PFAS Prioritisation for Targeted Testing

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The views expressed in this presentation are those of the author and do not necessarily reflect the views or policies of the U.S. EPA
Outline

- What are PFAS?
- What is the Landscape of PFAS?
- What are PFAS of potential interest to the Agency?
- How many substances might be procurable?
- What constitutes a representative set of PFAS to propose for targeted testing?
- Structural categories – current and future
- Some next steps
Per- and Polyfluoroalkyl Substances (PFAS)

Thousands of PFAS are associated with the production of industrial and consumer products.

**Poly** fluorinated = many fluorines

Polyfluorinated carboxylic acid from the production of polyvinylidene fluoride (PVDF) plastic

**Per** fluorinated = fully fluorinated

Perfluorooctanoic acid (PFOA, C-8)

Perfluorooctanesulfonate (PFOS)
Per- and Polyfluoroalkyl Substances (PFAS)

- A class of man-made chemicals that are ubiquitous due to:
  - Wide variety of industrial and consumer uses
  - Persistence
  - High mobility
- They are a concern due to:
  - Known or suspected toxicity, especially for PFOS and PFOA
  - Bioaccumulation
  - Long half lives (e.g., several years), especially in humans
  - Mobility - shorter chain PFAS tend to be highly mobile, longer chain PFAS less mobile
- Information on PFAS is rapidly evolving
Thousands of Chemicals: More Than Just PFOA and PFOS

- **Perfluoroalkyl acids (PFAAs)**
  - $C_nF_{2n+1}R$
  - Perfluoroalkyl carboxylic acids (PFCAs)
  - Perfluoroalkane sulfonic acids (PFSA)
  - Perfluoroalkyl phosphoric acids (PFPA)

- **Perfluoroalkane sulfon fluoride (PASF)** → **PASF-based derivatives**
  - $C_nF_{2n+1}SO_2F$
  - $C_nF_{2n+1}SO_2R$, $R = \text{NH, NHCH}_3\text{CH}_2\text{OH}$, etc.

- **Perfluoroalkyl iodides (PFAI)** → **Fluorotelomer iodides (FTIs)** → **FT-based derivatives**
  - $C_nF_{2n+1}I$
  - $C_nF_{2n+1}CH_2CH_2I$
  - $C_nF_{2n+1}CH_2CH_2R$, $R = \text{NH, NHCH}_3\text{CH}_2\text{OH}$, etc.

- **Per- and polyfluoroalkyl ethers (PFPEs)-based derivatives**
  - Polyfluoroalkyl ether carboxylic acids

- **Fluoropolymers**
  - Polytetrafluoroethylene (PTFE)
  - Polyvinylidene fluoride (PVDF)
  - Fluorinated ethylene propylene (FEP)
  - Perfluorooalkoxyl polymer (PFA)
  - Others

- **Side-chain fluorinated polymers**
  - Fluorinated (meth)acrylate polymers
  - Fluorinated urethane polymers
  - Fluorinated oxetane polymers

- **Perfluoropolyethers**

*Slide from J Lambert*
### PFAS: EPA Cross-Agency Research List (Late 2017)

https://comptox.epa.gov/dashboard/chemical_lists/epapfasrl

**Curation**
- Correct misspelled names
- Correct CASRN
- Fix errors in mappings of anions, salts, parents
- Create unique acronym
- Map to unique DTXSID

