Human Health Toxicity Assessment for Perfluorooctane Sulfonic Acid (PFOS)

January 2025
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The EPA published the final human health toxicity assessment for PFOS in April 2024.

> *A toxicity assessment summarizes the potential health effects associated with exposure to a particular chemical and identifies the dose levels at which the health effects may occur in order to calculate toxicity values.*

The PFOS toxicity assessment identified adverse health effects associated with PFOS exposure using a robust systematic review process based on EPA peer-reviewed human health risk assessment methodology.

> *Systematic review is a structured and documented process for transparent literature review using explicit, pre-specified scientific methods to identify, select, assess, and summarize the findings across relevant studies. Systematic review promotes use of the best available science and reduces bias.*

The EPA followed its peer-reviewed human health risk assessment methodology and applicable guidance documents for all steps of the toxicity assessment including hazard identification, cancer classification, and toxicity value development (e.g., USEPA, 2002; USEPA, 2005; USEPA, 2012; USEPA, 2022). The PFOS toxicity assessment incorporated expert scientific recommendations received from peer review and feedback from the public comment period.

Health Effects Identified for PFOS

The EPA's systematic review of over 700 human and animal health studies demonstrated PFOS exposure elicits adverse noncancer and cancer health effects (see table below).Consistent with EPA's Guidelines for Carcinogen Risk Assessment, the EPA concluded that PFOS is Likely to Be Carcinogenic to Humans via the oral route of exposure.

	Immune	Developmental	Cardiovascular	Liver	Cancer
Effects observed in human studies	↓ Vaccine response in children	↓ Infant birth weight ↑ Risk of preterm birth ↓ Gestational age	↑ Serum lipids (total cholesterol and LDL) ↑ Blood pressure in adults	↑ Serum liver enzymes (ALT) indicative of liver damage in adults	Liver cancer in adults
Effects observed in animal studies	↓ Immune response ↑ Toxicity on the immune system	↓ Pup survival ↓ Fetal and pup body weight	Changes in serum lipids	↑ Liver cell death and serum liver enzymes (ALT) indicative of liver damage	Liver, pancreatic, and thyroid tumors

Toxicity Values for PFOS

Based on the effects described above, toxicity values were calculated for PFOS – a cancer slope factor (CSF) and a reference dose (RfD) – in line with EPA peer-reviewed human health risk assessment methodology and applicable guidance documents.

- *A CSF is an upper bound, approximating a 95% confidence limit, on the increased cancer risk from a lifetime exposure to an agent. The CSF is the change in risk per unit dose.*
- *A RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. Uncertainty in the data is accounted for by including uncertainty factors in the RfD to protect public health.*

	Critical Effect	Study	Population	Toxicity Value
Cancer Slope Factor	Combined liver adenomas and carcinomas	Butenhoff, 2012 Thomford, 2002	Female rats	39.5 $(mg/kg/day)^{-1}$
Reference Dose (see page 2)	↓ Birth weight	Wikström, 2020	Infants	1×10^{-7} mg/kg/day
	↑ Serum total cholesterol	Dong, 2019	20- to 80-year-old adults	

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The chart below demonstrates that the PFOS exposure level expected to cause adverse noncancer effects on the immune system, development, the cardiovascular system, and the liver in humans (Point of Departure, **POD**) are similar. The chart also depicts the selected PODs with adjustments (Uncertainty Factors, **UF**) to be protective of at-risk populations and account for data gaps to derive **candidate reference doses (RfD)**. **Overall, or final, RfDs** are in orange.

Effects on the immune and cardiovascular systems, development, and the liver occur at the same or approximately the same doses of PFOS exposure in multiple studies, populations, and geographic locations, which increases confidence in the RfD.