Guidance for per- and polyfluoroalkyl substances: Analytical

Purpose and objectives

This guidance is intended for those producing, reporting, or reviewing PFAS data used to support MPCA program work. The purpose of the guidance is to provide data quality objectives and consistency with data quality. Visit https://www.pca.state.mn.us/about-mpca/science-and-data to access current versions of PFAS guidance including Guidance for per-and polyfluoroalkyl substances (PFAS): Sampling (p-eao2-27).

Per- and polyfluoroalkyl substances (PFAS) are emerging contaminants composed of thousands of human-made, fluorinated organic chemicals. The actual number of compounds is continuously changing, as some PFAS are no longer produced in the United States due to regulatory and voluntary actions, while new ones are created as alternatives. Phased-out PFAS still exist in the environment, human bodies, and some products due to their extreme environmental persistence, presence in waste streams, and ongoing global production.

Methods and laboratory accreditation

The Minnesota Pollution Control Agency (MPCA) requires private laboratories to have accreditation through the Minnesota Environmental Lab Accreditation Program (MNELAP) for all PFAS analytical data submitted to the MPCA. Laboratories and methods accredited by MNELAP can be found on their website (https://eldo.web.health.state.mn.us/public/accreditedlabs/labsearch.seam). The laboratory scope must accurately reflect the method and version preformed and reported. Laboratories are requested to maintain accreditation for the analytes that are approved by the method. The MPCA will request additional analytes for accreditation as more standards and analytes become viable.

Laboratories must incorporate the MPCA data quality objectives in this document when performing work for the MPCA. Modifications to approved Clean Water Act methods must follow requirements identified at 40 C.F.R. § 136.6: *Method modifications and analytical requirements* and be reviewed and accepted by the MPCA data quality unit. This includes use of method modifications that are not already allowed by the method. Contact the data quality unit for more information at qa.questions.mpca@state.mn.us.

Instrument and analyte identification

Most quantitative targeted PFAS analysis methods use liquid chromatography-tandem mass spectrometry (LC-MS/MS) instrumentation. Target analytes are identified using multiple criteria including comparing retention times in samples to those in quality control standards, such as continuing calibration verifications (CCVs). Ion ratios may also be used to distinguish between the target analyte and matrix interference. Target analytes may be quantified using a variety of techniques including internal standard or isotope dilution. U.S. Environmental Protection Agency (EPA) method 537.1 for drinking water uses internal standard quantification. EPA methods 533 for drinking water and 1633 for various matrices use isotope dilution quantification. The MPCA recommends using isotope dilution quantification for samples with complex matrices. Branched isomers should also be quantified for target analytes that have branched isomer standards available.

Isotope Dilution Analysis (IDA)

Isotope dilution is a quantitative analysis technique that uses isotopically labeled analogs of the target analytes added to samples prior to extraction to calculate target analyte results. These isotopically labeled standards are referred to as extracted internal standards (EIS) in EPA method 1633 and isotope dilution analogues in EPA method 533. For the purposes of this document, the isotope dilution isotopically labeled standards will be referred to as EIS. EIS analogs are structurally identical to the target analytes and are expected to behave the same during the extraction process. Exact EIS analogs do not exist for every target analyte. For those analytes without an exact analog an EIS with a similar structure and behavior are used to calculate the target analyte concentration. In isotope dilution quantitation the EIS are used as both an internal standard and a surrogate, so they are used to calculate target analyte concentration and monitor extraction efficiency. This means the target analyte results are recovery corrected and account for any losses that occurred during extraction. Isotope dilution is a more accurate method of quantitation than internal standard and should be used to analyze samples with complex matrices.

Laboratories should add additional EIS analogs as they become commercially available. The EIS used to quantify each target analyte should be identified in the report. EIS recoveries must meet method requirements and must be qualified if recoveries are less than 10%.

Interferences

Laboratories must have a documented process to review and limit cross-contamination and background interference. PFAS can be found in laboratory items such as polytetrafluoroethylene products (PTFE), solvent lines, aluminum foil, and methanol. These items could lead to method interferences and elevated baselines in chromatograms. Laboratory equipment and supplies that contact samples should be evaluated and documented to contain less than the method detection limit (MDL) for each target analyte. Delay columns should be used to minimize contamination from the LC solvent delivery system. A carbon clean up step is recommended for samples with potential matrix interference. Carbon clean up should also be performed for any associated batch quality control (QC) samples.

