Potential for Occupational Exposure to Per- and Polyfluoroalkyl Substances (PFAS)

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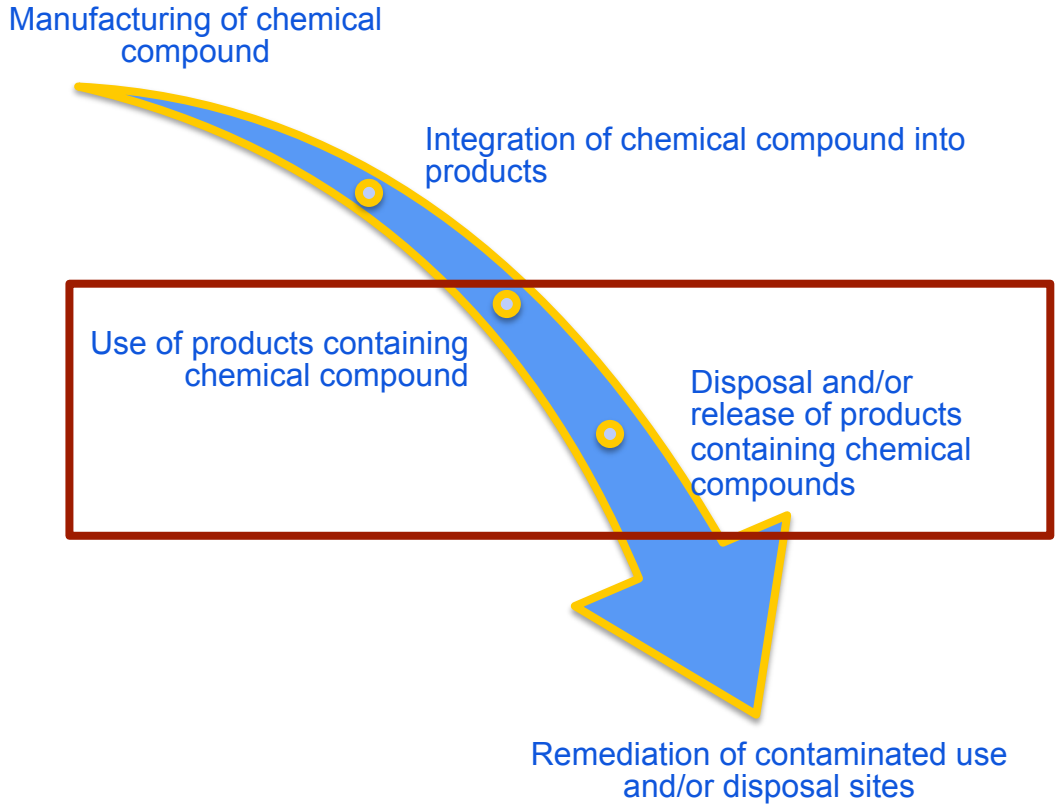
Occupational Exposures

- Occur throughout the life of a compound or product
  - Often include industry, occupation, and task-specific differences



