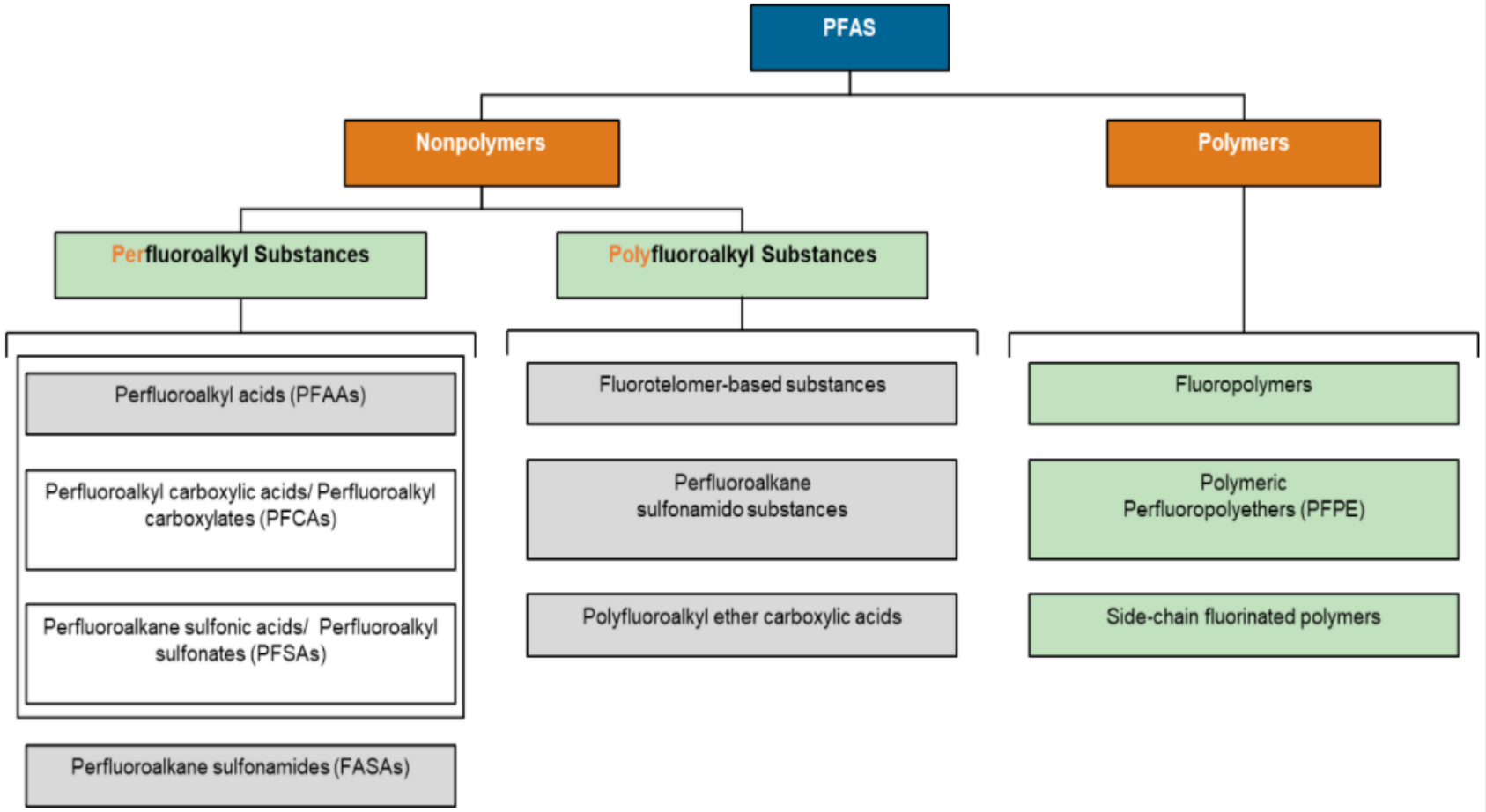
Overview of Per- and Polyfluoroalkyl Substances (PFAS) Activities and Considerations

Presented by

Miriam Calkins, PhD, MS
Research Industrial Hygienist
CDC/NIOSH/DFSE/FRB

April 21, 2023

Classification

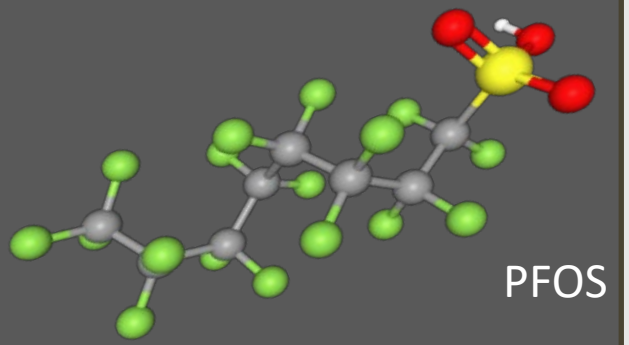


Interstate Technology & Regulatory Council (ITRC). 2020

Synthetic, not naturally occurring

> 12,000 substances

Fluorinated aliphatic (carbon chain) structure



PFOS

Why are PFAS a concern?

- Integrated extensively into products and processes since 1950s
- Desirable properties
- “Forever chemicals”
- Toxicological and epidemiological evidence of health effects affecting multiple systems

Community Exposure and Health

- Increased cholesterol levels
- Changes in liver enzymes
- Small decreases in infant birth weights
- Decreased vaccine response in children
- Increased risk of high blood pressure or pre-eclampsia in pregnant women
- Increased risk of kidney or testicular cancer

Image: Courtesy of ATSDR's *What are the Health Effects of PFAS?*

NHANES Blood Levels of Commonly Measured PFAS

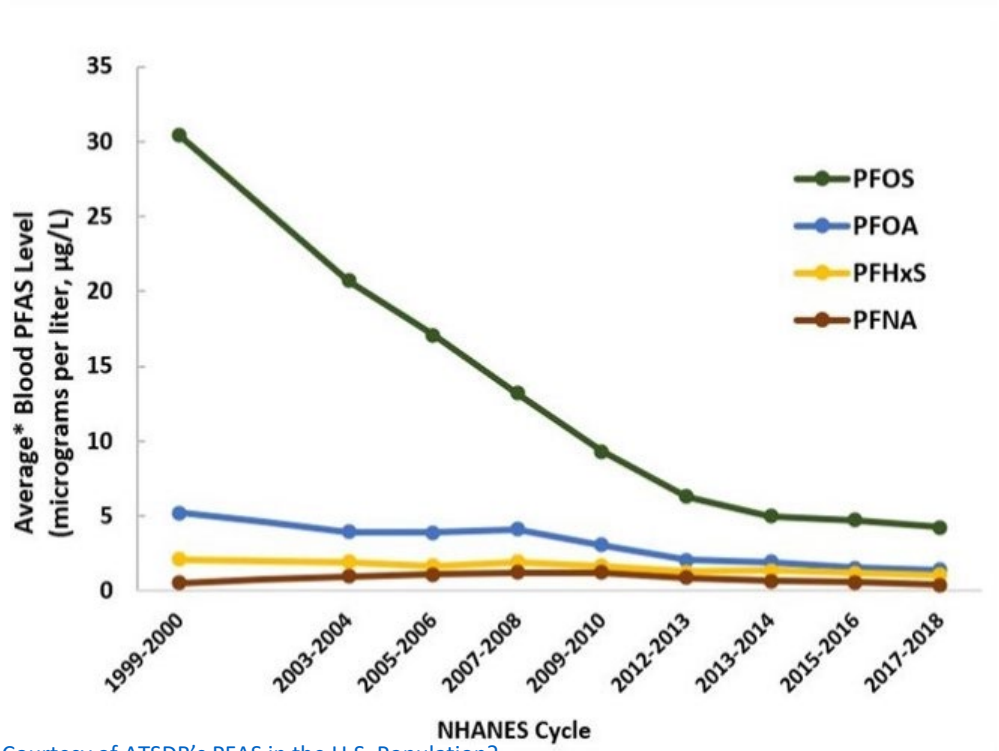


Image: Courtesy of ATSDR's PFAS in the U.S. Population?

