REPORT TO THE LEGISLATURE

JANUARY 2025

Recommendations for products containing lead, cadmium, and PFAS

MINNESOTA POLLUTION CONTROL AGENCY

Recommendations for products containing lead, cadmium, and PFAS

Report to the Legislature, January 2025

Legislative charge

2024 Session Law, Chapter 116, Article 2, Section 31

Sec. 31. RECOMMENDATIONS FOR PRODUCTS CONTAINING LEAD, CADMIUM, AND PFAS; ENFORCEMENT MORATORIUM.

(a) By January 31, 2025, the commissioner of the Pollution Control Agency must submit a report to the chairs and ranking minority members of the legislative committees with jurisdiction over environment and natural resources finance and policy with legislative recommendations related to the following chemicals and products:

(1) the use of intentionally added perfluoroalkyl and polyfluoroalkyl substances (PFAS) in electronic or other internal components of upholstered furniture in the 2025 prohibition under Minnesota Statutes, section 116.943;

(2) the use of lead and cadmium in internal electronic components of keys fobs in the prohibition under Minnesota Statutes, section 325E.3892;

(3) the use of lead in pens or mechanical pencils included in the prohibition under Minnesota Statutes, section 325E.3892; and

(4) the use of intentionally added PFAS in firefighting foam used in fire suppression systems installed in airport hangers in the prohibitions under Minnesota Statutes, section 325F.072.

(b) The report required by paragraph (a) must include recommendations on whether extensions should be allowed for the uses of the chemicals described in paragraph (a).

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Minnesota Pollution Control Agency

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Introduction

In the 2024 legislative session (Chapter 116, Section 31), the Minnesota State Legislature instructed the Minnesota Pollution Control Agency (MPCA) to develop recommendations for products containing lead, cadmium, and perfluoroalkyl and polyfluoroalkyl substances (PFAS). The recommendations must include whether extensions should apply for the uses of the chemicals described in the section. The law also put an enforcement moratorium through July 1, 2025, into effect for the chemicals and products listed in the section. The report is due to the legislative body by January 31, 2025.

The law specified that MPCA must report on the following materials and chemicals:

1. The use of intentionally added perfluoroalkyl and polyfluoroalkyl substances (PFAS) in electronic or other internal components of upholstered furniture in the 2025 prohibition under Minn Stat. § 116.943;
2. The use of lead and cadmium in internal electronic components of key fobs in the prohibition under Minn. Stat. § 325E.3892;
3. The use of lead in pens or mechanical pencils included in the prohibition under Minn. Stat. § 325E.3892; and
4. The use of intentionally added PFAS in firefighting foam used in fire suppression systems installed in airport hangers in the prohibitions under Minn. Stat. § 325F.072.

Per- and polyfluoroalkyl substances (PFAS) are a class of thousands of manmade chemicals that have been widely used in industry and consumer products for several decades. They have attracted significant scientific and regulatory attention due to their ubiquity in the environment and resistance to breakdown. Several specific PFAS have been linked to increased risks for cancer, liver disease, immune system disfunction, and other negative health impacts. PFAS can also negatively impact aquatic life and wildlife. Because of the difficulty in treating PFAS or removing them from the environment, pollution prevention efforts are necessary to reduce human and environmental exposure to these chemicals.

Lead or cadmium in household products can cause serious problems for brain health and human development, especially in children, whose bodies are still developing. No amount of lead is considered safe in children, according to the Centers for Disease Control, and high levels of lead in children can cause behavioral problems, shorter attention spans, slower growth, and decreased coordination.

Many people know lead is harmful and possibly fatal when swallowed, so some manufacturers now use cadmium as a replacement, particularly in inexpensive jewelry. This alternative is marginally safer at best. Breathing in cadmium dust or swallowing an item containing cadmium can cause vomiting, diarrhea, abdominal pain, muscle aches, and organ damage.

The MPCA looked at independent research, talked to industry groups, and considered availability of current alternatives and timeline for possible implementation during the development of these recommendations.

The use of intentionally added PFAS in electronic or other internal components of upholstered furniture

PFAS use is widespread in electronic or other internal components of products, serving a number of functions depending on the product. This poses a challenge for manufacturers of products within the 11 categories that prohibit PFAS in 2025. Replacement of PFAS-containing internal components with PFAS-free safer alternatives requires time. Implementing an alternative may take one or more years, assuming there is an alternative available.