Standards

Certified analytical standards are required, when available. The MPCA recommends laboratories use quantitative standards that contain both linear and branched isomers when available. Some analytes only have qualitative standards (also known as technical standards) available for branched isomers. These qualitative standards should be used to identify and integrate branched isomer peaks in sample chromatograms. The MPCA recommends laboratories add additional quantitative and qualitative standards for branched isomers as they become commercially available.

Some target analyte standards may be purchased in their salt form. The measured mass should be corrected for the salt content. Instructions on how to perform the salt correction can be found in the ITRC Technical and Regulatory Guidance document (https://pfas-1.itrcweb.org/11-sampling-and-analytical-methods/#11_3) The mass spectrometer measures the analyte in the anion form, which is the form most likely to be found in the environment. Report the target analytes in their acid forms for consistency so results from different data sets can be easily compared.

Instrument blanks

The ubiquitous nature of PFAS makes it critical to analyze instrument blanks to determine if the instrument is potentially affected by background contamination. Instrument blanks must be analyzed after highest calibration standard and daily prior to sample analysis. The concentration of each analyte must be $\leq$ the MDL.

Quality control samples

Laboratories must follow the method requirements for quality control samples. The MPCA recommends including the following QC Samples for MPCA projects. Laboratories should refer to the project specific QAPP or work plan for required QC samples.

- Method blanks - one per batch of up to 20 field samples. Each analyte must be ≤ ½ the method reporting limit. If a project is reported to the MDL, detections in the blank between the MDL and method reporting limit (RL) must be qualified.
- Sample duplicate (DUP) - recommended that one is collected per 20 field samples or fewer. The relative percent difference (RPD) should be < 30%. Data outside these limits for MPCA projects must be qualified as not meeting client specific requirements.
- Laboratory control sample (LCS) – One per analytical batch. The recovery acceptance for each target analyte must meet method specific criteria. If an LCSD is included in the batch the relative percent difference (RPD) for each analyte should be < 30%, data outside these limits for MPCA projects must be qualified as not meeting client specific requirements.
- Matrix spike and Matrix spike duplicate (MS/MSD) - recommend that one is collected per 20 field samples or fewer. The recovery acceptance for each analyte is 100 ± 50% and the RPD is ≤ 50%.

Representative sample

The following is recommended to ensure a representative sample/subsample is used for analysis:

- Avoid subsampling aqueous samples if possible. PFAS are known to adhere to sample container walls, so a solvent rinse of the original container is an important step in the analytical process. If subsampling cannot be avoided due to high total suspended solids (TSS) or other matrix interference laboratories should contact the MPCA project manager to determine how to proceed. If subsampling of aqueous samples occurs the laboratory must qualify the data. Some considerations for determining how to proceed with subsampling of aqueous samples with particulates/suspended solids can be found in the ITRC Technical and Regulatory Guidance Document.
- If a sample is known to have matrix interference or other issues that do not allow the full sample container to be extracted, the MPCA project manager and laboratory should work together to determine the appropriate volume that can be extracted, and that volume should be collected for subsequent analyses. Reducing extraction volume will raise reporting limits but collecting a smaller volume of the sample is preferred over subsampling.
- Sample filtration is not recommended with high particulate samples because retention of PFAS onto filters is likely. If a sample is filtered a qualifier must be applied to the samples in the final report.
- High PFAS concentrations can overload SPE cartridge capacity. Serial dilutions are recommended for known high concentration samples, such as aqueous film forming foam (AFFF).
- Homogenize soil samples prior to subsampling.

Method detection limits and method reporting limits

Method reporting limits (RL) or limit of quantitation (LOQ) at a minimum must meet method specific criteria. In addition, certain programs at the MPCA have reporting goals of ¼ the EPA Maximum Contaminant Level (MCL) concentration and/or the Health Based Value (HBV) from Minnesota Department of Health found at http://www.health.state.mn.us/communities/environment/risk/guidance/gw/table.html. See the table below for analyte specific reporting limits.

