteristics even at elevated temperatures. Although it is theoretically possible to develop a porous gas permeable polyethylene frit for some applications, this would be a long project and is risky regarding tightness and reproducibility of the gas transfer. Safety and accuracy would degrade in these specialized medical, laboratory, or industrial applications.	Yes. From the fracturing ('rubberizing') of the fluoropolymer to create the membrane fibre. Low concentration: 1 to 4 ppm	Membranes
12	PTFE as a lubricant additive under 30% concentration not in contact with drinking water.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 34, 84, 85, 86, 87, 88, 89, and 90	Widespread use. Mineral or silicone oil with PTFE powder added. Used in a wide range of consumer, professional, and industrial machinery to maintain low friction. PTFE added oil lubricants are both found inside machinery and are sold independently for use on moving parts.	The PTFE added lubricants significantly decrease the wear and increase the lifetime of machinery parts.	PTFE powder added to oils safely provides lubrication in a large range of environments necessary for proper function and lifetime of machinery.	No other material has the same impact as a low friction additive to mineral or silicone oil than PTFE.	No	Lubricant
13	PTFE as a fused coating on cookware	Cookware	HS Code Chapters 73, 76 and 84	Frying pans, electric griddles, electric waffle machines. (7323, 761510)	Cooking appliances and frying pans are essential to the continued functioning of society. Non-stick cookware is necessary to reduce cooking and cleaning time for consumers and professionals.	Fused PTFE powder to create anti-stick coating on cooking surface	No polymer provides the same low friction at high temperature. Ceramic cookware can provide sufficient non-stick (low friction) but is not as durable as PTFE coated cookware, reducing the lifetime of the fry pan or cooking appliance.	No	Cookware
14	PTFE as a coating for chemical containers	Containers	HS Code Chapters - 39, 73, 84, and 86	Chemical containers (for storage or industrial machinery) for hazardous chemicals (7309-7311) (841989, 8609)	PTFE has the necessary acid, water, oil, and temperature resistance to handle some of the most hazardous chemicals.	PTFE provides excellent resistance to chemicals, acids, water, and oils - and temperatures.	Alternatives do not provide sufficient resistance to acid, water, oils, and temperature for all harsh chemicals. Ceramics have similar performance characteristics but could only be used to coat metal vessels. Ceramic coatings are more difficult to coat completely without gaps in larger containers, creating leakage or degradation risk.	No	Harsh Env.
15	Fluoroelastomers (including perfluoroelastomers), fluorosilicone, and amorphous fluoro resins as a sealing and packing material in situations requiring chemical resistance, oil resistance, oxidation resistance, decompression resistance, elasticity, high temperature (over 150C), and/or low temperature (<-20C).	Rubbers, Building Products, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 32, 34, 39, 40, 49, 59, 68, 72, 73, 83, 84, 85, 86, 87, 88, 89, and 90.	Widespread use. Pumps, oil and gas (848790), industrial machinery (848420), chemical tanks (7309), food processing, medical devices, laboratory equipment, aerospace, chemical processing, pharmaceutical and cosmetic processing equipment, and equipment for extreme environments	Products using fluoroelastomer seals can be found in virtually every industrial or machinery application world wide. Without fluoroelastomer seals, virtually all industrial applications would no longer be viable.	Fluoroelastomers (including perfluoroelastomers and amorphous fluoro resins) are the necessary sealing material for applications requiring temperature resistance, chemical resistance, flexibility, and water/oil resistance. Without fluoroelastomers, sealing on machinery would not be viable in many applications.	No other rubbers have equivalent hydrophobic and oleophobic properties, oxidation resistance, and chemical safety over a range of low and high temperatures as fluoroelastomers. Fluoroelastomers are also very resistant to explosive decompression. Fluoroelastomer use can extend product life/service intervals thereby reducing potential chemical releases/exposures. Alternative materials would need to be replaced monthly, as they begin to leak. PTFE has similar environmental properties, but is a plastic and is not suitable for applications requiring the conformity of a 'rubber' seal. Fluoroelastomers also have a higher coefficient of friction than PTFE and create a superior 'seal' in most applications.	No	Seals
16	Fluoroelastomers (including perfluoroelastomers), fluorosilicone, and amorphous fluoro resins as a sealing and packing material for drinking water or food contact if compliant with NSF, FDA, and State food and/or drinking water regulations.	Rubbers, Industrial, Machinery	HS Code Chapters - 40, and 84.	Widespread use. Seals in water purification facilities and laboratory equipment. Very common material in drinking water contact. (842121, 842199)	Water purification is essential to the functioning of society.	Fluoroelastomers provide flexibility, biocompatibility, temperature resistance, and water resistance.	No other rubbers have equivalent hydrophobic and oleophobic properties, UV resistance, and chemical safety over a range of temperatures as fluoroelastomers. The most common alternatives are not chemically compatible for direct contact for long exposure time (years). PTFE has similar environmental properties, but is a plastic and is not suitable for applications requiring the conformity of a 'rubber' seal. Fluoroelastomers also have a higher coefficient of friction than PTFE and create a superior 'seal' in most applications. Additionally, silicone has reduced biocompatibility and high forever chemicals due to its normal high concentration of residual D4, D5, and D6 forever chemicals.	No. However, fluoroelastomers can contain 6:2 fluorotelomer from their emulsion surfactant. Any presence of 6:2 fluorotelomer (and related short chain perfluorocarboxylate degradation products) must conform to drinking water standards.	Water Seals
17	PTFE tape for moisture insulation, or joining of fluid or gas components.	Self adhesive tape, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 40, 84, 85, 86, 87, 88, 89, 90, and HS Code 3919.	Widespread use. PTFE tape for home and professional use, plumbing, machinery with fluids or gasses, drinking water equipment, food production equipment, industry water processes, medical endoscopes, analytical instruments, and any other equipment requiring piping to be sealed together. (3919)	PTFE tape is the most effective joining materials in a fluid environment. Alternative materials do not have equivalent water and oil sealing in a thin coating.	PTFE rubber tape has the best in class water and oil resistance in a thin applicable tape.	Alternative materials do not provide the same water or oil seal in a thin tape.	Yes. The fracturing of the PTFE polymer chain to produce PTFE rubber commonly produces PFOA and LC-PFCA. Manufacturing of PTFE tape without PFOA is possible and PFOA containing PTFE can be phased out.	PTFE Tape
18	PTFE tape for reduction of friction.	Self adhesive tape, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 39, 40, 84, 85, 86, 87, 88, 89, 90, and HS Code 3919.	Industrial machinery or equipment with moving parts. (3919). Printing equipment (3215)	PTFE tape provides a thin coating to reduce friction between moving parts.	PTFE rubber tape has very low friction, reducing the wear, and extends the lifetime of moving parts.	No other tape materials has as low friction as PTFE tape and the ability to conform to uneven surfaces. Replacement of PTFE tape in a low friction application will negatively affect product performance and reduce lifetime of the product - causing earlier disposal or replacement of the product using the PTFE tape.	Yes. The fracturing of the PTFE polymer chain to produce PTFE rubber commonly produces PFOA and LC-PFCA. Manufacturing of PTFE tape without PFOA is possible and PFOA containing PTFE can be phased out.	PTFE Tape
19	Fluorocoating of rubber, metal, carbon, and plastic seals in high temperature, professional, or industrial applications where chemical resistance is required.	Rubbers, Building Products, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory, Aerospace	HS Code Chapters - 40, 83, 84, 85, 86, 87, 88, 89, and 90	Plunger in a syringe (901831), rubber plunger in industrial equipment (841319), rubber component in contact with chemicals.	Most standard rubbers are high friction (nitrile rubber, styrene rubber, EPDM) and require a fluorocoating for low friction. This is necessary for plungers and other rubber parts likely to encounter friction in operation.	Fluorocoating of standard rubber such as nitrile or butadiene rubber provides low friction to a standard rubber.	Alternative materials do not sufficiently reduce the friction of rubber to allow for the necessary movement of the rubber part. No other coating material provides the same environmental protection to rubber and metal seals.	No	Rubber coating

20	PTFE, ETFE, and PFA coating of metal for environmental or temperature resistance not in contact with food or drinking water.	Metal, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory, Aerospace	HS Code Chapters - 72, 84, 85, 86, 87, 88, 89, and 90	Widespread use. Outdoor machinery, construction vehicles, oil and gas platforms, industrial equipment (3208) (721070)	Metals and machinery used in harsh or outdoor environment need chemical, water, and oil resistant coatings to protect from the conditions.	Fluoropolymer coatings provide environmental resistant to metal parts. Resistance to water, acids, and oils extends the lifetime of the parts in outdoor and harsh environments.	No other coating materials provide the same environmental (water, oil, acid, and chemical) protection to metals. Replacement PTFE and PFA environmental coatings for metals will reduce the corrosion resistance (in particular over temperature) of many metals resulting in failure of these metals and/or reduced product lifetime (resulting in more products entering end of life disposal sooner).	No	Outdoor
21	PTFE, FEP, and PFA coating of metal for low friction, improved wetting, and/or wear resistance in machinery or tools	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90.	Machinery or equipment with moving parts. Wood saw blade, pumps, and other moving components in contact with other materials. (721070). Machines and mechanical appliances (847989), pumps (8413), laboratory or plant machinery (841989), spectrometers (902730). Includes paint, anodization, and other coatings on metals.	Cutting, drilling, grinding, milling, and other activities with metal in contact with other materials requires low friction, high wear resistance and high temperature resistance.	Fluoropolymers coatings are nearly frictionless, have excellent wetting properties, and can withstand high temperature and wear.	Alternative materials do not have equivalent low friction, wetting, and/or temperature resistance. PEEK provides similar durability but not equivalent low friction. PFA does not have as low friction as PTFE, but is lower friction than PEEK. Replacement PTFE, FEP, and PFA environmental coatings will greatly reduce the performance of some machinery, increase wear, and reduce lifetimes on metal components. Liquid lubricants can be used, but they are temporary in nature, and the most effective lubricants for low friction in metal parts contain PTFE powder and are covered by another derogation request.	None except PFA. PFA can be manufactured without residual PFOA but time will be required for conversion.	Machinery
22	PTFE, PFA, FEP, and TFE copolymers in hoses in chemical, pump, or valve applications.	Tubing, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, 90; and HS Code 3917.	Widespread use. Pump hoses, chemical plants, gasoline hose, fuel lines, and oil and gas. (4009)	Transport of chemical or petroleum fluids requires specialized materials.	Fluoropolymers have excellent chemical, acid, and oil resistance - the requirements for transportation of many petroleum and chemical fluids. Fluoropolymers also have the flexibility necessary for hose (as opposed to rigid tube) applications.	No other polymer that can be formed into hoses or braided to transport chemicals has the equivalent acid, chemical, oil, fire, and temperature resistance with the necessary flexibility required for hoses.	None except PFA. PFA can be manufactured without residual PFOA but time will be required for conversion.	Hoses
23	Fluorocoatings on labels on products (excluding textiles) necessary for environmental resistance	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory, Personal Protective Equipment (PPE), Consumer	HS Code Chapters - 65, 84, 85, 86, 87, 88, and 90	Widespread use. Safety label on product, product serial number label, battery capacity and composition label, and other labels with indelibility and lifetime requirements. (482110)	Clear labels that do not degrade over time are required for safety and regulatory reasons on most electronic, personal protective equipment, professional, and industrial products. A thin fluorocoating protects the label from the environment, maintaining the legibility of the label and meet standards such as UL 969.	Fluoropolymer coatings provide water and oil resistance to labels - reducing, if not preventing legibility issues with the label's writing.	Alternative coatings do not have the equivalent water or oil resistance. Or, in the case of nitrile or EPDM rubber, do not have the required transparency to read the label's writing. PVC has nearly equivalent water and oil resistance, but has risks of other regulated substances (such as phthalates) and does not withstand temperature ranges as well as fluoropolymers.	No	Labels
24	PTFE, PFA, FEP, PVDF, ETFE, and fluoroelastomer (including perfluoroelastomer) tubing not in contact with drinking water.	Tubing, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, 90; and HS Code 3917.	Widespread Use. (391739) Transformers, power suppliers, laboratory equipment, medical devices (901839), accelerometers (903180), and servers	Electrical transformers are reliant on PTFE tubing to protect their wiring. Medical devices and laboratory equipment use fluoropolymer tubing for transport of fluids in situations where non-reactive materials are critical. Tubing and bellows are used in articulating joints in machinery and vehicles. Without which, the joints would be inflexible and would wear.	Fluoropolymers have flexibility, biocompatibility (low chemical reactivity), optical transparency, and high temperature resistance. For electronics, the flexibility and high temperature resistance is critical for power applications such as the leads in transformers. For medical devices, the flexibility, transparency, and low chemical reactivity are critical for human or laboratory processes.	Alternative polymers do not have equivalent low chemical reactivity, optical transparency, flexibility, and temperature resistance. Polyurethane and PVC tubing can be used in some applications, but have poor resistance to acids and bases, can release chemicals (isocyanates or phthalates) into the fluid, and both have poor temperature stability.	No	Tubes
25	Heat transfer fluids for industrial applications	Heat transfer fluids, Electronics, Vehicles, Industrial, Machinery, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, and 89; and HS Code 3824.	Servers, semiconductor manufacturing equipment, radar equipment, and large power supplies.	Specialized high performance products that require fast and efficient transfer of heat from the heat generation source.	Fluorinated fluids have best in class heat transfer properties.	No other fluids have equivalent heat capacity to transfer heat sufficiently in machinery. Replacement with other fluids would create safety and performance issues in industrial applications such as semiconductor manufacturing, data centers, and military/aerospace.	Unknown	N/A
26	PVDF and PTFE as the cathode binder in lithium batteries	Lithium batteries, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, 90; and HS Code 8507.	Lithium batteries in electronics, vehicles, medical devices, servers, power drills (846721), analysis equipment for water, and portable electronic equipment. (850760)	Lithium batteries are fundamental to electric vehicles, servers, and portable electronics / tools.	Fluoropolymer binders have high heat resistance and excellent electrical insulation - improving performance of lithium batteries and reducing delamination of the electrodes in the battery.	Alternative polymers do not have as good of temperature resistance and/or electrical insulation, reducing the performance and lifetime of lithium batteries. Other polymers could not maintain the rigorous performance requirements of a binder in a high density lithium battery. Lead acid batteries have similar performance to lithium batteries, but can release lead at the end of life and have a weight that makes them unusable for mobile applications including electrical vehicles.	No	Batteries/Cap
27	PVDF, PTFE, TFE, and sulfonated PTFE as a binder, separator, or spacer in capacitors (including copolymers)	Capacitors, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, 90; and HS Code 8532.	supercapacitors and other high capacitance capacitors have a broad use in electronics, electrical distribution, and industrial equipment. (8532)	Fluorinated binders in capacitors are fundamental to high performance / capacitance capacitors. The fluoropolymers fill a similar role in a capacitor as they do in a lithium battery.	Fluoropolymer binders, separators, and spacers provide the electrical insulation and temperature resistance needed in high capacitance capacitors.	Alternative polymers do not have as good temperature resistance and/or electrical insulation, reducing or preventing the performance of the high performance capacitors	No	Batteries/Cap
28	Surfactants in emulsion based bio-assays and dry-chemistry assays	Medical, Laboratory	HS Code Chapter 90	Specialized low volume use in laboratory assays. Research and development, and medical applications.	Surfactants are commonly needed in laboratory and medical assays. These assays are necessary for measurement of biological, human, and chemical properties.	Fluorinated surfactants have the best surfactant performance. High performance and critical measurements using bio and dry chemistry assays often have to use fluorinated surfactants for measurement accuracy.	Fluoro based surfactants are commonly used as the surfactants in specialized bio-assays and dry chemistry assays. Fluoro based surfactants are useful for membrane protein stabilization in subsequent purification steps as they do not strip natural lipids and other co-factors from the proteins. In addition, the bulky fluorinated tails can not penetrate into the interior and disrupt the structure. Fluorinated surfactants often decrease non-specific aggregation and are thought to result in improved distribution. Without fluoro based surfactants, many specialized laboratory or medical measurements would not be possible or, at least, not with the same accuracy.	Yes. The very small amount present is very low volume, specialized use, and has controlled disposal. No risk of impact to humans or drinking water.	N/A
29	PTFE foil coating of rubber for biotechnology or chromatography purposes.	Medical, Laboratory	HS Code Chapter 90	Specialized very low volume use in laboratory and medical testing. Research and development, and medical applications. (902720)	PTFE foil is a specialized use in gas (and other) chromatography. This is a low volume application necessary for very specialized tests.	By enclosing the gas / fluid path with PTFE, higher precision chromatography is possible due to the reduced friction and low chemical reactivity of the tubing.	No other polymer has as low reactivity and low friction as PTFE. Specialized biotechnology or chromatography applications require the highest possible performance for measurement accuracy and consistency.	No	N/A

30	Fluorinated polyethylene for chemical storage and handling.	Industrial, Machinery, Laboratory	HS Code 3904	Fluorinated polyethylene containers for hazardous or laboratory chemicals.	Certain laboratory and hazardous chemicals will dissolve standard polyethylene or other polymer containers. Fluorinated polyethylene containers are needed for transport and storage of these chemicals (pesticides, optical personal care products, and industrial cleaners).	Fluorinated polyethylene provides the chemical resistance to standard polyethylene containers necessary to contain and transport certain chemicals.	Alternative non-fluorinated polymers do not have the chemical resistance to safely contain or transport pesticides and industrial cleaners. PFA fluoropolymer has similar performance as fluorinated polyethylene, but is more flexible and not suitable for most applications of fluorinated polyethylene.	Yes. Small concentration of PFOA and LC-PFCA are created by the fluorination of polyethylene.	N/A
31	Fluorosilicone, fluoroacrylic, and nano-fluorocoatings for antismudge and antireflective coatings for plastics and glass.	Electronics, Building Products, Vehicles, Industrial, Machinery, Medical, Laboratory, Eyewear, Headwear	HS Code Chapters - 83, 84, 85, 86, 87, 88, 89, and 90.	LCD screens (852859), ski goggles (900490), motorcycle helmets (65061030), sunglasses and eyewear (900410), refrigerator shelves (841899), and windows (761010).	Anti-smudge and anti-reflective coatings are necessary to maintain optical clarity in products that are touched by humans or are exposed to the environment. Without anti-smudge and anti-reflective coatings, safety and functionality could be compromised by lack of visibility.	Fluorinated coatings provide hydrophobic (water repellant) and oleophobic (oil repellant) properties to glass and plastics while maintaining optical transparency. Necessary for product safety, viewing clarity, and to meet state motor vehicle codes. Fluoroacrylic coatings are critical for optical clarity for motor vehicles and related safety optical elements.	Alternative materials do not have equivalent water or oil resistance with the necessary optical clarity (especially in harsh environments). In particular, oil (fingerprint) repellency of other materials are not equivalent. Other anti-fingerprint coatings exist, such as parylene, but they do not adhere to plastic substrates as effectively as fluoropolymer side chain polymers and have lower thermal stability.	No Except fluoroacrylic coatings. Fluoroacrylic coatings can have under 1ppm LC-PFCA from the fracturing of the C-O-C bond in the fluoroacrylic coatings.	Anti-smudge
32	PTFE, PCTFE, PVDF, FEP, ePTFE, PFA, and TFE (including copolymers) as a sealing or spacer material.	Seals (plastic, rubber, or metal), Building Products, Electronics, Vehicles, Industrial, Machinery, Pumps, Medical, Laboratory	HS Code Chapters - 28, 32, 38, 39, 40, 49, 59, 72, 73, 74, 82, 83, 84, 85, 86, 87, 88, 89, and 90	Widespread use. Pumps, oil and gas, industrial machinery, food processing, pharmaceutical and cosmetic processing equipment, medical devices, laboratory equipment, aerospace, chemical processing, electronic components, and equipment for extreme environments.	Products using fluoropolymer seals can be found in a wide range of industrial or machinery applications. Fluoropolymer seals are used in situations requiring a solid or vacuum seal versus the rubber seal of a fluoroelastomer, or added / impregnated into sealing material to provide the necessary performance properties.	Fluoropolymers have the acid, alkali, temperature, heat, water, and oil resistance needed for industrial sealing applications.	Alternatives do not provide sufficient resistance to acid, chemicals, water, oils, and temperature. In most of the applications listed in this entry, alternative sealing materials were tested, and no materials and closure systems showed positive results.	No Except PFA and ePTFE. They often contain PFOA and LCPFCA from the fracturing of the C-O-C bond of PFA, and the crosslinking of the polymer in ePTFE. Both can be designed without PFOA or LC-PFCA.	Seals
33	PVDF and ETFE as a component in fluid or gas systems	Plumbing, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90 - HS Code 3917	Pumps (841381), water circulation systems (842121), water purification system (842121), laboratory equipment (8419), and water heaters (8419).	Fluid and gas transportation is critical for a wide range of industries. Society cannot function without the ability to transport fluids and gases.	PVDF and ETFE provide significant performance advantages as components in a fluid or gas transportation system as either part of the tubing or as connector pieces in the system.	Alternatives do not have sufficient resistance to water, oil, and chemicals; and with the necessary durability and biocompatibility. The only other polymer with similar properties is PTFE. PTFE is higher density and has less abrasion resistance than PVDF. PVDF is preferred in industrial or heating applications for piping. ETFE has higher tensile strength than PTFE and can be used under harsher conditions that PTFE. The exception is the PEEK polymer. PEEK is technically a viable alternative to PVDF. Validation work needs to be completed to ensure replacement is viable in all circumstances.	No	Fluid/Gas Comp.
34	PTFE in coatings of labels for security or tamper evidence.	Tamper proof labels	HS Code Chapters - 84, 85, 90 HS Code 3923	Food packaging (3923), smart cards (8523.52), secure forms delivery, passports, self-adhesive plates, sheets, film, foil, tape (3919)	Abrasion and tamper proof labelling is needed for the security of personal information and product safety.	PTFE coatings provide abrasion and tamper proof protection for labels. PTFE cannot be modified by chemicals and shows physical wear if tampered. such as leaving a "Void" marking when the tamper evident label is pulled away/off.	For security - no other polymer provides the same tamper proof properties (chemical resistance) as PTFE as a coating. Use of another polymer would reduce the security of devices especially those for financial transactions or personal identification. For tamper evidence - PTFE material film (plus an adhesive) is used in the label in order to provide evidence. Other plastics do not have the combination of chemical resistance and visibility of tampering than irradiated (soft) PTFE.	No	Labels
35	Fluoroacrylic and PFA coatings (and PFPE solvents) for encapsulation of capacitors or semiconductor components.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90; and HS Code 8532 and 8542	Capacitors and integrated circuits used in computers, servers, machinery, and laboratory equipment	Electronics with advanced capacitors and integrated circuits are necessary for the continued functioning of society.	Very thin fluoroacrylic and PFA coatings provide water resistance at high temperature to sensitive electronics. There will be a very small amount of residual perfluoropolyether (PFPE) from application of the coatings	Alternative non-fluorinated materials do not have adequate chemical, water, and heat resistance in a high density / thin film application.	Below measurable levels due to small size of application	IC Coating
36	PTFE and fluorosilicone sprays for maintaining lubrication in industrial equipment.	Lubricants, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 34, 84, 85, 86, 87, 88, 89, and 90	Widespread use. Pumps (841381), oil and gas, industrial machinery, food processing, medical devices, laboratory equipment, aerospace, chemical processing, and equipment for extreme environments.	Widespread use. Very common in longer life products with moving parts. Without these products, there would be no more automation or automated assistance.	PTFE and fluorosilicone sprays provides lubrication in a large range of environments necessary for proper function and lifetime of industrial machinery, metal parts, and wire/cable.	No other spray is as effective in low concentrations and thickness in achieving reduced friction. Silicone spray is less effective than fluoro sprays and often contains D4, D5, and D6 forever chemicals (also regulated in the EU with further restriction expected). Silicone lubricants stay 'wet', apply thicker, do not have good high temperature resistance, and are less effective on moving parts.	No	Lubricant
37	Ionic fluoro fluids as electrolytes in capacitors or batteries	Lithium batteries, Capacitors, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90; and HS Code 8507 and 8532.	Lithium batteries and supercapacitors in electronics (8507), vehicles (870380, medical devices, servers, power drills (8467), and portable electronic equipment.	Lithium batteries, capacitors, and supercapacitors are fundamental to electric vehicles, servers, industrial equipment, and portable electronics / tools.	Fluoro ionic fluids provide great surfactant power, chemical/biological inertness, easy recovery and recyclability, low surface tension, extreme surface activity, no flammability, and high thermal stability. The surface activity and high thermal stability are excellent for high performance lithium batteries and supercapacitors.	Other ionic fluids can be used, but these fluids do not exhibit either/or the performance or flammability resistance of FILs.	No	N/A
38	Perfluorinated polyether (PFPE) as a lubricant for harsh (very low or high temperature) environments	Building Products, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 83, 84, 85, 86, 87, 88, 89, and 90.	Industrial machinery, components, and equipment uses at low and high temperatures.	Industrial machinery is required to work in low and high temperatures in laboratory and outdoor environments.	PFPE provides lubrication at very low temperatures which is not available for other materials. PTFE can offer high temperature lubrication equivalent to PFPE.	Silicone oil does not have the temperature range of PFPE and is not suitable for contact with some plastics. PFPE can handle a higher temperature range and is compatible with a wider range of rubbers.	No	N/A