Fire Fighter Cancer and Occupational Exposures

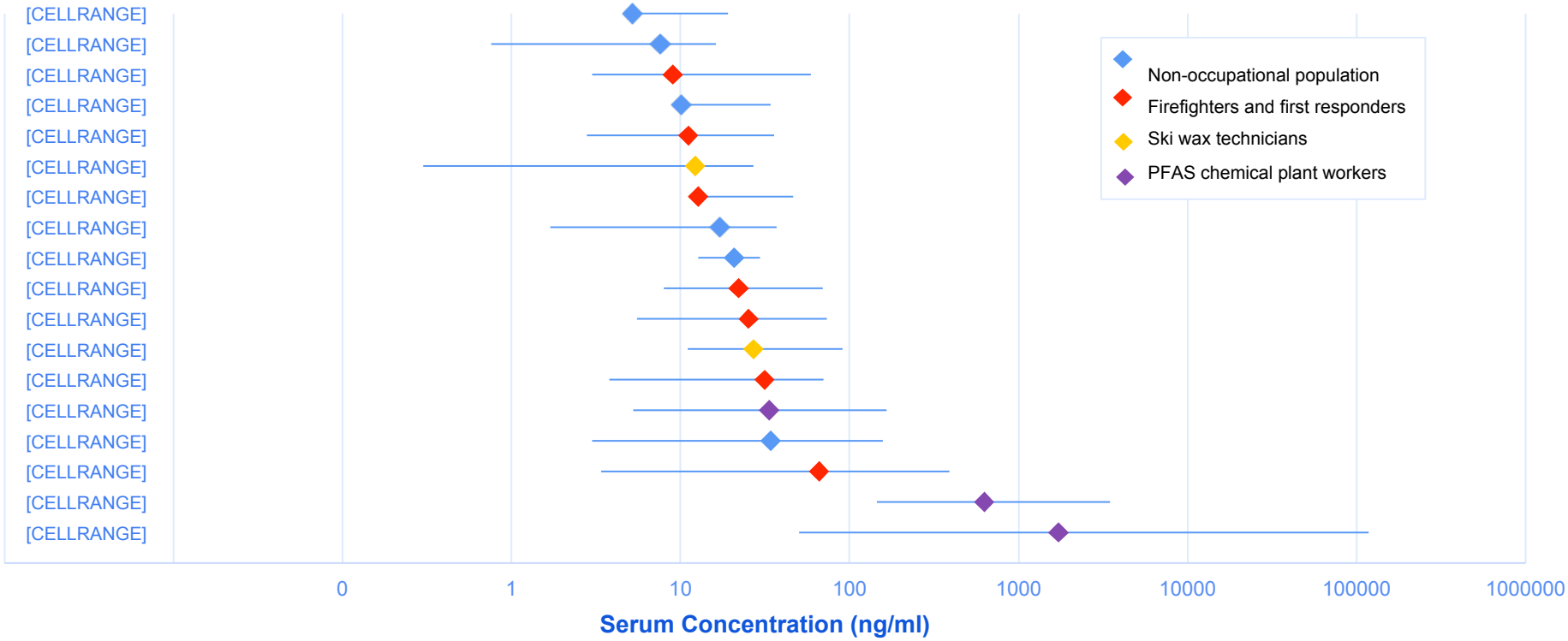
- Research by NIOSH determined fire fighters have 14% higher overall cancer mortality than the general public, with greater increases in some specific cancers

  [Daniels et al. *Occup Environ Med* 2014;71:388-397]

- Occupational exposures include a complex mixture of known and suspected carcinogens

Comparison of PFOS in Serum, Plasma, or Whole Blood by Population, Geographic Region, and Year of Most Recent Test

