A Science-Based Approach to Understanding and Managing Environmental Risk from PFAS

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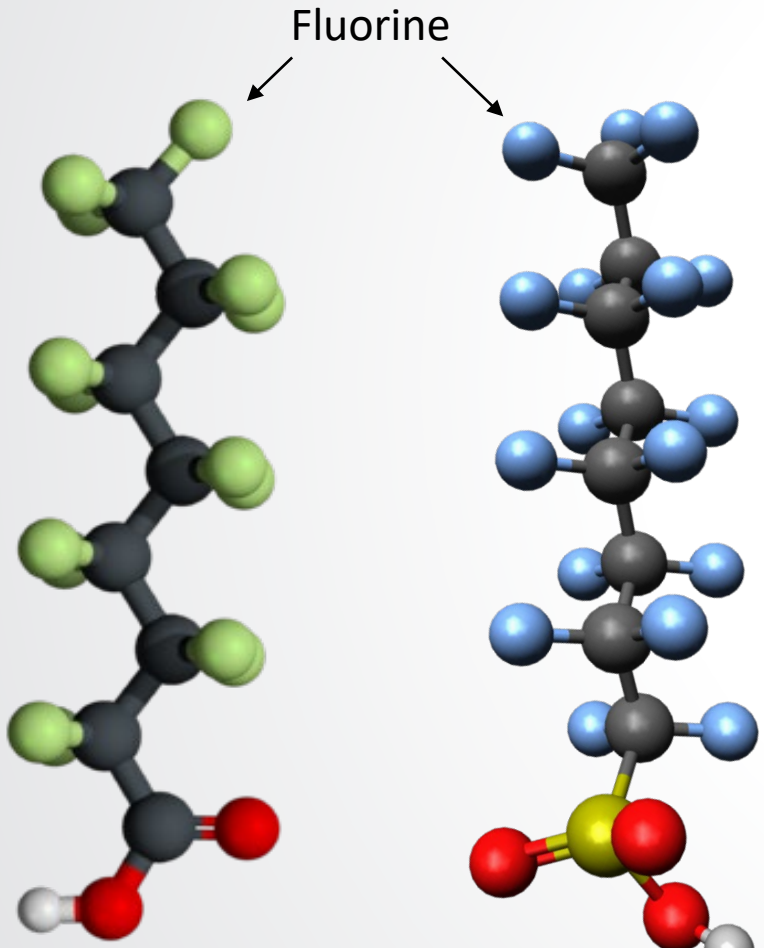
Per- & Polyfluoroalkyl Substances (PFAS)



PFOA *PFOS*

- **A very large class of synthetic chemicals**
  - **Chains** of carbon (C) atoms surrounded by fluorine (F) atoms, with different terminal ends
  - **Complicated chemistry** – thousands of different variations exist in commerce
  - **Widely used** in industrial processes and in consumer products
  - **Mobile** via multiple air, water pathways
  - Some PFAS are known to be PBT:
    - **Persistent** in the environment
    - **Bioaccumulative** in organisms
    - **Toxic** at relatively low (ppt) levels

Background

- PFAS are a group of synthetic chemicals that have been in use since the 1940s in a wide array of consumer products and facilities
- Most people have been exposed to PFAS
  - Some PFAS chemicals can accumulate and can stay in the human body for long periods of time
- There is evidence that exposure to certain PFAS may lead to adverse human health and environmental effects
- PFAS is an issue of high and growing concern for EPA customers and the public
  - EPA is committed to taking action to address public concerns

EPA's PFAS Action Plan

- National PFAS Leadership Summit – May 2018
  - Share information, identify actions, risk communication
- Major EPA Actions Announced at Summit
  - Develop groundwater cleanup recommendations for PFOA/PFOS
  - Examine options for listing PFOA/PFOS as hazardous substances
  - Release toxicity assessments for GenX and PFBS
- Community Events – June-September 2018
  - Series of public meetings on PFAS concerns
- EPA PFAS Action Plan – February 2019
  - Building on lessons learned from summit, engagements, public comments
  - Available at www.epa.gov/epas-pfas-action-plan