39	PVDF polymers and PVDF terpolymers for ferroelectric films.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90.	Specialized use of ferroelectric films in micromachines and memory devices. Use of PVDF terpolymer films in actuators for medical devices (e.g. catheters or other implantable devices).	Micromachines and memory devices are specialized use, but are necessary for miniature applications and memory storage. Medical devices such as catheters and other implantable devices have an essential medical use.	PVDF and similar films are fundamental to the specialized use of ferroelectric films. Without PVDF, ferroelectric films would not be possible. PVDF terpolymer ferroelectric films enable the construction of flexible actuators that assist medical devices in their function. Without PVDF films, flexible actuators would not be possible in medical uses.	Specialized PVDF films have the highest dielectric constant of polymers, are new innovations, and are not replaceable with other materials. Given the electroactivity, strength and flexibility of PVDF terpolymer films, they enable the construction of flexible actuators for which there is currently no alternative.	No	N/A
40	Fluoroethers for degreasing applications	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90.	Metal components for electronics, medical, industrial, or laboratory equipment are commonly degreased with fluoroethers.	Clean high precision metal components are needed for electronics, laboratory, medical, and high precision applications.	Fluoroethers provide degreasing cleanliness necessary for metals in high precision applications.	Chlorinated and brominated solvents can be used to degrease metal parts, they have higher greenhouse gas and environmental emissions; and reduced solvency power - resulting in most environmental hazards and would reduce part quality.	No	N/A
41	Residual hydrofluoroolefins used as blowing agents for insulating foam internal to products	Polyurethane foam, Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90, and HS Code 392690	Blown foam for refrigerators, centrifuges, buildings, and shipping of fragile products.	Blow foam is necessary for thermal insulation for food safety and for transportation of valuable / fragile products.	Hydrofluorolefins used as a blowing agent for insulated foam leaves residual hydrofluorolefins.	HFOs (hydrofluorolefins) are the environmentally friendly replacements for hydrofluorocarbons (HFCs). To meet greenhouse gas emissions targets, companies need to continue to use and convert to HFOs.	No	N/A
42	PTFE as a manufacturing aid or tool for high temperature (> 150C) applications	Tools for manufacturing	HS Code Chapter 84.	Tools includes tools, jigs, and molds for high temperature manufacturing.	Industrial manufacturing processes often involve high temperatures which require tools that can withstand high temperature with strong chemical resistance.	PTFE withstands high temperatures and has very good chemical resistance.	Metals are too thermally conductive for most high temperature manufacturing processes. Other polymers either do not have the temperature resistance of PTFE (example - polyethylene) or are difficult to machine into custom tools (example - PEEK).	No	Harsh Env.
43	Fluorocoatings on laser fibers, laser fiber components, and fibers for optical purposes including light guidance.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90.	Fibre optics in communication systems (854470), medical endoscopes (901890), industrial vehicles (8708), aerospace, and laboratory equipment.	UV curable coatings based on fluorinated polymers (amorphous fluoropolymers) are used in connecting optical fibres or fiber based components to maintain light guidance along a chain of fiber and fiber based components when making a device. For optical components, light guidance needs to be maintained with high reliability and precise optical matching to avoid losses and transmitting light between beam forming components.	Fluoropolymers have optical transparency, excellent optical matching properties, and can be used in thin or dense environments.	Alternative materials are not as transparent to visible light and have poorer optical matching properties.	None expected. The amount of amorphous fluoropolymer is not sufficient for measurable perfluorocarboxylates in the final device even for a potential degradation product.	Optical Coating
44	Fluorosilicone used as a surfactant or anti-foaming agent in semiconductor materials	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90; and HS Code 8532 and 8542	Integrated circuits used in computers, resistors, servers, industrial machinery, and laboratory equipment	Precision semiconductor products are fundamental to virtually all modern electronic applications.	The fluorosilicone surfactants are used in a manufacturing step for a microscopic material internal to a semiconductor device. The resulting chemical is only used in the manufacturing of the product and will not be present above 50 ppm organic fluorine in the final product.	Other surfactants are not as effective for this high precision application or as inert. In semiconductor manufacturing this surfactant cannot react without other materials.	No	N/A
45	F2 gas and PFA fluorinated plastics in capacitors and microchips	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 34, 39, 40, 48, 49, 73, 84, 85, 86, 87, 88, 89, and 90; and HS Code 8532 and 8542	Integrated circuits used in computers, servers, industrial machinery, and laboratory equipment	Precision semiconductor products are fundamental to virtually all modern electronic applications.	A microlayer of fluorinated material is created in capacitors and semiconductor devices by F2 gas fluorination (usually plasma fluorination) of a plastic such as polyethylene or polyphenylene sulfide The thin layer has amorphous fluorinated alkane molecules. This very thin internal fluorinated layer provides specialized capacitance curves and is useful in specialized applications. Capacitors and microchips require extreme chemical resistance or flexibility advantages.	Thin fluorinated plastics provide capacitance performance advantages plus environmental resistance not available in other materials, and temperature resistance necessary for dense electronics	No	N/A
46	PTFE filled die attach material for semiconductor devices	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90; and HS Code 8532 and 8542	Integrated circuits and semiconductor devices (854110) used in computers, servers, industrial machinery, and laboratory equipment	Precision semiconductor products are fundamental to virtually all modern electronic applications.	PTFE provides a chemical inertness and temperature resistance to microchip die attach material.	No other polymer powder is as chemically inert and has as high temperature resistance as PTFE powder.	No	N/A
47	PFBS (Perfluorobutane sulfonate) and its salts - for the purposes of optical clarity in flame retarded polymers.	Electronics, Vehicles, Industrial, Machinery, Medical, Laboratory	HS Code Chapters - 84, 85, 86, 87, 88, 89, and 90.	Refrigerator, computer display, kiosk terminal	Optically clear and flame retarded displays are important for displays used by consumers.	Flame retarded clear plastic tends to be slightly cloudy, reducing the transparency of the screen. By adding <0.01% PFBS, the plastic of the displays is 'clarified', and can be used easily and safety.	No information is available on a potential replacement for PFBS. Currently is it the only material effective for its specialized application.	No	N/A
48	PVDF, PTFE, PCTFE, FKM, ETFE, PFA, PVDF in chemical and pharmaceutical packaging	Diagnostic / laboratory reagents, Pharmaceuticals	HS Code Chapters - 38, 39, and 90.	Reagents (3822), chemical analysis instruments and apparatus (9027), plastic articles and materials (3926), pharmaceutical packaging	Pharmaceutical and chemical packaging has to be very chemical resistance, high purity, and have high biocompatibility (low leaching).	Fluoropolymers including PVDF, PTFE and other fluorinated polyethylenes, provide chemical resistance for corrosive and solvent chemicals. Heat or UV resistance needed during some uses. Fluoropolymers incorporated into liners and seals in chemical packaging, and through fluorinations of inner container surfaces maintains integrity of the containers, preventing potentially hazardous leaks and protecting human health and the environment.	No alternatives to fluorinated chemical containers currently exist. Replacement with non-fluorinated materials would create a safety hazard for workers. Non-fluorinated polymers such as polyethylene lack resistance to corrosive and solvent chemicals and harsh conditions.	No Except PFA. PFA often contains PFOA and LCPFCA from the fracturing of the C-O-C bond of PFA. Both can be designed without PFOA or LC-PFCA.	Chemical packaging

49	PTFE, PFA coated tubing to prevent clogging if compliant to applicable NSF, FDA, or State requirements	Analyzer reagent tubing, wastewater tubing, printer tubing	HS Code Chapters - 39, 40, 49, 73, 84, 85, 90	Printer system tubing & spigots, pumps (841381), water circulation systems (842121), water purification system (842121), laboratory equipment (8419), and water heaters (8419).	Water quality tubing, analyzers, printers.	Parts that require either low friction or have a role in hostile chemical environments. PTFE required to reduce friction to prevent clogs within a hostile environment.	No alternative material with required resistance to hostile environments.	No Except PFA. PFA often contains PFOA and LCPFCA from the fracturing of the C-O-C bond of PFA. Both can be designed without PFOA or LC-PFCA.	Tubes
50	Conductivity agent in continuous ink jet for coding and marking	Printing ink, ink cartridges	HS Code Chapters - 32 and 84.	Printer inks (321511, 844399)	Essential marking of information, tracing and tracking of product. Sell by dates for food, pharmaceuticals, bottling and packaging.	Lithium trifluoromethanesulfonat e is used as a conductivity agent in the ink formulation	No non-PFAS conductivity agents compatible with these formulations have been identified. Lithium trifluoromethanesulfonate is only used when other approaches are unsuccessful.	No	N/A
51	High temperature greases containing perfluoropolyether (PFPE)	Lubricating preparations	HS Code Chapter 34.	Fluorinated greases and oils (340399)	Assembly aid in production	Lubricant with high fluid resistance	No alternative material with required resistance to fluids	No	N/A
52	PTFE fibers and filtration disks used in corrosive gas filtration	Machinery, Electronics, Industrial	HS Code Chapter - 90 HS Code - 8421	Chemical analyzers, filtering or purifying machinery and apparatus for gases, others (8421)	These types of instruments are used to test if the water is safe for consumption or discharge in to the environment.The filtration allows successful conversion of these gases back to harmless forms that will not damage the environment or affect human health.	For filtration of corrosive or oxidizing gases the material is required to be very chemical resistant. The material must be able to separate particles from gas flow without damaging the filter.	Other polymers and filter material will react by dissolving and do not have the wide range of environmental resistance.	Yes. From the fracturing ('rubberizing') of the fluoropolymer to create the membrane fibre. Low concentration: 1 to 4 ppm	Membranes
53	PTFE Impregnated fabric for high temperature insulation	Electronics, Vehicles, Industrial, Machinery, Laboratory, Cooking Appliances	HS Code Chapters - 32, 39, 40, 83, 84, 85, 86, 87, 88, 89, and 90.	Insulation blankets in appliances, kilns, chemical reactors, conveyor belts	PTFE impregnated glass fabric is used as a heat insulating materials in high temperature professional and consumer products. The insulation fabric prevents heat from impacting other components including human contact surfaces.	PTFE provides additional insulation over glass fibre alone.	Silicone impregnated glass fibre does not have the temperature or chemical resistance of PTFE impregnated glass fibre.	No	Harsh Env.

Bruce Calder (Claigan Environmental) Attachment

Converted from Microsoft Excel to Adobe PDF 3/5/2024

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Low Friction	Excellent	Decent	Decent	Poor	Decent	Excellent	Excellent	Excellent	Poor	Poor	Decent	Poor	Poor	Poor	Excellent	Decent	Decent	Decent
Chemical Resistance	Excellent	Decent	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Poor	Decent	Excellent	Poor	Excellent
Water Resistance	Excellent	Excellent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Oil Resistance	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent
Temperature Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Excellent	Excellent	Decent	Decent	Excellent
Fire Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Excellent	Excellent	Decent	Excellent
Flexibility	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Poor	Excellent	Decent	Excellent	Poor
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Bio-compatibility	Excellent	Excellent	Decent	Decent	Excellent	Decent	Decent	Decent	Decent	Decent	Excellent	Decent	Decent	Excellent	Decent	Excellent	Decent	Excellent
Insulation	Excellent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Decent	Decent	Poor	Excellent	Excellent	Decent	Excellent
High density applications	Excellent	Decent	Poor	Decent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent
Polymer additive	Excellent	Poor	Poor	Poor	Excellent	Excellent	Poor	Poor	Poor	Poor	Excellent	Excellent	Decent	Poor	Poor	Excellent	Decent	Excellent
Porous	Poor	Poor	Poor	Poor	Poor	Poor	Excellent	Excellent	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor
Durability	Excellent	Excellent	Decent	Poor	Excellent	Decent	Poor	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent
Optical Transparency	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Poor	Poor	Poor	Excellent	Excellent	Excellent	Poor
Structural	Decent	Excellent	Poor	Poor	Poor	Poor	Poor	Poor	Decent	Decent	Excellent	Decent	Decent	Excellent	Poor	Excellent	Excellent	Excellent
Radiation Resistance	Poor	Excellent	Poor	Decent	Poor	Poor	Poor	Poor	Poor	Poor	Decent	Poor	Decent	Excellent	Poor	Poor	Poor	Poor

Comparison	**PTFE**	**PEEK**	**Silicone**	**Poly urethane**	**PFA**	**PTFE Rubber**	**ePTFE**	**Fluoro acrylates**	**FKM**	**FFKM**	**PVDF**	**Nitrile Rubber**	**EPDM**	**Stainless steel**	**Fluoro silicone**	**ETFE**	**PVC**	**ECTFE**
Chemical Resistance	Excellent	Decent	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Poor	Decent	Excellent	Poor	Excellent
Water Resistance	Excellent	Excellent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Oil Resistance	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent
Flexibility	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Poor	Excellent	Decent	Excellent	Poor
Bio-compatibility	Excellent	Excellent	Decent	Decent	Excellent	Decent	Decent	Decent	Decent	Decent	Excellent	Decent	Decent	Excellent	Decent	Excellent	Decent	Excellent
Acceptable	**YES**	**NO**	**NO**	**NO**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**

Bold - Critical Property

Comparison	**PTFE**	**PEEK**	**Silicone**	**Poly urethane**	**PFA**	**PTFE Rubber**	**ePTFE**	**Fluoro acrylates**	**FKM**	**FFKM**	**PVDF**	**Nitrile Rubber**	**EPDM**	**Stainless steel**	**Fluoro silicone**	**ETFE**	**PVC**	**ECTFE**
Low Friction	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Decent**	**Poor**	**Poor**	**Poor**	**Excellent**	**Decent**	**Decent**	**Decent**
Chemical Resistance	**Excellent**	**Decent**	**Decent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Poor**	**Excellent**
Water Resistance	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Oil Resistance	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Temperature Resistance	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**
Fire Resistance	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Excellent**
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Bio-compatibility	Excellent	Excellent	Decent	Decent	Excellent	Decent	Decent	Decent	Decent	Decent	Excellent	Decent	Decent	Excellent	Decent	Excellent	Decent	Excellent
Durability	Excellent	Excellent	Decent	Poor	Excellent	Decent	Poor	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent
Acceptable	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
High density applications	Excellent	Decent	Poor	Decent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent
Temperature Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Excellent	Excellent	Decent	Decent	Excellent
Optical Transparency	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Poor	Poor	Poor	Excellent	Excellent	Excellent	Poor
Acceptable	YES	NO	NO	NO	YES	YES	NO	YES	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Chemical Resistance	Excellent	Decent	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Poor	Decent	Excellent	Poor	Excellent
Water Resistance	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Temperature Resistance	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**
Fire Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Excellent	Excellent	Decent	Excellent
High density applications	Excellent	Decent	Poor	Decent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent
Acceptable	**YES**	**YES**	**NO**	**NO**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**	**YES**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Low Friction	Excellent	Decent	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Poor	Decent	Excellent	Poor	Excellent
Chemical Resistance	Excellent	Excellent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Water Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Excellent	Excellent	Decent	Decent	Excellent
Fire Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Excellent	Excellent	Decent	Excellent
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Bio-compatibility	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Decent**	**Decent**	**Decent**	**Decent**	**Decent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Decent**	**Excellent**	**Decent**	**Excellent**
Durability	**Excellent**	**Excellent**	**Decent**	**Poor**	**Excellent**	**Decent**	**Poor**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Excellent**
Structural	**Decent**	**Excellent**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Decent**	**Decent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**
Acceptable	**NO**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**YES**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Low Friction	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Decent**	**Poor**	**Poor**	**Poor**	**Excellent**	**Decent**	**Decent**	**Decent**
Chemical Resistance	Excellent	Decent	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Poor	Decent	Excellent	Poor	Excellent
Optical Transparency	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Poor	Poor	Poor	Excellent	Excellent	Excellent	Poor
Polymer additive	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent
Acceptable	**YES**	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**	**NO**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Chemical Resistance	Excellent	Decent	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Poor	Decent	Excellent	Poor	Excellent
Water Resistance	Excellent	Excellent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Temperature Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Excellent	Excellent	Decent	Decent	Excellent
Fire Resistance	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Excellent**
Flexibility	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Poor	Excellent	Decent	Excellent	Poor
Bio-compatibility	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Decent**	**Decent**	**Decent**	**Decent**	**Decent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Decent**	**Excellent**	**Decent**	**Excellent**
Insulation	Excellent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Decent	Decent	Poor	Excellent	Excellent	Decent	Excellent
High density applications	Excellent	Decent	Poor	Decent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent
Optical Transparency	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Poor	Poor	Poor	Excellent	Excellent	Excellent	Poor
Acceptable	**YES**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**

Bold - Critical Property

Comparison	**PTFE**	**PEEK**	**Silicone**	**Poly urethane**	**PFA**	**PTFE Rubber**	**ePTFE**	**Fluoro acrylates**	**FKM**	**FFKM**	**PVDF**	**Nitrile Rubber**	**EPDM**	**Stainless steel**	**Fluoro silicone**	**ETFE**	**PVC**	**ECTFE**
Chemical Resistance	Excellent	Decent	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Poor	Decent	Excellent	Poor	Excellent
Water Resistance	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Oil Resistance	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Temperature Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Excellent	Excellent	Decent	Decent	Excellent
Flexibility	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Poor	Excellent	Decent	Excellent	Poor
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Optical Transparency	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Poor	Poor	Poor	Excellent	Excellent	Excellent	Poor
Acceptable	**YES**	**NO**	**NO**	**NO**	**YES**	**YES**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**NO**	**NO**

Bold - Critical Property

Comparison	**PTFE**	**PEEK**	**Silicone**	**Poly urethane**	**PFA**	**PTFE Rubber**	**ePTFE**	**Fluoro acrylates**	**FKM**	**FFKM**	**PVDF**	**Nitrile Rubber**	**EPDM**	**Stainless steel**	**Fluoro silicone**	**ETFE**	**PVC**	**ECTFE**
Chemical Resistance	**Excellent**	**Decent**	**Decent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Poor**	**Excellent**
Water Resistance	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Oil Resistance	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Temperature Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Excellent	Excellent	Decent	Decent	Excellent
Fire Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Excellent	Excellent	Decent	Excellent
Flexibility	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Poor	Excellent	Decent	Excellent	Poor
Acceptable	**YES**	**NO**	**NO**	**NO**	**YES**	**YES**	**YES**	**NO**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Low Friction	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Decent**	**Poor**	**Poor**	**Poor**	**Excellent**	**Decent**	**Decent**	**Decent**
Water Resistance	Excellent	Excellent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Oil Resistance	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent
Temperature Resistance	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**
Durability	**Excellent**	**Excellent**	**Decent**	**Poor**	**Excellent**	**Decent**	**Poor**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Excellent**
Acceptable	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**	**NO**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Chemical Resistance	**Excellent**	**Decent**	**Decent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Poor**	**Excellent**
Water Resistance	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Oil Resistance	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent
Temperature Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Excellent	Excellent	Decent	Decent	Excellent
Acceptable	**YES**	**NO**	**NO**	**NO**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**YES**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Low Friction	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Decent**	**Poor**	**Poor**	**Poor**	**Excellent**	**Decent**	**Decent**	**Decent**
Chemical Resistance	Excellent	Decent	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Poor	Decent	Excellent	Poor	Excellent
Water Resistance	Excellent	Excellent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Oil Resistance	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent
Temperature Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Excellent	Excellent	Decent	Decent	Excellent
Flexibility	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Poor	Excellent	Decent	Excellent	Poor
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Acceptable	**YES**	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**	**NO**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Low Friction	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Decent**	**Poor**	**Poor**	**Poor**	**Excellent**	**Decent**	**Decent**	**Decent**
Chemical Resistance	**Excellent**	**Decent**	**Decent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Poor**	**Excellent**
Water Resistance	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Oil Resistance	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Temperature Resistance	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**
Flexibility	**Decent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Decent**	**Excellent**	**Poor**
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
High density applications	Excellent	Decent	Poor	Decent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent
Acceptable	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Bold - Critical Property

Comparison	**PTFE**	**PEEK**	**Silicone**	**Poly urethane**	**PFA**	**PTFE Rubber**	**ePTFE**	**Fluoro acrylates**	**FKM**	**FFKM**	**PVDF**	**Nitrile Rubber**	**EPDM**	**Stainless steel**	**Fluoro silicone**	**ETFE**	**PVC**	**ECTFE**
Chemical Resistance	**Excellent**	**Decent**	**Decent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Poor**	**Excellent**
Water Resistance	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Temperature Resistance	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**
Flexibility	**Decent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Decent**	**Excellent**	**Poor**
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	**Excellent**	**Excellent**	**Decent**	**Excellent**	**Decent**	**Excellent**	**Excellent**	**Decent**	**Excellent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Excellent**	**Excellent**	**Excellent**
Bio-compatibility	Excellent	Excellent	Decent	Decent	Excellent	Decent	Decent	Decent	Decent	Decent	Excellent	Decent	Decent	Excellent	Decent	Excellent	Decent	Excellent
Acceptable	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**NO**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Chemical Resistance	**Excellent**	**Decent**	**Decent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Poor**	**Excellent**
Water Resistance	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Oil Resistance	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Temperature Resistance	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**
Fire Resistance	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Excellent**
Flexibility	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Poor	Excellent	Decent	Excellent	Poor
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Acceptable	**YES**	**NO**	**NO**	**NO**	**YES**	**YES**	**YES**	**NO**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Low Friction	Excellent	Decent	Decent	Poor	Decent	Excellent	Excellent	Excellent	Poor	Poor	Decent	Poor	Poor	Poor	Excellent	Decent	Decent	Decent
Chemical Resistance	Excellent	Decent	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Poor	Decent	Excellent	Excellent	Excellent
Water Resistance	Excellent	Excellent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Oil Resistance	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent
Temperature Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Excellent	Excellent	Decent	Decent	Decent
Fire Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Excellent	Excellent	Excellent	Excellent
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Acceptable	YES	NO	NO	NO	NO	YES	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Chemical Resistance	**Excellent**	**Decent**	**Decent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Excellent**	**Excellent**
Water Resistance	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Oil Resistance	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Porous	Poor	Poor	Poor	Poor	Poor	Poor	Excellent	Excellent	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor	Poor
Acceptable	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Bold - Critical Property

Comparison	**PTFE**	**PEEK**	**Silicone**	**Poly urethane**	**PFA**	**PTFE Rubber**	**ePTFE**	**Fluoro acrylates**	**FKM**	**FFKM**	**PVDF**	**Nitrile Rubber**	**EPDM**	**Stainless steel**	**Fluoro silicone**	**ETFE**	**PVC**	**ECTFE**
Low Friction	Excellent	Decent	Decent	Poor	Decent	Excellent	Excellent	Excellent	Poor	Poor	Decent	Poor	Poor	Poor	Excellent	Decent	Decent	Decent
Chemical Resistance	Excellent	Decent	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Poor	Decent	Excellent	Poor	Excellent
Water Resistance	Excellent	Excellent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Oil Resistance	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Optical Transparency	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Excellent**	**Poor**	**Poor**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Poor**
Acceptable	**YES**	**YES**	**NO**	**NO**	**YES**	**YES**	**YES**	**YES**	**NO**	**NO**	**YES**	**NO**	**NO**	**NO**	**YES**	**YES**	**NO**	**NO**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Chemical Resistance	**Excellent**	**Decent**	**Decent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Poor**	**Excellent**
Water Resistance	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Oil Resistance	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Temperature Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Excellent	Excellent	Decent	Decent	Excellent
Flexibility	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Poor	Excellent	Decent	Excellent	Poor
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Bio-compatibility	Excellent	Excellent	Decent	Decent	Excellent	Decent	Decent	Decent	Decent	Decent	Excellent	Decent	Decent	Excellent	Decent	Excellent	Decent	Excellent
Porous	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**	**Poor**
High density applications	Excellent	Decent	Poor	Decent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent
Acceptable	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Chemical Resistance	Excellent	Decent	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Poor	Decent	Excellent	Poor	Excellent
Temperature Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Excellent	Excellent	Decent	Decent	Excellent
Fire Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Excellent	Excellent	Decent	Excellent
Insulation	**Excellent**	**Decent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Excellent**	**Decent**	**Decent**	**Poor**	**Excellent**	**Excellent**	**Decent**	**Excellent**
High density applications	Excellent	Decent	Poor	Decent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent
Polymer additive	Excellent	Poor	Poor	Poor	Excellent	Excellent	Poor	Poor	Poor	Poor	Excellent	Excellent	Decent	Poor	Poor	Excellent	Excellent	Excellent
Acceptable	**YES**	**NO**	**NO**	**NO**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**YES**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Low Friction	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Decent**	**Poor**	**Poor**	**Poor**	**Excellent**	**Decent**	**Decent**	**Decent**
Durability	Excellent	Excellent	Decent	Poor	Excellent	Decent	Poor	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent
Acceptable	**YES**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**	**NO**

Bold - Critical Property

Comparison	**PTFE**	**PEEK**	**Silicone**	**Poly urethane**	**PFA**	**PTFE Rubber**	**ePTFE**	**Fluoro acrylates**	**FKM**	**FFKM**	**PVDF**	**Nitrile Rubber**	**EPDM**	**Stainless steel**	**Fluoro silicone**	**ETFE**	**PVC**	**ECTFE**
Temperature Resistance	Excellent	Decent	Decent	Poor	Decent	Excellent	Excellent	Excellent	Poor	Poor	Decent	Poor	Poor	Poor	Excellent	Decent	Decent	Decent
Fire Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Excellent	Excellent	Decent	Excellent
Flexibility	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Poor	Excellent	Decent	Excellent	Poor
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Insulation	**Excellent**	**Decent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Excellent**	**Decent**	**Decent**	**Poor**	**Excellent**	**Excellent**	**Decent**	**Excellent**
High density applications	Excellent	Decent	Poor	Decent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent
Acceptable	**YES**	**NO**	**NO**	**NO**	**YES**	**YES**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**NO**	**NO**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Fire Resistance	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Decent**	**Poor**	**Poor**	**Poor**	**Excellent**	**Decent**	**Decent**	**Decent**
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Polymer additive	Excellent	Poor	Poor	Poor	Excellent	Excellent	Poor	Poor	Poor	Poor	Excellent	Excellent	Decent	Poor	Poor	Excellent	Decent	Excellent
Acceptable	**YES**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Low Friction	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Decent**	**Poor**	**Poor**	**Poor**	**Excellent**	**Decent**	**Decent**	**Decent**
Chemical Resistance	Excellent	Decent	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Poor	Decent	Excellent	Poor	Excellent
Water Resistance	Excellent	Excellent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Flexibility	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Poor	Excellent	Decent	Excellent	Poor
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Bio-compatibility	Excellent	Excellent	Decent	Decent	Excellent	Decent	Decent	Decent	Decent	Decent	Excellent	Decent	Decent	Excellent	Decent	Excellent	Decent	Excellent
High density applications	Excellent	Decent	Poor	Decent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent
Acceptable	**YES**	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**	**NO**

Bold - Critical Property

Comparison	**PTFE**	**PEEK**	**Silicone**	**Poly urethane**	**PFA**	**PTFE Rubber**	**ePTFE**	**Fluoro acrylates**	**FKM**	**FFKM**	**PVDF**	**Nitrile Rubber**	**EPDM**	**Stainless steel**	**Fluoro silicone**	**ETFE**	**PVC**	**ECTFE**
Low Friction	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Decent**	**Poor**	**Poor**	**Poor**	**Excellent**	**Decent**	**Decent**	**Decent**
Chemical Resistance	Excellent	Decent	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Poor	Decent	Excellent	Poor	Excellent
Water Resistance	Excellent	Excellent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Oil Resistance	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent
Temperature Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Excellent	Excellent	Decent	Decent	Excellent
Fire Resistance	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Excellent	Excellent	Decent	Excellent
Flexibility	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Poor	Excellent	Decent	Excellent	Poor
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Polymer additive	Excellent	Poor	Poor	Poor	Excellent	Excellent	Poor	Poor	Poor	Poor	Excellent	Excellent	Decent	Poor	Poor	Excellent	Decent	Excellent
Acceptable	**YES**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Bold - Critical Property

Comparison	**PTFE**	**PEEK**	**Silicone**	**Poly urethane**	**PFA**	**PTFE Rubber**	**ePTFE**	**Fluoro acrylates**	**FKM**	**FFKM**	**PVDF**	**Nitrile Rubber**	**EPDM**	**Stainless steel**	**Fluoro silicone**	**ETFE**	**PVC**	**ECTFE**
Chemical Resistance	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Decent**	**Poor**	**Poor**	**Poor**	**Excellent**	**Decent**	**Decent**	**Decent**
Water Resistance	**Excellent**	**Decent**	**Decent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Poor**	**Excellent**
Oil Resistance	**Excellent**	**Excellent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**
Temperature Resistance	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent
Flexibility	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Poor	Excellent	Decent	Excellent	Poor
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Acceptable	**YES**	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**

Bold - Critical Property

Comparison	PTFE	PEEK	Silicone	Poly urethane	PFA	PTFE Rubber	ePTFE	Fluoro acrylates	FKM	FFKM	PVDF	Nitrile Rubber	EPDM	Stainless steel	Fluoro silicone	ETFE	PVC	ECTFE
Flexibility	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Poor	Excellent	Decent	Excellent	Poor
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Insulation	**Excellent**	**Decent**	**Decent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Excellent**	**Decent**	**Decent**	**Poor**	**Excellent**	**Excellent**	**Decent**	**Excellent**
High density applications	Excellent	Decent	Poor	Decent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent
Acceptable	**YES**	**NO**	**NO**	**NO**	**YES**	**YES**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**NO**	**NO**

Bold - Critical Property

Comparison	**PTFE**	**PEEK**	**Silicone**	**Poly urethane**	**PFA**	**PTFE Rubber**	**ePTFE**	**Fluoro acrylates**	**FKM**	**FFKM**	**PVDF**	**Nitrile Rubber**	**EPDM**	**Stainless steel**	**Fluoro silicone**	**ETFE**	**PVC**	**ECTFE**
Temperature Resistance	**Excellent**	**Decent**	**Decent**	**Poor**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Decent**	**Poor**	**Poor**	**Poor**	**Excellent**	**Decent**	**Decent**	**Decent**
Fire Resistance	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Excellent**	**Excellent**	**Excellent**	**Poor**	**Poor**	**Excellent**	**Excellent**	**Excellent**	**Decent**	**Excellent**
Flexibility	Decent	Poor	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Poor	Excellent	Excellent	Poor	Excellent	Decent	Excellent	Poor
Forever Chemicals (initial)	Excellent	Excellent	Poor	Excellent	Decent	Decent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Forever Chemicals (over time)	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Decent	Excellent	Decent	Excellent	Excellent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent
Insulation	Excellent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent	Poor	Poor	Excellent	Decent	Decent	Poor	Excellent	Excellent	Decent	Excellent
High density applications	Excellent	Decent	Poor	Decent	Excellent	Excellent	Decent	Excellent	Excellent	Excellent	Decent	Decent	Decent	Decent	Excellent	Excellent	Excellent	Excellent
Acceptable	**YES**	**NO**	**NO**	**NO**	**NO**	**YES**	**YES**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**YES**	**NO**	**NO**	**NO**

Bold - Critical Property

Converted from Microsoft Excel to Adobe PDF 3/5/2024

JP4EE Attachment 1 - List of GPC Brick Codes covering EEE

Note: this list is prepared based on our best knowledge and non-exhaustive.