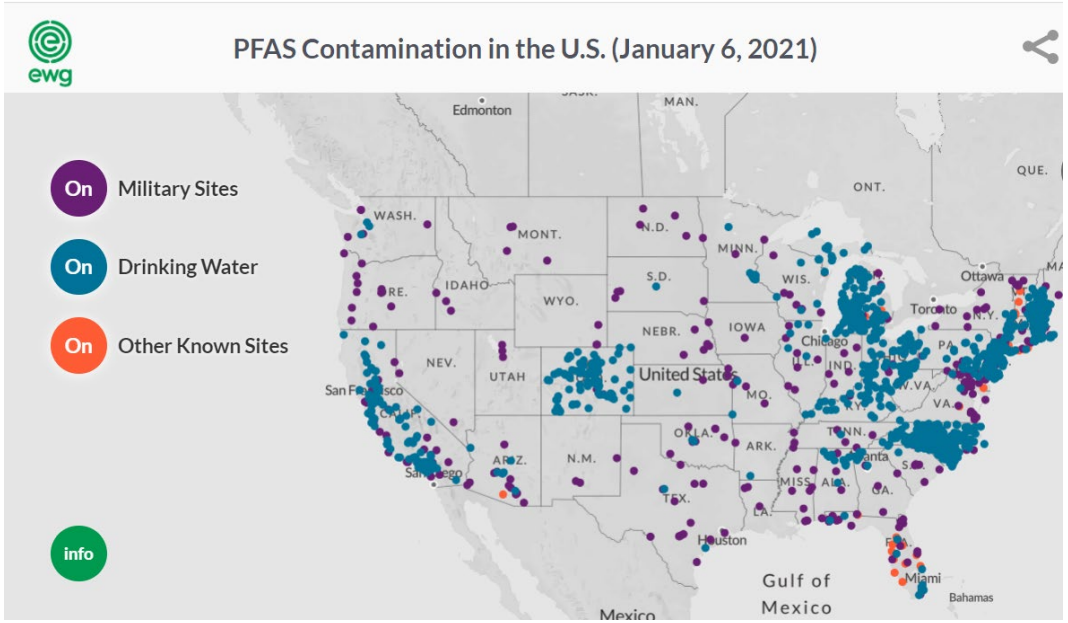
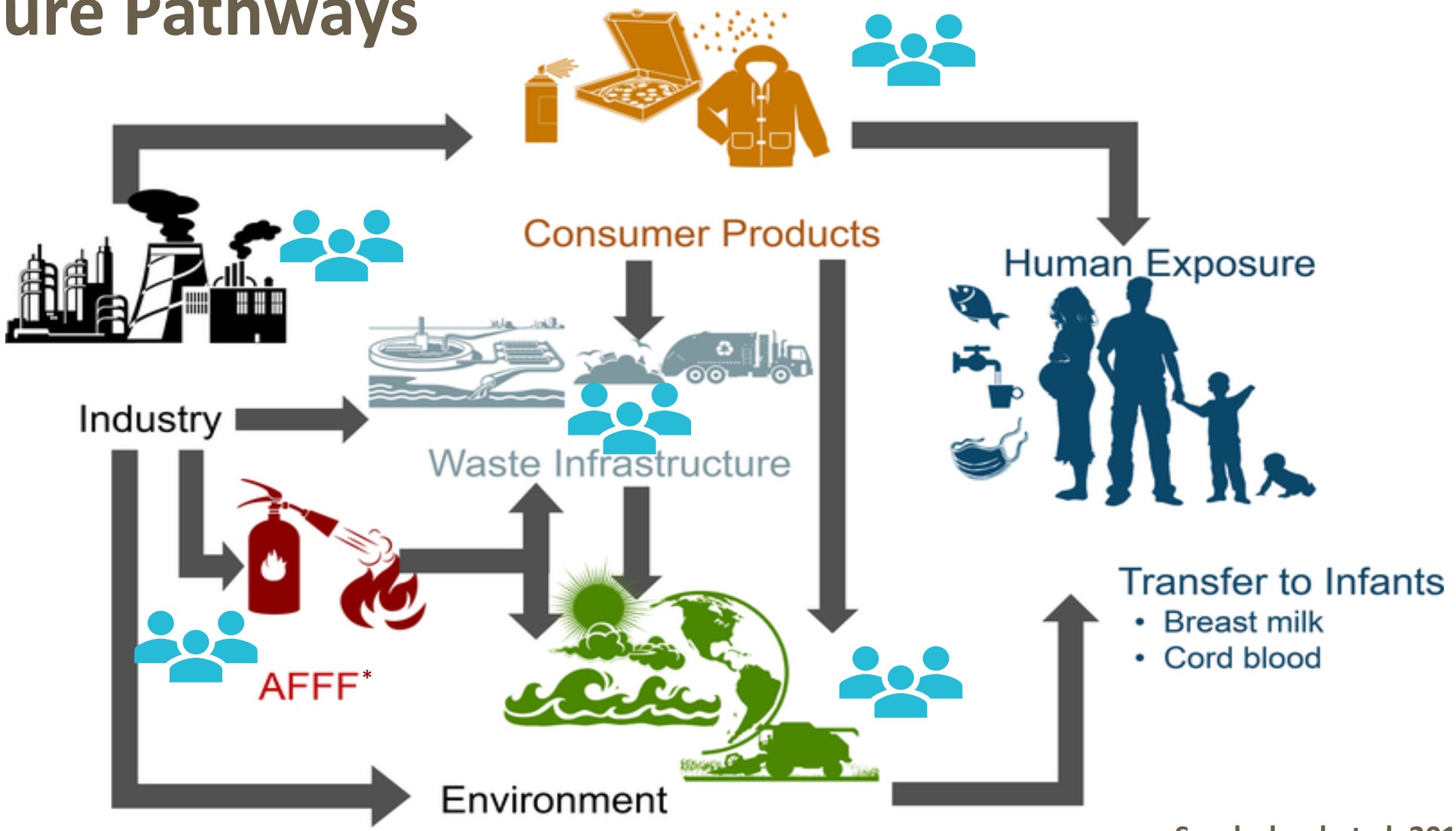


Image: Courtesy of EWG's Interactive Map

Exposure Pathways

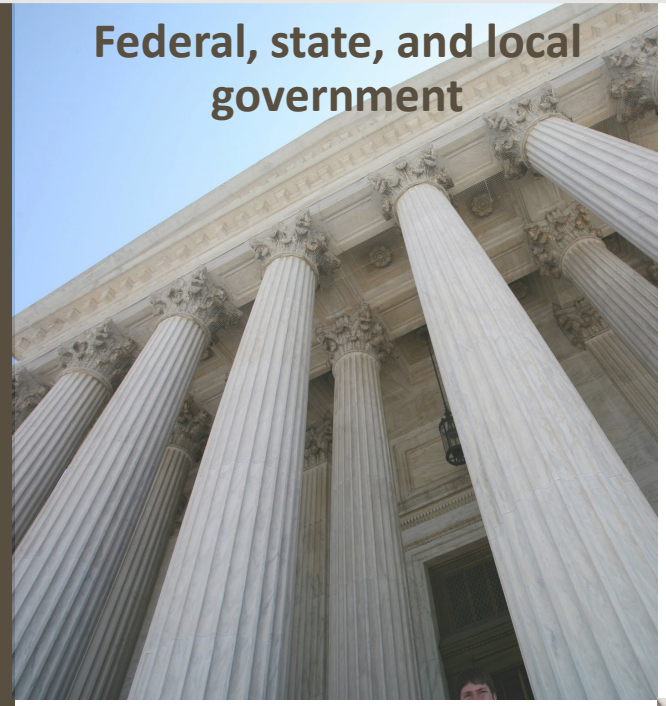


*Aqueous film forming foam

Sunderland et al. 2019

Big Picture

- High priority topic
- Challenges resulting from
  - PFAS as a class of chemicals
  - Different definitions
  - Availability of methods
- Voluntary phase out of select PFAS
- Highly litigious
- Legislation increasing



Standards organizations

ASTM INTERNATIONAL
Standards Worldwide

Unions and impacted parties

World's first ban on products with PFAS adopted in Maine

Law allows exemptions for health and safety when alternatives aren't available

by ***Cheryl Hogue***

July 19, 2021

Ski wax chemicals found in Park City's aquifer and groundwater wells

Leaders enact ban on use of fluoro ski wax due to 'forever chemicals'

By Amy Joi O'Donoghue | Mar 13, 2023, 6:55pm EDT

States Take on PFAS 'Forever Chemicals' With Bans, Lawsuits

STATELINE ARTICLE | September 22, 2022 | By: Alex Brown | Read time: 7 mi

3M to Exit PFAS Manufacturing by the End of 2025

ST. PAUL, Minn., Dec. 20, 2022 /PRNewswire/ -- 3M (NYSE: MMM) today announced it will exit substance (PFAS) manufacturing and work to discontinue the use of PFAS folio by the end of 2025. 3M's decision is based on careful consideration ion of the evolving external landscape, including multiple factors such as trends focused on reducing or eliminating the presence of PFAS in the

Biden-Harris Administration Proposes First-Ever National Standard to Protect Communities from PFAS in Drinking Water

March 14, 2023

Contact Information

EPA Press Office (press@epa.gov)

ECHA publishes PFAS restriction proposal

ECHA/NR/23/04

The details of the proposed restriction of around 10 000 per- and polyfluoroalkyl substances (PFASs) are now available on ECHA's website. ECHA's scientific committees will now start evaluating the proposal in terms of the risks to people and the environment, and the impacts on society.