**EPAPFASRL**
19 lists collapsed to single list of 194 unique DTXSID substances

<table>
<thead>
<tr>
<th>DTXSID</th>
<th>Substance Name</th>
<th>Substance _CASRN</th>
<th>Source_Name (incorrect or ambiguous)</th>
<th>Source_CASRN (incorrect or invalid)</th>
<th>Source_Acronym (incorrect or ambiguous)</th>
<th>Unique_Acronym</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTXSID20874028</td>
<td>2H,2H,3H,3H-Perfluorooctanoic acid</td>
<td>914637-49-3</td>
<td>5:3 Polyfluorinated acid</td>
<td>914637-49-3</td>
<td>5:3 acid</td>
<td>5:3 PFOA</td>
</tr>
<tr>
<td>DTXSID7027831</td>
<td>N-Methyl-N-[2-hydroxyethyl]perfluorooctanesulfonamide</td>
<td>24448-09-7</td>
<td>N-Methyl perfluorooctanesulfonamide</td>
<td>NMeFOSE, MeFOSE</td>
<td>NMeFOSE</td>
<td>NMeFOSE</td>
</tr>
<tr>
<td>DTXSID10892352</td>
<td>Perfluoro-2-((perfluoro-3-(perfluoroethoxy)-2-propanyl)oxy)ethanesulfonic acid</td>
<td>749836-20-2</td>
<td>Perfluoro-2-((perfluoro-3-(perfluoroethoxy)-2-propanyl)oxy)ethanesulfonic acid</td>
<td>749836-20-2</td>
<td>PFESA Byproduct 2</td>
<td>PFESA Byproduct 2</td>
</tr>
<tr>
<td>DTXSID70892479</td>
<td>Perfluoropentanesulfonate</td>
<td>175905-36-9</td>
<td>Perfluoropentanesulfonate</td>
<td>2706-91-4</td>
<td>PFPeS</td>
<td>PFPeS_i_on</td>
</tr>
<tr>
<td>DTXSID8071354</td>
<td>Ammonium perfluoropentanesulfonate</td>
<td>68259-09-6</td>
<td>Ammonium perfluoropentanesulfonate</td>
<td>68259-09-6</td>
<td>APFPeS</td>
<td>APFPeS</td>
</tr>
<tr>
<td>DTXSID40881350</td>
<td>4,8-Dioxa-3H-perfluorononanoic acid</td>
<td>919005-14-4</td>
<td>2,2,3-Trifluoro-3-(1,1,2,2,3,3-hexafluoro-3-(trifluoromethoxy)propano)perfluorononanoic acid</td>
<td>919005-14-4</td>
<td>ADONA</td>
<td>ADONA parent acid</td>
</tr>
<tr>
<td>DTXSID00874026</td>
<td>Ammonium 4,8-dioxa-3H-perfluorononanoate</td>
<td>958445-44-4</td>
<td>Ammonium 4,8-dioxa-3H-perfluorononanoate</td>
<td>958445-44-8</td>
<td>ADONA</td>
<td>ADONA</td>
</tr>
<tr>
<td>DTXSID3037707</td>
<td>Potassium perfluorobutanesulfonate</td>
<td>29420-49-3</td>
<td>Potassium perfluorobutanesulfonate</td>
<td>PFBS</td>
<td>PFBS-K</td>
<td>PFBS-K</td>
</tr>
<tr>
<td>DTXSID5030030</td>
<td>Perfluorobutanesulfonic acid</td>
<td>375-73-5</td>
<td>Perfluorobutanesulfonic acid</td>
<td>PFBS</td>
<td>PFBS</td>
<td>PFBS</td>
</tr>
</tbody>
</table>
PFAS Library and Chemical Selection

**EPA DSSTox Database:** > 758K chemicals

- Chemical structures, downloadable files
- Predicted phys-chem properties
- External links & list overlaps

**PFAS Chemical Landscape:**

- DSSTox-registered: >5000 PFAS substances
  - (>3 F, alkyl)
- ~2000
  - Attempt to procure (chemicals w/ structures)
- ~450
  - PFAS Standards library
- ~200
  - EPA’s prioritized list for PFAS research
    - (exposure, occurrence, health data)
- ~75
  - PFAS Reference subset (Phase 1)
    - ( tiered toxicity & toxicokinetic testing)

Per(poly)-fluorinated substances (PFAS)

- PFAS chemical names, acronyms, synonyms
- PFAS chemical structure categories

[https://comptox.epa.gov/dashboard](https://comptox.epa.gov/dashboard)
Workflow to prioritise structural categories to inform the PFAS for targeted testing

Step 0: Characterising the PFAS library
- Data collection: Pre-defined structural categories

Step 1: Select substances from categories of greatest interest to the Agency
- On Wkgp-31 list: Availability of in vivo data
- On EPA-PFAS list: Availability of in vivo data

Step 2: Select substances from categories of interest to the Agency
- Availability of in vivo data

Step 3: Select substances from remaining categories with in vivo data
- EPA interest in vivo data lacking