BrickCode covering EEE	BrickTitle covering EEE
10001686	Airbrushes (Powered)
10001742	Burning/Engraving Craft Tools (Powered)
10001694	Kilns (Powered)
10001732	Melter (Powered)
10001695	Pottery Wheels (Powered)
10001749	Printing Press (Powered)
10001693	Sculptors Tools (Powered)
10001707	Sewing/Knitting Tools (Powered)
10001754	Spinning/Weaving Tools (Powered)
10005726	Analogue/Digital Converters
10001467	Audio Headsets
10001483	Audio Visual Accessories - Replacement Parts
10001484	Audio Visual Accessories Other
10001482	Audio Visual Accessories Variety Packs
10005744	Audio Visual Labelling Systems
10001475	Converter Cassettes
10005204	Megaphones
10001476	Microphones
10005747	MP3 Docking Stations
10001468	Signal Boosters
10005809	Sound-active Effect Lighting
10001472	Switch-boxes
10001479	Television Internet Packs
10001470	Universal Remote Controls
10005735	Visual Distribution Amplifiers
10001469	Wireless Television Links
10001485	Audio Visual Equipment Variety Packs
10001429	Home Audio Amplifiers/Preamplifiers
10001432	Home Audio Cassette Decks
10001433	Home Audio CD Decks
10001443	Home Audio Effects Equipment
10001447	Home Audio Equipment - Replacement Parts/Accessories
10001448	Home Audio Equipment Other
10001446	Home Audio Equipment Variety Packs
10001440	Home Audio Jukeboxes
10001441	Home Audio Karaoke Systems
10001434	Home Audio MD Decks
10001437	Home Audio Receivers/Tuners/Radios
10001436	Home Audio Speaker Systems

10001435	Home Audio Speakers - Individual
10001442	Home Audio/Visual Mixers
10001430	Home Stereo Systems
10001431	Home Theatre Systems
10001444	Turntables - CD
10001439	Turntables - Vinyl
10001424	Clock Radios
10001425	Dictation Machines
10001419	Portable Audio Cassette Players
10001427	Portable Audio/Video - Replacement Parts/Accessories
10001428	Portable Audio/Video Other
10001426	Portable Audio/Video Variety Packs
10001416	Portable CD Players
10001421	Portable Digital Video Players
10001420	Portable DVD Players
10005765	Portable FM (Frequency Modulation) Transmitters
10001417	Portable MD Players
10001418	Portable MP3 Players
10005807	Portable PA (Public Address) Music Systems
10001423	Portable Radio-recorders
10001422	Portable Radios
10005710	Portable Speakers
10001401	Television Combinations
10001400	Televisions
10001402	Televisions - Hand-held
10001404	Televisions - Replacement Parts/Accessories
10001405	Televisions Other
10001403	Televisions Variety Packs
10001411	Aerials
10005841	Audio/Visual Receivers
10005736	Low-noise Block (LNB) Converters
10005760	Satellite Reception Accessories
10005829	Satellite/Terrestrial Antenna Systems
10001409	Set-top Boxes
10005739	Video Receiving/Installation Variety Packs
10005808	Audiograms
10001406	Camcorders
10001408	Combination Players/Recorders
10001407	DVD Players/Recorders
10005748	Memory Card Recorders
10001412	Video Cassette Players/Recorders
10001410	Video Hard Disc Recorders
10001414	Video Recording/Playback - Replacement Parts/Accessories

10001413	Video Recording/Playback Variety Packs
10006240	Audio (Non-Music) - Digital
10001464	Audio Cassettes - Pre-recorded
10001459	CD/MD - Pre-recorded
10003718	Dual Discs - Pre-recorded
10001460	DVD - Pre-recorded
10001466	Pre-recorded Media Other
10001465	Pre-recorded Media Variety Packs
10001463	Video Cassettes - Pre-recorded
10001449	Audio Cassettes - Recordable
10001450	CD/MD - Recordable
10001451	DVD - Recordable
10001456	Floppy Discs
10001452	Memory Cards
10001458	Recordable Media Other
10001457	Recordable Media Variety Packs
10006398	USB Flash Drives/Thumb Drives
10001455	Video Cassettes - Recordable
10003777	Audio Visual/Photography Variety Packs
10001533	Car Audio - Replacement Parts/Accessories
10001531	Car Audio Aerials
10001530	Car Audio Amplifiers
10005205	Car Audio Cassette Players/Changers
10001527	Car Audio CD Players/Changers
10001525	Car Audio Head Units
10001528	Car Audio MD Players/Changers
10001534	Car Audio Other
10001529	Car Audio Speakers
10005828	Car Audio Subwoofers
10001526	Car Audio Tuners/Receivers
10001532	Car Audio Variety Packs
10001519	Car DVD Players
10005749	Car GPS Antennae
10001517	Car Navigation Equipment
10005728	Car Radar Detectors
10001520	Car Video Cassette Players
10001518	Car Video Monitors
10001521	Car Video Receiving Equipment
10001523	Car Video/Navigation - Replacement Parts/Accessories
10001524	Car Video/Navigation Other
10001522	Car Video/Navigation Variety Packs
10003685	In-car Electronics Variety Packs
10001499	Binoculars

10001502	Microscopes
10001501	Monoculars/Telescopes
10001505	Optics - Replacement Parts/Accessories
10001506	Optics Other
10001504	Optics Variety Packs
10001486	Analogue Cameras
10005750	Camera Flash Accessories
10001489	Camera Flashes
10001487	Digital Cameras
10005700	Digital Photo Frames
10001491	Interchangeable Lenses
10005842	Mobile Photo Storage
10005755	Photographic Camera Filters
10001492	Photographic Slide Projectors
10005753	Photographic Studio Flash Gun
10001494	Photography - Replacement Parts/Accessories
10001498	Photography Other
10001496	Photography Variety Packs
10001508	Photograph Enlargers
10001512	Photography Dark Room Safelights
10001511	Photography Drying Equipment
10001515	Photography Printing/Dark Room Equipment - Replacement Parts/Accessories
10001516	Photography Printing/Dark Room Equipment Other
10001514	Photography Printing/Dark Room Equipment Variety Packs
10003686	Photography/Optics Variety Packs
10000807	Bath Massage/Toning
10000758	Body Massage/Toning - Replacement Parts
10000760	Body Massage/Toning Other
10000668	Body Massage/Toning Variety Packs
10000567	Body Toning/Firming Products (Powered)
10000759	Personal Warming/Massaging (Powered)
10000770	Oil Diffusers (Powered)
10000767	Nails - Accessories (Powered)
10000780	Nails - Aids (Powered)
10000828	Hair - Aids (Powered)
10000348	Hair - Perming
10000678	Hair - Styling (Powered)
10000830	Depilation/Epilation (Powered)
10000831	Shaving - Razors (Powered)
10008378	Gum Stimulator/Massager
10005839	Oral Care Centre - Brush/Cleanser/Storage (Powered)
10008374	Oral Cleaner System (Powered)

10008380	Tooth Stain Removers/Whitener (Powered)
10008373	Toothbrush (Powered)
10006246	Penetration Accessories (Powered)
10006248	Suction Devices (Powered)
10000806	Anti-spot Aids (Powered)
10000808	Cleansers/Cosmetics Removers (Powered)
10000809	Sunless Tanning (Powered)
10005560	Bells/Chimes/Buzzers
10006404	Gate/Garage Door Opener Replacement Parts and Accessories
10005673	Gate/Garage Door Opening Systems
10002551	Awnings - Powered
10007039	Window Shutter Motorisation
10002087	Camping Stoves/Grills/Ovens
10002077	Camping Heating/Lighting Equipment Other
10002078	Camping Heating/Lighting Equipment Variety Packs
10004099	Camping Water Heaters
10002075	Tent Heaters
10002097	Camping Showers
10004100	Camping Toilets (Powered)
10000696	Air Fresheners/Deodorisers (Powered)
10008278	Clothes Folder (Powered)
10002023	Clothes Irons (Powered)
10002025	Clothes Presses
10002024	Ironing Boards (Powered)
10002031	Steam Cleaners
10008006	Industrial Floor Cleaner - Powered
10005105	Environmental Respiratory Protection - Powered
10005107	Hearing Protection - Powered
10005109	Helmets - Powered
10001174	Caller ID Displays
10001379	Communication Accessories Other
10001380	Communication Accessories Variety Packs
10005745	Communication Headphones Replacement Parts/Accessories
10001181	Communications Hands Free Kits/Headphones
10005740	Digital Enhanced Cordless Telecommunications (DECT) Repeaters
10001382	Communication Variety Packs
10001184	Answering Machines
10001185	Conferencing Systems
10005677	Fax Machine Consumables
10001186	Fax Machines
10005681	Fixed Communication Devices Accessories
10001383	Fixed Communication Devices Other

10001384	Fixed Communication Devices Variety Packs
10001189	Intercoms
10001190	Telephone Switchboards
10001191	Telephones
10001192	Communication Radio Sets
10001193	GPS Equipment - Mobile Communications
10001194	GPS Software - Mobile Communications
10006237	GPS Software - Mobile Communications - Digital
10003779	Mobile Communication Devices/Services - Replacement Parts
10001385	Mobile Communication Devices/Services Other
10001386	Mobile Communication Devices/Services Variety Packs
10001196	Mobile Phone SIM Cards/SIM Card Adapters
10001197	Mobile Phone Software
10006238	Mobile Phone Software - Digital
10007020	Mobile Phone/Smartphone Accessories
10001198	Mobile Phones/Smartphones
10001199	Pagers
10005711	Personal Digital Broadcasters/Trackers
10001200	Two-way Radios
10006227	Sign - Replacement Part/Accessory
10006225	Signs, Combination
10006223	Signs, Preprinted
10006224	Signs, Unprinted
10001117	Computer Casing/Housing
10001118	Computer Components - Replacement Parts/Accessories
10001119	Computer Components Other
10001120	Computer Components Variety Packs
10001121	Computer Cooling
10001122	Computer Memory
10001123	Computer Motherboards
10001125	Computer Processors
10005683	Computer/Video Games Mass Storage
10001126	Expansion Boards/Cards
10001129	Computer Drives - Replacement Parts/Accessories
10001130	Computer Drives Other
10001131	Computer Drives Variety Packs
10001132	Floppy Disc Drives
10001133	Hard Disc Drives
10001128	Optical Drives - Reading Only
10001127	Optical Drives - Reading/Writing
10001134	Swap Drives
10001135	Tape Drives/Streamers

10001136	Zip/Jaz Disk Drives
10001172	Computer Networking Equipment - Replacement Parts/Accessories
10001170	Computer Networking Equipment Other
10001171	Computer Networking Equipment Variety Packs
10001162	Firewalls
10001163	Gateways
10001164	Modems
10001165	Network Access Points
10001167	Network Interface Cards
10001168	Network Routers
10001169	Network Switches
10001166	Network/USB Hubs
10001173	Repeaters
10005831	USB Internet Stick
10001115	Card Readers
10001116	Computer Casing/Housing Accessories
10001109	Computer Docking Ports/Cradles
10001124	Computer Power Supplies
10005438	Computer Stands/Supports
10001112	Computer Tools/Tool Kits
10001362	Computer/Video Game Accessories Other
10001363	Computer/Video Game Accessories Variety Packs
10001107	Computer/Video Game Cases/Carriers
10001108	Computer/Video Game Cleaning Products
10005741	Computer/Video Game Headsets
10001111	Computer/Video Game Security Products
10001110	Filters/Covers (Electronic Equipment)
10001113	Mats/Rests - Computing
10001114	Personal Data Assistant/Organiser Stylus
10006744	Personal Video Recorder
10005843	Video Editor
10001149	Computer Graphics Tablets
10001150	Computer Keyboards
10001151	Computer Pointing Devices
10001148	Computer/Video Game Control Devices
10001152	Computer/Video Game Control/Input Devices - Replacement Parts/Accessories
10001364	Computer/Video Game Control/Input Devices Other
10001365	Computer/Video Game Control/Input Devices Variety Packs
10005686	Digital Pens
10001154	Computer Speakers/Mini Speakers
10001153	Computer/Video Game Monitors

10001155	Computer/Video Game Peripherals - Replacement Parts/Accessories
10001366	Computer/Video Game Peripherals Other
10001367	Computer/Video Game Peripherals Variety Packs
10006745	Keyboard, Voice, Mouse (KVM) Switch
10001156	Printer Consumables
10001158	Printers
10001159	Projection Systems
10001160	Scanners
10001161	Web-cameras
10001138	Computer Software (Non Games)
10006236	Computer Software (Non Games) - Digital
10001137	Computer/Video Game Gaming Software
10006235	Computer/Video Game Gaming Software - Digital
10001139	Computer/Video Game Software Other
10001140	Computer/Video Game Software Variety Packs
10001141	Computers - Replacement Parts/Accessories
10001142	Computers Other
10001143	Electronic Organisers
10006405	Personal Computers - All-in-One
10001144	Personal Computers - Desktop/Internet Terminal
10001145	Personal Computers - Portable
10006276	Personal Computers - Tablets/E-Book Readers
10001146	Personal Digital Assistants
10001147	Servers
10006743	Smart Watches
10001370	Computers/Video Games Variety Packs
10005763	Console Accessories
10003817	Video Game Consoles - Non Portable
10003818	Video Game Consoles - Portable
10003819	Video Game Consoles - Replacement Parts
10005651	Cable Clips/Grommets/Ties
10005660	Cable Conduit Fittings
10005648	Cable Markers
10005674	Cable Marking Accessories
10005649	Cable Reels/Pullers
10005647	Cable/Wire Conduit/Ducting/Raceways
10005650	Cabling/Wiring Protection/Wrapping
10005757	Audio Visual Cables
10005754	Computer Cables
10005759	Satellite Installation Cables
10005758	Telecommunication Cables
10005541	Electrical Wires
10000546	Batteries

10000704	Batteries/Chargers Variety Packs
10005764	Battery Boxes
10000548	Chargers
10005573	Connectors (Electrical)
10005572	Electrical Connection Variety Packs
10000551	Plugs
10005567	Sockets/Receptacles/Outlets
10005496	Adaptors (Electrical)
10005575	Busbars/Busways
10005622	Capacitors
10005576	Circuit Breakers
10000547	Converters/Transformers
10005583	Distribution Boards/Boxes
10005577	Electrical Distribution Accessories/Fittings
10000549	Fuses
10005682	Multi-use/Universal Electrical Timers/Controllers
10005570	Relays/Contactors
10005568	Splitters
10005585	Surge Suppressors/Protectors
10005586	Switches
10005588	Terminal Blocks/Strips
10008391	Charge/Voltage Regulators
10008395	Electrical Generation Accessories/Fittings
10005211	Generators
10008390	Inverters
10008394	Power Generator Set
10008389	Solar Panels
10005875	Solar Power Stations
10008393	Water Turbines
10008392	Wind Turbines
10008402	Built-in Lighting
10005640	Fibre Optic Lighting
10005641	Freestanding Lighting
10008404	Hanging Lighting
10008292	Led Strips and Replacement Parts/Accessories
10000552	Light Bulbs/Tubes/Light-Emitting Diodes
10008403	Mounted Lighting
10008405	Plug-in Lighting
10005644	Rope/String Lights
10008406	Undercabinet and Mirror Lighting
10005643	Wide-angle and High-beem (work) Lighting
10005637	Lamp Brackets/Fittings Others
10005635	Lampshades
10005636	Lampstands/Bases

10005638	Light Bulb Changers
10007931	Tripod (Lighting)
10005481	Ballasts/Starters
10005634	Dimmers
10005633	Light Sockets
10006896	Electrical Lighting - Other
10005642	Electric Torches/Flashlights
10005661	Circuit Assemblies/Integrated Circuits
10005662	Discreet Components
10005667	Electronic Circuit Accessories
10005546	Bonding/Grounding Braid
10005571	Cable/Wire Pullers
10005742	Electronic Testers
10005559	Extension/Power Supply Cords
10008363	Monitors/Screens
10005599	Voltmeters/Multimeters
10005505	Wall Plates (Electrical)
10000869	Oral Rehydration/Electrolyte Maintenance
10000682	Anti-smoking Aids
10002423	Oral/Mouth Treatments
10000853	Pain Relief (Powered)
10000916	Humidifiers/Vaporisers (Powered)
10000878	Inhalers/Nebulisers/Respirators (Powered)
10000920	Respiratory/Allergy Products Other
10000884	Respiratory/Allergy Products Variety Packs
10000880	Throat Remedies
10000487	Hearing Aids
10000893	Parasite Infestation Equipment (Powered)
10000886	Parasite Infestation Treatments
10000843	Diagnostic Monitors Other
10000455	Home Diagnostic Monitors
10000844	Diagnostic Tests Other
10000648	Diagnostic Tests Variety Packs
10000454	Home Diagnostic Products - Accessories
10000453	Home Diagnostic Tests
10000452	Thermometers
10000647	Home Diagnostics Variety Packs
10005844	Medical Devices
10008118	Support Component of a Medical Device
10008111	Support Component of a Veterinary Medical Device
10006412	Veterinary Medical Devices
10001964	Dishwashers
10001965	Kitchen Washing Appliances Other
10001966	Kitchen Washing Appliances Replacement Parts/Accessories

10005322	Cooker Hoods
10001951	Hobs/Cooktops
10001953	Major Cooking Appliances Other
10001954	Major Cooking Appliances Replacement Parts/Accessories
10001952	Microwave Ovens
10001950	Ovens
10003690	Range Cookers/Stoves (Oven/Hob/Cook Top Combined)
10003691	Steam Ovens
10001959	Clothes Washers
10001961	Combination Clothes Washer/Dryers
10001962	Major Laundry Appliances Other
10001963	Major Laundry Appliances Replacement Parts/Accessories
10003692	Spin/Tumble Dryers
10003712	Water Dispensers - Freestanding
10003710	Beverage Chillers Other
10001940	Coolers/Heaters
10003698	Freezers
10001938	Ice Makers
10001941	Refrigerating/Freezing Appliances Other
10001942	Refrigerating/Freezing Appliances Replacement Parts/Accessories
10003695	Refrigerator/Freezers
10003694	Refrigerators
10001939	Wine Chillers
10001956	Hostess Trolleys (Powered)
10001957	Warming Appliances Other
10001958	Warming Appliances Replacement Parts/Accessories
10001955	Warming Drawers
10001929	Food Waste Disposers
10001928	Trash Compactors
10001930	Waste Disposing/Compacting Appliances Other
10001931	Waste Disposing/Compacting Appliances Replacement Parts/Accessories
10007950	Ash Vacuum Cleaners
10002032	Cleaning Appliances Other
10002033	Cleaning Appliances Replacement Parts/Accessories
10006220	Disinfecting Cabinet
10007952	Ducted Vacuum Cleaner Accessories/Replacement Parts
10007951	Ducted Vacuum Cleaners
10002030	Floor Polishers/Shampoo Cleaner

10008138	Handheld Vacuum Cleaner
10002028	Household Vacuum Cleaners
10007949	Robot Vacuum Cleaners
10003711	Shoe Cleaners/Polishers
10002029	Sweepers (Powered)
10005762	Vacuum Cleaner Bags
10007953	Vacuum Cleaner Filters
10007955	Vacuum Cleaner Heads
10007954	Vacuum Cleaner Hoses/Tubes
10008280	Window Cleaners (Powered)
10000820	Baby Feeding Aids (Powered)
10002015	Butter Makers (Powered)
10002000	Can Openers (Powered)
10002019	Candyfloss Machines
10002016	Carbonated Drinks Makers
10005690	Chocolate Fountains (Powered)
10006852	Coffee Bean Roasters
10002006	Coffee Grinders (Powered)
10005358	Cookie Guns (Powered)
10002018	Dehydrators (Powered)
10002022	Food/Beverage Appliances Variety Packs
10002020	Food/Beverage Preparation Appliances Other
10002021	Food/Beverage Preparation Appliances Replacement Parts/Accessories
10005689	Frozen Drinks Makers/Ice Shavers (Powered)
10002005	Graters (Powered)
10002011	Hot Beverage Makers
10002013	Ice Cream Makers (Powered)
10005357	Ice Crushers/Ice Cube Makers (Powered)
10002007	Juicers (Powered)
10002012	Kettles (Powered)
10006739	Kitchen Blending Appliances
10006737	Kitchen Chopping Appliances
10006735	Kitchen Combination Mixing/Blending/Chopping Appliances
10006738	Kitchen Mixing Appliances
10005695	Kitchen Scales (Powered)
10006736	Kitchen Slicing Appliances
10002002	Knife Sharpeners (Powered)
10001998	Knives (Powered)
10002004	Meat Grinders/Mincers (Powered)
10005868	Party Drink Fountains (Powered)
10006218	Soy/Rice Milk Maker
10002003	Vacuum Sealers (Powered)
10005691	Wine/Bottle Openers (Powered)

10002014	Yogurt Makers
10002026	Laundry Care Appliances Other
10002027	Laundry Care Appliances Replacement Parts/Accessories
10005317	Air Conditioners - Portable
10005335	Air Controlling Appliances - Multifunction - Portable
10005334	Air Coolers - Portable
10006798	Air Dehumidifier - Portable (Non-Powered)
10005332	Air Dehumidifiers - Portable (Powered)
10003992	Air Heaters - Portable
10005331	Air Humidifiers - Portable
10005333	Air Ionisers - Portable
10005336	Air Purifiers - Portable
10005337	Fans - Portable
10005697	Portable Air Control Appliances Replacement Parts/Accessories
10001983	Breadmakers
10006740	Cake / Pie Maker
10001991	Cooking Appliances Variety Packs (Powered)
10005365	Cooking Timers (Powered)
10001981	Deep Fryers
10001980	Egg Cookers
10001969	Electric Grills
10001986	Fondues (Powered)
10005704	Hot Dog Rollers
10001990	Hot Stones (Powered)
10001988	Mexican Diners (Powered)
10001978	Multi-cookers (Powered)
10001989	Paella Makers (Powered)
10001971	Pancake/Doughnut Makers
10001979	Pasta Cookers (Powered)
10001985	Pizza Makers
10001984	Popcorn Makers
10001976	Pressure Cookers (Powered)
10001972	Raclettes (Powered)
10001977	Rice Cookers/Steamers
10001974	Rotisseries/Roasters (Powered)
10001970	Sandwich/Waffle Makers
10001975	Slow Cookers/Hot Pots/Cocottes (Powered)
10002034	Small Cooking Appliances Other
10002035	Small Cooking Appliances Replacement Parts/Accessories (Powered)
10001987	Tajines (Powered)
10001968	Toaster Ovens

10001967	Toasters
10005359	Warming Trays (Powered)
10001982	Woks (Powered)
10006894	Small Domestic Appliances - Other
10003713	Water Dispensers - Tabletop
10007021	Smart Home/Home Automation Equipment - Control Panel
10007024	Smart Home/Home Automation Equipment - Lawn/Garden/Leisure Appliances
10007957	Smart Home/Home Automation Equipment - Power Monitoring Device
10007022	Smart Home/Home Automation Equipment - Security Appliances
10008303	Smart Home/Home Automation Equipment - Smart Plug/Socket
10007023	Smart Home/Home Automation Equipment - Temperature Regulation Appliances
10000801	Baby Bouncing Cradles/Rocker Seats (Powered)
10005197	Blankets/Throws (Powered)
10002208	Household Adjustable Beds (Powered)
10005096	Household Beds - Replacement Parts/Components
10005097	Household/Office Chairs - Replacement Parts/Components
10002192	Household/Office Chairs/Stools (Powered)
10002200	Household/Office Seating Variety Packs
10002194	Household/Office Sofas (Powered)
10007006	Alarm Clocks
10002252	Clocks
10004101	Clocks - Replacement Parts
10003816	Ornamental Furnishings Variety Packs
10008283	Christmas Tree - Artificial (Powered)
10008285	Christmas Wreath and Garland - Artificial (Powered)
10008302	Ornaments (Powered)
10002238	Ornaments Variety Packs
10002237	Seasonal Decorations (Powered)
10008341	Between Bearings Pumps
10008340	Overhung Pumps
10008342	Vertically Suspended Pumps
10008344	Fire Hydrant Systems
10008343	Submersible Pumps
10008355	Industrial Pumps - Electric Engines
10008356	Industrial Pumps -Combustion Engines
10008364	Industrial Pumps – Replacement Parts/Accessories
10008354	Pneumatics Pumps
10008353	Diaphragm Pumps

10008351	Piston Pumps
10008352	Plunger Pumps
10008349	Gear Pumps
10008350	Lobe Pumps
10008346	Peristaltic/Roller Pumps
10008348	Progressive Cavity Pumps
10008345	Screw Pumps
10008347	Vane Pumps
10002152	Cookware/Bakeware Other
10007241	Hob Pots/Pans/Woks/Cocottes Variety Packs
10002151	Kitchen Cookware/Bakeware Variety Packs
10002142	Food Measuring Equipment Other
10002141	Food Measuring Equipment Variety Packs
10002140	Food Thermometers
10002169	Corers/Peelers
10002178	Food Preparation Equipment Other
10002177	Food Preparation Equipment Variety Packs
10002172	Kitchen Slicers/Graters/Cutters
10002176	Multifunction Kitchen Tools
10002175	Openers - Kitchen
10002146	Sieves/Strainers/Colanders
10002183	Kitchen Merchandise Variety Packs
10002124	Kitchen Storage Other
10002121	Kitchen Storage Racks/Stands/Holders/Dispensers
10002123	Kitchen Storage Variety Packs
10002135	Water/Beverage Equipment Other
10002134	Water/Beverage Equipment Variety Packs
10007255	Bar and Wine Variety Pack
10007254	Other Bar and Wine Accessories
10007252	Wine Accessories
10007266	Tableware Accessories Other
10007267	Tableware Accessory Variety Packs
10007265	Tableware Variety Packs
10006853	Animal Scarers/Deterrents (Lawn/Garden) - Powered
10003328	Barbecues
10003330	Cooking Islands (Lawn/Garden)
10005369	Greenhouse Heaters/Ventilators
10003335	Lawn/Garden Cooking/Heating Appliances Other
10003336	Lawn/Garden Cooking/Heating Appliances Replacement Parts/Accessories
10003334	Lawn/Garden Cooking/Heating Appliances Variety Packs
10003323	Outdoor Heaters (Powered)
10006742	Smokers - Cooking