Method detection limits (MDL) must be established for each target analyte according to the procedure at 40 C.F.R. pt. 136, Appendix B. Refer to the project specific QAPP or work plan to determine if the data should be reported to the MDL or the RL. If the MPCA project requires data reporting between the MDL and the RL, laboratories must qualify results with an estimate or "J" flag. If sample data are reported to the MDL, the method blank must also be reported to the MDL.

Analyte specific MRL

The table below includes compounds and corresponding reporting limit goals that have MCL or HBV concentrations.

Compound	CAS number	Aqueous RL goals (ng/L)	Solid RL goals (ng/g) Dry weight	*Biota RL goals (ng/g) Wet weight
Perfluorobutanoic acid (PFBA)	375-22-4	4	50	50
Perfluorohexanoic acid (PFHxA)	307-24-4	4	50	50
Perfluorooctanoic acid (PFOA)	335-67-1	<1	50	50
Perfluorononanoic acid (PFNA)	375-95-1	2.5	50	50
Perfluorobutanesulfonic acid (PFBS)	375-73-5	4	50	50
Perfluorohexanesulfonic acid (PFHxS)	355-46-4	2.5	50	50
Perfluorooctanesulfonic acid (PFOS)	1763-23-1	<1	50	50
Hexafluoropropylene oxide dimer acid (HFPO-DA)	13252-13-6	2.5	50	50

*Biota reporting limits will depend on the biota sampled. Biota can cause matrix enhancement and greatly increase the method reporting limits.

Frequently Asked Questions (FAQs)

What is considered a modified method?

A modified method is when a method is not followed exactly as written and/or utilized for a matrix that is not specified in the method.

Can lab accreditation add more methods?

Yes, lab accreditation and MPCA work very closely with labs and EPA to be sure accreditation can offer what is needed. PFAS methods and analytes are constantly progressing.

Can alternate labeled isotopes be utilized?

Yes, labeled isotopes can have variable commercial availability and many PFAS methods are performance based. If you have reproducibility studies to demonstrate your ability to quantify accurately from a specific labeled isotope and it is documented, you can utilize alternate labeled isotopes.

What if we are unable to meet this guidance acceptance criteria?

If any guidance criteria are not able to be met, qualify the data on the final lab report and electronic data deliverable.

Why are the batch QC accuracy and precision limits set at the levels chosen? For each matrix?

As an agency we are encouraging good science. We understand that those limits may not be achievable now, with current technologies, for every compound. However, we are encouraging laboratory improvements as well as consistent data defensibility.

Can PFAS data be reported to the method detection limit (MDL)?

Yes, PFAS data can be reported to the MDL. Refer to the project specific QAPP or work plan to determine if the data should be reported to the MDL or the RL. If the MPCA project requires data reporting between the MDL and the RL, laboratories must qualify results with an estimate or "J" flag. If sample data are reported to the MDL, the method blank must also be reported to the MDL.

References and Resources

40 C.F.R. pt. 136, Appendix B

Interstate Technology and Regulatory Council (ITRC). 2023. PFAS Technical and Regulatory Guidance Document and Fact Sheets. https://pfas-1.itrcweb.org/

U.S. Environmental Protection Agency (EPA). 2024. Method 1633 Analysis of Per- and Polyfluoroalkyl Substances (PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS. https://www.epa.gov/system/files/documents/2024-01/method-1633-final-for-web-posting.pdf

EPA. 2020. Method 537.1 Determination of Selected Per- and Polyfluorinated Alkyl Substances in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS). https://cfpub.epa.gov/si/si_public_record_report.cfm

EPA. 2019. Method 533: Determination of Per- and Polyfluoroalkyl substances in drinking water by isotope dilution anion exchange solid phase extraction and liquid chromatography/tandem mass spectrometry. https://www.epa.gov/sites/default/files/2019-12/documents/method-533-815b19020.pdf

EPA. 2024. PFAS Analytical Methods Development and Sampling Research. https://www.epa.gov/water-research/pfas-analytical-methods-development-and-sampling-research

Willey, J., R. Anderson, A. Hanley, M. Mills, C. Hamilton, T. Thompson, and A. Leeson. 2021. Report on the Single-Laboratory Validation of PFAS by Isotope Dilution LC-MS/MS. Strategic Environmental Research and Development Program (SERDP) Project ER19-1409.