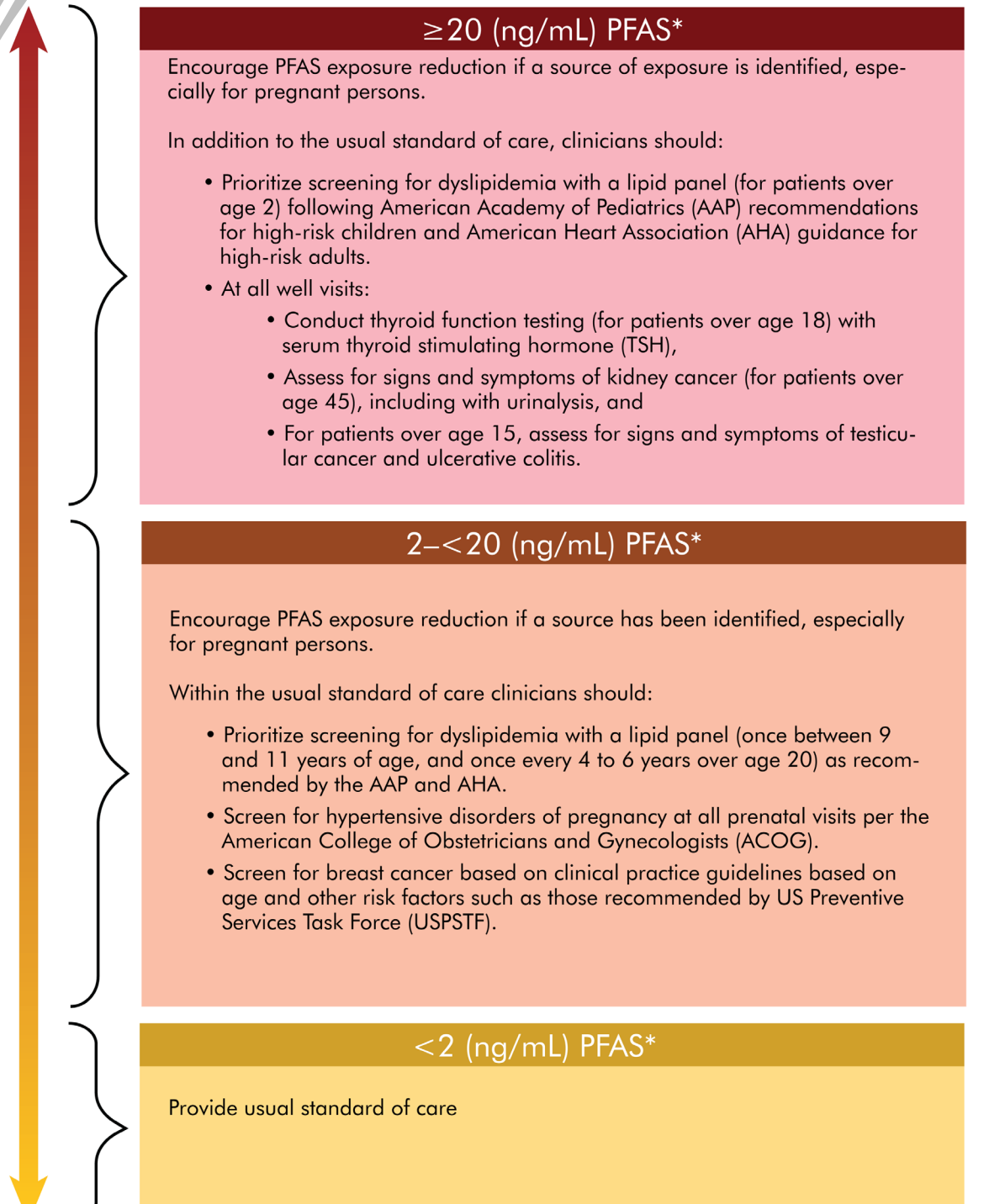
WHO International Agency for Research on Cancer (IARC)

- 2014 - PFOA determined to be group 2b in Monograph 110.
- November 2023 - PFOA and PFOS scheduled for Monograph 135.

National Academies of Sciences Engineering and Medicine (NASEM)

Guidance on PFAS Exposure, Testing, and Clinical Follow-Up

Released July 28, 2022



* Simple additive sum of MeFOSAA, PFHxS, PFOA (linear and branched isomers), PFDA, PFUnDA, PFOS (linear and branched isomers), and PFNA in serum or plasma

Regulating industry

Background sources

Health assessments

Methods development

NHANES

State biomonitoring programs

Serum testing of DoD firefighters

PFAS-free firefighting foams

PFAS Bill – recommendations to firefighters (FEMA)

Research assessing community:

- Drinking water exposure
- Other exposures
- Health

National Institutes of Health

Research into PFAS in

- Firefighter PPE
- Firefighting foams
- Fire response

Methods development

In vivo and in vitro toxicological studies

Industries

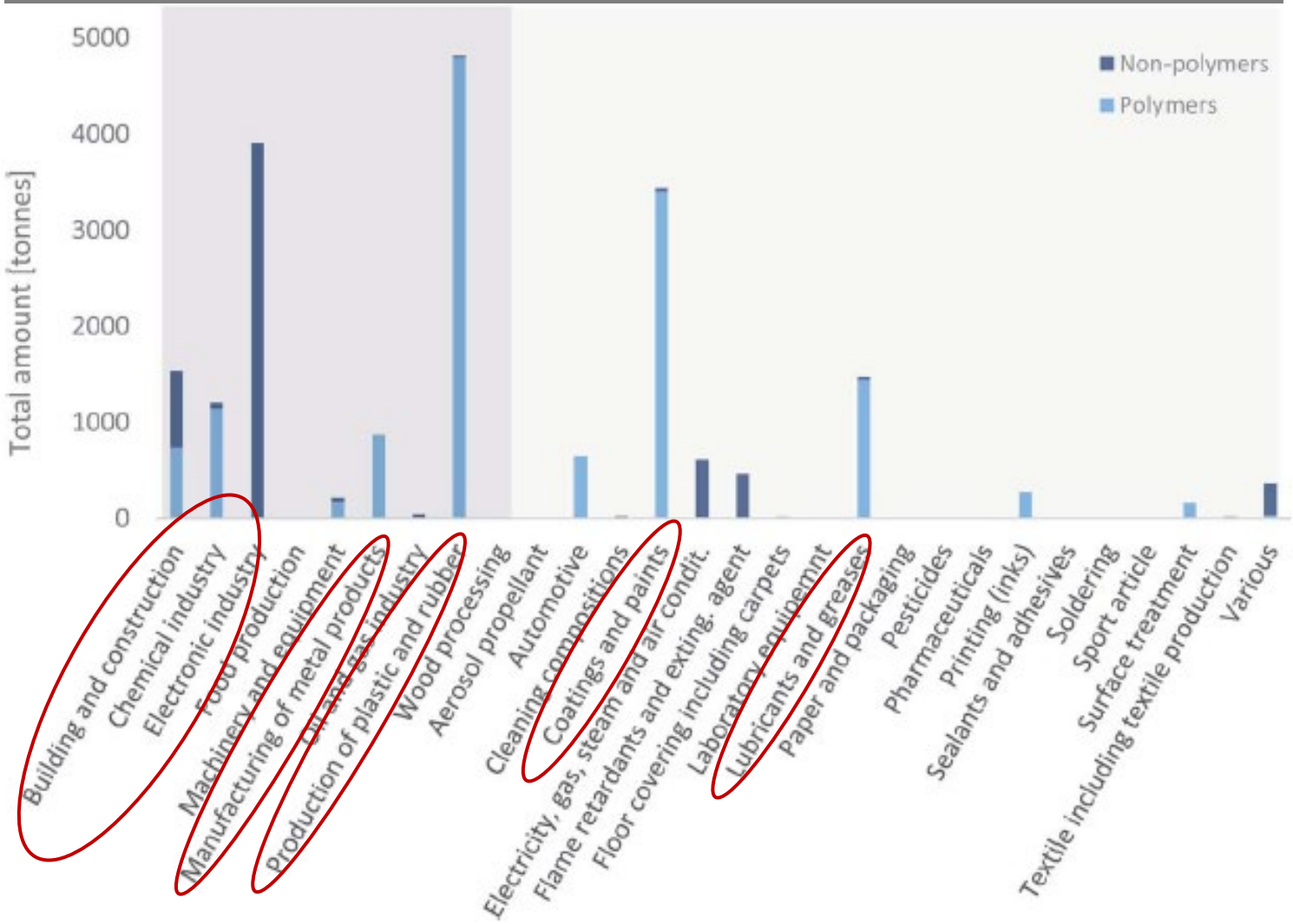


Fig. 3 Amount of PFAS employed in the different use categories in Sweden, Finland, Norway and Denmark from 2000 to 2017, as reported in the SPIN database.[44] Polymers include fluoropolymers and perfluoropolyethers. Side-chain fluorinated polymers have not been used above 0.2 t in any of the uses. Use categories with dark background are industrial branches, use categories with light grey background are other use categories.