10003332	Warmers/Drawers (Lawn/Garden)
10003869	Applicators/Feeders (Powered)
10003355	Brush Cutters/String Trimmers/Edgers (Powered)
10003359	Chain Saws (Powered)
10003351	Chippers/Shredders/Mulchers (Powered)
10003373	Cultivators/Tillers/Rotary Hoes (Powered)
10003365	Earth Augers (Powered)
10003376	Garden Carts (Powered)
10003408	Garden Power Tools Other
10003407	Garden Power Tools Variety Packs
10004102	Garden Tractors
10003338	Garden Vacuums/Blowers
10003870	Hedge Trimmers (Powered)
10003353	Lawn Mowers/Rakers (Powered)
10003841	Lawn Rollers (Powered)
10003347	Lawn Scarifiers/Aerators (Powered)
10003352	Lawn/Garden Equipment Accessories
10003872	Lawn/Garden Equipment Other
10003873	Lawn/Garden Equipment Variety Packs
10003865	Lawn/Garden Hand Tools Other
10003864	Lawn/Garden Hand Tools Replacement Parts/Accessories
10003866	Lawn/Garden Hand Tools Variety Packs
10003402	Lawn/Garden Power Tools Replacement Parts/Accessories
10003367	Log Splitters (Powered)
10003380	Loppers
10003861	Post Hole Diggers (Powered)
10007939	Pressure Washer Replacement Parts/Accessories
10003375	Pressure Washers (Powered)
10003843	Pruners (Powered)
10003381	Pruners/Secateurs
10003341	Snow Throwers (Powered)
10003368	Stump Grinders/Pullers (Powered)
10003370	Tampers (Powered)
10003401	Weed Burners (Powered)
10003283	Electric Fence/Radio Fences
10003287	Gates (Powered)
10005678	Lawn/Garden Fencing Accessories
10003289	Lawn/Garden Fencing Other
10003288	Lawn/Garden Fencing Variety Packs
10005218	Lawn/Garden Lighting Other
10005217	Lawn/Garden Lighting Replacement Parts/Accessories
10005215	Outdoor Lamps/Torches/Lanterns - Powered

10003215	Garden Water Features
10003225	Lawn/Garden Pools/Ponds/Water Features Other
10003224	Lawn/Garden Pools/Ponds/Water Features Variety Packs
10008367	Pond/Water Feature Accessories and Tools
10003220	Pond/Water Feature Aerators
10003218	Pond/Water Feature Foggers
10003216	Pool/Pond/Water Feature Filters (Powered)
10005253	Pool/Pond/Water feature Supplies/Accessories
10003219	Pool/Pond/Water Feature UV Clarifiers/Sterilizers
10003889	Lawn/Garden Testing Diagnostic Equipment Replacement Parts/Accessories
10003237	Water/Soil Testing Equipment (Powered)
10003264	Irrigation Systems
10003276	Irrigation Timers/Controllers
10003274	Lawn/Garden Watering Equipment Other
10003273	Lawn/Garden Watering Equipment Replacement Parts
10003272	Lawn/Garden Watering Equipment Variety Packs
10003271	Sprinklers/Sprayers/Misters (Powered)
10005318	Anemometers - Powered
10005316	Combination Weather Measuring/Monitoring Equipment - Powered
10003434	Evaporimeters/Atmometers - Powered
10005323	Hygrometers - Powered
10003452	Lawn/Garden Weather Monitoring/Observation Other
10003451	Lawn/Garden Weather Monitoring/Observation Replacement Parts/Accessories
10003453	Lawn/Garden Weather Monitoring/Observation Variety Packs
10003436	Light Meters - Powered
10003432	Psychrometers - Powered
10003433	Pyranometers/Solarimeters - Powered
10005320	Rain Gauges - Powered
10003435	Sunshine Recording Equipment - Powered
10005319	Thermometers - Garden - Powered
10005356	Lubricants Variety Packs
10005283	Lubricants/Protective Compounds Variety Packs
10005268	Lubricating Greases
10005267	Lubricating Oils/Fluids
10005270	Lubricating Products Variety Packs
10005269	Lubricating Waxes
10005273	Anti-corrosives
10005272	Antifreeze/Coolants
10005321	Anti-spatter Products
10005275	Protective Compounds Variety Packs

10005280	Lubricants/Protective Compounds Storage Variety Packs
10004117	Keyboard/Piano Accessories (Powered)
10004123	Metronomes/Tuners (Powered)
10004128	Musical Instrument Accessories Other
10004127	Musical Instrument Accessories Variety Packs
10000938	Brasswind Musical Instruments (Powered)
10000940	Keyboards/Pianos (Powered)
10000939	Musical Instrument Aids (Powered)
10001377	Musical Instruments Other (Powered)
10000941	Percussion Musical Instruments (Powered)
10000942	String Musical Instruments (Powered)
10000943	Woodwind Musical Instruments (Powered)
10004126	Musical Instruments/Accessories Variety Packs
10008105	Personal Fan - Hand (Hand Fan)
10008106	Personal Fan - Impeller
10001104	Watch Accessories/Replacement Parts
10001105	Watches
10001392	Watches Other
10000516	Aquarium Aids/Accessories
10007768	Aquarium/Vivarium
10000736	Pet Accessories Other
10000659	Pet Accessory Variety Packs
10000643	Pet Attire
10000660	Pet Food/Drink Dispenser
10000661	Pet Toys (Powered)
10000652	Pet Training/Control Aids/Accessories (Powered)
10008288	Pet Transportation Means
10006843	Terrarium Aids/Accessories
10000508	Pet Grooming Aids
10003982	Air Conditioners/Coolers - Fixed
10004063	Air Conditioning Equipment - Multifunction - Fixed
10003984	Air Conditioning/Cooling/Ventilation Equipment Replacement Parts/Accessories
10003985	Air Conditioning/Cooling/Ventilation Equipment Variety Packs
10003990	Air Dehumidifiers - Fixed
10003993	Air Humidifiers - Fixed
10006274	Air Monitors
10003988	Air Purifiers/Ionisers - Fixed
10003996	Duct Boosters
10003995	Fans - Ceiling
10003998	Fans - Extractor
10004064	Fans - Window/Exhaust

10005863	Backflow Test Kits
10002624	Bath Lifts
10006232	Hand Dryers
10002623	Shower Thermo Alarms
10004062	Toilet Seats/Lids
10007649	Health and Wellness Fittings - Accessories and Replacement Parts
10007646	Infrared Cabin
10007647	Sauna Cabin
10002660	Central Heating Replacement Parts/Accessories
10006399	Fireplace Tools
10007003	Heating Cable/Heat Tape/Heating Cord
10002662	Heating Equipment Variety Packs
10002653	Heating System Controls
10002658	Household Boilers/Furnaces/Tank Water Heaters
10007005	Household Boilers/Furnaces/Tank Water Heaters Replacement Parts/Accessories
10002657	Immersion Heaters
10002654	Radiators
10005717	Room Heaters
10005479	Tankless Water Heaters
10004002	Thermostats
10004003	Underfloor Heating Systems
10003994	Plumbing/Heating Ventilation/Air Conditioning Variety Packs
10006962	Bathroom Sink Accessories
10002610	Bathroom Suites
10002590	Bathtub/Shower Modules
10004029	Bathtub/Shower Modules - Jetted
10002596	Bathtubs - Jetted (Hot Tubs/Spas)
10007941	Faucet Replacement Parts/Accessories
10002602	Faucets/Taps
10007726	Shower Sets
10004044	Shower Spas
10006961	Toilet Accessories
10007017	Toilet/Bidet/Urinals Replacement Parts/Accessories
10002589	Toilet/Urinal Cisterns
10002586	Toilets
10002587	Urinals
10002611	Macerators
10004049	Septic Tanks
10004006	De-scalers (DIY)
10002649	Scale Inhibitors
10004016	Water Filtration Machines/Systems
10004012	Water Meters

10004008	Water Softeners (DIY)
10007038	Water Softeners Replacement Parts/Accessories
10004055	Pumps
10004024	Valves/Fittings - Water and Gas
10008011	Valves/Fittings Accessories/Replacement Parts - Water and Gas
10000791	Baby Safety Monitoring (Powered)
10006820	Baby Safety/Security/Surveillance - Other
10005385	Public Fire Alarms
10005389	Lifebelts/Life-Jackets/Lifesuits
10003427	Lightning Detectors - Powered
10005391	Lightning Rods/Accessories
10005872	Marine Electronic Chartplotters
10005874	Marine Navigation Radar Systems
10005873	Marine Navigation Software
10005474	Rock Salt/Ice Melting Products
10005394	Transponders
10005473	Alarm Systems Replacement Parts/Accessories
10005396	Burglar Alarms
10005397	Gas/Heat/Smoke Detectors
10007008	Glass Break Detector
10005398	Access Control Security Systems
10007007	Anti-Climb/Deterrent Security Product
10005401	Door Chains/Door Guards
10005399	Door/Gate Entry Intercoms
10005402	Door/Gate Viewers
10005403	Security Doors/Gates
10008069	Smart Doorbells
10005405	Window Burglar Bars/Panels/Shutters
10005407	Fire Blankets
10005408	Fire Extinguishers - Pressurised
10005409	Fire Hoses
10005410	Home/Business Fire Extinguishers Variety Packs
10005417	Home/Business Safety/Security/Surveillance Variety Packs
10005411	Bugging/Debugging Equipment
10005415	Home/Business Surveillance Equipment Variety Packs
10005412	Light/Motion/Sound Sensors
10005413	Security Lights
10005414	Surveillance Cameras/Recorders
10005373	Body Alarms
10005472	Emergency Survival Blankets/Sleeping Bags
10005374	Emergency Whistles
10005375	Key-ring Alarms
10005376	Personal Luggage Alarms

10005382	Personal Safety Devices Variety Packs
10005377	Personal Safety Flares/Signals
10005378	Personal Safety Lights
10006850	Remote Controlled Vehicles
10006851	Remotely Controlled Vehicle Replacement Parts and Accessories
10005380	Stun Guns
10005381	Wearable Wireless Webcams (Inverse Surveillance)
10005418	Safety/Security/Surveillance Variety Packs
10008110	Coin Operated Control Unit
10008109	Vending Machine
10004098	Fencing Sports Equipment (Powered)
10001813	Cycle Sports Equipment Other
10001812	Cycle Sports Equipment Variety Packs
10005815	Cycles (Powered)
10008275	Cycles Accessories - Computers/Navigation Equipment
10008276	Cycles Accessories - Other
10008260	Cycles Parts - Lighting
10001814	Exercise Machines (Powered)
10001822	Sports Exercise Monitors
10001843	Scooter/Skateboard Sports Equipment Other
10001842	Scooter/Skateboard Sports Equipment Variety Packs
10005814	Scooters/Skateboards/Hoverboards (Powered)
10001841	Skateboarding Sports Equipment - Replacement Parts/Accessories
10005703	Pumps (Powered)
10004111	Sports Scoring Equipment (Powered)
10001867	Target Sports Equipment - Replacement Parts/Accessories
10001869	Target Sports Equipment Other
10001868	Target Sports Equipment Variety Packs
10001865	Targets (Powered)
10001242	Calculators/Currency Converters (Powered)
10001243	Cash/Money Registers (Powered)
10001247	Laminating Machines (Powered)
10005229	Multifunctional Devices
10001248	Office Machinery Other
10001250	Office Machinery Variety Packs
10001251	Photocopier Consumables
10001252	Photocopiers
10005676	Typewriter Consumables
10001254	Typewriters (Powered)
10001262	Franking Machines
10001265	Letter Openers (Powered)

10001268	Postal Weighing Scales (Powered)
10005445	Overhead Projectors
10001277	Pointers (Powered)
10006406	Presentation Boards (Powered)
10001281	Presentation Equipment Accessories
10001280	Presentation Equipment Other
10001283	Presentation Equipment Variety Packs
10001288	Binding Machines (Powered)
10001300	Stationery Staplers (Powered)
10001312	Hole Paper Punches (Powered)
10005119	Paper Shredders (Powered)
10001231	Measuring/Geometrical Equipment
10001233	Pencil Sharpeners (Powered)
10006730	Electronic Cigarette Accessories
10006729	Electronic Cigarettes
10003461	Measuring Wheels
10003459	Micrometers
10006776	Moisture Meter (Soil)
10003458	Tape Measures (DIY)
10006777	Thermal Leak Detector
10008057	Military - Engineering Specialty Equipment - Powered
10003679	Hoists/Winches
10003749	Power Tools - Lifting/Handling Equipment Other
10003680	Power Tools - Lifting/Handling Equipment Replacement Parts/Accessories
10006779	Pulley Puller (Powered)
10005221	Wheelbarrows - Powered
10005230	Air Compressors - Stationary
10003597	Band Saws - Stationary
10003668	Belt Sanders - Stationary
10003598	Bench Grinders
10003604	Bench Jointers
10003611	Combination Sanders - Disc/Belt
10003609	Disc Sanders
10003613	Drill Presses/Mortisers
10003730	Jointer Planers - Stationary
10003605	Lathes - Stationary (Powered)
10003608	Power Tools - Stationary - Replacement Parts/Accessories
10003751	Power Tools - Stationary Other
10003603	Radial Arm Saws
10003602	Scroll Saws - Stationary
10003746	Shapers - Stationary
10003610	Spindle Sanders

10003729	Surface Planers - Stationary
10003601	Table Saws - Stationary
10008139	Tool Sharpeners (Powered)
10003596	Wet Saws/Tile/Glass Cutters
10007026	Abrasive Blasters/Sandblasters
10003555	Air Compressors - Portable
10003644	Angle Grinders
10003619	Angle Measurers (Powered)
10003651	Arc Welders
10005231	Band Saws - Portable
10003742	Belt Sanders - Portable
10005718	Biscuit Joiners
10003664	Caulking Guns (Powered)
10005214	Cement/Mortar Mixing Machines
10003643	Chisels (Powered)
10005223	Circular Saws
10003645	Cut-off Tools
10007028	Demolition Hammer
10003672	Detail Sanders
10005248	Disc Sanders/Drywall Sanders - Portable
10003618	Distance/Linear Measurers (Powered)
10003741	Drain Augers (Powered)
10003653	Drill/Drivers (Powered)
10003658	Drills - Combination (Powered)
10007029	Endoscope Camera (DIY)
10003669	Finishing Sanders
10003638	Foam Cutters - Powered
10005213	Glue Guns - Powered
10003663	Grease Guns (Powered)
10007027	Hammer Drill and Impact Driver Kit
10003659	Hammer Drills
10003662	Heat Guns
10007030	Hole Saw
10003655	Impact Drivers
10003656	Impact Wrenches
10007976	Industrial Wet/Dry Construction Vacuum Cleaner Filters
10007978	Industrial Wet/Dry Construction Vacuum Cleaner Heads
10007977	Industrial Wet/Dry Construction Vacuum Cleaner Hoses/Tubes
10007975	Industrial Wet/Dry Construction Vacuum Cleaners
10003631	Jigsaws - Powered
10003616	Jointer Planers - Portable
10003626	Laminate Trimmers

10003620	Laser Levels
10006277	Metal Detectors
10003738	Mitre Saws - Portable
10007031	Mixer/Vibrator
10003666	Nail Guns (Powered)
10003632	Nibblers/Shears - Metal (Powered)
10007032	Oscillating Multitools
10005653	Paint Applicators - Powered
10003640	Pipe Cutters (Powered)
10003750	Power Tools - Hand-held Portable Other
10003747	Power Tools - Hand-held Portable Replacement Parts/Accessories
10003629	Reciprocating Saws
10003660	Rotary Hammers
10007033	Rotary Multitools
10003641	Rotary Saws
10003737	Routers
10007034	Sanding Rollers (Powered)
10003657	Screw Guns
10003654	Screwdrivers (Powered)
10003649	Soldering/Brazing Irons
10003665	Staplers (Powered)
10003647	Straight/Die Grinders
10005869	Stud Finders/Detectors/Sensors
10003648	Surface Grinders
10003615	Surface/Thickness Planers - Portable
10003627	Table Saws - Portable
10007035	Wall Slotter (Powered)
10003884	Wall/Ceiling Covering Tools - Powered
10003744	Welding/Blow Torches
10007936	Welding/Blow Torches Replacement Parts/Accessories
10007937	Welding/Blow Torches Rods/Wire/Solder
10003682	Tools/Equipment - Power Variety Packs
10005134	Board Games (Powered)
10005136	Board Games/Cards/Puzzles Other
10005137	Board Games/Cards/Puzzles Variety Packs
10005139	Card Games (Powered)
10005141	Puzzles (Powered)
10005154	Baby/Infant Stimulation Toys (Powered)
10005155	Bath/Pool Water Toys
10005157	Communication Toys (Powered)
10005159	Developmental/Educational Toys Other
10005160	Developmental/Educational Toys Variety Packs
10005162	Push/Pull-along Toys (Powered)

10005164	Scientific Toys (Powered)
10005165	Spinning Tops/Yo-Yos
10005167	Toy Building Blocks (Powered)
10005712	Toy Computer Accessories
10005158	Toy Computers
10005442	Toy Drawing Boards/Accessories
10005169	Toy Model Construction (Powered)
10005171	Viewing Toys (Powered)
10006396	Action Figures (Powered)
10005144	Dolls/Puppets/Soft Toys Other
10005143	Dolls/Soft Toys (Powered)
10005145	Puppets
10006397	Action Figure Accessories
10005147	Dolls Buildings/Settings
10005149	Dolls Furniture
10005150	Dolls/Puppets/Soft Toys Accessories Other
10005151	Dolls/Puppets/Soft Toys Accessories Variety Packs
10005152	Puppet Theatres
10005440	Styling Dolls Heads (Powered)
10005176	Fancy Dress Accessories (Powered)
10005172	Fancy Dress Costumes
10005173	Fancy Dress Costumes/Accessories Other
10005174	Fancy Dress Costumes/Accessories Variety Packs
10005181	Indoor/Outdoor Games
10005182	Outdoor Play Structures
10005178	Musical Toys (Powered)
10005179	Musical Toys Other
10005684	Role Play - Housekeeping/Gardening/DIY Toys
10005250	Role Play - Kitchen Toys
10005685	Role Play - Shopping/Office/Business Toys
10005184	Table Games (Powered)
10005185	Table Games Other
10005192	Car/Train Set - Replacement Parts/Accessories
10005191	Car/Train Sets (Powered)
10005194	Toy Vehicles - Non-ride (Powered)
10005195	Toy Vehicles - Non-ride Other
10005196	Toy Vehicles - Non-ride Variety Packs
10005188	Toys - Ride-on (Powered)
10005441	Toys - Ride-on Accessories
10005189	Toys - Ride-on Other
10005443	Practical Jokes
10006899	Toys/Games - Other
10005186	Toys/Games Variety Packs

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JP4EE Attachment 3-List of EEE Functions needing PFAS

◆ List of the functions and properties necessary to electrical and electronic equipment (EEE), which need PFAS materials to attain required performances.

	Functions and properties required for EEE	Characteristic of parts and materials to achieve their functions and properties of EEE	Performance requirements for materials (PFAS)	(e.g.) Specific parts or components that accomplish the functions or characteristic of EEE	(e.g.) Typical EEE	Necessary applications of PFAS to attain the functions and properties (Linked with Column D of Attachment 5)
1	Optical function	No interference of light transmission (Transparency)	Low refractive index, High transmissivity + Water and oil repellency, Flexibility, Flame retardancy	Optical fiber, Optical Lens, LED, Monitor/Panel, Fiberglass, Optical adhesive, Protective coating material, Anti-reflective material, etc.	Camera, Lighting, Monitor/Panel, Optical cable, Smartphone, etc. Other products in EU RoHS categories 1- 11 would need this function if they use optical function in control panels for example.	2) Optical elements. 5) Optical elements for LCD panels. 25) Transparent electronic circuit board and circuit. 27) Optical elements. 29) Functional coatings.
2	High speed communication and transmission function	Low transmission loss at high frequencies and wide frequency range	Low dielectric constant and Low transmission loss + Water and oil repellency, Flame retardancy	Printed circuit boards (Smartphone, PC, Base stations, etc.), Antenna, Cable for High-frequency, Protective coating material, etc.	Smartphone, PC, Antenna, Base stations, etc. Other products in EU RoHS categories 1- 11 would need this function if they use communication function to operate or update it for example.	6) Electronic circuit boards for high-frequency applications. 29) Functional coatings.
3	Piezoelectric function (Conversion/Inversion between the mechanical power and electrical voltage) Refer to separate sheet "3. Piezoelectric function" for functional explanation.	Piezoelectricity (pressure-sensitive detection) and good workability and durability	High Piezoelectricity (High piezoelectric coefficient) + Heat resistance, Flexibility	Speaker, Touch panel, Sensor, Actuator, etc.	Touch panel, Speaker, Various sensor, etc. Other products in EU RoHS categories 1- 11 would need this function if they use touch panels or sounds for example.	3) Piezoelectric elements
4	Sliding function in mechanical section Refer to separate sheet "4. Sliding function" for functional explanation.	Lubricity and abrasion resistance, Elasticity, Low water absorption, Low moisture permeability	Lubricity, Abrasion resistance, Machineability + Flame retardancy, Durability, Low water absorption, Low moisture permeability	Sliding parts in mechanical section (Bearing, Gear, Roll), Seal material (Packing, O-ring, etc.), Grease, Lubricant, Protective coating material, Epilame, Sealing material, etc.	Motor, Printer, Industrial equipment, Camera, Display, etc. All the EEE in EU RoHS categories 1- 11 would need this function.	1) Sliding elements in mechanical section. 8) High performance materials for mold release and protection purposes used in the article molding process. 11) Hermetic sealant requiring low percentage of the compression set as well as simultaneously other functions such as excellent elongation followability, durability, flame resistance, heat and hot water resistance, low water absorption, low moisture permeability, chemical resistance and/or low outgassing. 29) Functional coatings. 30) Lubricants where the use takes place under harsh conditions or the use is needed for safe and intended functioning and/or safety of equipment.
5	Display function(Liquid crystal display / LCD)	Low voltage drive and fast response (Low anisotropic refractive index and low viscosity)	Low anisotropic refractive index, Low viscosity, Low voltage drive + Heat resistance, Durability	Liquid crystal panel (TV, various monitor), etc.	Liquid crystal display panel (TV, Monitor for various device), etc. Other products in RoHS categories 1- 11 would need this function if they use control panels or monitors for example.	26) Liquid crystal display (LCD) elements.
6	Safety and safety functions	Electrical insulation and flame retardancy, Chemical resistance, Heat resistance, Durability, Dripping prevention	Low dielectric constant, Flame retardancy, Machineability, Chemical resistance + Heat resistance, Durability	Cable, Pipe/Tube, Package, Seal material, Enclosure, Encapsulation, Protective coating material, Sealing material, Protection tube, etc.	Cable, Monitor, Medical equipment, Electric appliance, Industrial control equipment, Printer, etc. All the EEE in EU RoHScategories 1- 11 would need this function.	4) Insulating material requiring flame-retardancy and/or heat-resistant, where the use is needed for safe functioning and safety of equipment. 7) Anti-dripping agent used for safety and to enhance flame retardancy. 8) High performance materials for mold release and protection purposes used in the article molding process. 10) Film, sheet or membrane requiring surface performance which ensures multiple functions such as electrical insulation property, chemical resistance, heat resistance, flame resistance, flex resistance and excellent elongation followability at the same time. 12) Fluid tubes and containers requiring chemical resistance, high cleanliness. 16) High performance materials for mold release and protection purposes, which ensures multiple functions such as electrical insulation, heat resistance, chemical resistance or flame resistance, etc. at the same time. 29) Functional coatings. 30) Lubricants where the use takes place under harsh conditions or the use is needed for safe and intended functioning and/or safety of equipment.