Recent EPA Actions on PFAS

- Announced a final determination to regulate PFOA and PFOS in drinking water (January 2021)
- Proposed the fifth Unregulated Contaminant Monitoring Rule, which would require public water systems to monitor for 29 PFAS in 2023-2025 (January 2021)
- Issued an ANPRM to solicit public comment and data to inform whether EPA should develop future regulations pertaining to PFOA and PFOS under CERCLA and RCRA (January 2021)
- Released OTM-45, a sampling and analysis method for measuring 50 PFAS in air emissions from stationary sources (January 2021)
- Released *Interim Guidance on the Destruction and Disposal of PFAS and Materials Containing PFAS* for public comment (December 2020)
- Published a final Significant New Use Rule (SNUR) for certain PFAS in manufactured products (July 2020)
  - Released *Compliance Guide* (January 2021)

PFAS Action Plan – Research

- The EPA is rapidly expanding the scientific foundation for understanding and managing risk from PFAS
- This research is organized around:
  - Understanding **exposure**
  - Understanding **toxicity**
  - Assessing **hazard and dose response**
  - Identifying effective **treatment and remediation** actions

Research – Analytical Methods

- **Data Gap:** Standardized/validated analytical methods for measuring PFAS
- **Action:** Develop and validate analytical methods for detecting and quantifying PFAS in water, air, solids and tissues
- **Near Term Research Products:**
  - Method for air emission sampling and analysis (OTM-45 released January 2021)
  - Validated isotope dilution method for measuring up to 40 PFAS in surface water, groundwater, soils, sediments and biosolids
  - Total organic fluorine (TOF) method
  - Non-targeted analysis methods to characterize PFAS in environmental media
- **Impact:** Stakeholders will have reliable standardized analytical methods to test for known and discover new PFAS in water, solids and air

Research – Exposure

- **Data Gap:** Knowledge on nature, sources, extent, fate and transport, bioaccumulation, and human and ecological exposure
- **Action:** Develop databases and models to characterize and prioritize PFAS sources and pathways and to predict human and ecological exposures
- **Near Term Research Products:**
  - Case Study: PFAS fate and transport/air dispersion – Published Jan. 4, ES&T
  - Development of human exposure datasets
  - Multimedia household human exposure estimates for 8 PFAS
- **Impact:** Stakeholders will be able to identify and assess potential PFAS sources and exposures, and identify key pathways for risk management

Research – Chemical Data Curation

- **Data Gap:** Lack of tools to access and integrate PFAS chemical data
- **Action:** Develop databases and tools to streamline access to PFAS chemical data
- **Near Term Research Products:**
  - Models to predict PFAS chemical/physical properties
  - Public repository for high throughput toxicity/toxicokinetic data
  - Public online databases, such as the CompTox Chemicals Dashboard and ECOTOX Knowledgebase, to curate data on chemical and physical properties, sources, exposure and toxicity
- **Impact:** Stakeholders will have easy access to the most comprehensive and current PFAS chemical data

Research – Human Health Assessment

- **Data Gap:** Lack of human toxicity information for many PFAS of interest
- **Action:** Address data gaps for PFAS with **sufficient** existing published studies by:
  - Conducting systematic review/evidence mapping of PFAS toxicology literature
  - Add PFAS literature to the HERO database of scientific references
  - Develop standard toxicity assessments where data are available
- **Near Term Research Products:**
  - Final toxicity assessments for PFBS and GenX chemicals (HFPO-DA)
  - External review draft IRIS assessments for PFBA, PFHxA, PFHxS, PFNA, PFDA
- **Impact:** Stakeholders will have PFAS toxicity reference values to inform risk analysis, risk management decisions and risk communication

Research – Human Health Toxicology

- **Data Gap:** Lack of human toxicity information for many PFAS of interest
- **Action:** Address data gaps for PFAS with **limited/no existing** published studies by:
  - Using *in vitro*, high throughput toxicity/toxicokinetic testing to fill in data gaps and support prioritization, chemical grouping, relative toxicity and mixtures assessment
  - Appling New Approach Methods (NAMs) to inform hazard characterization and prioritization for targeted *in vivo* testing
- **Near Term Research Products:**
  - Risk-based testing strategy using high throughput results
  - Report on bioactivity analysis of ~120 different PFAS (7 sets of assays)
  - Categorization of PFAS
- **Impact:** Stakeholders will have PFAS toxicity data to inform risk analysis, risk management decisions and risk communication