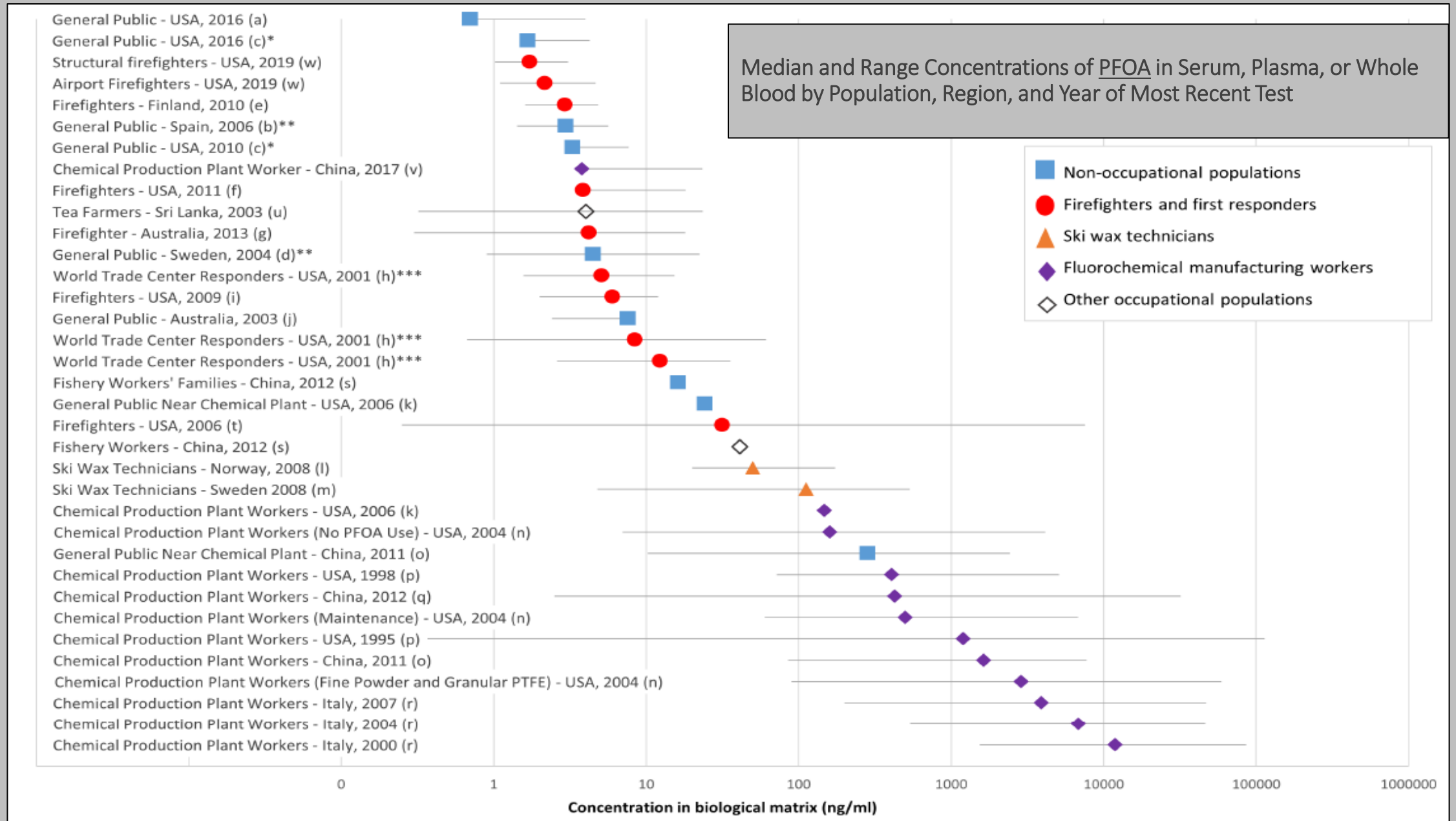
Gluge et al. 2019

Table 1 Industry branches and other use categories where PFAS were or are employed. The numbers in parentheses indicate the number of subcategories. No parentheses indicate no subcategories

Industry branches	
Aerospace (7)	Mining (3)
Biotechnology (2)	Nuclear industry
Building and construction (5)	Oil & gas industry (7)
Chemical industry (8)	Pharmaceutical industry
Electroless plating	Photographic industry (2)
Electroplating (2)	Production of plastic and rubber (7)
Electronic industry (5)	Semiconductor industry (12)
Energy sector (10)	Textile production (2)
Food production industry	Watchmaking industry
Machinery and equipment	Wood industry (3)
Manufacture of metal products (6)	

Other use categories	
Aerosol propellants	Metallic and ceramic surfaces
Air conditioning	Music instruments (3)
Antifoaming agent	Optical devices (3)
Ammunition	Paper and packaging (2)
Apparel	Particle physics
Automotive (12)	Personal care products
Cleaning compositions (6)	Pesticides (2)
Coatings, paints and varnishes (3)	Pharmaceuticals (2)
Conservation of books and manuscripts	Pipes, pumps, fittings and liners
Cook- and bakingware	Plastic, rubber and resins (4)
Dispersions	Printing (4)
Electronic devices (7)	Refrigerant systems
Fingerprint development	Sealants and adhesives (2)
Fire-fighting foam (5)	Soldering (2)
Flame retardants	Soil remediation
Floor covering including carpets and floor polish (4)	Sport article (7)

Median and Range Concentrations of PFOA in Serum, Plasma, or Whole Blood by Population, Region, and Year of Most Recent Test

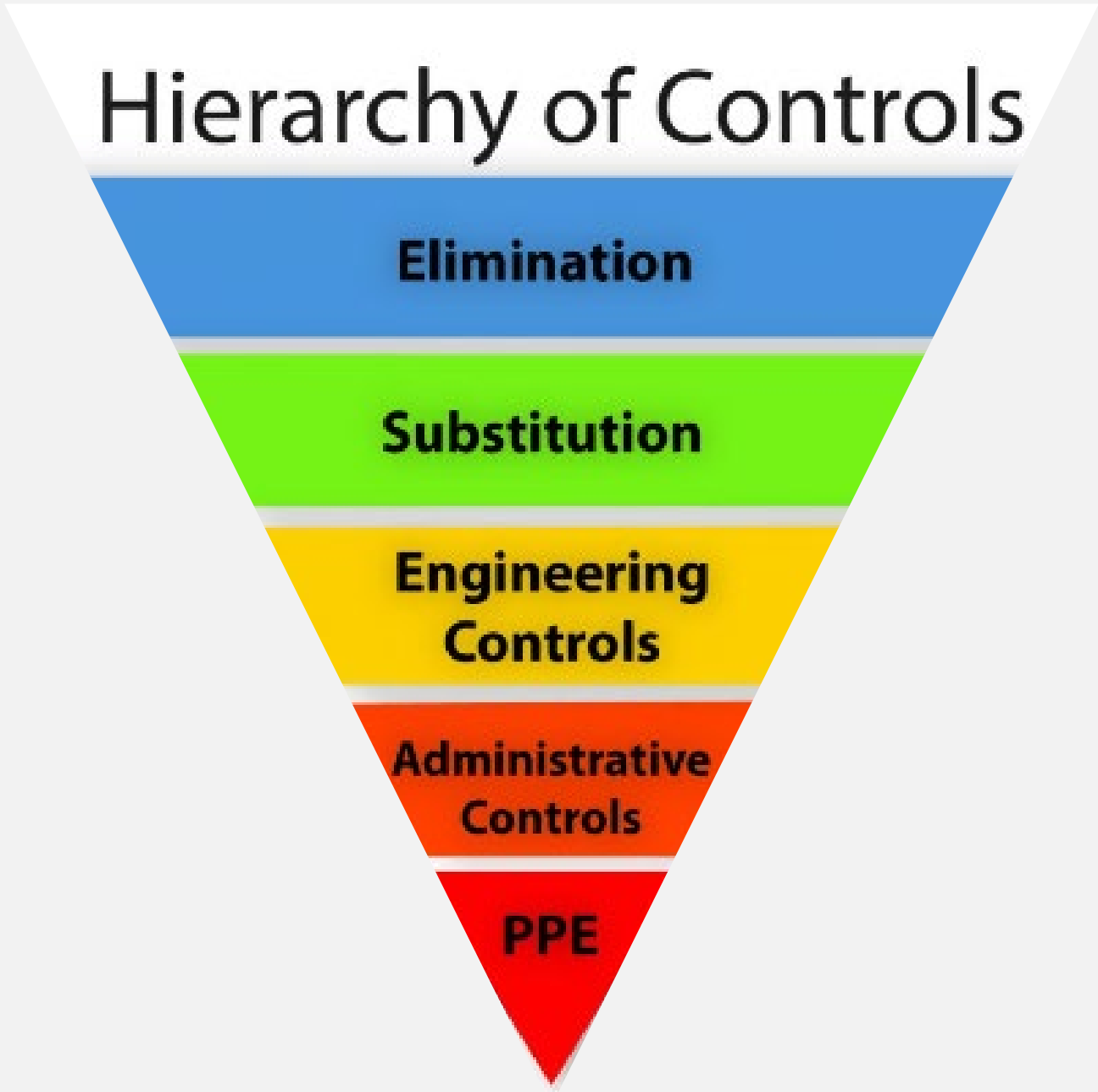


*Upper limit based on 95th percentile
**Whole blood sample. Serum concentration multipled by 1.8 for comparison to serum and plasma
***Serum sample