7	**Functional surface**	**Releasability and Heat resistance, UV protection, Antifouling, Waterproof**	**Water and oil repellency, Heat resistance, Weather resistance**	Releasing and Protective coating material, Film, etc.	Cooking appliance, Touch panel, Smartphone, Printer, etc. All the EEE in RoHS categories 1- 11 would this function.	8) High performance materials for mold release and protection purposes used in the article molding process. 10) Film, sheet or membrane requiring surface performance which ensures multiple functions such as electrical insulation property, chemical resistance, heat resistance, flame resistance, flex resistance and excellent elongation followability at the same time. 16) High performance materials for mold release and protection purposes, which ensures multiple functions such as electrical insulation, heat resistance, chemical resistance or flame resistance, etc. at the same time. 29) Functional coatings.
8	**Semiconductor**	**Photoacid Generators (PAG) , Surfactants, anisotropic/isotropic etching and protective layer formation, low dielectric constants, high thermostability, chemical inertness (to acids, bases, and solvents), and low moisture absorption, low electric permittivity /dielectric loss, low water absorption, and low coefficient of thermal expansion(CTE), In heat transfer fluid uses, electrically non-conducive, and usability in very broad temperature range, and non-corrosive in closed-loop systems**	**Photoacid Generators (PAG) , Surfactants, anisotropic/isotropic etching and protective layer formation, low dielectric constants, high thermostability, chemical inertness (to acids, bases, and solvents), and low moisture absorption, low electric permittivity /dielectric loss, low water absorption, and low coefficient of thermal expansion(CTE), In heat transfer fluid uses, electrically non-conducive, and usability in very broad temperature range, and non-corrosive in closed-loop systems**	Photolithography and thin films formed thereby, dry etching, cleaning, heat transfer fluids, resins, manufacturing equipment materials	All the EEE in EU RoHS categories 1- 11 would use semiconductors.	13) PFAS used for semiconductor manufacturing process, semiconductor manufacturing equipment, and semiconductor. 17) Semiconductor manufacturing process. 21) Refrigerant, coolant, cleaning agent and solvent used for semiconductor process. 23) Chemicals for ultra-fine processing applications, as typified by semiconductor and MEMS manufacturing processes.
9	**Thin-film device manufacturing process**	**Semiconductor manufacturing process and similar microfabrication process Refer to item 8. Semiconductor**	**Refer to item 8. Semiconductor**	Thin-film device such as MEMS(Sensor, Gyroscope, Inkjet head), SAW filter, Angular velocity sensor, Moisture sensitive membrane, Capacitor, Resistor, etc.	Car navigation system, Sphygmomanometer (blood pressure meters), Inkjet printer, Smartphone, PC, etc. Other products in EU RoHS categories 1- 11 may use thin-film device.	14) PFAS used for thin-film device (Micro Electro Mechanical System/MEMS, SAW device, Capacitor, etc) manufacturing process, thin-film device manufacturing equipment, and thin-film device. 18) Thin-film device (Micro Electro Mechanical Systems/MEMS, SAW, Capacitor, etc) manufacturing process. 22) Refrigerant, coolant, cleaning agent and solvent used for thin-film device (Micro Electro Mechanical Systems/MEMS, SAW etc.) process. 23) Chemicals for ultra-fine processing applications, as typified by semiconductor and MEMS manufacturing processes.
10	**Energy supply (Batteries, Fuel cells, Solar cells)**	**[Batteries] Refer to comments from BAJ ＊BAJ ： Battery Association of Japan [Fuel cells] For core materials (Proton exchange membrane, catalyst layer (ionomer), electrode water repellent, rubber seal, etc.), resistance to strong acidity as well as high temperature steam are required to ensure a product life of 90 K hours in the harsh environment of the cell. [Solar cells] Surface materials (front sheet, back sheet) must be durable and weather resistant with UV, high temperatures, high humidity, steep temperature changes, and salt damage, and must also be fire resistant.**	**[Batteries] Refer to comments from BAJ [Fuel cells] Resistance to strong acidity as well as high temperature steam [Solar cells] weather resistant with UV, high temperatures, high humidity, steep temperature changes, salt damage, fire resistant**	[Batteries] Refer to comments from BAJ [Fuel cells] Proton exchange membrane, catalyst layer (ionomer), electrode water repellent, rubber seal [Solar cells] Frontsheet, Backsheet	All the EEE in EU RoHS categories 1- 11, automotive, aircraft, and industrial equipments would use batteries, Fuel cells, and Solar cells	4) Insulating material requiring flame-retardancy and/or heat-resistant, where the use is needed for safe functioning and safety of equipment 9) Batteries 10) Film, sheet or membrane requiring surface performance which ensures multiple functions such as electrical insulation property, chemical resistance, heat resistance, flame resistance, flex resistance and excellent elongation followability at the same time 29) Functional coatings.
11	**Refrigeration, Air-conditioning and heat pump sector RACHP (Refrigerant)**	**Refer to comments from JRAIA ＊JRAIA : Japan Refrigeration and Air Conditioning Industry Association**	**Thermodynamic properties and temperature tracking over a wide range + Low flammability and low toxicity**	Refrigerant	All the EEE in EU RoHS categories 1- 11, automotive, aircraft, and industrial equipments would use refrigerant	20) Refrigerant used in various appliances such as those for Refrigeration, Air Conditioning and Heat Pump (RACHP) products.
12	**Passive electronic components and manufacturing process**	**Safety, high reliability and high durability (Passive electronic components are essential components in the electrical circuits of electrical and electronic equipments that protect semiconductors, filter electrical signals, and attenuate, store, and release electrical energy.)**	**・Water and oil repellency, Electrical insulation, Heat resistance ・Binding properties, chemical and electrical stability + Reliability (heat resistance, moisture resistance, durability)**	Passive electronic components (Capacitors, transformers, etc.)	Essential Device for circuit configuration of electrical and electronic equipments All electrical and electronic equipment such as Automobiles, Medical equipment, Industrial/Infrastructure equipment, Information/Communication equipment, Home appliances, Solar power generation, etc. Other products in EU RoHS categories 1- 11, automotive, aircraft, and industrial equipments may use passive electronic components.	8) High performance materials for mold release and protection purposes used in the article molding process 10) Film, sheet or membrane requiring surface performance which ensures multiple functions such as electrical insulation property, chemical resistance, heat resistance, flame resistance, flex resistance and excellent elongation followability at the same time 29) Functional coatings.

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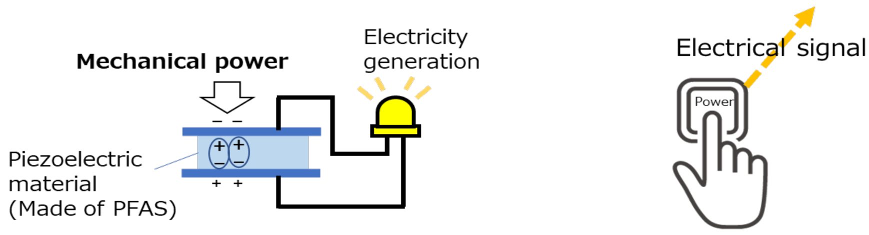
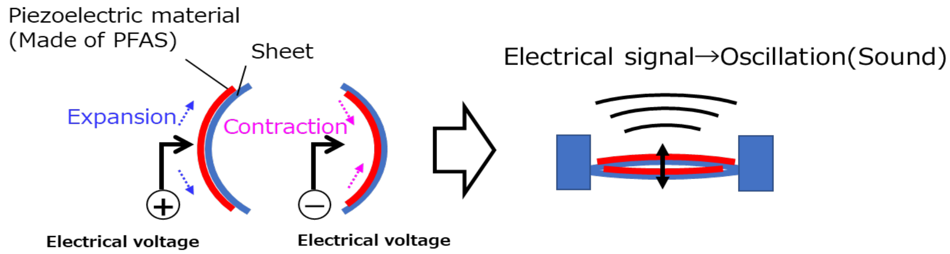
3. Piezoelectric function

1) Piezoelectric effect: Convert mechanical power into electrical voltage



2) Inverse piezoelectric effect: Convert electrical voltage into mechanical power(Expansion and Contraction)



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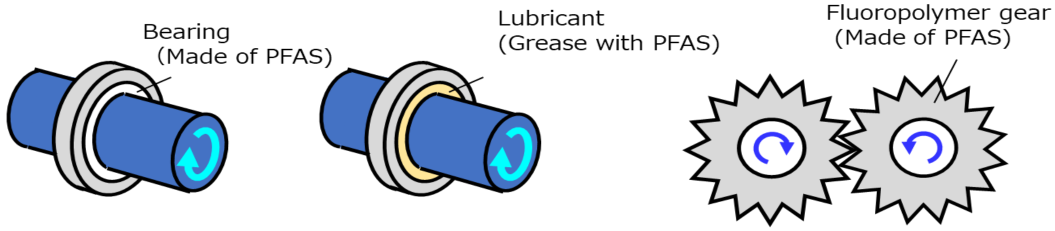
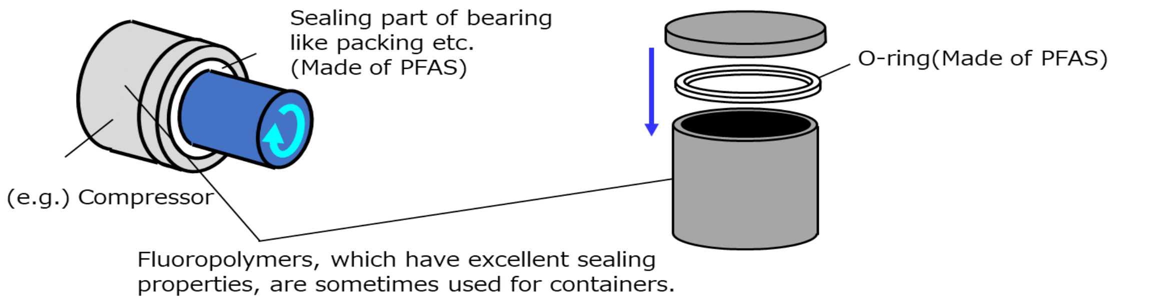
4. Sliding function

1) Lubrication improvement (Sliding part)



2) Seal improvement (Sliding part)

3) Seal improvement (Fixed part)



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JP4EE Attachment 5-List of PFAS essential uses in EEE: The list explains CUU in EEE by OECD categories of PFAS as chemical materials.
The list links the functions listed in Attachment 3 and includes the reasons why these PFAS cannot be substituted.

PFAS classification	Representative Chemical Materials	Ref. No.	Currently Unavoidable Use (CUU) in electrical and electronic equipment (EEE) [Derogations for EEE should be set at this level.]	Non-exhaustive examples of uses	Reasons why PFASs are un-replaceable	Functions of EEE requiring the use of PFAS (Link to Column C of Attachment 3)	Functions of EEE requiring the use of PFAS (Link to Column G of Attachment 3)
Fluoropolymers and Perfluoropolyethers	PTFE PFA FEP ETFE PVDF PCTFE FKM FFKM FEPM FFKO PFPE	1	Sliding elements in mechanical section	Plain bearings Conductive plain bearings Sliding parts of various electric components (motors, connectors, switches, etc.) Sliding parts of various mechanical components (bearings, gears, winder, etc.) Fixing and photoconductive components, etc., in printing equipment	Fluoropolymers with multiple functions such as excellent self-lubrication (low coefficient of friction), electrical insulation property, chemical resistance, releasability, heat resistance and flame retardancy are used in sliding elements in mechanical section of EEE and its components to function normally in various environments. The Non-PFAS alternatives listed in Attachment 6 cannot be used as they exhibit the worst performance. In addition, some components are required to maintain their indispensable sliding characteristics over a long period of time under severe conditions such as high temperature, high pressure, high voltage, and high friction. Fluoropolymers are the only materials that resist such severe conditions, and substituting other materials is impracticable.	4.Sliding function in mechanical section	Motor, Printer, Industrial equipment, Camera All the EEE in RoHS categories 1- 11 would need this function.
		2	Optical elements	Optical fiber materials, optical adhesives	Optical element used in EEE and its components requires fluorine materials with no absorption at specific wavelengths, high weather resistance, and low refractive index. Therefore, it is impossible to substitute to the Non-PFAS alternatives listed in Attachment 6.	1.Optical function	Camera, Lighting, Monitor/Panel, Optical cable, Smartphone Other products in RoHS categories 1- 11 would need this function if they use optical function in control panels for example.
		3	Piezoelectric elements	Piezoelectric elements pressure sensitive films, speakers, microphones, piezo pickups for acoustic guitar	PVDF and its copolymers with unique dielectric and piezoelectric properties, which are also excellent in durability, electrical insulation property, and heat resistance are used in piezoelectric elements used in EEE and its components. Therefore, it is impossible to substitute to the Non-PFAS alternatives listed in Attachment 6.	3.Piezoelectric function	Touch panel, Speaker, Various sensor Other products in RoHS categories 1- 11 would need this function if they use touch panels or sounds for example.
		4	Insulating material requiring flame-retardancy and/or heat-resistant, where the use is needed for safe functioning and safety of equipment	Cables, heat insulator, tubes, wire coating	Insulating material used for product safety of EEE and its components requires multiple functions of fluoropolymers such as electrical insulation property, heat resistance, flame retardancy, and durability. Therefore, product safety of EEE and its components cannot be guaranteed if the Non-PFAS alternatives listed in Attachment 6 are used singly or in combination.	6.Safety and safety functions 10.Energy supply (Battery,Fuel cells, Solar cells)	Cable, Monitor, Medical equipment, Electric appliance, Industrial control equipment All the EEE in RoHS categories 1- 11 would need this function.
		5	Optical elements for Liquid crystal display (LCD) panels	Anti-fingerprint layer on panel surface and anti-reflection (high light transmittance) layer	The fluoropolymer on the panel surface has a refractive index of 1.3, which is almost half the refractive index of 1.0 for air and 1.5 for TAC (Triacetylcellulose) film of the polarizer, and suppresses surface reflection. This translates to a 3% increase in backlight utilization efficiency (i.e. energy efficiency). In addition, since the visibility of the panel is improved by preventing fingerprint stains on the surface, the brightness of the panel can be reduced. Only fluoropolymer has the above properties. It cannot be substituted with silicone or other resins that are considered substitutes.	1.Optical function	Camera, Lighting, Monitor/Panel, Optical cable, Smartphone Other products in RoHS categories 1- 11 would need this function if they use optical function in control panels for example.
		6	Electronic circuit boards for high-frequency applications	Electronic substrate materials	Electronic circuit board used in high-frequency applications requires low dielectric constant and low transmission loss. Additionally it needs functions such as electrical insulation property, high water and oil-repellent property, thermal and flame resistance. Fluoropolymers are the only materials that have those multiple functions, therefore it is impossible to substitute to other materials.	2.High speed communication and transmission function 12.Passive electronic components and manufacturing process	Smartphone, PC, Antenna, Base stations Other products in RoHS categories 1- 11 would need this function if they use communication function to operate or update it for example.
		7	Anti-dripping agent used for safety and to enhance flame retardancy	Anti-dripping agent to enhance flame retardancy	PTFE is used as anti-dripping agent to enhance flame retardancy, as it is flame-retardant and has an extremely high melt viscosity. Product safety of EEE and its components cannot be guaranteed if the Non-PFAS alternatives listed in Attachment 6 are used singly or in combination.	6.Safety and safety functions	Cable, Monitor, Medical equipment, Electric appliance, Industrial control equipment All the EEE in RoHS categories 1- 11 would need this function.
		8	High performance materials for mold release and protection purposes used in the article molding process	Developer additives and resin additives used in electrical and electronics manufacturing processes Coating material (use as mold release agent)	Fluorine compounds such as PFAS are the only materials that can simultaneously provide and exhibit multiple functions, such as low dielectric constant, low dielectric loss tangent, low refractive index, oil repellency, electrical insulation, water repellency, heat resistance, chemical resistance, weather resistance, mold releasability, flame resistance, separability, wear resistance, surface properties (friction coefficient), bending strength, stretching properties, non-flammability, etc. which are necessary for electrical and electronic devices as well as manufacturing equipment of components for such devices to function normally under various environments, making substitution by other materials listed in Attachment 6 extremely difficult.	4.Sliding function in mechanical section 6.Safety and safety functions 7.Functional surface 12.Passive electronic components and manufacturing process	Motor, Printer, Industrial equipment, Camera Cable, Monitor, Medical equipment, Electric appliance, Industrial control equipment, Cooking appliance, Touch panel, Smartphone All the EEE in RoHS categories 1- 11 would need this function.
		9	Batteries *Please refer to the input from the battery industries, such as those from Battery Association of Japan (BAJ) for the concrete details.	Battery materials	Please refer to the relevant industry association's comments for details on the reasons why substitution is not possible. For example, please refer to the input from Battery Association of JAPAN (BAJ).	10.Energy supply (Battery,Fuel cells, Solar cells)	Battery All the EEE in RoHS categories 1- 11 would use batteries.

JP4EE Attachment 5-List of PFAS essential uses in EEE: The list explains CUU in EEE by OECD categories of PFAS as chemical materials.
The list links the functions listed in Attachment 3 and includes the reasons why these PFAS cannot be substituted.

PFAS classification	Representative Chemical Materials	Ref. No.	Currently Unavoidable Use (CUU) in electrical and electronic equipment (EEE) [Derogations for EEE should be set at this level.]	Non-exhaustive examples of uses	Reasons why PFASs are un-replaceable	Functions of EEE requiring the use of PFAS (Link to Column C of Attachment 3)	Functions of EEE requiring the use of PFAS (Link to Column G of Attachment 3)
		10	Film, sheet or membrane requiring surface performance which ensures multiple functions such as electrical insulation property, chemical resistance, heat resistance, flame resistance, flex resistance and excellent elongation followability at the same time	Film material, electrostatic adsorption belt, Waste Powder Collection Filter, Friction Reduction Tape, peeling tape, ventilation film, moisture permeable film, Dial (Polarizing plate, plastic raw material), protective film, release sheet Films for analytical testing	Multiple functions such as electrical insulation property, chemical resistance, heat resistance, flame resistance, flex resistance and excellent elongation followability are also required for films, sheets, and membranes that require performance based on low surface free energy (water repellency, oil repellency, lubrication, non-adhesiveness) used in the facilities for manufacturing EEE and its components. Fluoropolymers are the only materials that have those multiple functions at the same time, therefore it is impossible to substitute to other materials.	6.Safety and safety functions 7.Functional surface 10.Energy supply (Battery,Fuel cells, Solar cells) 12.Passive electronic components and manufacturing process	Cable, Monitor, Medical equipment, Electric appliance, Industrial control equipment Cooking appliance, Touch panel, Smartphone All the EEE in RoHS categories 1- 11 would need this function.
		11	Hermetic sealant requiring low percentage of the compression set as well as simultaneously other functions such as excellent elongation followability, durability, flame resistance, heat and hot water resistance, low water absorption, low moisture permeability, chemical resistance and/or low outgassing.	Gasket materials, sealing materials, rubber valves (umbrella valves, duckbill valves, etc.), four-way reversing valve, check valve, ball valve, O rings, buttons on the operating unit, sealing materials, encapsulating materials and tube element for various electronic component	The compression set of a material is the permanent deformation remaining after removal of a force that was applied to it. The percentage of the compression set of hermetic sealant used in the facilities for manufacturing EEE and its components to function normally in various environments must be low. And at the same time, sealant as EEE parts needs other functions such as excellent elongation followability, durability, flame resistance, heat and hot water resistance, low water absorption, low moisture permeability, chemical resistance (including resistance to chlorine contained in tap water), low outgassing (to avoid contamination of impurities and to maintain the vacuum of instrument). Fluoropolymers are the only materials that have those multiple functions at the same time. If the Non-PFAS alternatives listed in Attachment 6 are used singly or in combination, the worst performance is exhibited. Therefore, it is impossible to substitute to those alternatives.	4.Sliding function in mechanical section	Motor, Printer, Industrial equipment, Camera, Display All the EEE in RoHS categories 1- 11 would need this function.
		12	Fluid tubes and containers requiring chemical resistance, high cleanliness	Chemical supply tubes, Tube for flow path of analytical equipment Air tubes used in air piping, etc. tube for a chemical supply system chemical-resistant containers	Fluoropolymers with multiple functions such as chemical resistance, excellent fluid barrier properties, high cleanliness and low surface tension are used for fluid tubes and containers in the facilities for manufacturing EEE and its components. If the Non-PFAS alternatives listed in Attachment 6 are used singly or in combination, the worst performance is exhibited. Therefore, it is impossible to substitute to those alternatives.	6.Safety and safety functions	Cable, Monitor, Medical equipment, Electric appliance, Industrial control equipment All the EEE in RoHS categories 1- 11 would need this function.
		13	PFAS used for semiconductor manufacturing process, semiconductor manufacturing equipment, and semiconductor	Construction of polymer substrates and dielectric materials, manufacturing equipment for adhesives, underfills, filter, die bond resins, valve seals, etc., heat transfer fluids surface protection	Fluorine compounds such as PFAS are the only materials that can simultaneously provide and exhibit multiple functions, such as low dielectric constant, low dielectric loss tangent, low refractive index, oil repellency, electrical insulation, water repellency, heat resistance, chemical resistance, weather resistance, mold releasability, flame resistance, separability, wear resistance, surface properties (friction coefficient), bending strength, stretching properties, non-flammability, etc. which are necessary for semiconductor manufacturing processes, semiconductor manufacturing equipment and semiconductors to function normally under various environments, making substitution by other materials listed in Attachment 6 extremely difficult. Additionally, for more information on why PFAS cannot be substituted in semiconductors, please refer to information from the Semiconductor Industry Association. For example, the following information from SIA PFAS Consortium of the Semiconductor Industry Association of America: "The Impact of a Potential PFAS Restriction on the Semiconductor Sector2" https://www.semiconductors.org/wp-content/uploads/2023/04/Impact-of-a-Potential-PFAS-Restriction-on-the-Semiconductor-Sector-04_14_2023.pdf	8.Semiconductor	Semiconductor All the EEE in RoHS categories 1- 11 would use semiconductors.
		14	PFAS used for thin-film device (Micro Electro Mechanical System/MEMS, Surface Acoustic Wave/SAW device, Capacitor, etc) manufacturing process, thin-film device manufacturing equipment, and thin-film device	Construction of polymer substrates and dielectric materials, manufacturing equipment for adhesives, underfills, filter, die bond resins, valve seals, etc., heat transfer fluids surface protection	Fluorine compounds such as PFAS are the only materials that can simultaneously provide and exhibit multiple functions, such as low dielectric constant, low dielectric loss tangent, low refractive index, oil repellency, electrical insulation, water repellency, heat resistance, chemical resistance, weather resistance, mold releasability, flame resistance, separability, wear resistance, surface properties (friction coefficient), bending strength, stretching properties, non-flammability, etc. which are necessary for thin-film device(Micro Electro Mechanical Systems/MEMS, Surface Acoustic Wave/SAW, Capacitor, etc) manufacturing processes, thin-film device manufacturing equipment and thin-film device to function normally under various environments, making substitution by other materials listed in Attachment 6 extremely difficult. Additionally, for more information on why PFAS cannot be substituted in thin-film devices, please refer to information from the Semiconductor Industry Association. For example, the following information from SIA PFAS Consortium of the Semiconductor Industry Association of America: "The Impact of a Potential PFAS Restriction on the Semiconductor Sector2" https://www.semiconductors.org/wp-content/uploads/2023/04/Impact-of-a-Potential-PFAS-Restriction-on-the-Semiconductor-Sector-04_14_2023.pdf	9.Thin-film device manufacturing process	Car navigation system, Sphygmomanometer (blood pressure meters), Inkjet printer, Smartphone, PC Other products in RoHS categories 1- 11 may use thin-film devices

JP4EE Attachment 5-List of PFAS essential uses in EEE: The list explains CUU in EEE by OECD categories of PFAS as chemical materials.
The list links the functions listed in Attachment 3 and includes the reasons why these PFAS cannot be substituted.

PFAS classification	Representative Chemical Materials	Ref. No.	Currently Unavoidable Use (CUU) in electrical and electronic equipment (EEE) [Derogations for EEE should be set at this level.]	Non-exhaustive examples of uses	Reasons why PFASs are un-replaceable	Functions of EEE requiring the use of PFAS (Link to Column C of Attachment 3)	Functions of EEE requiring the use of PFAS (Link to Column G of Attachment 3)
		15	Functional material used in printing process *Please refer to the input from the related industries, such as Japan Business Machine and Information System Industries Association (JBMIA), for the concrete details.	Toner additives, Ink additives, Developer additives	Printing process need various functions such as electrical insulation, water repellency, oil repellency, chemical resistance, surface activity, low surface tension, and high negative charge. These functions are achieved by adding fluorinated materials to toner, ink, developers, organic photoconductors etc. Only fluorinated-based materials can achieve above functions simultaneously. It is impossible to achieve this with alternative materials listed in Attachment 6.	Materials such as "Printing inks/Toner" used in "printing process". These would be separately covered by stakeholders such as printing industry, therefore our current Application list (Attachment 3) does not cover them. For the details on chemicals used in printing process, please see the input from the related industries.	
Fluoroalkyl compounds with functional groups (such as -OH, -COOH, N-R, etc.) and Side-chain fluorinated polymers	PFHxA, PFBA, PFBS, Polyfluoroalkyl (meth)acrylate	16	High performance materials for mold release and protection purposes, which ensures multiple functions such as electrical insulation, heat resistance, chemical resistance or flame resistance, etc. at the same time	Resistive/Conductive Paste, Mold release agent, Antistatic agent, Solder flux, flame retardant	Fluorine compounds such as PFAS are the only materials that can simultaneously provide and exhibit multiple functions, such as electrical insulation, heat resistance, chemical resistance, flame resistance, etc. which are necessary for electrical and electronic devices as well as manufacturing equipment of components for such devices to function normally under various environments, making substitution by other materials described in Attachment 6 extremely difficult.	6.Safety and safety functions 7.Functional surface	Cable, Monitor, Medical equipment, Electric appliance, Industrial control equipment Cooking appliance, Touch panel, Smartphone All the EEE in RoHS categories 1- 11 would need this function.
		17	Semiconductor manufacturing process	Photoacid generator Photoresist	Various materials have been considered for the photoacid generators and photoresist needed for the semiconductor manufacturing process, but in the end only fluorine materials remained and are currently used. The alternative materials described in Attachment 6 have been studied in the past and when they are used, their performance is poor and they are not practical. Additionally, for more information on why PFAS cannot be substituted in thin-film devices, please refer to information from the Semiconductor Industry Association. For example, the following information from SIA PFAS Consortium of the Semiconductor Industry Association of America: "The Impact of a Potential PFAS Restriction on the Semiconductor Sector" https://www.semiconductors.org/the-impact-of-a-potential-pfas-restriction-on-the-semiconductor-sector/	8.Semiconductor	Semiconductor All the EEE in RoHS categories 1- 11 would use semiconductors.
		18	Thin-film device (Micro Electro Mechanical Systems/MEMS, Surface Acoustic Wave/SAW, Capacitor, etc) manufacturing process	Photoacid generator Photoresist	The thin-film device (MEMS(Micro Electro Mechanical Systems), SAW, Capacitor, etc.) manufacturing process, which started by making mechanical components using semiconductor manufacturing technology, uses fluorinated materials for photoacid generators and photoresist for the same reason as the semiconductor manufacturing process. The alternative materials described in Attachment 6 have been studied in the past and when they are used, their performance is poor and they are not practical. For more information on the reasons, please refer to information from the Semiconductor Industry Association. For example, the following information from SIA PFAS Consortium of the Semiconductor Industry Association of America: "The Impact of a Potential PFAS Restriction on the Semiconductor Sector" https://www.semiconductors.org/the-impact-of-a-potential-pfas-restriction-on-the-semiconductor-sector/	9.Thin-film device manufacturing process	Car navigation system, Sphygmomanometer (blood pressure meters), Inkjet printer, Smartphone, PC Other products in RoHS categories 1- 11 may use thin-film devices
		19	Functional material used in printing process *Please refer to the input from the related industries, such as Japan Business Machine and Information System Industries Association (JBMIA), for the concrete details.	Toner additives, Ink additives, Resin additives, Developer additives, Organic photoconductor additives	Printing process need various functions such as-water repellency, oil repellency, chemical resistance, releasability, surface activity, flame resistance (anti-drip function), low surface tension, and high negative charge. These functions are achieved by adding fluorinated materials to toner, ink, resin, developers, organic photoconductors etc. Only fluorinated-based materials can achieve above functions simultaneously. It is impossible to achieve this with alternative materials listed in Attachment 6.	Materials such as "Printing inks/Toner" used in "printing process". These would be separately covered by stakeholders such as printing industry, therefore our current Application list (Attachment 3) does not cover them. For the details on chemicals used in printing process, please see the input from the related industries.	
Fluoroalkanes and fluoroalkenes, and Fluoroethers and fluoro-ketones	HFC, PFC, HFO, HFE	20	Refrigerant used in various appliances such as those for Refrigeration, Air Conditioning and Heat Pump (RACHP) products *Please also see the input from the related industries, such as Japan Refrigeration and Air Conditioning Industry Association (JRAIA) about the details of the essentiality of the PFAS refrigerants.	Refrigerant is used in various refrigeration, air conditioning and heat pump products. Such RACHP products are not only used in refrigerators, freezers or air conditioners but also further incorporated into may other products for medical, measurement, manufacturing, etc.	Fluorine-based refrigerant has excellent thermodynamic properties in a wide range and is also excellent in temperature followability. Moreover, because of its low flammability and low toxicity, it does not ignite the surroundings or cause harm to the human body, even if equipment or pipes are damaged by an earthquake or storm and then the refrigerant leaks. Natural refrigerants such as ammonia (NH3), hydrocarbon (propane, isobutane, etc.) are not applicable to all the appliances as they are highly flammable or toxic. Please refer to the comments of the related industries, such as Japan Refrigeration and Air Conditioning Industry Association (JRAIA), for details on why fluorine-based coolants cannot be substituted.	11.Refrigeration, Air-conditioning and heat pump sector RACHP (Refrigerant)	Refrigerant All the EEE in RoHS categories 1- 11 may use refrigerant if needed.