-Comparison based on median and range values-

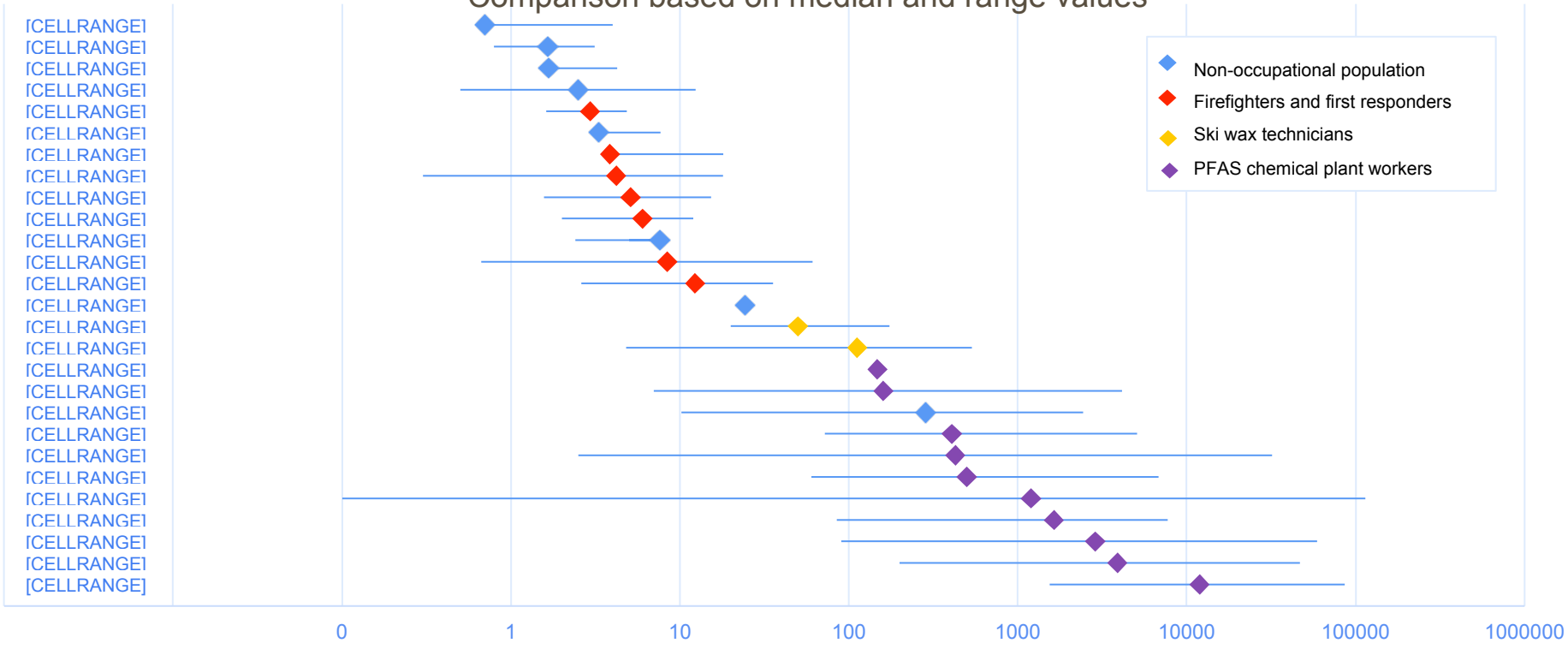


*Upper limit based on 95th percentile

(a) CDC, 2019; (b) Ericson et al., 2007; (c) Shaw, 2013; (d) Laitinen et al., 2014; (e) Nilsson et al., 2010; (f) Dobraca et al., 2015; (g) Karrman et al., 2006b; (h) Karrman et al., 2006a; (i) Tao et al., 2008; (j) Freberg et al., 2010; (k) Wang et al., 2012; (l) Rotander et al., 2015; (m) Olsen et al., 2007; (n) Fu et al., 2016

Comparison of PFOA in Serum, Plasma, or Whole Blood by Population, Geographic Region, and Year of Most Recent Test

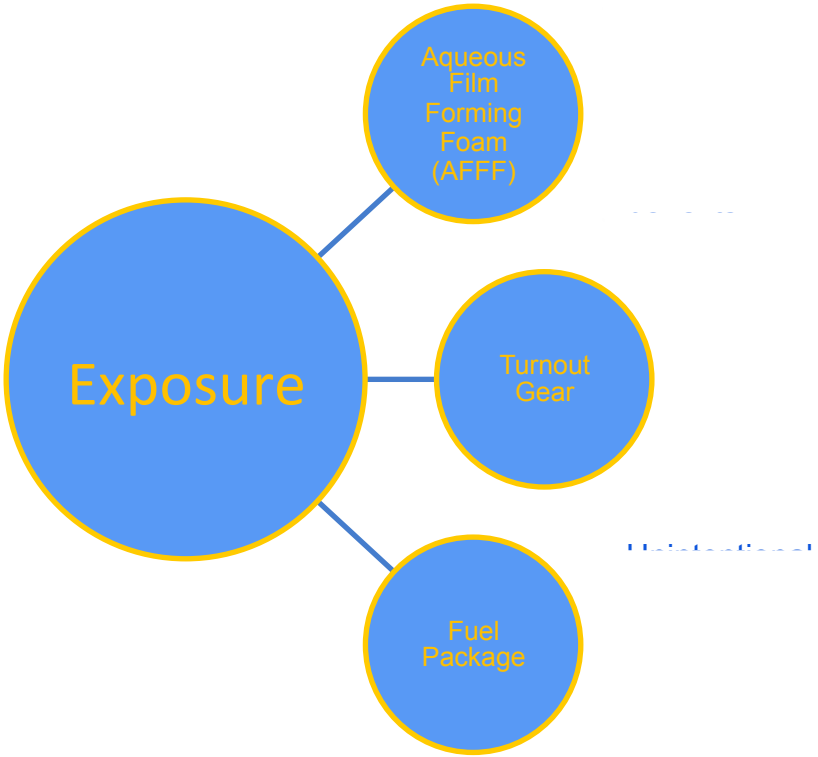
-Comparison based on median and range values-



*Upper limit based on 95th percentile

(a) Kato et al., 2018; (b) Ericson et al., 2007; (c) CDC, 2019; (d) Karrman et al., 2006b; (e) Laitinen et al., 2014; (f) Dobraca et al., 2015; (g) Rotander et al., 2015; (h) Tao et al., 2008; (i) Shaw et al., 2013; (j) Karrman et al., 2006a; (k) Steenland et al., 2009; (l) Freberg et al., 2010; (m) Nilsson et al., 2010; (n) Woskie et al., 2012; (o) Wang et al., 2012; (p) Olsen et al., 2007; (q) Fu et al., 2016; (r) Costa et al., 2009