Christensen and Calkins, 2023

Occupational Exposure Limits and Guidance

- 3 ACGIH TLVs (all air)
  - Perfluoroisobutylene (PFIB)
  - Perfluorobutyl ethylene
  - Ammonium perfluorooctanoate (APFO)—a salt of PFOA
- Limited research noting protective practices
- Lacking recommendations for personal protective equipment (PPE)



Availability of Methods

Analytical Chemistry

- Targeted analyses
  - Semi-volatile (LC-MS)
  - Volatile (GC-MS)
- Semi-targeted analyses
- Non-targeted analyses
  - Total organic fluorine (TOF)
  - Particle-induced gamma-ray emission (PIGE)

Matrices

- Readily available
  - Water
  - Biological (blood/serum)
- Less available
  - Air
  - Products/bulk materials
  - Dust
  - Other biological material (urine, milk, etc.)
  - Other

Routes of Exposure

Majority of research

ORAL

Relevant to workers

INHALATION

DERMAL

Essential Use Principle

Table 1 Three essentiality categories to aid the phase out of non-essential uses of chemicals of concern, exemplified with PFAS uses

Category	Definition	PFAS examples
(1) "Non-essential"	Uses that are not essential for health and safety, and the functioning of society. The use of substances is driven primarily by market opportunity	Dental floss, water-repellent surfer shorts, ski waxes
(2) "Substitutable"	Uses that have come to be regarded as essential because they perform important functions, but where alternatives to the substances have now been developed that have equivalent functionality and adequate performance, which makes those uses of the substances no longer essential	Most uses of AFFFs, certain water-resistant textiles
(3) "Essential"	Uses considered essential because they are necessary for health or safety or other highly important purposes and for which alternatives are not yet established[a]	Certain medical devices, occupational protective clothing

[a] This essentiality should not be considered permanent; rather, a constant pressure is needed to search for alternatives in order to move these uses into category 2 above.

Cousins et al. 2019

Clarifying Questions and Discussion

Limited occupational guidance, including

- OELs (3 ACGIH TLVs)
- Guidance control mechanisms
- Monitoring methods

Challenges in identifying specific PFAS

- Broad class of chemicals
- Analytical methods
- Changes in production over time

Limited research on occupationally relevant exposure routes

Considered essential in some settings

NIOSH Research, Technical Support, and Strategies

Presented by

Susan Moore, PhD

Associate Director for Science

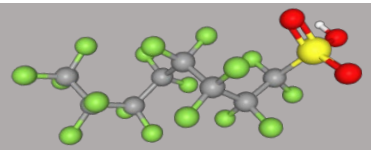
Co-Coordinator, Public Safety Sector

Co-Coordinator, Personal Protective Technology

CDC/NIOSH/NPPTL

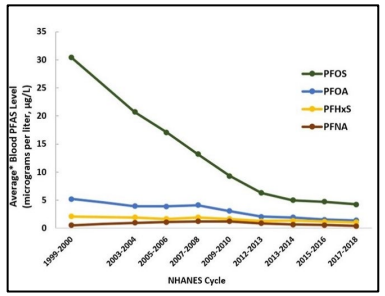
Projects Leads

Miriam Calkins, Crystal Forester, Stacey Anderson, Lisa Weatherly, Todd Stueckle, Jen Roberts, Cindy Striley, Jess Rinsky, and Jessica Li



Timeline of select events informing the state of PFAS research at NIOSH

1999
NCEH Includes PFAS Blood Levels in NHANES



2006
C8 Science Panel
C8 Science Panel Studies Begin

2012
NIOSH Dermal Absorption Study Published


Dermal Penetration Potential of Perfluorooctanoic Acid (PFOA) in Human and Mouse Skin

Jennifer Franko , B. J. Meade , H. Frederick Frasch , Ana M. Barbero & Stacey E. Anderson

To cite this article: Jennifer Franko , B. J. Meade , H. Frederick Frasch , Ana M. Barbero & Stacey E. Anderson (2012) Dermal Penetration Potential of Perfluorooctanoic Acid (PFOA) in Human and Mouse Skin, Journal of Toxicology and Environmental Health, Part A, 75:1, 50-62, DOI: 10.1080/15287394.2011.615108

To link to this article: https://doi.org/10.1080/15287394.2011.615108

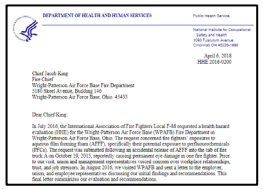
Foundational to inform future, interdisciplinary NIOSH studies

2013
EPA Includes PFAS in UCMR 3

2014
IARC Assigned 2B Classification to PFOA

2015
NIOSH OEP Funds Its First PFAS Grant

2016
NIOSH HHE on PFAS


DEPARTMENT OF HEALTH AND HUMAN SERVICES

2019
NIOSH In vivo Dermal Toxicology Study Starts

2020
NIOSH Exposure & Health Study Assessments Start

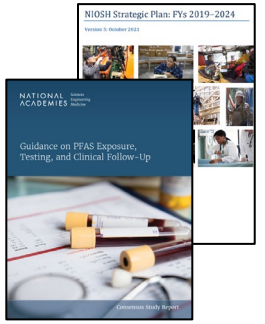
NIOSH In vitro AFFF Toxicity Assessment Starts & NIOSH Established Workgroup

2021
EPA Publishes Roadmap & NIOSH receives more TA & HHE Requests

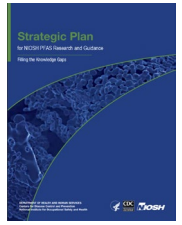
NIOSH Turnout Gear Study Starts

2022
NIOSH In vivo Dermal & Immune Study Starts

NIOSH Incorporates Select PFAS Language into Strategic Plan & NASEM Publishes Guidance



2023
Strategic Plan for NIOSH PFAS Research & Guidance



ATSDR revises their Clinical Guidance informed by ongoing ATSDR Tox Profiles

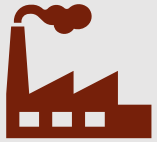
Exposure Assessments and Epidemiology

Project Lead: Miriam Calkins

Occupational Exposure and Health Indicator Assessment of PFAS: A Feasibility Study

Industries with moderate to high potential for worker exposure

Biomonitoring, industrial hygiene measures, and survey materials



NTP National Toxicology Program
U.S. Department of Health and Human Services

Fire Fighter Cancer Cohort Study (FFCCS) – Exposure and Epigenetic Markers

30-year, multi-center prospective study – carcinogenic effects and cancer prevention

Firefighter sub-groups and conducting assessments of fire dept practices

Exposure routes and epigenetic changes

UNIVERSITY OF MIAMI

THE STATE UNIVERSITY OF NEW JERSEY RUTGERS

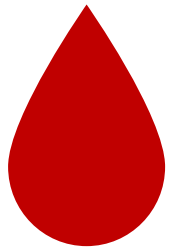
UNIVERSITY OF MICHIGAN

THE UNIVERSITY OF ARIZONA

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention

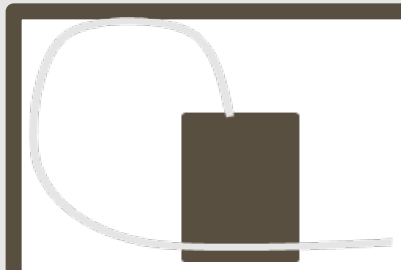
Occupational Exposure and Health Indicator Assessment of PFAS: A Feasibility Study Ongoing

Personal measurements: two biological matrices, breathing zone samples, employment history
Worksite measurements: drinking water and area air



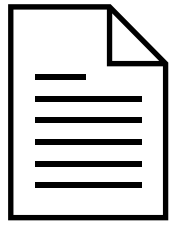
Serum
- Targeted panel of 10 PFAS
- 2 samples

Urine
- Pre and post shift
- Lab analysis
- Targeted expanded PFAS panel



Air samples
- Personal breathing zone and area
- Lab analysis
- Targeted panel of 40+ PFAS

Drinking water and bulk products
- One sample per site
- Lab analysis



Survey
- Demographics
- Work history
- Exposure factors

- *Cross-sectional study; manufacturing and services sectors*
- *Targeting 150 participants and 10 worksites – currently in recruitment phase → reach out to Miriam Calkins for more information on how to be involved*

Fire Fighter Cancer Cohort Study (FFCCS)