Step 4: Select substances from categories of interest to the Agency
- Characterising the PFAS Landscape

Step 5: Select substances from remaining categories

- 53 structural categories
- +2 structural categories
- +5 structural categories
- +6 structural categories*
  
  *chemical, so were not included

- 53 substances: 12 categories
- 9 substances: 6 categories
- 13 substances: 10 categories

Agency interest

Availability of in vivo data

53 structural categories

EPA interest

Characterising the PFAS Landscape

Maximising Read-across

Capturing Structural Diversity
Step 0: Characterising the PFAS library

**Structural Categories**

- Manually annotated the ‘procurable’ substances into structural categories
- Categories built upon those defined by Buck et al (2011)
- Characterised on the standard nomenclature – fluorotelomers, perfluorinated substances etc.
- Identified 53 unique structural categories
- These represent a generalised description of a category
- In some cases these can be subcategorised into greater detail – e.g. n:2 fluorotelomer alcohol vs fluorotelomer alcohols
Step 0: Characterising the PFAS library

**Workflow Step:**
1. Wkgrp-31
2. EPA-PFAS
3. PFAS-Landscape Categories

(a) **Total Chemical Count**
- Wkgrp-31
- EPA-PFAS

(b) **ToxVal Record Count**

(c) **Final Chemical Count**

- Availability of *in vivo* toxicity information in the context of the pre-defined structural categories
- Representation of PFAS of interest to the Agency in the context of the pre-defined structural categories
Workflow to prioritise structural categories to inform the PFAS for targeted testing

Step 0:
Characterising the PFAS library

- Data collection:
  - Pre-defined structural categories
- On Wkgrp-31 list:
  - Availability of in vivo data
- Availability of in vivo data

Step 1: Select substances from categories of greatest interest to the Agency

- Agency interest
- Availability of in vivo data

- 5 structural categories
- 53 structural categories

Step 2: Select substances from categories of interest to the Agency

- 53 substances: 12 categories

Step 3: Select substances from remaining categories with in vivo data

- +2 structural categories
- +5 structural categories

Step 4: Select substances from categories of interest to the Agency

- +6 structural categories
- +2 structural categories* (chemical, so were not included)

Step 5: Select substances from remaining categories

- +10 structural categories

Characterising the PFAS Landscape

- EPA interest in vivo data lacking
- EPA-PFAS list:
  - +5 structural categories

- Agency interest
- Availability of in vivo data

- 9 substances: 6 categories
- 13 substances: 10 categories
Steps 1-3: Maximising read-across

Known information on the property of a substance (source chemical) is used to make a prediction of the same property for another substance (target chemical) that is considered “similar” i.e. Endpoint & often study specific

<table>
<thead>
<tr>
<th>Property</th>
<th>Source chemical</th>
<th>Target chemical</th>
</tr>
</thead>
</table>

- Use of information for “PFAS source substances” is used to infer (read-across) missing information for a related similar PFAS target
- Similarity context as a pragmatic starting point is “structural similarity” using the structural categories that have been defined
- Requirement is in vivo toxicity information
- Depending on the structural diversity within the structural category - opportunities may exist to explore trends in activity - impact of chain length C4 vs C6 vs C8; impact of n:H in fluorotelomer alcohols n:3 vs n:3 vs n:1; impact of position of ether linkage etc.
Workflow to prioritise structural categories to inform the PFAS for targeted testing

**Step 0:** Characterising the PFAS library
- On Wkgrp-31 list:
  - Pre-defined structural categories
- On EPA-PFAS list:
  - Availability of in vivo data
- Availability of in vivo data

**Maximising Read-across**
- Agency interest
- 53 structural categories
- Availability of in vivo data
- 53 substances: 12 categories

**Step 1:** Select substances from categories of greatest interest to the Agency
- 5 structural categories
- 2 structural categories

**Step 2:** Select substances from categories of interest to the Agency
- 2 structural categories

**Step 3:** Select substances from remaining categories with in vivo data
- 5 structural categories

**Step 4:** Select substances from categories of interest to the Agency
- 6 structural categories
- Chemical, so were not included
- 10 structural categories