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		21	Refrigerant, coolant, cleaning agent and solvent used for semiconductor process	Cooling of manufacturing equipment	Fluorinated compounds such as PFAS are the only media that can be used over a wide range of operating temperatures for safe and efficient heat transfer, while simultaneously possessing excellent properties such as electrical insulation, inertness, and extremely low surface tension, along with excellent thermodynamic properties, making substitution by other materials extremely difficult. For more details on why fluorinated coolants cannot be substituted in semiconductor processes other than etching, please refer to the comments of the relevant industry associations.	8.Semiconductor	Semiconductor All the EEE in RoHS categories 1- 11 would use semiconductors.
		22	Refrigerant, coolant, cleaning agent and solvent used for thin-film device (Micro Electro Mechanical Systems/MEMS, Surface Acoustic Wave/SAW etc) process	Cooling of manufacturing equipment	Fluorinated compounds such as PFAS are the only media that can be used over a wide range of operating temperatures for safe and efficient heat transfer, while simultaneously possessing excellent properties such as electrical insulation, inertness, and extremely low surface tension, along with excellent thermodynamic properties, making substitution by other materials extremely difficult. For more details on why fluorinated coolants cannot be substituted in thin-film device processes other than etching, please refer to the comments of the relevant industry associations. A similar exemption to that for semiconductor process is needed for the thin-film device manufacturing process, since the thin-film device manufacturing process uses the same materials and technologies as the semiconductor manufacturing process.	9.Thin-film device manufacturing process	Car navigation system, Sphygmomanometer (blood pressure meters), Inkjet printer, Smartphone Other products in RoHS categories 1- 11 may use thin-film devices
		23	Chemicals for ultra-fine processing applications, as typified by semiconductor and MEMS manufacturing processes *HFC-23 (CHF 3), HFC-32 (CH 2 F 2), HFC-152 a (CHF 2-CH 3) , HCFC-141 b (CCl 2 F-CH 3), HFO-1132 a (CH 2=CF 2) , are outside the scope definition of this regulation. Minor uses; In the electronics and semiconductor industries, fluorinated gases are used in etching and chamber cleaning processes to form nano-level fine semiconductor integrated circuits, etc., including CHF 3, CF 4, perfluoroethane, perfluoroalkane, and perfluorocycloalkane	Etching gas for semiconductor and glass substrates Equipment such as etching equipment/CVD equipment Substrate cleaning gas	In the semiconductor industry, perfluorogas and polyfluorogas are used in etching and chamber cleaning processes to form nano-level fine semiconductor integrated circuits etc.. Although the amount used is small, today's electronics products require extremely complicated and delicate processing to realize various functions such as high performance, multi-function, and low power consumption. To achieve this, we combine various gases to perform processing with advanced and delicate control. There is no substitute for the gas currently in use in the semiconductor manufacturing process, which is highly and finely assembled. If its use is prohibited, all semiconductor manufacturing will be stopped. The semiconductor industry controls the chemical substances used at all stages of the manufacturing process. Most of the chemical substances used are decomposed during the manufacturing process, and equipment is installed to decompose and recover unreacted residual gases in order to reduce emissions. The continued use of PFAS in the semiconductor manufacturing process is an essential component of the supply of electronics products that support wide range of current and future daily necessities and social infrastructure and is a fundamental prerequisite for semiconductor production. For this reason, it is considered essential to exempt semiconductor manufacturing, the semiconductor itself, and related equipment from the scope of regulation as CUU. PFAS gases are always stable, easy to handle, and very reactive with the material to be etched (such as semiconductor or glass substrates) in reactive ion etching (RIE). Moreover, only fluorinated compounds such as PFAS gases can etch Si, and other materials gases have high volatility (high vapor pressure) of reaction products (such as SiF4), making it difficult to substitute them.	8.Semiconductor 9.Thin-film device manufacturing process	Semiconductor Car navigation system, Sphygmomanometer (blood pressure meters), Inkjet printer, Smartphone All the EEE in RoHS categories 1- 11 would use semiconductors. Other products in RoHS categories 1- 11 may use thin-film device.
		24	Fluids for immersion processes (testing, measuring or adding function) in production processes and laboratories	Test solvent for gross leak test, etc., high-precision temperature characteristic measurement, and voltage application medium for polarization of piezoelectric ceramic elements	Fluorinated compounds are the only media that can maintain the quality of an object without leaving stress or contamination on the object in the process due to their extremely low surface tension and high volatility. Furthermore, fluorinated compounds simultaneously possess excellent functions such as excellent thermodynamic properties, electrical insulation, and inactivity, which ensure the stability and accuracy required in the process. The MIL standard (MIL-STD-883/750) specifies the use of hollow packages in airtight testing, which is essential to ensure their airtight performance. Therefore, it is difficult to substitute other substances.	This application is described not in current Application List (Attachment 3)	Car navigation system, Sphygmomanometer (blood pressure meters), Inkjet printer, Smartphone. Other products in RoHS categories 1- 11.
Others (PFAS other than ones mentioned above)	Fluorinated engineering plastic materials such as fluorinated polyimide and Liquid crystal materials. Other fluorinated compounds	25	Transparent electronic circuit board and circuit	Transparent printed circuit board for touch panels	Fluorinated polyimide has transparency, heat resistance, and low water absorption required for touch panels used in smartphones and tablets. The high water absorbency of transparent heat-resistant plastic (polyether sulfone) reduces low dimensional stability and impairs the linearity of touch panels, so it cannot be used.	1.Optical function	Camera, Lighting, Monitor/Panel, Optical cable, Smartphone Other products in RoHS categories 1- 11 would need this function if they use optical function in control panels for example.
		26	Liquid crystal display (LCD) elements	Liquid crystal substances (small molecules), Vertical alignment liquid crystal display device, Interlayer spacer to control the cell gap of LCD panels.	"Fluorinatad Liquid Crystal substances (PFAS LC)" have low driving voltage, high response speed, and low temperature dependence of driving voltage, which are required for low power consumption video displays that require multiple functions simultaneously. Cyano-based crystal substances cannot meet these requirements simultaneously. So it was replaced by "PFAS LC" as a technological breakthrough. The power consumptions of other displays (e.g. OLED) are higher than LCDs using PFAS LC. Fluorinated polyimides with long-chain fluorinated alkyl groups in the side chains have high heat resistance and stable. For other LCD elements, fluorinated polyimides with long-chain fluorinated alkyl groups in the side chains have high heat resistance and stable vertical orientation over a wide temperature range. These properties cannot be replaced by polyimides with hydrocarbon side chains. The structural materials for maintaining uniform cell gap of a large-sized liquid crystal panels are required to have high precision thickness uniformity, no contamination in the manufacturing process, chemical resistance, no influence to optical system and heat resistance at the same time. These are not able to be replaced by silicone or acrylic resin.	5. Display function(Liquid crystal display / LCD) 7. Functional surface	Liquid crystal display panel (TV, Monitor for various device) Other products in RoHS categories 1- 11 would need this function if they use control panels or monitors for example.
		27	Optical elements	Additives for polyamideimides, polyimides, and polyester tapes	By introducing a trifluoromethyl group or the like into the polyimide, low refractive index, low dielectric constant, separation, light transmission, and flexibility can be imparted. In this way, the fluorinated material introduced with fluorine as a substituent in the engineer plastic material has excellent electrical properties, water and oil-repellency, surfactant resistance, flame retardancy (anti-drip function), low surface tension. It can simultaneously impart and express multiple functions, and if the Non-PFAS alternatives listed in Attachment 6 are used singly or in combination, the worst performance is exhibited. Therefore, it is impossible to substitute to those alternatives.	1.Optical function	Camera, Lighting, Monitor/Panel, Optical cable, Smartphone Other products in RoHS categories 1- 11 would need this function if they use optical function in control panels for example.

JP4EE Attachment 5-List of PFAS essential uses in EEE: The list explains CUU in EEE by OECD categories of PFAS as chemical materials.
The list links the functions listed in Attachment 3 and includes the reasons why these PFAS cannot be substituted.

PFAS classification	Representative Chemical Materials	Ref. No.	Currently Unavoidable Use (CUU) in electrical and electronic equipment (EEE) [Derogations for EEE should be set at this level.]	Non-exhaustive examples of uses	Reasons why PFASs are un-replaceable	Functions of EEE requiring the use of PFAS (Link to Column C of Attachment 3)	Functions of EEE requiring the use of PFAS (Link to Column G of Attachment 3)
		28	Functional materials used in printing process *Please refer to the input from the related industries, such as Japan Business Machine and Information System Industries Association (JBMIA), for the concrete details.	Toner additives, Ink additives, Developer additives, Organic photoconductor additives	Printing process need various functions such as water repellency, oil repellency, chemical resistance, releasability, surface activity, low surface tension, and high negative charge. These functions are achieved by adding fluorinated materials to toner, ink, developers, organic photoconductors etc. Only fluorinated-based materials can achieve above functions simultaneously. It is impossible to achieve this with alternative materials listed in Attachmemt 6.	Materials such as "Printing inks/Toner" used in "printing process". These would be separately covered by stakeholders such as printing industry, therefore our current Application list (Attachment 3) does not cover them. For the details on chemicals used in printing process, please see the input from the related industries.	
All the PFAS (fluoropolymers and others)	PTFE, PFA, FEP, ETFE, PVDF,PFHxA Polyfluoroalkyl (meth)acrylate	29	Functional coatings* (* "Functional coating" is a coating applied to an article in order to give it the required functions, such as low dielectric properties, low dielectric loss tangent, electrical insulation, heat resistance, UV resistance, chemical resistance, corrosion resistance, weather resistance, water repellency, oil repellency, slipperiness, low refractive index and so on. "Functional coating" includes, but not limited to, "conformal coating" used to protect electronic materials. In our input, we use the term "functional coating" because the required functions are not only to protect the objects.)	Electronic circuit boards, semiconductors, small electronic components (e.g. capacitors, resistors, coils, diodes, transistors, switches, connectors and their electrical junction points), casing, motors, voice coils, parts to protect optical features (e.g. liquid crystal panels, touch panels, optical sensors, LED, Toslink, optical fibers, lenses for electronic cameras, projection lenses, polarizers), printing process (Toner/ink adhesion prevention, toner/developing carrier themselves), oil barrier, fan, razor blade, and so on.	Fluorine compounds are the only coating materials that can simultaneously provide and express multiple functions required for the proper functioning of electrical and electronic equipment in various environments, such as low refractive index, low dielectric constant and low dielectric loss tangent, electrical insulation, oil repellency, water repellency, heat resistance, UV resistance, chemical resistance, weather resistance, mold release and optical protection (i.e. for optical sensors, lenses and so on). In addition to the above, toner/development carriers are also required to be fluidity, charging characteristics, and durability.	1.Optical function 2.High speed communication and transmission function 4.Sliding function in mechanical section 6.Safety and safety functions 7.Functional surface 10.Energy supply (Battery,Fuel cells, Solar cells) 12.Passive electronic components and manufacturing process	Camera, Lighting, Monitor/Panel, Optical cable, Smartphone, PC, Antenna, Base stations Motor, Printer, Industrial equipment, Cable, Medical equipment, Electric appliance, Industrial control equipment, Cooking appliance, Touch panel, All the EEE in RoHS categories 1- 11 would need this function.
	PTFE, PFPE, PFHxA, PFBS	30	Lubricants where the use takes place under harsh conditions or the use is needed for safe and intended functioning and/or safety of equipment	Electronic cameras, lens systems for electronic cameras, moving parts of the helicoid of projection lenses and moving ball frames, driving parts of ultrasonic testing equipment, drives for optical discs, torque limiters for scanners and other moving parts of precision equipment in electrical and electronic equipment.	To protect the mechanical properties of the moving parts of precision components in electrical and electronic equipment, the lubricant (e.g. grease) is given an autophobic property to prevent wetting and spreading. If the lubricating components applied to the operating parts of precision components become wetted and diffuse, the durability and performance of the product will be significantly reduced. To prevent this, fluorine compounds are added which have good dispersibility in lubricants (e.g. grease) and can provide oil repellency due to their self-hydrophobic properties. Only fluorine compounds with low surface free energy can provide oil repellency and are difficult to replace. In addition, due to the recent miniaturisation and high integration of components, it is difficult to avoid them due to the structure of the components.	4.Sliding function in mechanical section 6.Safety and safety functions	Motor, Printer, Industrial equipment, Camera, Cable, Monitor, Medical equipment, Electric appliance, Industrial control equipment All the EEE in RoHS categories 1- 11 would need this function.

Emi Yamamoto (JP4EE)Attachment

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List of abbreviations

Acronym	Explanation
PTFE	Polytetrafluoroethylene
PFA	Perfluoroalkoxyl polymer
FEP	Fluorinated ethylene propylene
ETFE	Ethylene tetrafluoroethylene
PVDF	Polyvinylidene fluoride
PCTFE	Polychlorotrifluoroethylene
FKM	Family of fluorocarbon-based fluoroelastomer materials
FFKM	Perfluorelastomers
FEPM	Tetrafluoroethylene propylene
FFKO	Perfluoropolyether elastomer
PFPE	Perfluoropolyether
PFHxA	Perfluorohexanoic acid
PFBA	Perfluorobutanoic acid
PFBS	Perfluorobutane sulfonic acid
HFC	Hydrofluorocarbon
PFC	Perfluorinated compound
HFO	Hydrofluoroolefin
HFE	Hydrofluoroether

Converted from Microsoft Excel to Adobe PDF 3/5/2024

JP4EE Attachment 6- Unfeasibility of “possible substitutes” in actual EEE

As far as we know, the most comprehensive available information on alternatives to PFAS would be "A guide to PFAS in electronics" by ChemSEC. However, from the point of view of the actual manufacturers of EEE, the listed "possible substitutes" seem to be (still) infeasible to achieve the EEE performance needed in today's IT society. Therefore, we prepare this attachment to explain why alternatives are not feasible. Please refer to Column G (Comments on ChemSec-Electronics-Guide).

ChemSEC: “A guide to PFAS in electronics”:
https://chemsec.org/reports/check-your-tech-a-guide-to-pfas-in-electronics/

Category of use	Function performed	Product(s)	PFAS identified	Contained in the product?	Actively used?	Alternatives available?	Alternatives Identified	Additional Comments	References	Comments on ChemSec-Electronics-Guide
Electrical Devices	Structure/low dielectric constant/insulation	Printed Circuit Boards (PCB)/ Printed Wiring Board (PWB)	6:2 FTSA (27619-97-2) Perfluorooctane sulfonamid (754-91-6) PFOS (1763-23-1) PFBA (375-22-4) PTFE (9002-84-0) ethene,1,1,2,2-tetrafluoro-, polymer with 1,1'oxybis[ethene] (102646-47-9)	Yes[1,2]	Confirmed[3]	Yes	FR-4 epoxy, Polyimide laminates, liquid crystal polymer, polyester, polyethylene naphthalate (PEN), bismaleimide triazine (BT), ~~cyantate~~ cyanate ester, ceramics [4]	PFOS and PFOA are banned so considered unlikely to be still be used for this function. The alternative FR4 contains brominated flame retardants, which might lead to a case of regrettable substitution [62] Noted by industry [62] that for existing designs, PTFE cannot be easily substituted in PCB/PWB without a complete redesign of the equipment (including the mechanical dimensions of the product) and not feasible for spare parts.	1,2,3,4, 62	All of the materials listed as alternatives have a high relative permittivity (square root proportional to transmission loss), and especially the dissipation factor (proportional to transmission loss) is very large, so it is not a substitute for high-frequency printed circuit boards. This difference in properties will have a significant impact on the social demand for reduced power consumption in the carbon-neutral era, as well as on the dramatic reduction of power consumption for the transmission of millimeter wave band mobile communications (5G/6G) and digital data communications in high-speed servers (224/448 Gbps) that are expected in the future.
Electrical Devices	Final Coating/protection/waterproofing	Printed Circuit Boards (PCB)/ Printed Wiring Board (PWB)	6:2 FTSA (27619-97-2) Perfluorooctane sulfonamid (754-91-6) PFOS (1763-23-1) PFBA (375-22-4) PTFE (9002-84-0) ethene,1,1,2,2-tetrafluoro-, polymer with 1,1'oxybis[ethene] (102646-47-9)	Yes[5]	Confirmed[6]	Yes	Acrylic Resin, Epoxy, Urethane resin, silicone resin [7]		5,6,7	The substances listed in the alternatives identified cannot be substituted for all applications. For example, epoxy resin is hard and cannot be used for flexible substrates. In addition, even if it can be used, urethane resin and acrylic resin are inferior to PFAS in moisture-proof, so it is necessary to increase the film thickness to obtain the necessary moisture-proof properties. Silicone resin cannot be used in the vicinity of relays, mechanical switches or membrane switches, where the silicone resin has a risk that siloxanes that deteriorate and release the silicone accumulate on the conduction part and cause conduction failure and may cause malfunction due to contact failure. For details, please refer to the high-speed communication section of Attachment 4, Smartphone and Protective Coat.
Electrical Devices	Liquid impregnates	Capacitors	Aliphatic perfluoroalkane (355-42-0) Perfluoromethylcycloalkane (1805-22-7, 255-02-2) Perfluoro-1,3-dimethylcycloalkane (355-27-3) Perfluorotrialkyl amine (311-89-7) Perfluorinated cyclic ethers (?)	Yes[1]	Unconfirmed	Yes	Mineral oils, vegetable oils, silicone oils, and biodegradable synthetic oils.[8]		1,8	We have no information.
Electrical Devices	Dielectric films	Capacitors	PTFE (9002-84-0) PVDF (24937-79-9)	Yes[8]	Unconfirmed	Yes	Various other polymers such as polypropylene (PP), polyethylene (PE), polystyrene (PS), polycarbonate (PC), PEN, polyphenyl sulfide (PPS), polyester imides (PEI), polyethyleneterephthalate (PET), polybutyleneterephthalate (PBT), polyetheretherketone (PEEK), polyvinylchoride (PVC), polyimides (PI), polyamides (PA), and polymethylmethacrylate (PMMA)		1	We have no information.
Electrical Devices	Electrical signal; Piezoelectrical material	Acoustical Equipment	PVDF (24937-79-9) Copolymers with trifluoroethylene	Yes[1]	Confirmed[9]	Yes	Piezoelectric films seem to all be made of PVDF, but there are other piezoelectric materials that can be used depending on the application, such as ceramic piezoelectric materials or piezoelectric crystals[10]		1,9,10	Ceramics have been proposed as alternatives to piezoelectric elements, but they are fragile and limited in shape, making it difficult to form large areas.
Electrical Devices	Acoustic vent membranes	Acoustical Equipment	Not specified	Yes	Unconfirmed	No	No alternatives identified	Alternatives for moist protection do not seem to be available.	*REF for this one?*	We cannot comment on PFAS or alternatives because there are no examples.
Electrical Devices	Dipole moment	LCDs(Liquid Crystal Displays)	Fluoropolymers	Yes[1,11]	Unconfirmed	Yes	Can use other screen technologies instead of LCD		1,11	OLEDs (organic light-emitting diode) cannot replace all LCDs. Compared to LCDs, OLEDs have some challenges to solve such as higher power consumption (contrary to energy saving), shorter life, and inability to repair (high cost). Therefore, it is impossible to replace the LCDs during the proposed five-year grace period. It took 20 years for OELDs to reach their current status, so we think that it will take a similar number of years to solve such challenges and replace LCDs.

Category of use	Function performed	Product(s)	PFAS identified	Contained in the product?	Actively used?	Alternatives available?	Alternatives Identified	Additional Comments	References	Comments on ChemSec-Electronics-Guide
Electrical Devices	Protective coating	LCDs(Liquid Crystal Displays)	PCTFE (9002-83-9)	Yes[1]	Unconfirmed	Yes	Can use other screen technologies instead of LCD		1	We have no information.
Electrical Devices	Electrical Insulation/dust repellent	Flat panel display	Tetrabutylphosphonium perfluorobutane sulfonate (220689-12-3) Tetrabutylphosphonium perfluoromethane sulfonate Tetrabutylphosphonium perfluorohexane sulfonate Tetrabutylphosphonium perfluorooctane sulfonate	Yes[1]	Unconfirmed (patent)	Yes	Various other polymers such as polyester and polycarbonate		1, 12, 13	In flat panel display materials, the required performance (optical properties) of the product can be satisfied by introducing fluorine atoms to the functional molecules in the material. Alternative substances must have the characteristics of "low surface tension", "high wettability to the base material", and "hydrophobicity" equivalent to fluorine, but no substitute substance has been found that satisfies these sufficiently. In addition, general-purpose polymers are listed as alternatives, but as described above, polymers alone cannot meet the required performance (optical properties) and some alternatives have fluorine introduced, so they are considered inappropriate as non-PFAS alternatives.
Electrical Devices	Not specified	Razors	PTFE (9002-84-0)	Yes[1]	Unconfirmed	Uncertain	Unconfirmed		1,14	PFAS are used for lubricity, durability, and antifouling requirements.
Electrical Devices	Not specified	Various (Switches, Vacuum cleaners, Coffee makers, Keyboards, Screens, TVs	Not specified	Yes[1]	Unconfirmed	Uncertain	Unconfirmed		1,14	We have no information.
Electrical Devices	Coating	Electroluminescent lamps in commercial/safety signs	PCTFE (9002-83-9)	Yes[1]	Unconfirmed	Uncertain	Unconfirmed		1	We have no information.
Electrical Devices	Insulation/Fire prevention	Wiring and cable insulation	PVDF-HFP copolymer (9011-17-0) FEP (25067-11-2) ETFE (68258-85-5) ECTFE (25101-45-5) PCTFE (9002-83-9) PTFE (9002-84-0)	Yes[1]	Confirmed[15]	Yes	Plastics (PVC, PE, PP, etc.) Rubbers (neoprene, silicone, etc) [16,17,18]	Industry note that, in practice PVC is favoured for this use, so in fact PFAS could be used if PVC is not possible. Other materials mentioned as alternatives have some drawbacks [62].	1,15,16,17,18	Flame retardant cables used in harsh conditions must have very good fire resistance. PVC as a flame-retardant material is not satisfactory, and safety cannot be guaranteed at all with other PFAS alternatives.
Electrical Devices	Insultation / heat resistant	Wiring and cable insulation	PTFE (9002-84-0)	Yes[62]	Confirmed [62]	Yes[62]	Rubbers (neoprene, silicone, etc)	Industry association [62] note that rubbers have less mechanical strength and less abrasion resistance. Thicker insulation might be needed or additional mechanical support. Might lead to partial redesign to accomodate for the additional space required.	62	Flame retardant cables used in harsh conditions must have very good fire resistance. PVC as a flame-retardant material is not satisfactory, and safety cannot be guaranteed at all with other PFAS alternatives.
Electrical Devices	Insultation / heat resistant in combination with specific sensors	Wiring and cable insulation	PTFE (9002-84-0)	Yes[62]	Confirmed [62]	Yes[62]	Rubbers (neoprene, silicone, etc)	Industry association [62] note that silicone insulation will lead to chemical deposition on the sensors, making them malfunction.	62	Special sensors used in harsh conditions are required to be heat-resistant, chemical-resistant, and durable. Neoprene rubber has lower characteristics than PFAS. In addition, silicone rubber deteriorates and separates siloxanes, which may cause conduction failure of the contacts.
Electrical Devices	Insulation / chemical resistant	Wiring and cable insulation	PTFE (9002-84-0)	Yes[62]	Confirmed [62]	No[62]	No alternatives identified	Industry association [62] note that no alternative available when chemical resistance is required.	62	Insulated cables used in acidic or alkaline atmospheres and environments where chemicals come into contact are required to have excellent chemical resistance, and no material other than PFAS has been identified that can ensure safety.
Electrical Devices	High frequency electrical insulation	Wiring and cable insulation	PTFE (9002-84-0)	Yes[62]	Confirmed [62]	Uncertain[62]	Unconfirmed	Industry association [62] note thatPTFE has a very low dielectric constant. There is no comparable alternative.	62	No alternatives for high frequency electronic insulating materials have been identified.
Electrical Devices	Insulating spacers locate conductive components	(Coaxial) cable	PTFE (9002-84-0)	Yes[62]	Confirmed [62]	Uncertain[62]	Unconfirmed		62	In the insulated spacers in coaxial cables, PFAS alternatives cannot be identified.
Electrical Devices	High voltage insulator	Connectors and other parts in submarine long distance telecommunication cable applications	PTFE (9002-84-0)	Yes[62]	Confirmed [62]	Uncertain[62]	Unconfirmed		62	No alternative to PFAS has been identified in high-voltage insulators used in connectors and other components for submarine long-distance communication cable applications.
Electrical Devices	Additive in plastic resins (e.g. PC/ABS)	Plastic Enclosures	PTFE (9002-84-0)	Yes[62]	Confirmed [62]	Uncertain[62]	Unconfirmed		62	We have no information.

Category of use	Function performed	Product(s)	PFAS identified	Contained in the product?	Actively used?	Alternatives available?	Alternatives Identified	Additional Comments	References	Comments on ChemSec-Electronics-Guide
Electrical Devices	V0 flame retardancy plastics	Adapters, PSUs, wiring	PTFE (9002-84-0)	Yes[62]	Confirmed [62]	Yes[62]	(Unspecified) BFRs, CFRs [62]	PTFE as an additive (3000-5000 ppm) in PC [62]; Industry noted that in order for plastics to meet the V0 flame retardancy grade, it is required that there is suppression of dripping of any melted plastic as the plastic is heated. Only alternatives would be brominated or chlorinated flame retardants which are also restricted.	62	Resins used in the housings of devices such as TVs and personal computers, and resins used around power supplies and heating elements in electrical parts may be required to be certified as flame retardant according to UL94 standards by law. In order to satisfy these standards, the addition of flame retardants is unavoidable, but especially for advanced resins of V-0 grade or higher, it is necessary to prevent the generation of burning particles that can ignite, and drip prevention is essential. When halogen flame retardants are regulated by law, and inorganic flame retardants and phosphate ester flame retardants may be used, inorganic flame retardants need to be added in large quantities to obtain a sufficient flame-retardant effect, resulting in impaired physical properties of the resin. On the other hand, phosphate ester flame retardants are limited to resins that are easy to exert effects (resins that are easily carbonized including oxygen) due to the flame-retardant expression mechanism (carbonization layer formation during combustion). Flame retardant resins using phosphate ester flame retardants in polycarbonate and styrene resin alloys (PC/ABS) are widely used in home appliances and OA equipment, but because they are easy to drip due to the plasticizing effect of phosphate ester flame retardants. In order to achieve V-0, it is essential to add PTFE, which is an anti-drip agent (fibrillated fluoropolymer increases the melt tension of low-viscosity resins and has an anti-drip effect) as a flame retardant auxiliary. In addition, the addition of an anti-drip agent makes it possible to reduce flame retardants.
Electrical Devices	Protective coatings (dirt, scratch, smudge resistance)	Radiation Curable Coatings on Smartphones & other screens	PTFE (9002-84-0) PVDF (24937-79-9) Perfluoropoly-ether and polyurethane blend	Yes[19]	Unconfirmed	Yes	Silica-based coatings, Polymethylmethacrylate powder coating[19]		19	PFAS alternatives for antifouling coatings that satisfy solvent resistance have not been identified.
Electrical Devices	Protective coatings (dirt, water, UV)	Solar Panels	FEP (25067-11-2) ETFE (68258-85-5) FEVE (146915-43-7)	Yes[19]	Unconfirmed	Yes	PET、PC、Polyamides、PS Titanium Dioxide nanoparticles[19]		19	Durability, weather resistance, light resistance (especially UV resistance), and antifouling are important for the protective film of photovoltaic panels, but PET, PC, Polyamide, and PS are easily degraded by the ultraviolet light contained in sunlight, which shortens the life of the panel. TiO2 is added to improve hydrophilicity, not an alternative.
Electrical Devices	Coating	ICT equipment with imaging senors	Not specified	Yes[62]	Confirmed [62]	No[62]	No alternatives identified	Industry association notes that use in coating to fill main ingress path to oleic acid and thus prevent glue failure at imaging sensor. Coating must be able to fill the gap by capillary action after jet dispensing. Only potential alternative is Silicone but Silicone absorbs oil, is sticky, causes cross contamination and leads to adhesion loss of other components. [62]	62	We have no information.
Electrical Devices	Lubricant	ICT equipment	Not specified	Yes[62]	Confirmed [62]	No[62]	No alternatives identified	Lubrication/coating e.g. for Silicone O ring installation – e.g. to provide good corrosion resistance, low Coefficient of Friction <0.15, good adhesion to substrate, low surface roughness Ra < 0.6 um, harder than Polycarbonate to withstand 30K cycles of REL testing. Coating to fill main ingress path to oleic acid and thus prevent glue failure at imaging sensor. Coating must be able to fill the gap by capillary action after jet dispensing. Industry association noted that all alternative dry coatings have been tested and failed for either corrosion or cosmetics. Alternative lubricants have been tested and do not meet performance requirements [62].	62	In ICT equipments, PFAS alternatives for dry coat cannot be used due to corrosion and appearance problems. Also, PFAS alternatives for lubricants do not meet the required properties.
Electrical Devices	Coating	Touchscreen displays, camera glass, mousepads, backglass	Not specified	Yes[62]	Confirmed [62]	Yes [62]	Silicone-based coatings	Low surface energy anti-finger printing and haptics enabling coatings Industry association[62] note that silicone alternatives absorb oil, are sticky, and cross contamination leads to adhesion loss of other components. Silicone alternatives would create dysfunction in haptics - blocking transmission to sensors in touchscreens.	62	When a touch display or camera lens is coated with a silicone base alternatives it is not suitable for high-performance products because silicone base alternatives absorb oil, increase stickiness, which causes dysfunction of haptics (blocking transmission to touchscreen sensors) .