Research – Ecological Toxicity

- **Data Gap:** Knowledge on bioaccumulation and ecotoxicity of PFAS of concern
- **Actions:**
  - Identify sensitive taxa, quantify bioaccumulation, support establishment of effects benchmarks and thresholds
  - Develop PFAS-related adverse outcome pathways (AOPs) to provide basis for predicting ecological effects of poorly tested PFAS
- **Near Term Research Products:**
  - Review/synthesis of PFAS bioaccumulation literature
  - Update bioaccumulation factors for PFAS in aquatic species
  - Develop putative AOPs for PPAR signaling (fish), thyroid (avian)
- **Impact:** Stakeholders will have PFAS ecotoxicity information to support risk management decisions (e.g., aquatic life criteria/benchmarks)

Research – Drinking Water Treatment

- **Data Gap:** Water treatment technology performance and cost data for PFAS removal
- **Actions:**
  - Review PFAS performance, cost data from different configurations and range of system sizes (collaborative with utilities, industry, DoD, academia, international)
  - Test commercially available granular activated carbons (GACs) and ion exchange (IX) resins for effectiveness over a range of PFAS under different water quality conditions
  - Evaluate technologies for regeneration or disposal of spent GAC and IX
- **Near Term Research Products:**
  - Updated drinking water treatment performance, cost models and data
  - Updates to EPA's Drinking Water Treatability Database
  - PFAS fate from reactivation/thermal treatment of spent GAC and IX
- **Impact:** Utilities will be able to better identify cost-effective treatment strategies for removing PFAS from drinking water, given their specific situation

Research – Site Remediation

- **Data Gap:** Knowledge to support remediation/clean up of PFAS-contaminated sites
- **Actions:**
  - Characterize PFAS-contaminated sites, such as fire training/emergency response sites, manufacturing facilities, production facilities, disposal sites
  - Evaluate technologies for remediating PFAS-impacted soils, waters, sediments
  - Generate performance and cost data to develop models and provide tools to determine optimal treatment choices
- **Near Term Research Products:**
  - Groundwater remediation performance, cost models, data
  - PFAS fate and transport from land application of PFAS-contaminated biosolids
  - Migration potential of PFAS via vapor intrusion
- **Impact:** Responsible officials will more information to make decisions to reduce risk of PFAS exposure and effects at contaminated sites

Research – Destruction & Disposal

- **Data Gap:** Knowledge regarding end-of-life management and ultimate disposal of PFAS-containing materials
- **Actions:**
  - Characterize end-of-life PFAS disposal streams (e.g., municipal, industrial, manufacturing, recycled waste streams)
  - Evaluate efficacy of disposal/destruction technologies (e.g., landfilling, incineration, *in situ* stabilization) to manage end-of-life disposal
  - Evaluate possibility of products of incomplete combustion/destruction
- **Near Term Research Products:**
  - PFAS presence in different types of landfills and leachates
  - PFAS behavior in incineration environments
  - Thermal treatment of PFAS-contaminated biosolids
- **Impact:** Responsible officials will be able to manage effectively end-of-life disposal of PFAS-containing materials

Research – Innovative Treatment

- **Data Gap:** Validated solutions for destroying/disposing PFAS molecules in various media
- **Action:** Establish the PFAS Innovative Treatment Team to identify, develop and verify a suite of effective approaches and technologies for destroying or disposing of PFAS-contaminated media
  - Intensive, 6-month effort in 2020
  - Continued research on supercritical water oxidation, pyrolysis/gasification, mechanochemical treatment and electrochemical oxidation
- **Near Term Research Products:**
  - Research Briefs describing research efforts
  - Introductory research paper on innovative PFAS destruction technologies
- **Impact:** Provides officials with data on approaches for destruction/disposal of PFAS, leading to confidence in permitting and monitoring of clean-up operations

Competitive Grants & Prizes

- **National Priorities** – Congressional mandate to fund water quality and water availability research by not-for-profit organizations
  - 2019: PFAS impacts on water quality and availability (2 awards)
  - 2020: PFAS impacts on agriculture and rural communities (3 awards)
- **Science to Achieve Results (STAR)** – EPA's competitive extramural grant program
  - 2019: PFAS waste management, including landfills and PFAS destruction technologies (8 awards)
- **Competitive Challenge** – "Innovative Ways to Destroy PFAS"
  - $50,000 in prizes for creative solutions submitted via Challenge.gov
  - Received >60 potential solutions from 18 countries