Manufacturers have already been searching for and testing non-PFAS alternatives for electronic or other internal components, with limited success. They are having difficulty finding alternatives for several reasons, including failure to meet performance standards for safety and longevity, lack of sufficient quantities of alternatives once identified, and redesign time constraints. Once an alternative is identified, the timeline for implementation varies by application and can take one or more years. This includes time for research and development, manufacturing changes, inventory buildup, and other considerations. PFAS alternatives are often not directly substitutable and require redesign of components and systems to accommodate the different properties.

PFAS are widely used in electronic components, the manufacture of electronics, and in semiconductors. The electronics industry uses PFAS for properties such as flame retardancy, chemical inertness, hydrophobicity, and dielectric strength. Examples of electronic components in the 11 categories that currently use PFAS include lithium-ion batteries, circuit boards, high pressure pumps, internal wirings, power cords, and wire insulations. Many uses of PFAS in electronics currently have limited available alternatives, including use in semiconductors, lithium-ion batteries, wiring and cable insulation for high voltage, lubrication and coatings in information and communication technology equipment, touchscreen displays with haptic feedback, gaskets in electronic circuits, and others. However, new alternative technologies are in development. PFAS-free alternatives in many electronics applications are limited for several reasons, including supplier perception of being outside the scope of PFAS regulations, information gaps, and supply chain complexity.

PFAS are also widely used in other internal components of products in the 11 categories. Many of these applications have limited available alternatives. Examples of PFAS use in internal components of furniture include ball bearings, lubricants, and other mechanical parts. Since “cookware” includes complex products such as kitchen appliances, examples of PFAS use in internal components of cookware include aluminum rivets, sealants, gaskets, protective nylon washers, gas exposed components, and foam blowing agents for insulation. Examples of PFAS use in internal components of cleaning products include gaskets, O-rings, and valves.

The statute has already provided an exemption for electronic products in the juvenile products category. This exemption addresses that replacing PFAS in electronics poses a specific challenge. California and Colorado have also exempted electronics from their prohibitions on PFAS in juvenile products and have additionally exempted other internal components. The language used in their electronics exemption mirrors our statute. The language used in their internal components exemption is: An internal component of a juvenile product that would not come into direct contact with a child’s skin or mouth during reasonably foreseeable use and abuse of the product.

There are many products that utilize electronic or other internal components. Some of these products are in the 11 categories that prohibit PFAS in 2025. Therefore, an exemption for electronic or other internal components until 2032 is recommended to allow manufacturers time to find and implement alternatives. This exemption will give manufacturers of products in the 11 categories the same amount of time to implement PFAS-free alternatives for electronic and other internal components as is provided to manufacturers of products outside the 11 categories that use similar internal components.

PFAS are a known threat to human health and environment. The early prohibitions on PFAS use in 11 product categories are meant to quickly reduce human exposure to PFAS in commonly used products. An update to the legislation to exclude electronic or other internal components from the 2025 prohibitions should not result in greatly increased risk of direct human exposure from product use. PFAS are also known to cause pollution through manufacture and disposal, which will be addressed by the overall PFAS prohibition in 2032.

References

Business and Institutional Furniture Manufacturers Association (BIFMA) report on PFAS in furniture.

Association of Home Appliance Manufacturers (AHAM) report on PFAS in cookware.

Household and Commercial Products Association (HCPA) report on PFAS in cleaning products.

Chemsec. Check Your Tech, A guide to PFAS in electronics. (2023) https://chemsec.org/reports/check-your-tech-a-guide-to-pfas-in-electronics/

Recommendation

The recommendation of the MPCA is to grant an exemption (until 2032) for the use of intentionally added PFAS in electronic or other internal components in the 11 product categories that prohibit intentionally added PFAS in 2025. Internal components pose less threat of direct human exposure. Products within the 11 categories often use similar electronic or other internal components as products outside these categories. There are currently limited available alternatives to PFAS for many electronic or other internal component applications. This exemption will allow manufacturers time to find, develop, test, and implement PFAS-free safer alternatives. It will give manufacturers of products within the 11 categories the same amount of time provided to manufacturers of products outside these categories (until 2032) to find and implement PFAS-free electronic or other internal components.