**Step 5:** Select substances from remaining categories
- 9 structural categories
- 13 substances: 10 categories

**Capturing Structural Diversity**
- EPA interest
  - In vivo data lacking
  - Characterising the PFAS Landscape
Steps 4-5: Capturing Structural Diversity

• Characterising the biological activity of the PFAS landscape that comprises substances of current interest to the Agency
• Characterising the biological activity of the PFAS landscape beyond substances of current interest to the Agency
• Testing broad PFAS landscape may enable detection of hotspots in activity that could help in prioritising future PFAS research and anticipating future problem areas
## Considerations for PFAS selection

<table>
<thead>
<tr>
<th>Aspect Name</th>
<th>Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Structural diversity within a category</td>
<td>Approximated by category size, with score ranging from 1 (20 or more members) to 0 (1 member)</td>
</tr>
<tr>
<td>2) Data availability</td>
<td>Availability of in vitro ToxCast data (score=0.5) or ToxVal in vivo data (score=0.75) or both (score=1)</td>
</tr>
<tr>
<td>3) Data quantity</td>
<td>Number of ToxVal records for a substance indicating a stronger source-analogue for read-across, with scores ranging from 0.15 (for 1 record) to 1 (for 20 or more records)</td>
</tr>
<tr>
<td>4) Read-across category-level weight</td>
<td>Value of substance for anchoring read-across trends within a category (e.g., chain length etc.), serving as a source analog (score=0.5) or target analog (score=0.25), or as a target analog for capturing structural diversity (score=0.15)</td>
</tr>
<tr>
<td>5) Numerical indicator of EPA interest</td>
<td>Wkgrp-31 (score=1), other EPA-PFAS (score=0.75), only in PFAS-Landscape (score=0.5)</td>
</tr>
<tr>
<td>6) Phys-chem indicators of testability</td>
<td>Both LogKow and Vapor Pressure favorable (score=0.75), one favorable (score=0.5), both unfavorable (score=0). E.g. LogKow &lt; 4.5, Vapor Pressure &lt; 10^3 mmHg considered favorable.</td>
</tr>
<tr>
<td>7) Figure 1 Workflow Step</td>
<td>Step 1 (score=1), Step 2 (score=0.75), Step 3 (score=0.5), Step 4 (score =0.25), Step 5 (score=0)</td>
</tr>
<tr>
<td>Total Score</td>
<td>Summation of scores from the preceding considerations used to rank each PFAS substance</td>
</tr>
<tr>
<td>List Account</td>
<td>List Name</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td>EAPFASF7SS1</td>
<td>PFAS/EPA: List of 75 Test Samples (Set 1)</td>
</tr>
<tr>
<td>EAPFASF7SS2</td>
<td>PFAS/EPA: List of 75 Test Samples (Set 2)</td>
</tr>
<tr>
<td>EAPFASCAT</td>
<td>PFAS/EPA Structure-based Categories</td>
</tr>
<tr>
<td>EAPFASDW</td>
<td>PFAS/EPA: New EPA Method Drinking Water</td>
</tr>
<tr>
<td>EAPFASDWS37</td>
<td>PFAS/EPA: Existing EPA DW Method 537.1</td>
</tr>
<tr>
<td>EAPFASDTREAT</td>
<td>PFAS/EPA: Drinking Water Treatment Technology</td>
</tr>
<tr>
<td>EAPFASINSOL</td>
<td>PFAS/EPA: Chemical Inventory Insoluble in DMSO</td>
</tr>
<tr>
<td>EAPFASINV</td>
<td>PFAS/EPA: ToxCast Chemical Inventory</td>
</tr>
<tr>
<td>EAPFASINVIVO</td>
<td>PFAS/EPA: In Vivo Studies Available</td>
</tr>
<tr>
<td>EAPFASLITSEARCH</td>
<td>PFAS/EPA: Literature Search Completed</td>
</tr>
</tbody>
</table>

