PFAS (perfluoroalkyl and polyfluoroalkyl substances) and Ortho-Phthalates in Packaging: A Guidance Document in Support of the 2021 Update to Toxics in Packaging Clearinghouse Model Legislation

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This TPCH guidance document represents the best information available at the time of publication. Analytical methods are subject to change. Other information may be available in the future. Compliance with the law should not be based solely on this guidance document.

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A. Overview & Background

In February 2021**,** the Toxics in Packaging Clearinghouse (TPCH) announced the organization's 2021 update to their Model Toxics in Packaging Legislation. The 2021 update includes the addition of the class of perfluoroalkyl and polyfluoroalkyl substances (PFAS) and ortho-phthalates as regulated chemicals, as well as new processes and criteria for identifying and regulating additional chemicals of high concern in packaging. The previous (prior to 2021) TPCH Model Legislation and laws enacted in 19 states prohibit the intentional use of cadmium, lead, mercury, and hexavalent chromium in any package or packaging component. The laws also limit the total incidental concentration of the four metals to 100 ppm. Incidental concentration may result from the use of post-consumer recycled content to manufacture new packaging and components. The laws take a pollution prevention approach by prohibiting intentional use, and they place the primary burden of compliance on the supply chain by requiring manufacturers and suppliers to verify that their packaging is in compliance.
It will be up to each state to adopt changes to their existing laws or adopt a new law to address toxics in packaging.

Several TPCH member and non-member states have recently enacted laws that address PFAS in packaging, most of the laws are specific to food packaging. A listing of these laws can be found on the TPCH website on the page titled 'Related Laws'.

B. Ensuring Compliance with the Laws

The best source of information on whether packaging contains intentionally added PFAS is likely to be the manufacturer or supplier of the packaging. To ensure compliance with the law, we recommend that anyone purchasing packaging for sale or distribution or anyone who sells products contained in such packaging consult with the manufacturer or supplier as soon as possible to confirm that PFAS is not intentionally added to the product.

C. Disclosure (Source: WA Ecology Guide for Plant-Fiber Based Food Packaging)

Transparency is the most effective way to identify if a product is compliant with current or future regulations. To determine if PFAS is intentionally added to any of the materials in your packaging/product, we suggest three options:

1. **Ask suppliers for full material disclosure**. If possible, ask for full material disclosure—a list of all the materials and substances in the components or material. There are a number of chemical management platforms, transparency standards, and third-party consultants that can help you gather this information. They can help you identify any PFAS being intentionally used, provide additional details for you to assess compliance status for any regulations, and help you identify opportunities for future optimization.

What to look for: Review the list of chemicals provided for "-fluoro-" which indicates the presence of fluorine. If you notice this wording within a chemical name, ask your supplier if that function is really necessary, or if they have alternative chemistries or materials that meet the necessary function. We recommend you also ask if the alternatives have robust chemical hazard assessments, to ensure that the alternatives are safer.

2. **Ask suppliers to disclose if PFAS chemicals are added**. If full material disclosure isn't possible, ask if any PFAS chemicals are added - they're commonly used for oil and grease resistance. Some PFAS can also be added to plastics that are then added to packaging. Some high-density polyethylene (HDPE) and polypropylene (PP) containers are treated with fluorine gas and are known as 'fluorinated containers.' We recommend you ask if containers are fluorinated.

3. **Look for third-party certification of your materials**. Some certifications can assess and certify both materials and final products. These certifications restrict certain toxic chemicals, require disclosure of ingredients, and assess the hazards of the ingredients. For food packaging, look for materials that are certified by Cradle to Cradle version 4.03 or GreenScreen Certified version 1.0.4 Both of these certifications restrict the use of intentionally added PFAS.
If your product is compostable, find out if the material you use is Biodegradable Products Institute (BPI) certified. BPI requires testing of products for total organic fluorine; the results must be 100 parts per million (ppm) or less. Products made from paper, paperboard, or other plant fiber materials with total organic fluorine below this limit are expected to be free of intentionally added PFAS. BPI may change this limit in the future.

D. Analytical Testing

If your suppliers don't provide the information you request, you can gather test data to assess if your product contains intentionally added PFAS. Before you test, we recommend you ask your supplier if they have test data that demonstrates the packaging/product doesn't contain intentionally added PFAS—they might have already assessed the material.

Lab Data

You or your supplier can test the packaging/product or components for total fluorine. If the results are less than 100 ppm and quality control criteria are met, your product likely doesn't have intentionally added PFAS and would likely comply with state's restrictions in packaging.