Collaboration

- PFAS is a topic of interest to many different organizations, and EPA is committed to leveraging partnerships and collaborations to achieve results
  - **National Toxicology Program (NTP)** – High throughput toxicology testing
  - **FDA and USDA** – Analytical methods
  - **DoD** – Analytical method development, treatment/remediation approaches, and participation in the Strategic Environmental Research and Development Program (SERDP)
  - **States and public utilities** – Testing and applying PFAS sampling, measurement, and treatment methods
  - **Academic community** – EPA's STAR and National Priorities competitive grant programs

Technical Assistance

- **Data Gap:** State, tribes and communities often lack some capabilities for managing PFAS risk
- **Actions:**
  - Make EPA technical staff available to consult on PFAS issues
  - Utilize applied research while also providing technical support to site managers
  - Summarize and share lessons learned from technical support activities
- **Examples:**
  - NC, NH, NJ – Identify novel PFAS in air, water, soil and vegetation
  - MI/MN – Characterize PFAS sources in chrome plating facilities
  - AK/North Slope Borough – PFAS contamination in water, sediment and fish tissue
- **Impact:** Enable states, tribes and communities to take scientifically sound action on PFAS

For More Information

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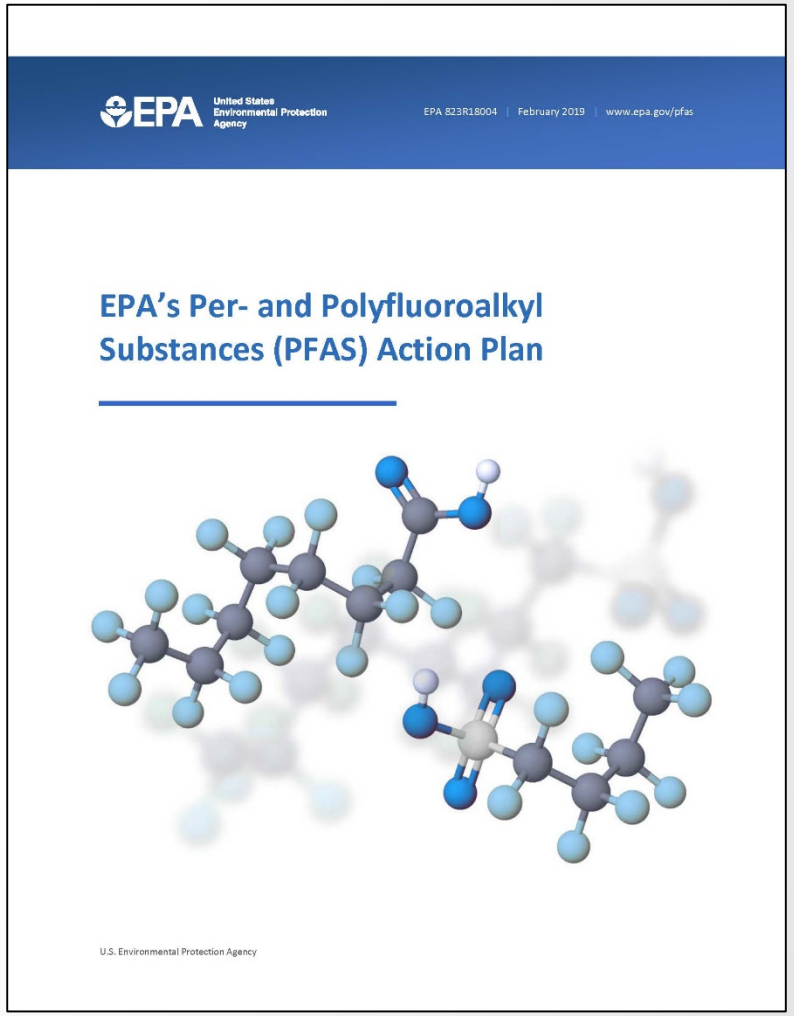

- **EPA PFAS Activities** – www.epa.gov/pfas
- **PFAS Research and Development** – www.epa.gov/chemical-research/research-and-polyfluoroalkyl-substances-pfas