Category of use	Function performed	Product(s)	PFAS identified	Contained in the product?	Actively used?	Alternatives available?	Alternatives Identified	Additional Comments	References	Comments on ChemSec-Electronics-Guide
Electrical Devices	Proton exchange membrane	Fuel Cell	Ethanesulfonic acid, 2-[1-[difluoro[(trifluoroethenyl)oxy]methyl]-1,2,2,2,-tetrafluoroethyoxy-1,1,2,2-tetrafluoro-, polymer with tetrafluoroethene (31175-20-9) PTFE (9002-84-0) Other proprietary polymers	Yes[20]	Confirmed	Uncertain	Hydrocarbon multi-block copolymer electrolyte membranes [multiblock copolymer poly(sulphonate phenylene)-b-poly(arylene ether ketone)] - under development. [20] Car industry argues that no replacements are available, since for example only PFSA ionomers have reached technological maturity for use in proton exchange membranes for these functions in the harsh environment of a fuel cell. [21]		20, 21	PTFE is the only material that can withstand redox environments. For details, please refer to the comments of the organizations that handle the equipments.
Electrical Devices	Binder	Lithium Ion Batteries	PVDF (24937-79-9)	Yes[22,23]	Confirmed[24]	Maybe	PI, PAA, CMC, SBR Many suggest that PVDF will soon be replaced with better performing and more environmentally friendly alternatives, but this appears to be largely at research stage.[22,23]		22.23.24	Please refer to the input from the battery industries, such as those from Battery Association of Japan (BAJ) for the concrete details.
Electrical Devices	Electrolyte	Lithium Ion Batteries	LiTFSI (90076-65-6) LiBETI (132843-44-8) LiFAP、LiTFAB LiFSI (171611-11-3) LiTA	Yes[25]	Confirmed[26]	Yes	$LiPF_6$ is the standard electrolyte for lithium ion batteries, but more efficient PFAS compounds are being developed/implemented.		25, 26	Please refer to the input from the battery industries, such as those from Battery Association of Japan (BAJ) for the concrete details.
Electrical Devices	Cathode electrode binder material	Lithium Batteries	PVDF and copolymers	Yes[62]	Confirmed [62]	No	No alternatives identified	Industry association [62] consider that there is no alternative to PVDF for cathode electrode binder material. It is noted [62] that over the years many polymers have been tried and PVDF has consistently been found to be the best option to meet the performance and process requirements for binder material. Originally PVDF was used as the binder material for both anode and cathodes. More recently styrene-butadiene copolymer (SBR) was found to be a good alternative for the anode binder material. CMC is used together with SBR as a thickener to control slurry viscosity. CMC/SBR is now the most popular anode binder material due to its low cost and good cell performance. But SBR is not a good option for the cathode binder material as its double bound structure can be oxidized under cathode potential. Replacing PVDF with other polymers will likely cause cell performance and manufacturability issues.	62	Please refer to the input from the battery industries, such as those from Battery Association of Japan (BAJ) for the concrete details.
Electrical Devices	Battery separator material	Lithium Batteries	PVDF and copolymers	Yes[62]	Confirmed [62]	No[62]	No alternatives identified	Industry association [62] consider that no alternative would result in similar performance of battery.	62	Please refer to the input from the battery industries, such as those from Battery Association of Japan (BAJ) for the concrete details.
Electrical Devices	Creation of important microporous structures	Speaker modules	Expanded PTFE	Yes[62]	Confirmed [62]	No[62]	No alternatives identified	Expanded PTFE for speaker membrane. Industry association[62] notes that PTFE has a unique ability to create important microporous structures that allow for proper air permeability and good water and dust-proofing. Industry association [62] consider that using an alternative would result in loss of sound transmission quality and durability,	62	We have no information.
Electrical Devices	Gaskets	Electronic circuits	PTFE	Yes[62]	Unconfirmed	No[62]	No alternatives identified	Industry association [62] notes that PTFE has unique quality to allow vapor and gas to pass through while preventing liquds from doing so which is required for applications in which venting is very important. This is important in many elecronic circuits that require venting without water entering an enclosure and building up around circuits. Industry association [62] consider that using an alternative would not allow for water proofing simultaneous with gas permeability.	62	There is no gasket material that is both solvent resistant and heat resistant other than PFAS.

Category of use	Function performed	Product(s)	PFAS identified	Contained in the product?	Actively used?	Alternatives available?	Alternatives Identified	Additional Comments	References	Comments on ChemSec-Electronics-Guide
Electrical Devices	Low friction	Moving parts, paper handling in printers	PTFE	Yes[62]	Confirmed [62]	Yes [62]	Several other materials, depending on the specific use case.	Industry association [62] notes that alternatives have to be investigated on case by case basis and there is no drop-in replacement. Often a more comprehensive redesign is required.	62	The low-friction properties of PTFE include not only a low coefficient of dynamic friction but also a low coefficient of static friction, as well as heat resistance, electrical insulation, flame retardancy, and chemical resistance. Replacing it with a substitute product causes an increase in power consumption due to an increase in sliding resistance, a deterioration in quietness, and a shortening of service life due to deterioration in durability. *Please refer to the input from the related industries, such as Japan Business Machine and Information System Industries Association (JBMIA), for the concrete details.
Electrical Devices	Low friction - non-stick (e.g. prevent toner sticking)	Moving parts e.g. in printers	PTFE	Yes[62]	Confirmed [62]	No[62]	No alternatives identified		62	*Please refer to the input from the related industries, such as Japan Business Machine and Information System Industries Association (JBMIA), for the concrete details.
Electrical Devices	Chemical resistance	Printers: ink tubing, sealing, parts in contact with ink	Fluoropolymers and fluoroelastomers	Yes[62]	Confirmed [62]	No[62]	No alternatives identified	Industry association [62] consider that for chemcial resistance, there is no alternative	62	Containers and tubes that can maintain the performance of the things contained inside must have multiple functions such as abrasion resistance, heat resistance, chemical resistance, and cleanliness, and such materials have not been confirmed except for PFAS. *Please refer to the input from the related industries, such as Japan Business Machine and Information System Industries Association (JBMIA), for the concrete details.
Electrical Devices	Lubrication	Lubricant	PTFE, PFHxA related substances	Yes[62]	Confirmed [62]	Yes [62]	Silicone lubricants	Industry association [62] consider that product redesign could be required due to chemical interactions between the alternative and the product. PFAS are very inert and alternatives might have unwanted interactions with the product	62	Silicone may be substituted in some applications, but in applications that are overused in harsh environments, silicone lubricants deteriorate and produce volatile low-molecular siloxanes, resulting in poor electrical contacts and unsafe use.
Manufacture	Chemical resistance, flexibility, sealing	Tubing, valves, sealing	PTFE, PVDF, fluoroelastomers	No (only used in factory, not in electronic product)	Confirmed [62]	No[62]	No alternatives identified	Industry association [62] consider that for chemcial resistance, there is no alternative	62	
Manufacture	Separation of high voltage components	Dielectric Fluids (3M™ Novec™ 7100 Engineered Fluid 3M™ Fluorinert™ Electronic Liquids)	1,1,1,2,2,3,4,5,5,5-decafluoropentane (138495-42-8) PTFE	Yes[1]	Confirmed[27]	Yes	Natural and synthetic esters[28,29,30]		27,28,29,30	-Alternatives tend to have a flash point, and the lower the viscosity, the lower the flash point. Therefore, when designated as a hazardous material, more caution is required in storage, transportation, and handling than before. In addition, the use of these products requires explosion-proof equipment, which entails a huge investment. - Ester-based products deteriorate due to hydrolysis and require caution.
Manufacture	Liquid burn-in testing		Perfluoroperhydrofluorene (307-08-4) PFPEs	Yes[1]	Unconfirmed	Uncertain	N/A		1	
Manufacture	Reliability testing		Perfluoroalkyl methyl ether (375-03-1)	Yes[1]	Unconfirmed	Uncertain	N/A		1	
Manufacture	Dielectric test media	Galden® PFPE Hermetic Seal Testing[36], 3M™ Fluorinert™ Electronic Liquids[40]	Methyl perfluoroalkyl ether (163702-07-6) Methyl perfluoroisoalkyl ether (163702-08-7)	Yes[1]	Confirmed[31]	Uncertain, see reference [32] for a list of compounds and their respective dielectric strengths that may meet manufacturing requirements	Use would need high dielectric breakdown strength, be non-flammable[1]		1,31,32	PFAS is used because it is a low-dielectric and nonflammable material at the same time, but no alternative has been found.
Manufacture	Thermal shock testing	Galden® PFPE Hermetic Seal Testing[36], 3M™ Fluorinert™ Electronic Liquids[40]	Perfluoroisohexane (355-04-4) Perfluoro-1,3-dimethylcycloalkane (355-27-3) Perfluoromethyldecalin (306-92-3) Perfluoroperhydrofluorene (307-08-4) Perfluorotetradecahydrophenanthrene (306-91-2) PFPEs	Yes[1]	Confirmed[33]	Uncertain	Use would need to be non-reactive[1]		1,32,33	PFAS is used because it is a material with low dielectric constant and stability at the same time, but no alternative to it has been found.
Manufacture	Gross and fine leak testing	Galden® PFPE Hermetic Seal Testing[36], 3M™ Fluorinert™ Electronic Liquids[40]	PFPEs	Yes[1]	Confirmed[33]	Uncertain	Use would need to be non-reactive[1]		1,31,33,34	There is no alternative that is non-flammable, insulating, low-viscosity, inert, low erosive and moderately volatile.
Manufacture	Electrical environmental testing	3M™ Fluorinert™ Electronic Liquids [40]	Perfluorinated fluids	Yes[1]	Confirmed[31]	Uncertain	Use would need to be non-reactive[1]		1,31	It is required to be non-flammable and must contain a certain amount of fluorine. Since alternative products are not nonflammable, using them requires investment in explosion-proof equipment.
Manufacture	Use for testing in general		Perfluoromethylcycloalkane (355-02-2) Perfluoro-1,2-dimethylcycloalkane (306-98-9) Perfluoroperhydrofluoranthene (662-28-2)	Yes[1]	Unconfirmed	Uncertain	N/A		1	Solvents for thermostatic chambers that measure the temperature characteristics of electronic components with ultra-high accuracy must be non-flammable, insulating, low-viscosity, inert, low-erosive, and highly thermally conductive, and have moderate volatility, and there is no alternative.

Category of use	Function performed	Product(s)	PFAS identified	Contained in the product?	Actively used?	Alternatives available?	Alternatives Identified	Additional Comments	References	Comments on ChemSec-Electronics-Guide
Manufacture	Heat transfer fluids	General heat transfer	1H-Perfluoroalkane (354-33-6) 1,1,2,2,-Tetrafluoroethane (359-35-3) 1,1,2,2-tetrafluoro-ethene, oxidized, polymd., reduced, decaroxylated (161075-02-1)	Yes[1]	Confirmed[35]	Yes	Various proprietary blends on the market that claim to be environmentally friendly; based on "ester chemistry" and others, and generally said to be biodegradable and often halogen free[36,37,38,39]		1,35,36,37,38,39	It must have high volume resistivity, low viscosity, and prevent moisture content from increasing during use. In addition, it must be nonflammable unless it is used in an explosion-proof facility, which requires a huge investment. Ester-based products require attention because of degradation due to hydrolysis.
Manufacture	Heat transfer fluids	Total Immersion cooling	Methyl perfluoroalkyl ether (375-03-1) Ethyl perfluoroisoalkyl ether (297730-93-9)	Yes[1]	Confirmed	Yes	See row for "General Heat Transfer"		See row for "General Heat Transfer"	See row for "General Heat Transfer"
Manufacture	Heat transfer fluids	Evaporative Cooling	Aliphatic perfluoroalkane (76-19-7) 1,1,1,2,2,3,4,5,5,5-decafluoropentane (138495-42-8)	Yes[1]	Confirmed	Yes	See row for "General Heat Transfer"		See row for "General Heat Transfer"	See row for "General Heat Transfer"
Manufacture	Heat transfer fluids	Brine Cooling	1,1,1,2,2,3,4,5,5,5-decafluoropentane (138495-42-8) Methyl perfluoroalkyl ether (163702-07-6) Methylperfluoroisoalkyl ether (163702-08-7) Ethyl perfluoroalkyl ether (163702-05-4) Perfluoroindane (374-80-1)	Yes[1]	Confirmed	Yes	See row for "General Heat Transfer"		See row for "General Heat Transfer"	See row for "General Heat Transfer"
Manufacture	Heat transfer fluids	Direct contact cooling	Aliphatic perfluoroalkane (335-57-9) 1H-perfluoroalkane (354-33-6) 1,1,2,2,-tetrafluoroethane (359-35-3) Perfluoroisohexane (355-04-4) Perfluoro-2-methyl-3-ethylpentane (354-97-2) Perfluoro-2,4-dimethyl-3-ethylpentane (50285-18-2) Perfluoromethylcycloalkane (1805-22-7) (355-02-2) Perfluoro-1,2-dimethylcycloalkane (306-98-9) Perfluoro-1,3-dimethylcycloalkane (335-27-3) Perfluorodecalin (306-94-5) Perfluoromethyldecalin (306-92-3) Perfluoroperhydrofluorene (307-08-4) Perfluorotetradecahydrophenanthrene (306-91-2) Perfluoroperhydrofluoranthene (662-28-2) Perfluoroperhydrobenzyltetralin (116265-66-8)	Yes[1]	Confirmed	Yes	See row for "General Heat Transfer"		See row for "General Heat Transfer"	See row for "General Heat Transfer"
Manufacture	Cleaning	Solvent Systems and Cleaning Products	3,3,4,4,5,5,6,6,-octafluoro-1-Hexene (159148-08-0) 3,3,4,5,5,5-hexafluoro-1-Pentene (2375-68-0) 1,1,1,2,3,4,5,5,5-nonafluoro-2-(trifluoromethyl)-Pentane (85720-78-1) 1,1,1,2,2,3,4,5,5,5,-decafluoro-Pentane (138495-42-8) Methyl perfluoroalkyl ether (22410-44-2), (375-03-1), (163702-07-6) Methyl perfluoroisoalkyl ether (22052-84-2) Methyl perfluoroisobutyl ether (163702-08-7) Ethyl perfluoroalkyl ether (163702-05-4) Ethyl perfluoroisobutyl ether (163702-06-5) 1,1,2,2-tetrafluoro-1-(2,2,2-trifluoroethoxy)-ethane (406-78-0) Aliphatic non-branched perfluoroalkanes (76-19-7)	Yes[1]	Confirmed[40]	Yes	IPA, Other alcohol cleaners without PFAS added Products listed on Green-Screen website[41]		1,40,41	When cleaning, low surface tension is required, as well as nonflammability unless the equipment is explosion-proof, which entails a huge investment.
Manufacture	Carrier fluid/lubricant deposition	Carrier fluid/lubricant deposition	Perfluoroisohexane (355-04-4) 1,1,1,2,2,3,4,5,5,5-decafluoro-Pentane (138495-42-8)	Yes[1]	Confirmed[42]	Yes	Honeywell fluorinated (but not perfluorinated) Solstice® solvents[43]		1,42,43	It is required to be nonflammable and must contain a certain amount of fluorine. Since the alternatives are not non-flammable, using them requires explosion-proof equipment, which entails a huge investment.
Manufacture	Etching	Piezoelectric ceramic filters	PFOS (1763-23-1)	No[1]	Unconfirmed[44]	Yes	Fluoroboric acid[45]	Industry association [62] note that PFOS and PFOA are banned. Unlikely to be still in use	1,44,45, 62	
Manufacture	Pulsed plasma nano-coating	Smartphones and Tablets	PFOA (335-67-1)	Yes[1,46]	Confirmed[47]	Yes	Epoxy, urethane, acrylic, silicone, paralyne[47] PFAS-free nanocoatings[48]	Industry association [62] note that PFOS and PFOA are banned. Unlikely to be still in use There are other types of coatings used in the industry for the same purpose: evaporative curing, moisture curing and heat curing. Examples of non-fluorinated radiation curable coatings are silica-based coatings and polymethylmethacrylate powder.	1,46,47,48, 62	
Manufacture	Haptics enabling coating	Smartphones and Tablets	-	Yes	Unconfirmed	Uncertain	For touchscreens, which needs haptics enabling coatings, good alternatives are currently lacking.			
Manufacture	Air/moisture resistance	General electronic equipment packaging	PCTFE (9002-83-9)	Yes[1]	Confirmed[49]	Yes	Other moisture and vapor-barrier packaging, such as mylar and a mixture of aluminium foil and various non-fluorine-containing polymers[50]		1,49,50	Since aluminum foil does not allow the user to see the parts in the package, fluorine film can only be used where moisture-proofing and transparency are required at the same time.

Category of use	Function performed	Product(s)	PFAS identified	Contained in the product?	Actively used?	Alternatives available?	Alternatives Identified	Additional Comments	References	Comments on ChemSec-Electronics-Guide
Semiconductors	Photolithography		PFOA (335-67-1) PFOS (1763-23-1) Perfluoropolymers	Yes	Unconfirmed [51]	Potentially	hydrocarbon-based greases, Molybdenum disulfide, graphite (for photolithography) [52]	PFOA and PFOS have been largely phased out	51, 52	PFOS and PFOA have already been eliminated in Japan, and PFOS and PFOA are not used as identified PFAS (we agree with Additional Comments), but they are used as PFAS. Also, 'Contained in the product? (Column E)' is Yes. As with antireflection films, the resist used in the front-end process does not remain in the final semiconductor product. In other applications, current semiconductor technology uses photoresist in many applications to provide properties by leaving a variety of products in the final semiconductor product. In this case, the PFAS remains in the final semiconductor product. The authorities should review the materials of "Semiconductor PFAS Consortium https://www.semiconductors.org/pfas/" in detail. Hydrocarbon greases, molybdenum disulfide, and graphite (for photolithography) already use carbon films as mask materials, but lithography is essential for patterning mask materials, and resist materials are still needed.
Semiconductors	Photoresist matrix, changes solubility when exposed to light	Photoresist	PFOA (335-67-1) PFOS (1763-23-1) PFHxS (alternative to PFOS/PFOA) [28,29,30]	Yes	Confirmed	Yes	KrF (248nm) (active ingredient not disclosed) [53] DOW™ photo-resists (non-PFOS) composed of solvents, acrylic, other polymer resins, cross-linking agents, stabilizers and/or surfactants Alternatives should containt fluorine	PFOS has been largely phased out	53,54,55,56	KrF resists and DOWTM photo-resists (non-PFOS), which are listed as alternative resists, are of limited use and do not cover all resists with different exposure wavelengths. If non-PFOS is used, PFOS is excluded under the Stockholm Convention, and the resists currently used in Japan are already PFOS-free but not PFAS-free. Photoresist requires several actions such as photoacid generation as well as surface activity, and the authorities only mention some of them, so the difficulty of replacing non-PFAS is clearly underestimated. The authorities should review the materials of "Semiconductor PFAS Consortium https://www.semiconductors.org/pfas/" in detail. It is stated that the replacement of photo-oxidants will take more than 25 years.
Semiconductors	Increase the photosensitivity of the photoresist	Photoresist (photosensitizer)	PFOA (335-67-1) PFOS (1763-23-1)	Yes	Unconfirmed	No	N/A	PFOS has been largely phased out	-	
Semiconductors	Generate strong acids by light irradiation	Photoresist (Photo-acid generator, PAG)	PFOA (335-67-1) PFOS (1763-23-1) Shorter-chain PFAS (PFBS) functionalized fluoroethanesulfonates	Yes	Confirmed	None currently (patents filed/fluorine free alternatives have been proposed)	Aromatic PAGs identified in patents (WO2009091704) Heteroaromatic PAGs identifed in patents (WO2009091702, US20110183259).Triphenylsulfoniumbenzo[b]thiophene-2-sulfonic acid, 4(or7)-nitro-,ion(1-) (TPS TBNO) is identified Glodde et al. have proposed a Fluorine free PAG in their 2010 publication. Functionally need to generate strong acids	PFOS has been largely phased out	57,58	From "SIA PFAS Consortium"page38 https://www.semiconductors.org/pfas/ The authorities need to consider all the material at this URL. "non-PFAS PAGs (CN5 and thiophene sulphonate), which has highlighted the difficulty of developing formulations that meet all performance criteria simultaneously, as shown in Table 4-4. As such, non-PFAS PAGs are for a narrow range of use applications only, as no known non-PFAS PAG/photoacid exhibits the same level of performance for all criteria. While a candidate chemistry might show good acid strength, it will have lower photospeed because of lower acid diffusivity, and at the same time the acid anion might be transparent for a single wavelength only. PFAS PAGs, on the other hand, present simultaneously good to excellent performance for all listed performance criteria with the notable exception of environmental persistence."
Semiconductors	Controlling the diffusion of the acid to unexposed region	Photoresist (Quencher)	PFOA (335-67-1) PFOS (1763-23-1)	Yes	Unconfirmed	Uncertain	N/A	PFOS has been largely phased out	-	
Semiconductors	Provide low reflectivity	Antireflective coating	PFOA (335-67-1) PFOS (1763-23-1) PFHxS (alternative to PFOS/PFOA, 355-46-4)	It is noted the FP coating is not present in the final chip and is spun out and goes to waste/destroyed in the etching process	Confirmed	Yes	-AZ Aquatar 8 (Fluoroalkyl acid ester, homopolymer, hydrolyzed, 67829000004-6092P)[2] -DOW™ anti-reflect (non-PFOS), composed of solvents, acrylic, other polymer resins, cross-linking agents, stabilizers and/or surfactants -FP with a short fluoroalkyl side chain less than C4 -Alternatives should containt fluorine; functionally require low refractive index		19,59	The materials listed in column D has already been published in the Stockholm Convention. Column G is substituted for "present" and column H is substituted for "FP with a short fluoroalkyl side chain less than C4." This indicates that there is no substitute for all applications of semiconductors. The applications are diverse, and it is very dangerous to understand that there is one substitute for all alternatives. The authorities themselves describe FPs whose substitutions eventually have short fluoroalkyl side chains less than C4.
Semiconductors	Facilitate the control of the development process	Developer	PFOA (335-67-1) PFOS (1763-23-1) Shorter-chain PFAS used as alternatives to PFOA/PFOS	Yes	Confirmed	Uncertain	Patent US20080299487 for unfluorinated surfactant, vaguely described.	PFOS has been largely phased out	57	Contained in the product? is Yes,but like an antireflection film, no developer remains in the final semiconductor. But, the opinion that "photoresist used in semiconductor manufacturing does not remain in the product" is decades old, and current semiconductor technology uses photoresist in many applications to provide properties by leaving a variety of products in the final product. In this case, the PFAS remains in the final semiconductor product. In some applications, it should be emphasized that the PFAS remains in the final semiconductor product. Authorities should review the materials of the Semiconductor PFAS Consortium https://www.semiconductors.org/pfas/ in detail.
Semiconductors	Rinsing the photoresist to remove the developer	Rinsing Solution	Unknown	Uncertain	Unconfirmed	Uncertain	Use would require low surface tension		57	

Category of use	Function performed	Product(s)	PFAS identified	Contained in the product?	Actively used?	Alternatives available?	Alternatives Identified	Additional Comments	References	Comments on ChemSec-Electronics-Guide
Semiconductors	Etching	3M™ Fluorinert™ Electronic Liquids	PFOA (335-67-1) PFOS (1763-23-1) short-chain perfluoroalkyl sulfonates are alternatives in use today	No (at least there shouldn't be, its reported that PFAS is captured in the waste/it's a closed system)	Confirmed	Yes	Amyl acetate (628-63-7)、Anisole (100-66-3) n-Butyl acetate (123-86-4)、Ethyl lactate (97-64-3) Propylene glycol methyl ether acetate (108-65-6) Methyl-3-methoxypropionate (3852-09-3) non PFOS-based surfactants are in use for etching application for etching agents with ceramic filters (WSC 2011),		60	It seems that the description of equipment coolant is urged from row C, but since PFOS and PFOA are neither etchant nor coolant, it is strange in a double sense. The authorities do not understand the dry etching process of semiconductors. The authorities should review the materials of "Semiconductor PFAS Consortium https://www.semiconductors.org/pfas/" in detail.
Semiconductors	Etching Wetting agent	See General etching	See General etching	See General etching	See General etching	See General etching	Use would require low surface tension		See row for "General etching"	
Semiconductors	Etching Reduce the reflection of the etching solution	See General etching	See General etching	See General etching	See General etching	See General etching	Use would require low refractive index		See row for "General etching"	
Semiconductors	Etching agent in dry etching	See General etching	See General etching	See General etching	See General etching	See General etching	Use would require Strong acids		See row for "General etching"	The main dry etch is PFC, and those indicated by "PFAS identified" are not used. "Alternatives Identified" are also completely wrong.
Semiconductors	Etch Cleaning of Silicon Wafers	General etching	PFOA (335-67-1) PFOS (1763-23-1) PFBS (375-73-5) PFNA (375-95-1) PFHxA(307-24-4)	No	Unconfirmed (patented) [1]	Uncertain	Patent EP 3 588 535 A1 details several surfactants including PFAS and non-fluorosurfactants which may be alternatives[1] Use would require Strong acids [35]		1, 61	Perfluoroalkyl acids such as PFOA and PFOS (which are already substances subject to the Stockholm Convention) are not used for "etch cleaning of silicon wafer". This usage information for PFOA and PFOS is incorrect. Therefore, the description of line H is completely wrong. It can be guessed from the document of the authority that the description is about photo-oxidizer, but it seems that the answer is not about wafer etching but about photoresist. In addition, the description of the patent is found on the whole, but for this technology to be established as a substitute, many tests and quality assurance are required for mass production. In the end, there are many patents that are not used because the test and quality assurance cannot be satisfied and cannot be applied to mass production. By listing the patent number, authorities that provide alternative cases underestimate the difficulty of substitution. Authorities should review the Semiconductor PFAS Consortium https://www.semiconductors.org/pfas/ document in detail.
Semiconductors	Remove cured epoxy resins/Cleaning of integrated circuit modules		Unknown	Uncertain	Unconfirmed	Uncertain	N/A			
Semiconductors	Remove dielectric film build up	Cleaning vapour deposition chamber	Unknown	Uncertain	Unconfirmed	Uncertain	Use would require reactive oxygen species (ROS) generation[1]		1	
Semiconductors	Non-stick coating composition on carrier wafer	Wafer thinning	PFOA (335-67-1), PFOS (1763-23-1) likely if used, but unconfirmed	Uncertain	Unconfirmed (patented) [1]	Uncertain	Use would require low surface tension[1]		1	PFOA and PFOS subject to the Stockholm Convention are described in Wafer thinning, but the meaning of this description is not understood.
Semiconductors	working fluid	Vacuum pumps	Perfluoroalkoxy alkanes (PFA) fluoropolymers	Uncertain	Unconfirmed	Uncertain	Use would require alternative be stable, non-reactive[1]		1	
Semiconductors	polymeric PFAS used in inert moulds, pipes, elastomers	Technical equipment in contact with process chemical or reactive plasma	Polymeric PFAS	Uncertain	Unconfirmed	Uncertain	Use would require alternative be stable, non-reactive[1]		1	
Semiconductors	Bonding ply composition	Multilayer circuit board	PFOA (335-67-1), PFOS (1763-23-1) likely if used, but unconfirmed	Uncertain	Unconfirmed (patented) [1]	Uncertain	Use would require low dielectric constant, low dissipation factor[1]		1	PFOA and PFOS subject to the Stockholm Convention are described, but the meaning of this description is not understood. "Authorities should review the Semiconductor PFAS Consortium https://www.semiconductors.org/pfas/ document in detail.
Semiconductors	Vapor Phase Soldering	Galden® LS and HS grades (LS/HS) [36]	PFPEs	Yes	Confirmed	Uncertain			33	Alternative materials that do not affect the substrate by soldering with high temperature reflow need to be developed. Authorities should review the Semiconductor PFAS Consortium https://www.semiconductors.org/pfas/ document in detail.