The use of lead and cadmium in internal electronic components of key fobs

The MPCA reached out to the Motorcycle Industry Council, Recreational Off-Highway Vehicle Association, the Specialty Vehicle Institute of America, and The Alliance for Automotive Innovation in developing this recommendation. In addition, MPCA conducted a literature search to identify relevant alternatives to lead in circuit boards used in key fobs.

NextPCB is an international manufacturer of printed circuit boards (PCB). Their website includes an analysis comparing lead vs. lead-free solder in manufacturing printed circuit boards (NextPCB, 2024). According to NextPCB , the PCB industry has tried different types of lead-free solder, however, lead solder is still preferred because it has a lower melting point and provides a smooth appearing joint that causes fewer quality issues. The most common lead-free solders are:

- Tin Copper – The most commonly used, improves the mechanical strength of the solder
- Tin Silver – One of the best electrical conductors, provides good corrosion resistance, while increasing conductivity
- Tin Zinc – Used when low melting point is critical, also is cost effective

These lead-free solders should be selected by considering their properties for the specific use. NextPCB concludes that lead-free solder has become a requirement due to the toxicity of lead. Lead-free solder is harder to work with, has a higher melting point, and is less reliable, but safe to use. Ultimately, they state that the right solder depends on the project and specific needs of the product. Therefore, understanding the properties and differences of the solder is critical to have a successful project.

Electronic Manufacturing Service (EMS) lays out similar strengths and weakness of lead solder and non-lead alternatives. EMS also articulates the European Union's Restriction on Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive, which restricts the use of six substances in electrical and electronic equipment, including lead. RoHS Directive requires that lead concentrations be lower than 0.1% by weight. EMS also discusses the European Union's Parallel Waste in Electrical and Electronic Equipment (WEEE) directive, aimed at collecting and recycling waste electronics. One important note is that Minn. Stat. § 325E.3892 is stricter than these other standards, however, the RoHS and WEEE standards have caused a lot of research into alternatives.

Wevolver, an online community of tech companies, universities, and individual contributors dedicated to helping engineers share information and stay up to date on new innovations, agrees with NextPCB that there are strengths and weaknesses to the various solder types. According to Wevolver, leaded solder is easier to work with but has toxicity issues. The proper non-lead solder to use varies by application. This information lines up with our research from the industry.

Science Direct is an online platform of peer reviewed research. Science Direct came to the conclusion that there are several alternatives to lead solder, but the only cost-effective versions are Zn-Al based or Bi based alloys. These low-cost alternatives have weak bonding strength. This finding does not line up with statements from some of the manufacturers of printed circuit boards.

Based on this information, there are alternatives to lead solder for the use in key fob circuit boards. There are various alternatives with different properties for use in different applications. It may take some time to make the changes to the manufacturing process to completely phase lead out of key fob circuit boards.

References

Lead vs Lead-free Solder - An Ultimate Guide - NextPCB (Next PCB, 2024)

High-temperature lead-free solder alternatives - ScienceDirect (Microelectronic Engineering, 2011)

Lead vs. Lead Free Solder: Is Lead Free Solder Better? - EMS (Electronic Manufacturing Service, 2024)

Lead vs. Lead-free Solder: Which is better for PCB manufacturing? (Wevolver, 2023)

Industry feedback

The Motorcycle Industry Council, Recreational Off-Highway Vehicle Association, the Specialty Vehicle Institute of America, and The Alliance for Automotive Innovation provided letters to the MPCA to help develop this report. This section summarizes their comments about the challenges of moving to lead-free solder in key fobs and they also addressed their concerns about the keys.

Motorcycle Industry Council
Specialty Vehicle Institute of America
The Recreational Off-Highway Vehicle Association

The Motorcycle Industry Council, Specialty Vehicle Institute of America, and the Recreational Off-Highway Vehicle Association submitted a letter about the lead and cadmium ban.