First Responder PFAS Exposure Pathways and Routes



Exposure routes

- Inhalation
- Dermal absorption
- Hand-to-mouth/ mucous membrane contact


Insulation
Sunscreen
Waxes
Leather goods
Rubber
Plastics
Photography
Pesticides
Oil recovery processes
Wire coatings
Adhesives
Food-handling materials
Medical devices
Polishes
Ski wax
Firefighting foam
Stain resistant textiles & carpeting
Shampoo
Insect repellant and baits
Hydraulic fluids
PFAS
Electronics
Turnout gear
Engineering coatings
Construction materials
Paint
Outdoor textiles
Packaging materials
Cosmetics
…many other sources
Cleaners
Water resistant material
Water resistant textiles
Non-stick cookware
Metal Plating
Printer and copy machine parts

Occupational Health Challenges for Reducing PFAS-Related Health Outcomes

- Limitations of existing research
  - Potential for exposure to different mixture of compounds than studied in environmental health contexts
  - Occupationally relevant routes of exposure
  - Transition towards short-chain and alternative PFAS compounds
- Risk trade-offs
  - Example 1: Safety

    Potential for reduced efficiency of firefighting foam in PFAS-free AFFF
  - Example 2: Carcinogen exposure

    Potential for reduced water resistance in PFAS-free turnout gear
  - Example 3: Populations at risk

    Environmental remediation may increase exposure for remediation workers
- Limited occupational reference limits and guidance

NIOSH Proposed Research

1. Expand ongoing study - **F**ire **F**ighter **C**ancer **C**ohort **S**tudy (FFCCS)

2. Potential new study – Targeted Occupational Exposure Assessment

Expand ongoing study - Fire Fighter Cancer Cohort Study (FFCCS)

- Multi-city study focused on carcinogenic exposures and health effects
- Collaboration between CDC/NIOSH, University of Arizona, University of Miami, and industry partners
- Proposed research adds an evaluation of PFAS exposure
  - Survey
  - **Acute exposure assessment (fire-response, AFFF, and turnout gear)**
  - Chronic exposure assessment
  - Toxicity testing
- 3-year addition to study

Potential new study – Targeted Occupational Exposure Assessment

- Study objectives
  - Identify industries and occupations where PFAS is likely present
  - Identify PFAS compounds currently in use
  - Conduct a targeted occupational exposure assessment focusing on ongoing exposures
- Exposure assessment
  - Two to three industries
    - High to moderate PFAS use
    - Anticipated industries include: manufacturing, services, and public safety
  - Biological and work environment monitoring
- 3-year study anticipated to start in FY2020

Thank you!
Questions?