Ongoing

Future Medicine Ltd
Epigenomics
Volume 13, Issue 20, October 2021, Pages 1619-1636
https://doi.org/10.2217/epi-2021-0225

Research Article

Epigenomics

Per- and polyfluoroalkyl substances, epigenetic age and DNA methylation: a cross-sectional study of firefighters

Jaclyn M Goodrich [1], Miriam M Calkins [2], Alberto J Caban-Martinez [3], Todd Stueckle [4], Casey Grant [5], Antonia M Calafat [6], Amy Nematollahi [7], Alesia M Jung [8], Judith M Graber [9], Timothy Jenkins [10], Angela L Slitt [11], Alisa Dewald [1], Julianne Cook Botelho [6], Shawn Beitel [7], Sally Littau [7], John Gulotta [12], Darin Wallentine [12], Jeff Hughes [13], Charles Popp [14] & Jefferey L Burgess [7,*]

Received: 27 February 2022 | Revised: 5 June 2022 | Accepted: 8 July 2022
DOI: 10.1002/ajim.23413

RESEARCH ARTICLE

AMERICAN JOURNAL OF INDUSTRIAL MEDICINE WILEY

Serum per- and polyfluoroalkyl substance concentrations in four municipal US fire departments

Jefferey L. Burgess MD, MS, MPH[1] | Julia M. Fisher MS, PhD[2] | Amy Nematollahi[1] | Alesia M. Jung PhD[1] | Miriam M. Calkins PhD, MS[3] | Judith M. Graber PhD[4] | Casey C. Grant[5] | Shawn C. Beitel MSc[1] | Sally R. Littau BS[1] | John J. Gulotta[6] | Darin D. Wallentine[6] | R. Jeffrey Hughes[7] | Charles Popp[8] | Antonia M. Calafat PhD[9] | Julianne C. Botelho PhD[9] | Alissa D. Coleman MS[1] | Natasha Schaefer-Solle PhD[10] | Paola Louzado-Feliciano[10] | Simi O. Oduwole[10] | Alberto J. Caban-Martinez DO, PhD, MPH[10]

Example of information provided in publications

Serum levels from different fire departments similar to NHANES with some departments having higher levels than others

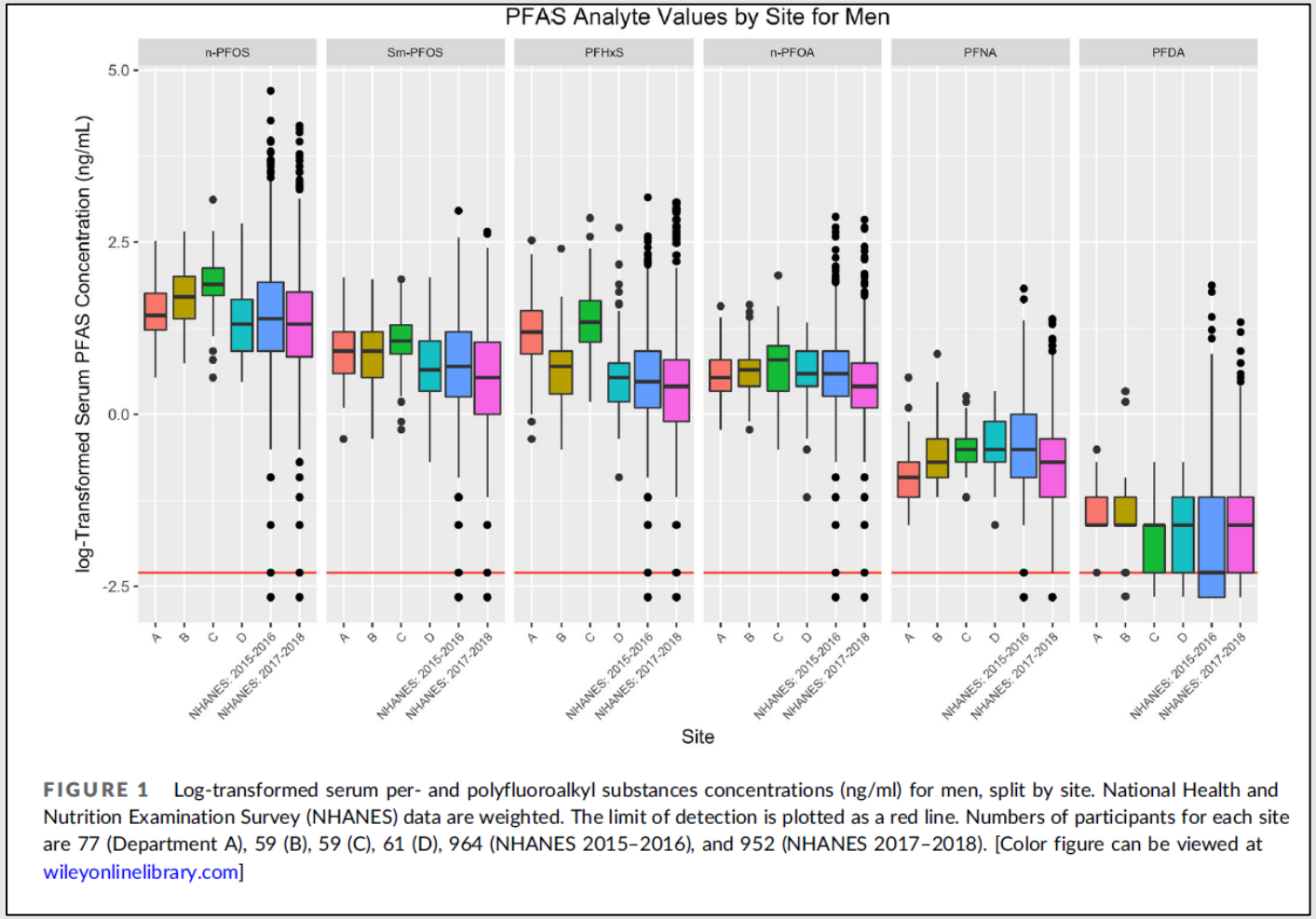


FIGURE 1 Log-transformed serum per- and polyfluoroalkyl substances concentrations (ng/ml) for men, split by site. National Health and Nutrition Examination Survey (NHANES) data are weighted. The limit of detection is plotted as a red line. Numbers of participants for each site are 77 (Department A), 59 (B), 59 (C), 61 (D), 964 (NHANES 2015–2016), and 952 (NHANES 2017–2018). [Color figure can be viewed at wileyonlinelibrary.com]

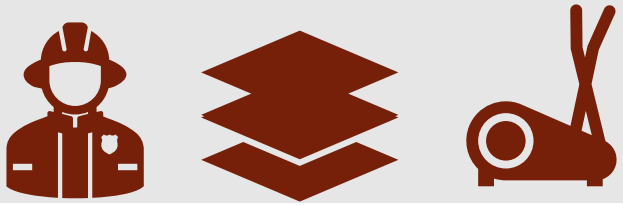
Personal Protective Equipment: Dermal exposures and materials testing Ongoing

Project Lead: Miriam Calkins

Part of FFCCS – Dermal exposure to PFAS

New garments worn by firefighters during physical activities (excluding live burn exercise)

Serum (pre and post), urine (daily), silicone wristbands (during activity)



