Toxicology and Risk Assessment Challenges with Evaluating Health Effects of PFAS

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Maine Center for Disease Control and Prevention
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PFOS

Carbon backbone

H  H  H  H  H  H  H  H  H  H

H—C—C—C—C—C—C—C—C—H

H  H  H  H  H  H  H  H  H

Octane

Acid Group

O

SO

F  F  F  F  F  F  F  F  F  O

F—C—C—C—C—C—C—C—C—SO

F  F  F  F  F  F  F  F  F  O

F  F  F  F  F  F  F  F  F  O

Perfluorooctane sulfonic acid (PFOS)
**Available Toxicity Data**

**Human Studies**
- Liver damage
- Thyroid hormone disruption
- Decreased immune response to vaccinations
- Low birth weight (LBW)
- Testicular, kidney and prostate cancer (PFOA)
- Ulcerative colitis
- Changes in cholesterol
- Hypertension during pregnancy

**Animal Studies**
- Increased liver size / liver damage
- Thyroid hormone disruption
- Changes in immune function
- LBW and other developmental effects
- Liver, testicular and pancreatic cancers (PFOA)
- Increased kidney weight

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Key Decisions in Deriving Toxicity Values

- Use human or animal data
- If animal, which animal study
- What endpoint from any given animal study
- How to adjust for much longer half-life in humans versus animals
- What to apply for uncertainty factors
Deriving a Toxicity Value for PFOS

100,000 ng/kg/day

No adverse effect observed in rodent pups

510 ng/kg/day

Human equivalent dose

20 ng/kg/day

Dose that is safe in the most vulnerable people (like developing babies)

~200x

~30x

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## Differences in Toxicity Values for PFOS

<table>
<thead>
<tr>
<th>Agency</th>
<th>Endpoint</th>
<th>Species</th>
<th>Human equivalent dose (ng/kg/day)</th>
<th>Cumulative uncertainty factor</th>
<th>Reference dose (ng/kg/day)</th>
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<tbody>
<tr>
<td>Federal</td>
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<tr>
<td>EPA</td>
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<td>Rats</td>
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<tr>
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<td>EFSA</td>
<td>Changes in cholesterol</td>
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<td>1</td>
<td>2</td>
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</table>

* Proposed/Draft
Deriving a Drinking Water Guideline

Toxicity Value
20 ng/kg/day

Water Intake Rate
0.054 L/kg/day

Drinking Water Exposure Limit
370 ng/L

Background Exposure (RSC) 20% Default
70 ng/L

Health Advisory

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# Drinking Water Values for PFOS

<table>
<thead>
<tr>
<th>Agency</th>
<th>Reference dose (ng/kg/day)</th>
<th>Receptor</th>
<th>Drinking water intake (L/kg/day)</th>
<th>Relative source contribution</th>
<th>Drinking water guideline (ng/L)</th>
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<td>ATSDR</td>
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<td>Infant birth to 1 yr</td>
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<td><strong>States</strong></td>
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<td>Adult</td>
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<td>0.021</td>
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<td>600</td>
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</tbody>
</table>

* Proposed / Draft.
Who is most at risk?

- Exposure During Pregnancy
- Formula Fed
- Breastfeeding

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Spike in Infant PFOS Serum Levels from Breastfeeding

Breastfed Infant Scenario PFOS Serum Concentration at Water Concentration - 70 ng/L

Helen M. Goeden ● Christopher W. Greene ● James A. Jacobus
Background Exposure Estimated from U.S. Population PFOS Serum Levels

Estimated Daily Intake
1.5 ng/kg/day
0.4 ng/kg/day

National Report on Human Exposure to Environmental Chemicals – US CDC:
https://www.cdc.gov/exposurereport/index.html

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Soil Related Exposure Pathways

- Residential Soil
- Soil-to-Groundwater
- Agronomic
- Irrigation
PFOS Soil Levels for Residential Soil Exposure Pathway

Based on Chapter 418 risk standard of 0.5 HI, USEPA RSL model with standard (EPA/ME) defaults, and USEPA RfD.

PFOS
1500 µg/kg
PFOS Soil Levels for Agronomic Exposure Pathway

PFOS
3.1 µg/kg (hay)
6.5 µg/kg (corn)

**DRAFT – Under development.** Chapter 418 risk standard of 0.5 HI, USEPA PRG agronomic model, MECDC milk action level based on USEPA RfD.
# Maine Action Level for PFOS Adulterated Milk

<table>
<thead>
<tr>
<th>Agency</th>
<th>Reference dose (ng/kg/day)</th>
<th>Receptor</th>
<th>Cow’s milk intake (L/kg/day)</th>
<th>Relative Source Contribution</th>
<th>Cow’s milk action level (ng/L)</th>
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<tbody>
<tr>
<td>Maine CDC/DACF</td>
<td>20</td>
<td>1 - 2 year old</td>
<td>0.074</td>
<td>80</td>
<td>210</td>
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</table>

PFOS 210 ng/L
Based on Chapter 418 risk standard of 0.5 HI, USEPA RSL tap water model modified with use of SESOIL soil to groundwater model, and USEPA RfD.
Transfer pathways:

1. Deposition
2. Soil resuspension
3. Root uptake
# Toxicity Values for Other PFAS

## Reference dose by Agency or various States

<table>
<thead>
<tr>
<th>PFAS</th>
<th>EPA</th>
<th>ATSDR</th>
<th>States</th>
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<tbody>
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<td>PFBA</td>
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*Proposed

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Things we are thinking about:

• Whether to stay with EPA toxicity values
• Whether to use the breast fed receptor
• Expanding agronomic screening levels
• Whether to derive toxicity values for other PFAS (e.g., PFHxS, PFHxA, PFNA)
• Whether to continue chemical-by-chemical approach, or grouping of “like” PFAS
Questions?

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