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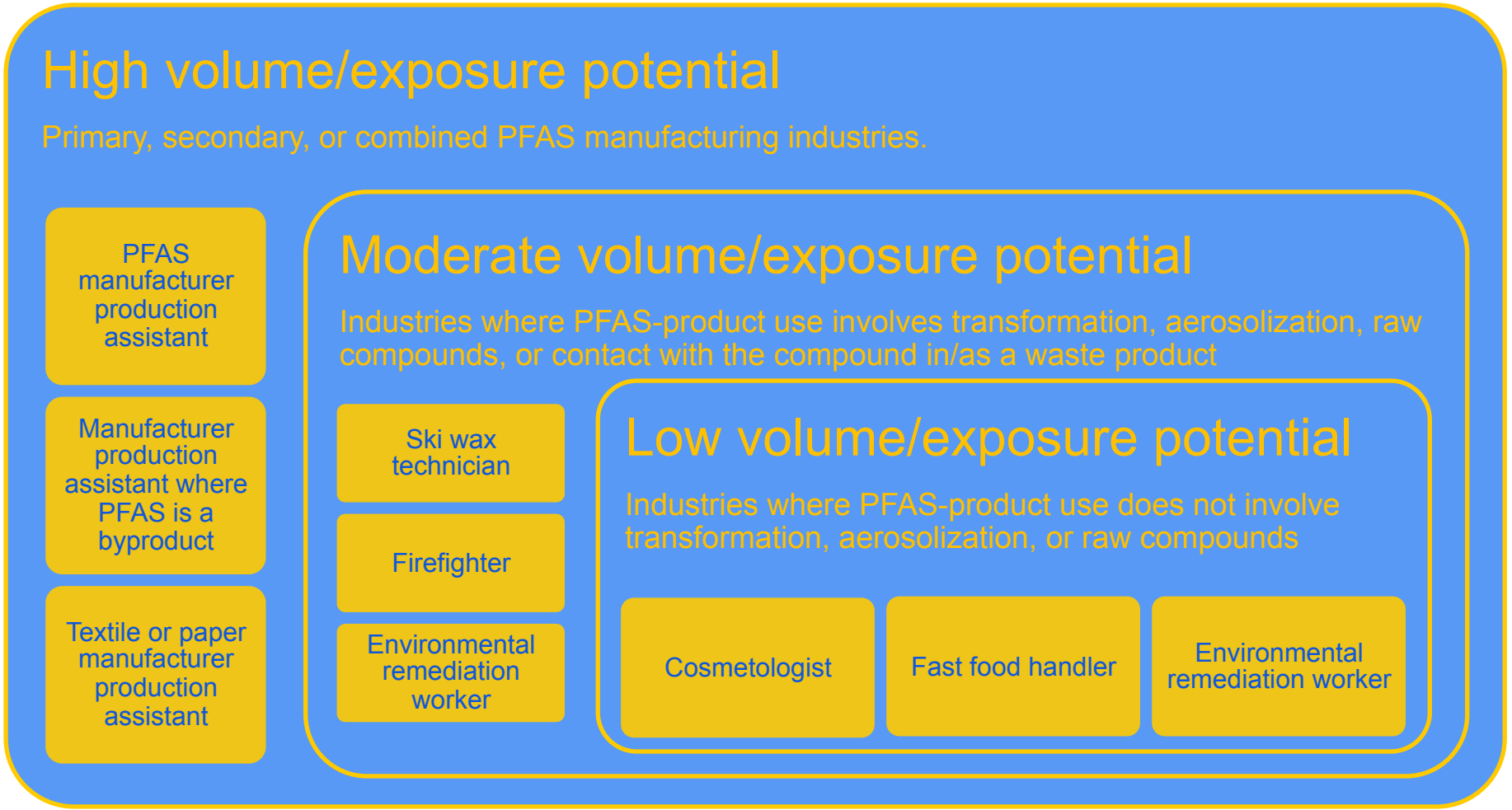
The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.


High volume/exposure potential
Primary, secondary, or combined PFAS manufacturing industries.
PFAS manufacturer production assistant
Manufacturer production assistant where PFAS is a byproduct
Textile or paper manufacturer production assistant
Moderate volume/exposure potential
Industries where PFAS-product use involves transformation, aerosolization, raw compounds, or contact with the compound in/as a waste product
Ski wax technician
Firefighter
Environmental remediation worker
Low volume/exposure potential
Industries where PFAS-product use does not involve transformation, aerosolization, or raw compounds
Cosmetologist
Fast food handler
Environmental remediation worker

History of Common PFAS

Table 2-1. Discovery and manufacturing history of select PFAS

PFAS[1]	Development Time Period							
	1930s	1940s	1950s	1960s	1970s	1980s	1990s	2000s
PTFE	Invented	Non-Stick Coatings			Waterproof Fabrics			
PFOS		Initial Production	Stain & Water Resistant Products	Firefighting foam				U.S. Reduction of PFOS, PFOA, PFNA (and other select PFAS[2])
PFOA		Initial Production		Protective Coatings				
PFNA					Initial Production	Architectural Resins		
Fluoro-telomers					Initial Production	Firefighting Foams		Predominant form of firefighting foam
Dominant Process[3]		Electrochemical Fluorination (ECF)						Fluoro-telomerization (shorter chain ECF)
Pre-Invention of Chemistry /			Initial Chemical Synthesis / Production			Commercial Products Introduced and Used		

Notes:
1. This table includes fluoropolymers, PFAAs, and fluorotelomers. PTFE (polytetrafluoroethylene) is a fluoropolymer. PFOS, PFOA, and PFNA (perfluorononanoic acid) are PFAAs.
2. Refer to Section 3.4.
3. The dominant manufacturing process is shown in the table; note, however, that ECF and fluorotelomerization have both been, and continue to be, used for the production of select PFAS.

Sources: Prevedouros et al. 2006; Concawe 2016; Chemours 2017; Gore-Tex 2017; US Naval Research Academy 2017

Source: Interstate Technology Regulatory Council (ITRC) 2017

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