If you identify low levels of total fluorine, we recommend you talk with your suppliers - even if they are less than 100 ppm. This can:

- Confirm PFAS isn't intentionally added.
- Identify unintentional sources of PFAS so they can try to reduce or eliminate them.
- Identify sources of inorganic fluorine (which are not PFAS).

If you need to change your materials, we encourage you to go beyond compliance and seek out alternatives that are safer.

Product or packaging test results of 100 ppm or greater TF or TOF may indicate that companies or regulators should investigate to determine if PFAS have been intentionally added somewhere in the supply chain. Please note that test results for TF will be representative of both organic and inorganic fluorine, and as such may include chemicals that are not PFAS.

Levels below 100 ppm Total Fluorine (TF) or Total Organic Fluorine (TOF) are generally regarded by labs and standards organizations as not providing PFAS functionality in a food package or as evidence of intentional addition of PFAS. However, manufacturers should confirm with their supply chain that PFAS are not intentionally added, regardless of measured TF or TOF levels. Post consumer recycled content could be a source of measured TF or TOF where suppliers have confirmed that PFAS are not intentionally added. https://bpiworld.org/Fluorinated-Chemicals

Information on testing is subject to revision in the future based on testing methods and our understanding of TF thresholds warranting attention.

E. Screening Technologies with Portable Implementation (for the heavy metals):

Fourier-Transform Infrared Spectroscopy (FTIR): FTIR is a technique used to obtain an infrared spectrum of absorption or emission of a solid, liquid or gas. An FTIR spectrometer simultaneously collects high-resolution spectral data over a wide spectral range.

X-Ray Fluorescence Spectrometry (XRF): XRF is a non-destructive analytical technique used to determine the elemental composition of materials. Handheld XRF analyzers work by measuring the fluorescent (or secondary) X-rays emitted from a sample when excited by a primary X-ray source. Each of the elements present in a sample produces a set of characteristic fluorescent X-rays, or "unique fingerprints". These "fingerprints" are distinct for each element, making handheld XRF analysis an excellent tool for quantitative and qualitative measurements.

Instrumental Neutron Activation Analysis (INAA): Sample is bombarded with neutrons leading to radioactive isotopes. The radioactive emission and decay are element specific and can be used to determine the elements. Can be used as a rapid screening tool to determine extractable organic fluorine (EOF) or absorbable organic fluorine (AOF). [Note: Schultes 2019 paper found it to be less sensitive than combustion-ion chromatography (CIC)]

F. Available Test Methods for Fluorine and Fluorinated Chemicals; How They Are Used (together or individually), in Different Packaging Medias (inks, paper, adhesives, etc.)

Total Organic Fluorine (TOF): TOF measures Fluorine (F) content in samples as a proxy for PFAS. To determine the organic fluorine in a sample both the Total Fluorine (TF) and the Inorganic Fluorine need to be tested. The TOF is equal to the Inorganic Fluorine subtracted from the TF.

Adsorbable Organic Fluorine (AOF): AOF uses activated carbon and adsorption of liquid samples and determines the fluoride content of the extract by combustion ion chromatography (CIC).

Extractable Organic Fluorine (EOF): EOF uses an extraction procedure to extract the organic fluorine present in solid matrices. The extraction can be performed using the same solvent systems used for conventional targeted LC-MS/MS method. The extractable organic fluorine content is then determined by CIC. EOF is a tool to estimate organic fluorine levels in a wide array of solid sample matrices that might need to be monitored for disposal purposes.
Note: Current extraction processes are not effective at capturing polymeric PFAS and some larger molecules of PFAS. Therefore, a low EOF result doesn't necessarily mean that there is little to no PFAS present. Confirmation with material suppliers about PFAS content is highly recommended.

Total Fluorine (TF): TF of a sample is determined by using CIC of the sample "as is" (with no sample preparation). With no sample preparation there is no process to remove inorganic fluorine, therefore the result may include both organic and inorganic fluorine. Inorganic fluorine is not representative of PFAS.

Inorganic Fluorine: To isolate the Inorganic Fluorine in a sample it must undergo a water extraction procedure. The extract is then analyzed by CIC or ion selective electrode (ISE) to determine the fluorine concentration.

Note: CIC is a leading technology, however there are other techniques such as oxygen bomb and ISE that can also be used.