Emi Yamamoto (JP4EE)Attachment

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List of abbreviations

Acronym	Explanation
6:2 FTSA	6:2 Fluorotelomer sulfonic acid
PFOS	Perfluorooctane sulfonic acid
PFBA	Perfluorobutanoic acid
PTFE	Polytetrafluoroethylene
PVDF	Polyvinylidene fluoride
PCTFE	Polychlorotrifluoroethylene
HFP	Hexafluoropropylene
FEP	Fluorinated ethylene propylene
ETFE	Ethylene tetrafluoroethylene
ECTFE	Ethylenechlorotrifluoroethylene
FEVE	Fluoroethylene Vinyl Ether Resin
LiTFSI	Lithium bis(trifluoromethanesulfonyl)imide
LiBETI	Lithium bis(pentafluoroethanesulfonyl)imide
LiFSI	Lithium Bis(fluorosulfonyl)imide
PFHxA	Perfluorohexanoic acid
PFPE	Perfluoropolyether
PFHxS	Perfluorohexane sulfonic acid
PFBS	Perfluorobutane sulfonic acid
PFNA	Perfluorononanoic acid

Attachment: Flow Control Coalition Submission: Currently Unavoidable Uses **Converted from Microsoft Excel to Adobe PDF 3/5/2024** March 1, 2024

Product Description	GPC/HTS Code	Use of PFAS	Alternatives
Backflow Preventer Parts / Accessories	10005865	Fluoroelastomer/polymer seals	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Backflow Preventers	10005866	Fluoroelastomer/polymer seals	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Backflow Test Kits	10005863	Fluoroelastomer/polymer seals	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Vacuum Breakers	10005864	Fluoroelastomer/polymer seals	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Overhung Pumps	10008340	Fluoroelastomer/polymer seals, Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Between Bearings Pumps	10008341	Fluoroelastomer/polymer seals, Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Vertically Suspended Pumps	10008342	Fluoroelastomer/polymer seals, Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Submersible Pumps	10008343	Fluoroelastomer/polymer seals, Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Fire Hydrant Systems	10008344	Fluoroelastomer/polymer seals, Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Screw Pumps	10008345	Fluoroelastomer/polymer seals, Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Peristaltic/Roller Pumps	10008346	Fluoroelastomer/polymer seals, Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Vane Pumps	10008347	Fluoroelastomer/polymer seals, bearing components, wear disc, valve coating, magnetic couplings, vanes, push rods Flame resistant plastics used in wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Progressive Cavity Pumps	10008348	Fluoroelastomer/polymer seals, bearings, stators, joint sealing Flame resistant plastics used in wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".

Product Description	GPC/HTS Code	Use of PFAS	Alternatives
Gear Pumps	10008349	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Lobe Pumps	10008350	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Piston Pumps	10008351	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Plunger Pumps	10008352	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Diaphragm Pumps	10008353	Fluoroelastomer/polymer seals, valve seats, check valves, diaphragms, pump head components, tubing, valving, pistons, Flame resistant plastics used in cables, wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Pneumatics Pumps	10008354	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Industrial Pumps - Electric Engines	10008355	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Industrial Pumps -Combustion Engines	10008356	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Industrial Pumps – Replacement Parts / Accessories	10008364	Replacement parts would use various PFAS for repair of pumps (seals, components, etc)	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Fire Fighting Equipment	10008382	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Industrial Pumps - Engines	11030100	Fluoroelastomer/polymer seals Bearing components Flame resistant plastics used in Wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Industrial Pumps – Replacement Parts / Accessories	11050100	Replacement parts would use various PFAS for repair of pumps (seals, components, etc)	Alternate materials do not exist that meet the MDEP definition for "Alternative".

Product Description	GPC/HTS Code	Use of PFAS	Alternatives
Pumps	10004055	Fluoroelastomer/polymer seals, bearing components, molded plastic components, Tribologic components, coatings Flame resistant plastics used in cables, wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Valves/Fittings - Water and Gas	10004024	Fluoroelastomer/polymer seals, valve liners	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Valves/Fittings Accessories/Replacement Parts - Water and Gas	10008011	Includes multiple PFAS materials for replacement/repair. (e.g. bearings, gaskets, compression packings, seals, seats, linings)	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Underfloor Heating	10004003	Fluoroelastomer/polymer seals Flame resistant plastics used in cables, wiring, Motors and Controllers required to meet UL safety standards.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Relays/Contactors	10005570	PFAS critical for meeting UL and NEC flammability safety standards	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Switches	10005586	PFAS critical for meeting UL and NEC flammability safety standards	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Inverters	10008390	PFAS critical for meeting UL and NEC flammability safety standards	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Distribution Boards/Boxes	10005583	PFAS critical for meeting UL and NEC flammability safety standards	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Circuit Assemblies/Integrated Circuits	10005661	PFAS critical for meeting UL and NEC flammability safety standards. Used in coatings for water resistance	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Thread Sealant (Paste)	3403.19.00.00	Fluoropolymer friction reducer and thread sealant critical to NPC piping systems and system sealing. Chemical resistance, Gas permeability, coefficient of friction, non-hardening properties.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Thread Sealant (Tape)	3403.19.00.00	Fluoropolymer friction reducer & thread sealant critical to piping systems and system sealing. Chemical resistance, Gas permeability, coefficient of friction, non-hardening properties.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Lined Hoses	3917.39.00.10 3917.21.00.00 4009.42.00.50 3917.33.00.00 3917.29.00.90 3917.39.00.50	Temperature and chemical resistance	Alternate materials do not exist that meet the MDEP definition for "Alternative".

Product Description	GPC/HTS Code	Use of PFAS	Alternatives
Lined Pipes Valves and Fittings	7306.19.10.10 8481.30.20.90 8481.80.30.65 8481.80.30.20 7307.19.90.80 8481.80.90.50 7307.99.10.00 7306.19.10.50 8481.80.10.90 8481.80.30.30 8481.80.30.75	Temperature and chemical resistance	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Sealants	10003204	Chemical resistance, Gas permeability, Diffusion coefficient	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Adhesives		Chemical resistance, Gas permeability, Diffusion coefficient	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Lubricating Greases	10005268	Long period operation, High temperatures, Low friction/low wear, Good gliding properties, Resistant to aggressive chemicals and reagents	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Lubricating Oils/Fluids	10005267	Long period operation, High temperatures, Low friction/low wear, Good gliding properties, Resistant to aggressive chemicals and reagents	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Lubricating Products Variety Packs	10005270	Long period operation, High temperatures, Low friction/low wear, Good gliding properties, Resistant to aggressive chemicals and reagents	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Lubricating Waxes	10005269	Long period operation, High temperatures, Low friction/low wear, Good gliding properties, Resistant to aggressive chemicals and reagents	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Grinder/Macerator	10002611	Fluoroelastomer/polymer seals, bearing components	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Mechanical Seals	10008364	Fluoroelastomer/ polymer seals	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Compression Packing	6815.19.00.00 3901.10.50.30 5911.90.00.40 6815.13.00.00 6815.19.00.00	Fluoropolymer yarns and yarn coatings. Chemical resistance, Gas permeability, temperature capability and coefficient of friction.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Reciprocating Seals	3926.90.45.00	Fluoropolymer/ Fluoroelastomer base material for molded/machined seals. Chemical resistance, Gas permeability, temperature capability and coefficient of friction.	Alternate materials do not exist that meet the MDEP definition for "Alternative".

Product Description	GPC/HTS Code	Use of PFAS	Alternatives
Rotary Seals	3926.90.45.00 4016.93.00.00	Fluoropolymer/Fluoroelastomer base material for molded/machined seals. Chemical resistance, Gas permeability, temperature capability and coefficient of friction.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Gasketing	3920.99.10.00 3920.99.50.00 3921.90.40.90 4002.59.00 3904.61.00.90 3926.90.45 3920.10.00.00	Fluoropolymer and fluoroelastomer base material for sheets, tapes, fabricated parts. Chemical resistance, Gas permeability, temperature capability, compressibility and coefficient of friction.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Flange Guards (Fabric)	5407.71.00.60	Fluoropolymer fibers/yarns/ fabrics. Chemical resistance, Gas permeability, temperature capability and coefficient of friction.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Expansion Joints	4016.93 3926.90.90 7307.99.00 4016.99 3926.90.90 3926.90.99	Fluoropolymer and fluoroelastomer base material, coating, liner or cover. Chemical resistance, Gas permeability, temperature capability and coefficient of friction, flexural toughness	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Diaphragms	8413.91 3926.90.45	Fluoropolymer and fluoroelastomer base material. Chemical resistance, Gas permeability, temperature capability and coefficient of friction, flexural toughness	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Industrial Valves & parts	9032 8481	Includes multiple PFAS materials based on the specific application need; multiple performance characteristics depending on application.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Actuators	8412 8471	Includes multiple PFAS materials based on the specific application need; multiple performance characteristics depending on application.	Alternate materials do not exist that meet the MDEP definition for "Alternative".
O-Rings	4016.93.0000	Includes multiple PFAS materials based on the specific application need; multiple performance characteristics depending on application, to include chemical and temperature resistance; reduce friction	Alternate materials do not exist that meet the MDEP definition for "Alternative".
Spring energized seals	8481	Specialty seals used in extreme temperatures to restrict emissions to atmosphere in cryogenic applications	Alternate materials do not exist that meet the MDEP definition for "Alternative".

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Valve Manufacturers Association: Heather Rhoderick, hrhoderick@vma.org; (202) 331-4039
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Baker Hughes PFAS UUD

Product	Product Uses	Baker Hughes Brand	Product GPC Brick Codes https://gpc-browser.gs1.org/	Applicable HTS US Code-(import)	Components in Product Containing PFAS Substances	Type of PFAS Used in Components	Intended use of the product and explain how it is essential for health, safety or the functioning of society	Describe how the specific use of PFAS in the product is essential to the function of the product	Available Alternative Technologies	Additional Comments
Condition Monitoring and Industrial Inspection Equipment, Pressure and Flow Measurement Devices and Sensing Equipment	Power Generation (e.g., power plants gas/steam turbines, wind, hydro, nuclear) Chemicals Mining and Metals Industrial applications Municipal applications Transportation applications (highways, roads, bridges, railway lines, aircraft)	Bently Nevada Waygate Technologies Panametrics Druck Reuter-Stokes		9031.80.8085 8537.10.9170 8543.90.8885 8543.70.4500 9031.49.9000 9002.19.0000 9031.90.9195 9022.12.0000 9022.90.2500 9022.90.4000 9026.10.2100 9026.80.2000 9026.20.4000 9026.90.6000 9032.89.6050 9026.90.2000 9026.20.8000 9026.90.0000 9026.20.8000 9030.10.0000 9027.50.4060	PFAS is in the value chain of condition monitoring/inspection/sensing equipment and has been identified in electronic components and sensors, including: • Semiconductors • Printed Wiring Boards • Cables • O Ring seals, Gaskets	• Polytetrafluoroethylene (PTFE) • Fluorocarbon Rubber (FKM) • Perfluoroelastomer (FFKM) • Trifluoroethylene-propylene copolymer (FEPM) • CAS Number: 9002-84-0 Teflon • CAS Number: 9011-17-0 Viton • CAS Number: 25067-11-2 Hexafluoropropylene / tetrafluoroethylene copolymer • CAS Number: 29420-49-3 Potassium 1,1,2,2,3,3,4,4,4-nonafluorobutane-1-sulphonate • CAS Number: 65545-80-4 2-(Perfluoroalkyl) Ethanol	Monitoring of the performance of various types of equipment and infrastructure to ensure integrity and safety. Equipment monitoring includes air compressors, compressors, gear boxes, gas and steam turbines, marine propulsion, motors, pumps, cooling tower fans, centrifuges, ball mills, blowers, agitators. Infrastructure monitoring includes bridges, railroad tracks, aircraft and industrial infrastructure. Industrial sensors applications include precise radiation measurement, nuclear reactor monitoring, UV flame detection, and downhole sensing for directional drilling. Druck's piezo-resistive pressure sensors, pressure transducers, pressure test and calibration instruments are used in toughest environment across wide range of industries including Aerospace, Transportations, and other Industrial applications. Panametrics' solutions for measuring and analyzing moisture, oxygen, liquid, steam, and gas flow are widely deployed across many industries, including oil and gas. Industrial inspection products	These products use components containing Teflon, Viton, and PTFE which have the following properties: Chemical resistance, Low volatility/high stability, Thermal resistance, Cleanliness, UV resistance, and Flame resistance. Teflon can withstand temperatures from -200 to 260 degrees Celsius, which makes it a good choice for cables and wires that will be exposed to high temperatures like in the case of turbines or compressors where our sensors will be installed.	We are not aware of any available alternative at this time. Similar products include: • Polyurethane: It is a type of potting compound that is often used as an insulator in for PWA assemblies. This cannot be used at higher temperatures such as up to 260 degrees. • Ethylene-propylene diene monomer (EPDM): It is a type of rubber that is also often used as O-rings. This material is not resilient to petroleum products and has low resistance. It cannot be used in high temperatures. • Silicone: is a material often used as a coating for cables and wires. At prolonged high temperatures, aging silicone rubber will result in gradual hardening, shrinkage, and embrittlement. This means that frequent maintenance will be required. Silicone does not meet the temperature, chemical resistance, and lifespan requirements.	
Compressors	Hydrogen Mining Energy Injection of CO2 Gas pipelines Industrial facilities Petrochemical Plants Power Generation Municipal facilities	Nuovo Pignone		8414.80.2015 8537.10.9170	PFAS can be found in compressors in gaskets, seals, washers, abradable seals, anti-friction and/or anti-corrosion coatings. Also, in a compressor system, PFAS are used in most of subcomponents like control and safety valves, lube oil system, flexible hoses, filtering systems, heat exchangers, and cables. Compressors also have a set of auxiliary equipment (e.g., sensors and their cabling) that contain PFAS. Compressors are incomplete without the auxiliaries and cannot function.	• Polytetrafluoroethylene (PTFE) • Fluoroelastomers (FKM) • Fluorosint 500 • Halar • Teflon • FFKM - Perfluoro elastomer • Aflas • VITON • Xylan • FVMQ • Fluorosilicone • Sermalon • PFA • ETFE • Modified polyolefin	Compressors are used for a wide variety of industrial, manufacturing and municipal applications: • Hydrogen (reciprocating compressor) • CCUS (high pressure compressors working with CO2) • Liquefied Natural Gas (centrifugal compressors) • Industrial (refining, chemicals – usually centrifugal compressor) • Pipeline (centrifugal compressors) • Air compression	Given the extreme working conditions that are typical for compressors (high pressure, cryogenic or high temperature, corrosive and toxic environment with H2S, CO2, NH3), PFAS are instrumental to ensure safe operations, high efficiency, and extended maintenance intervals. PFAS are critical for use in gaskets, seals and coatings. Gasket and seals are essential to avoid leaks or sudden release of high pressure and toxic gas. Coatings are necessary to withstand harsh gas mixtures. The design of compressors, including use of components with PFAS, is dictated by specific industrial standards (e.g., API 617, API 692, API 684, API 6A) or customer's technical specifications.	The use of metallic seals in gaskets could be studied for the face seal on the head flange, while a complete redesign is required for radial gaskets. The redesign would require 200 hours per compressor model (we have 10 different compressor models), a complete test campaign, a review of the assembly cycle of all models and consequent investments would require significant amount of money for cycle variations. The use of metallic seals in gaskets could be studied for the face seal on the head flange, while a complete redesign would be required for radial gaskets. Such redesign effort for the entire compressor product line would require thousands of engineering hours and dedicated component and full-scale validation and verification tests. Also, a review of manufacturing and assembly cycles with relative investments would be needed. Overall, the impact is estimated in the order of several millions of euros. We tested valves with a graphite packing and a metal seal, but they increased energy use or did not meet standards due to higher leakage. For coating in Xylan, an alternative solution is still not available. Once available, product redesign will be	Feasibility of complete replacement of PFAS gaskets and seals with PFAS free alternatives is uncertain. The efforts to transition to a PFAS-free operation of compressors will be challenging as alternatives that will guarantee the same level of safety and efficiency of machines do not exist. It is also notable that non-PFAS seals are not compliant with some customer specifications, resulting in the loss of competitiveness by US manufacturers/importers. Known alternatives to PFAS for seals (e.g., graphite) provide significantly worse sealing performance and add additional friction to the valve motion. This friction increases the entire energy consumption of the industrial plants leading to even more emissions to provide that power. Even if an alternative component is identified, our compressors would need to be redesigned, retested, new manufacturing processes established, new sub-supplier qualifications,
Gas and Steam Turbines	Power Generation Chemical Industrial applications Gas transportation pipelines Navy (marine)	Nuovo Pignone		8411.82.8010 8406.81.1020 8406.82.1010 8406.82.1020	PFAS components are used in gaskets, O-rings, seals and washers. Other elements include valves and filtering systems, which are needed to ensure the proper operation. Turbines also have a set of auxiliary equipment (e.g., sensors and their cabling) that contain PFAS. Turbines are incomplete without the auxiliaries and cannot function.	• Chemloy • Polytetrafluoroethylene (PTFE) • Fluoroelastomer (FKM) • Perfluoroelastomer (FFKM) • CAS Number: 9002-84-0 Teflon • CAS Number 9011-17-0 – Viton	Turbines are used as a mechanical drive for compressors and pumps (e.g., LNG liquefaction plants, CO2 injection sites), pipelines and power generation and for heat and power systems (notably cogeneration).	Both gas and steam turbines are operated with high pressure and high temperature fluids to achieve the highest levels of efficiency, and due to this both technologies require durable components to ensure reliable and safe operations. PFAS substances are critical elements in turbines - they can be found in gaskets, seals and washers. All these pieces of equipment ensure the expected performance in terms of power and efficiency. Gas and steam turbines, which are used for the oil and gas industry, are specifically designed according to several industrial standards (e.g., API 612, API 616) and customers' specifications may be even more stringent. In general, PFAS substances are instrumental to guarantee safe operations and extended intervals without failure.	At this stage, we do not have any information on potential alternatives as we have not tested them during the period of consultation. Mineral fibers have been assessed in a theoretical setting but are less flexible. Spiro-metal gaskets are less flexible and must be studied further for radial applications. Metallic gaskets (which are non-flexible) are an option for a limited number of seals. Studying and applying alternatives would require: - Approximately 500 engineering hours for feasibility studies; • If feasible, product redesign would require 1,000 hours per engine model; and • a complete test campaign, a review of the assembly cycles of all models and consequent high investments would be required. PFAS oil seals allow for reduced clearances and consequent reduced safety and environmental risks. Metallic seals are already in use, but normally are associated with higher leakages thus resulting in lower efficiency and performance versus non-metallic seals. They have lower resistance to harsh conditions	Feasibility of complete replacement of PFAS gaskets and O-ring with PFAS free alternatives is not yet confirmed. The efforts to transition to a PFAS free operation for turbines will be challenging as finding alternatives that will guarantee the same level of safety and efficiency of machines does not exist at this stage. It is also notable that non-PFAS seals are not compliant with some customer specifications, resulting in the loss of competitiveness by US manufacturers/importers. Even if an alternative component would be found, which is uncertain at this stage, our turbines would need to be redesigned, retested, new manufacturing processes established, new sub-supplier qualifications, sources established. Furthermore, new certifications would be necessary, which requires human resources and takes time.

Masatoshi Tsuruoka (NECA) Attachment

Converted from Microsoft Excel to Adobe PDF 3/5/2024

			Application/HTS code
1	Safety switches	1	Emergency stop pushbutton switch / 8535.**, 8536.** (excluding .10), 8531.**, 8538.90 Safety switches / 8535.**, 8536.** (excluding .10), 8531.**, 8538.90 Safety limit switches / 8535.**, 8536.** (excluding .10)
2	Safety switches / Microswitch / Limit switch	2	Push-button switch / 8535.**, 8536.** (excluding .10), 8531.**, 8538.90 Microswitch / 8535.**, 8536.** (excluding .10) Limit switch / 8535.**, 8536.** (excluding .10)
3	Safety switches	3	Emergency stop pushbutton switch / 8535.**, 8536.** (excluding .10) Safety switches / 8535.**, 8536.** (excluding .10) Safety limit switches / 8535.**, 8536.** (excluding .10)
4	Push-button switch / Microswitch / Limit switch	4	Push-button switch / 8535.**, 8536.** (excluding .10) Microswitch / 8535.**, 8536.** (excluding .10) Limit switch / 8535.**, 8536.** (excluding .10)
5	Push-button switch / Microswitch / Limit switch	5	Push-button switch / 8535.**, 8536.** (excluding .10) Microswitch / 8535.**, 8536.** (excluding .10) Limit switch / 8535.**, 8536.** (excluding .10)
6	Limit switch	6	Limit switch / 8535.**, 8536.** (excluding .10)
7	Proximity switch	7	Proximity switch / 8536.50.70.00
8	Proximity switch	8	Proximity switch / 8536.50.70.00
9	Environment-resistant photoelectric switch with built-in amplifier	9	Environment-resistant photoelectric switch with built-in amplifier / 8536.50.70.00
10	External protection of liquid leak sensor	10	External protection of liquid leak sensor / 8536.50.70 00, 8536.70.00.00
11	External protection of fiber unit for Measurement use	11	External protection of fiber unit for Measurement use / 8536.70.00.00
12	Hermetic seal for optical junction unit for vacuum environment	12	Hermetic seal for optical junction unit for vacuum environment / 8536.70.00.00
13	Vibration Sensor	13	Vibration Sensor / 9026.10.20.80,
14	Connector Cable	14	Connector Cable / 8544.42.90, 8544.49.20.00
15	Pressure Sensors	15	Pressure Sensors / 9026.20.40.00
16	Sapphire Capacitance Diaphragm Gauge	16	Sapphire Capacitance Diaphragm Gauge / 9026.20.40.00
17	Coating and protective covering for diaphragm of industrial pressure transmitter	17	Coating and protective covering for diaphragm of industrial pressure transmitter / 9026.20.40.00
18	Displacement measurement sensor	18	**Displacement measurement sensor / 9032.89.20 00**
19	Displacement measurement sensor	19	**Displacement measurement sensor / 9032.89.20 00, 8536.5***
20	Safety Sensor	20	Safety Sensor / 8536.50.90.65
21	Relay	21	Relay / 8536.4*
22	Safety relay unit	22	Safety relay unit / 8536.4*
23	Safety Relay	23	Safety Relay / 8536.4*
24	Relay/Safety Relay	24	Relay / 8536.4* Safety Relay / 8536.4*
25	Terminal with communication function / Programmable display	25	Terminal with communication function / 8471.80.40 Programmable display / **8531.20:**
26	Image processing system	26	Image processing system / **8525.80**
27	Coding for sliding rubber parts of industrial controllers	27	Coding for sliding rubber parts of industrial controllers / 9032.89.60.40
28	Temperature sensor	28	Temperature sensor / **9032.89.60.40, 8538.90.40.00, 9025.19.80**
29	Humidity sensor	29	Humidity sensor / 9025.80.10.00
30	Safety controller	30	Safety controller / 8536.4*
31	Switching power supply / Transformer	31	Switching power supply / 8504.3* Transformer / 8504.3*
32	Measuring pipe lining material for industrial electromagnetic flowmeters	32	Measuring pipe lining material for industrial electromagnetic flowmeters / 9026.10.20.40
33	Fill Fluid for chlorine or oxygen pressure measurement	33	Fill Fluid for chlorine or oxygen pressure measurement / 9026.10.20.40
34	Mass Flow Controller seal	34	Mass Flow Controller seal / 9026.10.20.40
35	Mass Flow Controller lubricant oil	35	Mass Flow Controller lubricant oil / 9026.10.20.40
36	Control valve of mass flow controller	36	Control valve of mass flow controller / 9026.10.20.40
37	Fittings for micro-flow rate liquid flow meter for semiconductor manufacturing p	37	Fittings for micro-flow rate liquid flow meter for semiconductor manufacturing process / 9026.10.20.40
38	Control valve seat ring	38	Control valve seat ring / 8481.**
39	Material for scraper rings in industrial control valves	39	Material for scraper rings in industrial control valves / 8481.**
40	Lining and throttling mechanism materials for industrial control valves	40	Lining and throttling mechanism materials for industrial control valves / 8481.**
41	Valve for air volume and room pressure control	41	Materials for ensuring slidability, corrosion resistance, chemical resistance, and solvent resistance for airflow valves / 8481.**, 8415.10
42	RFID tag and antenna	42	RFID tag and antenna / **8523.52.00.??**
43	Ionizer	43	Ionizer / **8421.39**