Duke UNIVERSITY

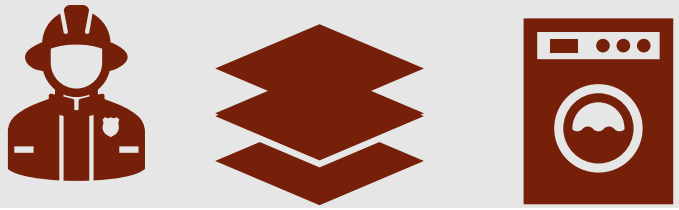
Carnegie Mellon University

Project Lead: Crystal Forester

Evaluation of Firefighter Textiles for PFAS

New textiles laundered

PFAS concentration on each layer determined



NIST National Institute of Standards and Technology U.S. Department of Commerce

Acute PFAS toxicity of firefighter turnout gear

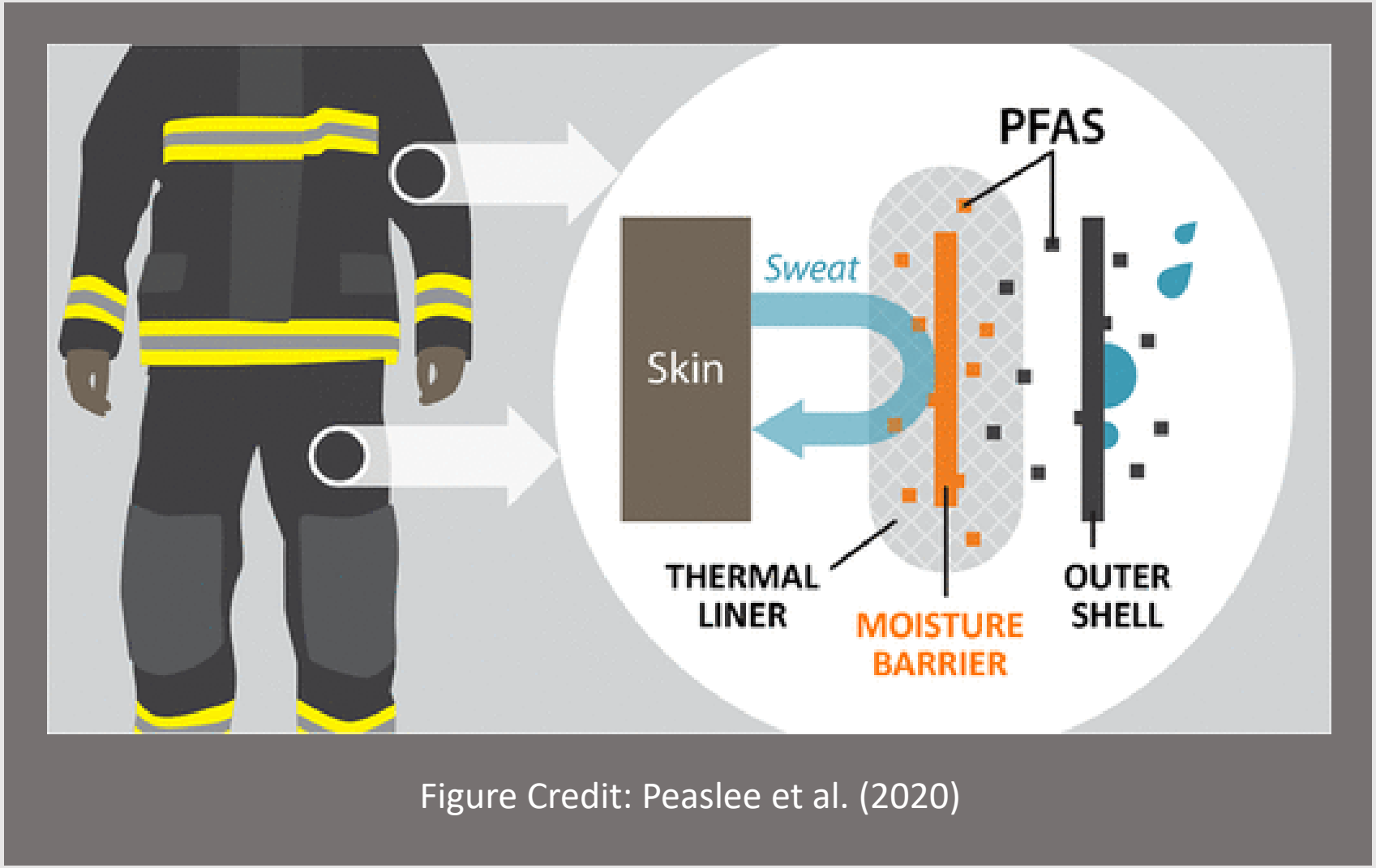
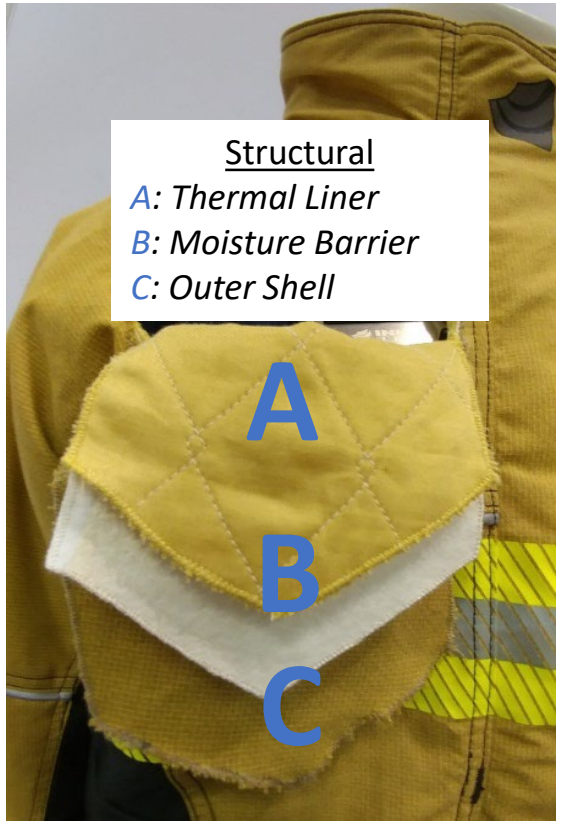


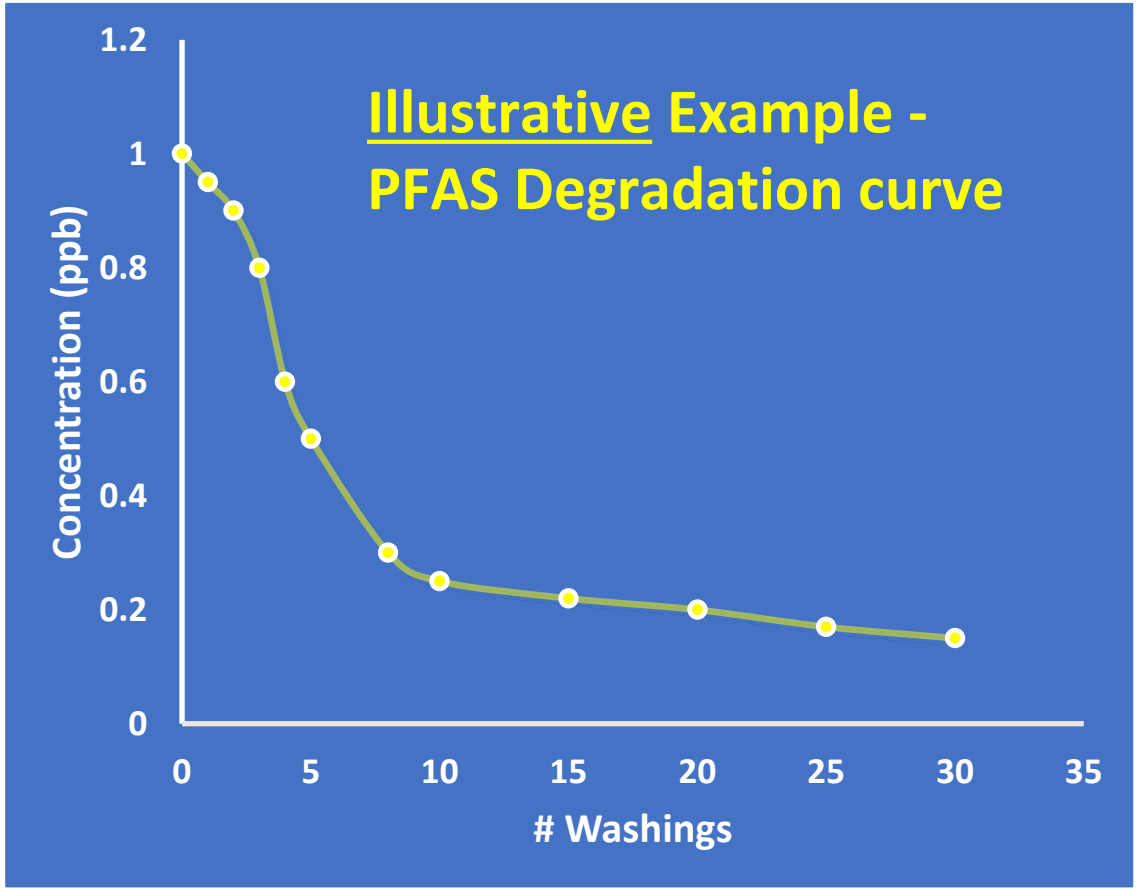
Figure Credit: Peaslee et al. (2020)

Evaluation of firefighter textiles for PFAS



Outer Shell (n=7)
Scoured Outer Shell (n=2)
Moisture barriers (n=5)
Thermal liners (n=7

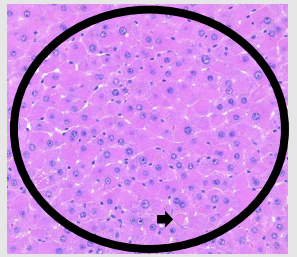
Wildland (n=5)



Toxicology Ongoing

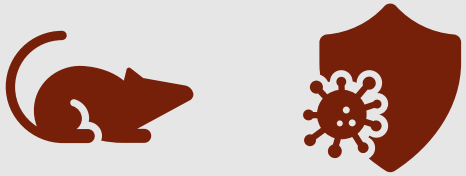
Project Leads: Lisa Weatherly and Stacey Anderson