Total Oxidizable Precursors (TOP): TOP Assay oxidizes PFAS precursors, most of which are compounds not currently measured by targeted techniques, turning them into their terminal PFAS compounds that can then be measured. The increase in PFAS measured after the TOP Assay oxidation relative to pre-oxidation levels is a maximum estimate of the total concentration of PFAS precursors present in a sample. PFAS analysis by TOP Assay is particularly useful in forensic studies designed to identify the source of elevated PFAS levels in all matrices. TOP Assay is commonly used on complex sample matrices such as leachate, wastewater, biosolids, and AFFF.

Targeted Analysis: These analyses include methods that are applicable to a specific defined set of known analytes. Analytical standards exist for quantitation and methods only measure for analytes on the targeted list; once the analysis is complete, you can't look for other analytes.

G. Standard Test Methods for Ortho-Phthalates

Ortho-phthalates are a subset of semivolatile organic compounds, and as such can be determined using SW 846 Method 8270. Several sample preparation procedures can be used under this method; however, EPA Methods Method 3541 (automated Soxhlet/Soxtherm extraction) is likely the most suitable method for packaging materials.

Below are Ortho-Phthalates that are commonly analyzed using SW 846 Method 8270 (with CAS Numbers):

- Bis(2-ethylhexyl)phthalate (117-81-7)
- Butyl benzyl phthalate (85-68-7)
- Dicyclohexyl phthalate (84-61-7)
- Diethyl phthalate (84-66-2)
- Diisobutyl phthalate (84-89-5)
- Diisodecyl phthalate (26761-40-0)
- Diisononyl phthalate (28553-12-0)
- Dimethyl phthalate (131-11-3)
- Di-n-butyl phthalate (84-74-2)
- Di-n-hexyl phthalate (84-75-3)
- Di-n-octyl phthalate (117-84-0)
- Dipentyl phthalate (131-18-0)

Ortho-phthalates testing resources:

U.S. Consumer Product Safety Commission: https://www.cpsc.gov/s3fs-public/CPSC-CH-C1001-09.4_Standard_Operating_Procedure_for_Determination_of_phthalates.pdf

U.S. EPA: https://archive.epa.gov/epa/sites/production/files/2015-12/documents/8270d.pdf

California Office of Environmental Health Hazard Assessment: https://biomonitoring.ca.gov/sites/default/files/downloads/PotenDesig_orthoPhthalates_071615_0.pdf

California Department of Toxic Substances Control: https://dtsc.ca.gov/wp-content/uploads/sites/31/2019/10/Final-Public-Background-Document_FoPa_Ortho-phthalates.pdf

H. TPCH State Members Existing Guidance

State of Washington Department of Ecology:

- Guide for Plant Fiber–Based Food Packaging Manufacturers
- PFAS in Food Packaging

New York State Department of Environmental Conservation:

- PFAS in food packaging law
- Guidance on packaging types subject to the PFAS in food packaging law and on when to obtain a certification of compliance.

I. To Do's for Product Manufacturers, Brand Owners and Retailers Using Compliant Packaging Materials:

1. Require Certificate of Compliance for all packaging materials and their components from all suppliers in any contract or bid specification.
2. Ask for criteria used to determine compliance.
3. If material formulations change from suppliers require updated information.
4. Prepare your own Certificate of Compliance based on your packaging supply chain information and identify appropriate authorized signer.
5. Maintain records indefinitely by working with your Risk Management policies.

J. To Do's for Packaging Material Formulators and Suppliers

1. Identify regulated materials in your chemical formulation or in the supplied chemical inputs.
2. Identify potential incidental additions of regulated chemicals or contaminants in the manufacturing process.
3. Test for baseline information on regulated chemicals or contaminants.
4. Require Certificate of Compliance for all packaging materials and their components from all suppliers in any contract or bid specification.
5. Ask for criteria used to determine compliance.
6. If material formulations change from suppliers require updated information.
7. Prepare your own Certificate of Compliance based on your packaging supply chain information and identify appropriate authorized signer.
8. Maintain records indefinitely by working with your Risk Management policies.

K. Additional Resources

EPA PFAS Analytical Methods Development and Sampling Research Page with additional links and information

Biodegradable Products Institute (BPI) Certification Scheme for Fluorinated Chemicals

PFAS Navigating Analytical Method Options, Part 3
Eurofins Webinar from March 2023. More PFAS related webinars from Eurofins can be found at https://www.eurofinsus.com/environment-testing/resources/webinars/webinar-series/.

PFAS in Food Packaging Webinar
NYSDEC Webinar from September 6, 2022

TPCH's Guidance on Laboratory Analysis for Toxics in Packaging