These three industry groups outlined several barriers to being able to phase lead out of keys and key fobs as laid out below:

- Lead is currently present in keys of all types and fashion.
- Current law allows no phase out period.
- Current law does not allow for any time to search out alternatives to lead and cadmium.

Due to the challenges listed, the industry groups are requesting 24 months to accomplish the required changes. They are also requesting exemptions for after-market or replacement/service parts for vehicles and inventory in existence prior to the law's passage.

Alliance for Automotive Innovation (AAI)

The Alliance for Automotive Innovation (AAI) also provided feedback for MPCA's request for information on the report. In the letter, they referenced a 2001 case from the State of California, where key manufacturers agreed to lower their lead content by 40%, which resulted in bringing the amount of lead in brass keys below 1.5%, but that is still 15,000 parts per million (ppm). The AAI states that it would be much more difficult to attain the 90 ppm threshold stated in the Minn. Stat. § 325E.3892. They also state that the European Union exempted lead in keys below 4%.

The AAI believes that most keys in production at this time exceed the threshold established in Minn. Stat. § 325E.3892, but they appreciate that MPCA's guidance puts less emphasis on the key fobs at this time.

Finally, the AAI identified several challenges to implementing lead-free keys:

- Lead-free solder can cause tin whiskers that cause shorts and would be even more problematic on small circuit boards such as those used in key fobs.
- Replacement parts are built when the vehicle is, so should not be included in the law. Replacement parts include key fobs.

Recommendation

The MPCA recommends providing a 3-year extension for the key industry to implement changes in the solder in key fobs. While there are alternatives, there are reasonable barriers, and time to identify workable alternatives in the key fob boards. The MPCA agrees that additional time should be allowed for the industry to identify feasible non-harmful alternatives to lead solder. If an extension is provided, the law should require progress reports every six months. The reports should detail the barriers to implementation, progress achieved and provide an updated timeline for full adoption of non-lead products.

Key fobs are not the only product that contains internal circuit boards subject to the new law. The MPCA believes that all of the other categories should get similar extensions for lead solder in internal electronic components. As such, the MPCA recommends an extension of three years for the internal components for lead solder to be consistent and fair in the implementation of Minn. Stat. § 325E.3892.

The use of lead in pens or mechanical pencils

Industry feedback

The Writing Instrument Manufacturing Association (WIMA)

The Writing Instrument Manufacturing Association (WIMA) submitted a letter to MPCA about the challenges of complying with the requirements in Minn. Stat. § 325E.3892. The challenge for WIMA is the pen tips. All pen tips consist of a tungsten carbide ball contained within a tip made of brass, nickel silver, or stainless steel. Most pen tips have lead that exceeds 2,500 ppm.

According to WIMA, writing manufacturers have been working for years to identify alternative materials for pen tips, but none have been identified. Even the stainless steel used in pen tips exceeds the 90 ppm lead limit Minnesota has set.

The WIMA is also concerned about higher end mechanical pencils with metal tips and sleeves that contain lead. Although WIMA admits in their letter that there are alternative plastic mechanical pencils that do not contain lead.

Mikron

Mikron manufactures the equipment that make 90% of pen tips worldwide. The Mikron website contains useful information about the use of brass, nickel silver, and stainless steel.

Mikron informed MPCA about the manufacturing process and the limitations of their equipment. Through their website and conversations with the company, MPCA found the following:

- All brass has lead in it, but the use of brass tips is declining. It is possible to use lead-free brass, but it is currently cost prohibitive to change the equipment.
- Nickel silver has small amounts of lead, less than 0.05% (500 ppm). Currently there are not lead-free alternatives.
- There are two types of stainless steel used for pen tip manufacturing.
  - SF20T: It’s the most common, with a lead content of 0.1% to 0.3% (1,000 ppm to 3,000 ppm).
  - SF20E: Uses sulfur instead of lead. The cost for switching to this material is almost zero, but cannot be manufactured as quickly as SF20T.
- Different materials are compatible with different inks. Stainless steel is used for gel-type or roller type inks, where brass and nickel silver are used for low viscosity oil-based inks.
- Because oil-based inks need brass and nickel silver pen tips, those pen types are not currently able to comply with Minnesota’s law.