List Description:
- **EAPFASF7SS1**: PFAS list corresponds to 75 samples (Set 1) submitted for initial testing screens conducted by EPA researchers in collaboration with researchers at the National Toxicology Program.
- **EAPFASF7SS2**: PFAS list corresponds to a second set of 75 samples (Set 2) submitted for testing screens conducted by EPA researchers in collaboration with researchers at the National Toxicology Program.
- **EAPFASCAT**: List of registered DisTox “category substances” representing PFAS categories created using ChemAxon’s Markush structure-based query representations.
- **EAPFASDW**: EPA is developing and validating a new method for detecting these PFAS in drinking water sources.
- **EAPFASDWS37**: EPA has recently revised method 537.1 for the PFAS on this list to detect them in drinking water.
- **EAPFASDTREAT**: EPA is gathering and evaluating treatment effectiveness and cost data for removing these PFAS from drinking water systems.
- **EAPFASINSOL**: PFAS chemicals included in EPA’s expanded ToxCast chemical inventory found to be insoluble in DMSO above 5mM.
- **EAPFASINV**: PFAS chemicals included in EPA’s expanded ToxCast chemical inventory and available for testing.
- **EAPFASINVIVO**: These PFAS have published animal toxicity studies available in the online HERO database.
- **EAPFASLITSEARCH**: A literature review of published toxicity studies for these PFAS.

Lists of PFAS on the Dashboard
https://comptox.epa.gov/dashboard/chemical_lists/?search=PFAS
Manual Structural categories: examples used

- Fluorotelomer acrylates 6 members
  - Methacrylate & acrylates
  - $n = 2$, $n_{CF2} = 6-10$

- Fluorotelomer alcohols 21 members
  - $n = 1-4$, $n_{CF2} = 2-11$

- Fluorotelomer amines 7 members
  - $n = 1$, $n_{CF2} = 2-6$

- Fluorotelomer carboxylates 5 members
  - $n = 2$, $n_{CF2} = 3-5$
Structural Categories

- Pragmatic approach for the initial PFAS library but...
- Subjective, manual..
- How to efficiently chart the PFAS landscape that is being tested against other PFAS inventories/libraries of interest e.g. OECD?
PFAS “Categories”: Per & Poly-fluorinated alkyl substances

• “Expert”-assigned PFAS categories – manual, subjective
  – Buck et al. (DuPont), based on chemical & series informed by synthetic pathways (e.g., fluorotelomers)
  – data-gathering, occurrence reports, ecotox
  – OECD PFAS listing (>4500 chemicals) – manually assigned groupings

<table>
<thead>
<tr>
<th>Class</th>
<th>Category_Name1</th>
<th>Category_Name2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>Fluorotelomer alcohols</td>
<td>Fluorotelomer (linear) n:2 alcohols</td>
</tr>
<tr>
<td>Sulfonic Acid</td>
<td>Perfluoroalkyl sulfonic acids</td>
<td>Perfluoroalkyl (linear C4-C10) sulfonic acids</td>
</tr>
<tr>
<td>Polyfluoroalkyl carboxylates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perfluoroalkyl ethers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluorotelomer phosphates</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
OECD Database of PFAS

- Released May 2018
- Substance Count: 4729
- Category Count: 173

http://www.oecd.org/chemicalsafety/portal-perfluorinated-chemicals/
"Expert-assigned" OECD PFAS Categories, e.g.

- 4730 PFAS in list
- 173 expert-assigned categories under 8 general headings (bold)
- Broad “catch-all” terms (in red)
- Structural elements, but NOT structure-based
- Requires expert to assign new chemicals to categories