Mikron shared that changing to non-lead alternatives was possible because they already make non-brass tips, although they identified some challenges. The non-lead alternatives are somewhat slower to manufacture and the wear on the equipment is such that more maintenance is needed.

Recommendation

Due to the existence of plastic mechanical pencils and traditional wooden pencils, the MPCA does not recommend any extension for lead in mechanical pencils. Lower cost plastic mechanical pencils and traditional wooden pencils can satisfy pencil demands. Higher end metal mechanical pencils could still be sold in Minnesota, if they utilize metal for the tips and sleeves that do not contain lead at 90 ppm.

There is more complexity and challenge with pens. The MPCA recommends a 3-year extension to allow the pen manufacturers to switch to lead-free pen tips for Minnesota. Most pen manufacturers have some production of lead-free tips and should be able to increase production to accommodate the volume of pens needed in Minnesota. The MPCA also recommends progress reports every 6 months to ensure that the industry is progressing toward compliance. The report should detail the barriers to implementation, progress achieved and an updated timeline for full adoption of non-lead products.

The use of intentionally added PFAS in firefighting foam used in fire suppression systems installed in airport hangars

Background

One of the legacy uses of PFAS is specialized firefighting foams for petroleum product fires, especially fires involving aviation fuels. Due to the weather, airports in Minnesota present especially high-risk situations for aviation fuel fires because most aircraft maintenance work and storage takes place in purpose-built buildings on airport grounds called hangars.

> **Note:** In common parlance, the word "hangar" may be used to mean either the whole building that may hold many aircraft, or an individual partition within that building that each typically houses only a single aircraft. In the airport industry, the term hangar usually applies to the former whole building meaning, and the term "stall" is used for the latter meaning. The MPCA applies the former meaning throughout this section of this Legislative Report.

Findings

There are roughly 2,631 hangars on the 136 licensed land-based airports in Minnesota. The majority of hangars in Minnesota are small, stand-alone structures, house only one or two aircraft each, and are not equipped with any firefighting system beyond portable fire extinguishers and proximal aircraft rescue and fire fighting (ARFF) trucks or the municipal fire department. However, for the small minority of large hangars used for maintenance on large passenger jets or military aircraft in the state, which may include "hot work" such as welding or grinding in close proximity to engines or fuel tanks and which may hold extremely expensive aircraft, more fire protection may be required by controlling parties such as insurance carriers or by building codes. Because aviation fuels generally will float on water, standard fire sprinkler systems may aggravate rather than extinguish a fire. Thus, specialized firefighting foam or complicated water deluge systems may be built directly into these large hangars, referred to in this Legislative Report as fixed firefighting systems.

After requesting information from the Minnesota Department of Transportation (MnDOT) and all land airport operators in Minnesota, the MPCA is aware of only 19 hangars in the state equipped with fixed firefighting systems. Of these, the majority are either deluge water systems or utilize a type of modern firefighting foam does not contain PFAS, called high-expansion foam. The MPCA is aware of only eight hangars remaining in the state with fixed firefighting systems that use PFAS-containing firefighting foam, all of them owned and operated by Delta Air Lines (Delta) and located at the Minneapolis-St. Paul International Airport (MSP).

Current regulatory status

While most PFAS-containing firefighting foam use in Minnesota has been banned, under the effect of the current Minnesota Statute § 325F.072, Subdivision 3, paragraph (c), last amended in 2023, this ban does not apply "…at an airport…" until the state fire marshal makes a determination that certain conditions have been met. This temporary exemption does not currently differentiate between use of PFAS-containing firefighting foam in ARFF trucks or in fixed firefighting systems in hangars.

Therefore, until the State Fire Marshal makes a determination, continued use of the eight remaining hangar fixed firefighting systems that use PFAS-containing foam is allowed. However, this exemption is temporary and of indeterminate period.

Use of PFAS-containing foam in hangar fixed firefighting systems is not directly required under any federal, Minnesota, or local law, however hangar fire protection systems are specified by National Fire Protection Association (NFPA) Standard 409, which is referenced in the 2018 International Building Code (IBC), Chapter 4, Section 412, itself adopted by reference as the 2020 Minnesota Building Code under Minnesota Rules, Part 1305.0011.

> **Note:** The development and application of NFPA standards and compliance with them by industries whether or not adopted by law is discussed in more detail in the MPCA's January, 2024, Legislative Report on PFAS in firefighting turnout gear, available at: https://www.pca.state.mn.us/sites/default/files/lrc-pfc-5sy23.pdf.

Previously, since 1985, NFPA 409 required certain hangars considered to present high risks, designated as Group I hangars, to default to fixed firefighting systems utilizing PFAS-containing foam in many instances. As of 2022, NFPA 409 allows alternatives for determining and defining hangar fixed firefighting system type and specifications other than those utlizing PFAS-containing foam. This process, however, involves a lengthy comprehensive fire risk assessments for each affected hangar, together with review and approval by the airport operator and relevant fire official.

Considerations in transition

Transition from PFAS-containing firefighting foams to alternative fire suppressants, such as water deluge, or fluorine-free foam (F3) systems is not a simple matter of draining and refilling the system. New F3 and high-expansion foam products are not only generally chemically incompatible with legacy foam products, they themselves vary widely in the physical characteristics that are critical to the design and installation of a safe fixed firefighting system, such as density, viscosity, solubility, thermal stability, and even compatability with system component materials, such as certain metals or sealants. In parallel, fixed firefighting systems, to maximize safety, effectiveness, and efficiency, are designed and tailored to the specifications of the foam or other suppressant to be used in them, such that a component intended for use with one product may commonly be unusable for a different foam or other suppressant product. Therefore, replacement of a fixed firefighting system other than a simple sprinkler system may require major renovation to remove the legacy system and provide space for a replacement system, with different discharge points, piping runs, and tankage necessary.

The eight remaining hangars with fixed firefighting systems utilizing PFAS-containing foam located at MSP and operated by Delta are among the largest hangars in the state, and provide necessary workspace for critical maintenance and inspection operations for the airplanes carrying nearly 24 million passengers annually through MSP, 68% of all passengers passing through this nationwide air hub. The

MPCA recognizes that any fixed firefighting system replacement for these hangars may require temporary relocation of these activities during building renovation. A phased approach will likely be necessary, with the hangars being transitioned in staggered sequence to allow for large passenger aircraft maintenance and inspection to continue, since this work cannot be safely or effectively performed outside during many months in Minnesota.

Current transition status

In the October, 2024, Minnesota Airports PFAS Transition White Paper published jointly by MnDOT and the University of Minnesota's Airport Technical Assistance Program (AirTAP), Delta stated that it had begun the NFPA 409 alternative determination process, and anticipated that a complete transition, including the determination process, would take at least three years from the date of the White Paper.

In support of this Legislative Report, Delta reported that it expected to have the required individual fire risk assessments completed for each of its eight hangars completed by the end of 2024. Delta stated that it believes customized water deluge systems may provide sufficient fire protection, and that such systems would be the fastest replacement option to design and install after completion of the major structural renovation necessary to remove the existing PFAS-containing foam fixed firefighting systems and provide access for a new system. Delta estimated that completion of transition to a water deluge system could be completed in three years from the date of this Legislative Report.

However, Delta also cautioned that it is possible that some or all of its hangars may additionally or instead require high-expansion foam or other non-PFAS-containing foam systems, which would require additional design and construction time beyond the estimated three year minimum when time needed for supplementary review and approval of the alternate systems by required parties such as the Metropolitan Airports Commission (MAC) and fire officials is included.

Recommendation

The MPCA recommends that the Legislature establish a specific date for a mandated transition of airport hangars separate from the general airport PFAS-containing foam use exemption in current law, paired with the potential for extensions of this date upon a showing of genuine need and public protection. The MPCA suggests establishing January 1, 2028, as the hangar transition deadline, two and a half years from the date of enactment and three years from the date of this Legislative Report, the minimum time currently forecast by Delta.

The MPCA further recommends that the Legislature allow a hangar operator to apply for one-year extensions to this deadline, upon a showing that the need for the additional time is beyond the hangar operator’s control and joint determinations by the MPCA that the environment will protected and by the State Fire Marshal that public safety will be protected during the extension.

The MPCA does not recommend that the Legislature extend the current temporary exemption for general PFAS-containing foam use at airports solely for consideration of hangar fixed firefighting systems transition.