<table>
<thead>
<tr>
<th>Perfluorooalkyl Carbonyl Compounds</th>
<th>CnF2n+1_C(O)_R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfluorooalkyl carbonyl halides</td>
<td>R = F/Cl/Br/I</td>
</tr>
<tr>
<td>Perfluorooalkyl carboxylic acids (PFCAs), their salts and esters</td>
<td>R = OH, ONa, OCH3, etc.</td>
</tr>
<tr>
<td>Other perfluorooalkyl carbonyl-based nonpolymers</td>
<td>to be refined</td>
</tr>
<tr>
<td>Perfluorooalkyl carbonyl amides / amidoethanols and other alcohols</td>
<td>R = NH2, NH(OH), etc.</td>
</tr>
<tr>
<td>Perfluorooalkyl carbonyl (meth)acrylate</td>
<td>polymers</td>
</tr>
<tr>
<td>Perfluorooalkyl carbonyl (meth)acrylate polymers</td>
<td>R = R’_OC(O)CH=CH2</td>
</tr>
<tr>
<td>1-H perfluorooalkyl carboxylic acids</td>
<td>H(CF2)nCOOH</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Perfluorooalkane Sulfonfyl Compounds</th>
<th>CnF2n+1_S(O)(O)_R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfluorooalkane sulfonfyl halides</td>
<td>R = F/Cl/Br/I</td>
</tr>
<tr>
<td>Perfluorooalkane sulfonic acids (PFSAs), their salts and esters</td>
<td>R = OH, ONa, OCH3, etc.</td>
</tr>
<tr>
<td>Perfluorooalkane sulfonfyl-based nonpolymers</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Per- and Polyfluorooalkyl Ether-Based Compounds</th>
<th>CnF2n+1_O_CmF2m+1_R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per- and polyfluorooalkyl ether sulfonic acids (PFESAs), their salts and esters, as well as derivatives</td>
<td>CnF2n+1_O_CmF2m+1_SO3H</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fluorotelomer-Related Compounds</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Perfluorooalkyl iodides (PFAIs)</td>
<td>CnF2n+1_I</td>
</tr>
<tr>
<td>n:2 fluorotelomer-based non-polymers</td>
<td>CnF2n+1_C2H4_R, to be refined</td>
</tr>
</tbody>
</table>
Markush Record Creation

- Fluorotelomer (linear) sulfonic acids
  - DTXSID: DTXSID30892558
  - CASRN: NOCAS_892558
  - TOXCAST: -

- Fluorotelomer (linear) alcohols
  - DTXSID: DTXSID10893581
  - CASRN: NOCAS_893581
  - TOXCAST: -

- Fluorotelomer (linear) n2 acrylates
  - DTXSID: DTXSID70893582
  - CASRN: NOCAS_893582
  - TOXCAST: -

- Fluorotelomer (linear) n2 methacrylates
  - DTXSID: DTXSID30893583
  - CASRN: NOCAS_892558
  - TOXCAST: -

- Fluorotelomer symmetric diols
  - DTXSID: DTXSID90893584
  - CASRN: NOCAS_893584
  - TOXCAST: -

- Fluorotelomer (linear) amines (secondary)
  - DTXSID: DTXSID50893585
  - CASRN: NOCAS_893585
  - TOXCAST: -

- Fluorotelomer (linear) carboxylic acids
  - DTXSID: DTXSID10893586
  - CASRN: NOCAS_893586
  - TOXCAST: -

- Fluorotelomer (linear) phosphate esters...
  - DTXSID: DTXSID30893588
  - CASRN: NOCAS_893588
  - TOXCAST: -
Translating Expert Categories to Markush

Expert category
Fluorotelomer acrylates
Fluorotelomer alcohols
Polyfluorinated alcohols
Fluorotelomer sulfonates
N-alkyl perfluoroalkyl sulfonamidoacetic acids
N-alkyl perfluoroalkyl sulfonamidoethanols
Perfluoroalkyl aldehydes
Perfluoroalkyl amides
Perfluoroalkyl carboxylates
Perfluoroalkyl acyl fluorides
Perfluoro vinyl esters
Perfluoroalkyl ketones
Semi-fluorinated alkenes
Perfluoroalkyl vinyl ethers
Perfluoroalkyl alkyl ethers
Fluorotelomer amines
Perfluoroalkyl sulfonamides
Semi-fluorinated alkanes
Perfluoroalkyl sulfonates
Perfluoroalkyl sulfonamidoamines
Polyfluoroalkyl carboxylates
Perfluoroalkyl ethers
Fluorotelomer phosphates
Example of Markush representation
PFASMASTER Markush Category Coverage

https://comptox.epa.gov/dashboard/chemical_lists/PFASMASTER
Next steps

• Complete targeted testing

• Data analysis per NAM technology and integrated across technologies to inform both read-across efforts and structural categories

• Work to extend objective structural categories to facilitate harmonisation across different inventories
Acknowledgements

• Too many to name but include:
  • Ann Richard
  • Reeder Sams
  • Rusty Thomas
  • Chris Grulke
  • Brian Meyer
  • Tony Williams
  • Jason Lambert