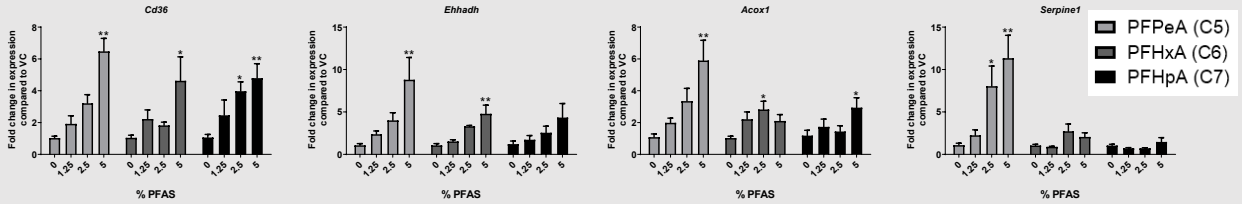
Toxicology Following Dermal Exposure to PFAS – animal study



4 Carboxylate and 4 sulfonate PFAS

Serum, urine, organ weight, histology, gene expression, skin integrity, immune phenotyping





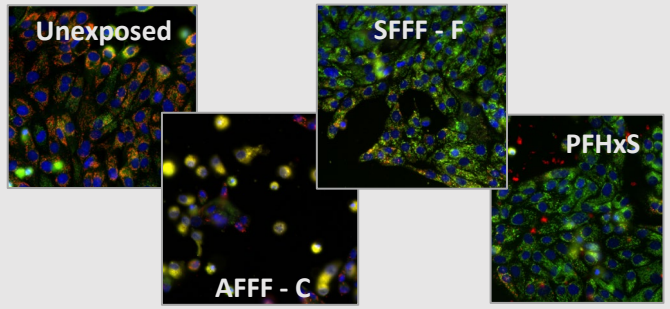
Project Lead: Todd Stueckle

Acute Toxicity of Firefighting Foams – in vitro study

Aqueous Film Forming Foam, AFFF (n=5)

Synthetic Fluorine-Free Foam, SFFF (n=6)

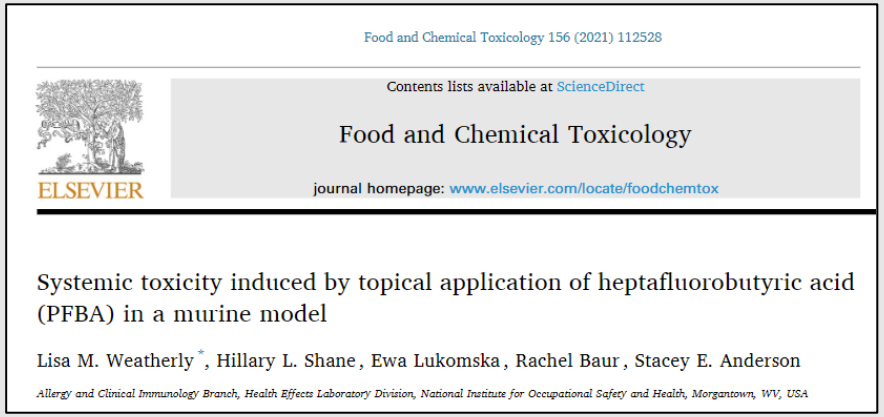
Cell viability, live cell counts, mitochondrial membrane potential, intracellular reactive oxygen species, gene expression via RNAseq



HARVARD T.H. CHAN

Toxicology following dermal exposure shows that some PFAS:

- Are dermally absorbed (long- and short-chain)
- Alter organs (weight, histology, phenotyping, and gene expression)
- Disrupt skin (fibrosis, mild/moderate inflammation, and cell death)
- Produce liver toxicities that are not associated with carbon chain length (sulfonic acid PFAS shows opposite association)



Food and Chemical Toxicology 156 (2021) 112528

Contents lists available at ScienceDirect

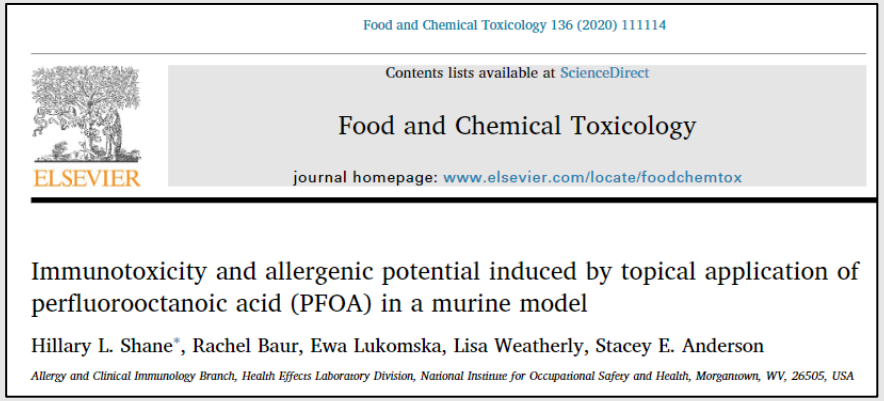
Food and Chemical Toxicology

journal homepage: www.elsevier.com/locate/foodchemtox

Systemic toxicity induced by topical application of heptafluorobutyric acid (PFBA) in a murine model

Lisa M. Weatherly*, Hillary L. Shane, Ewa Lukomska, Rachel Baur, Stacey E. Anderson

Allergy and Clinical Immunology Branch, Health Effects Laboratory Division, National Institute for Occupational Safety and Health, Morgantown, WV, USA



Food and Chemical Toxicology 136 (2020) 111114

Contents lists available at ScienceDirect

Food and Chemical Toxicology

journal homepage: www.elsevier.com/locate/foodchemtox

Immunotoxicity and allergenic potential induced by topical application of perfluorooctanoic acid (PFOA) in a murine model

Hillary L. Shane*, Rachel Baur, Ewa Lukomska, Lisa Weatherly, Stacey E. Anderson

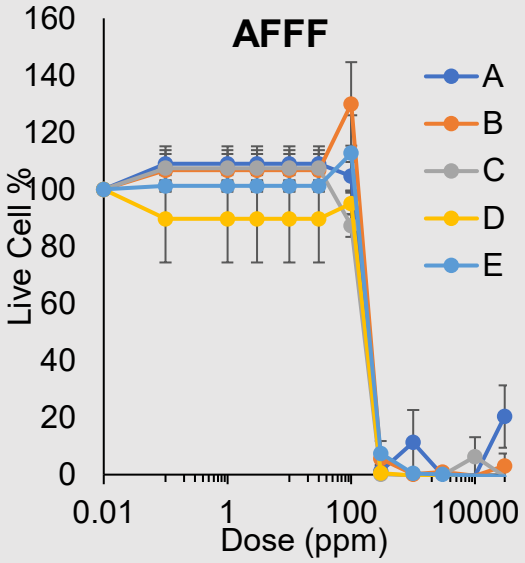
Allergy and Clinical Immunology Branch, Health Effects Laboratory Division, National Institute for Occupational Safety and Health, Morgantown, WV, 26505, USA

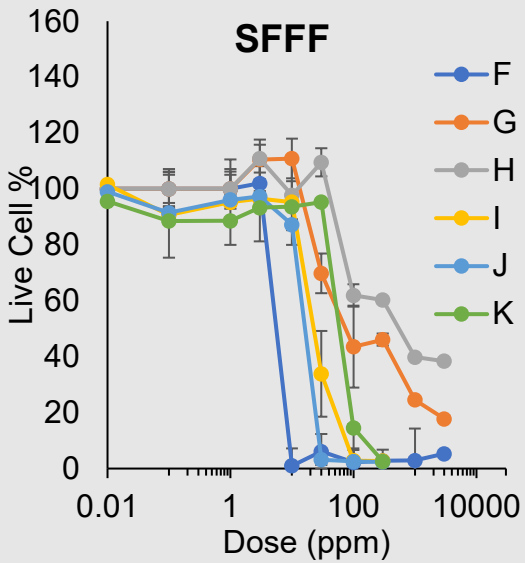
Acute toxicity of firefighting foams – in vitro study

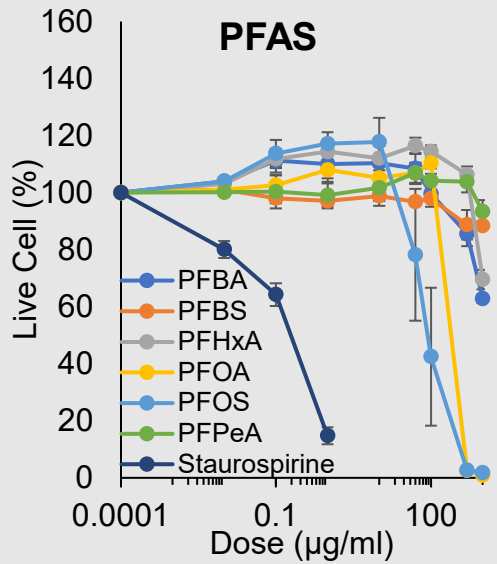
Exposures to AFFF (a PFAS mixture) had substantially greater acute toxicity than single PFAS exposures but lower acute toxicity than SFFF (PFAS-free alternative)

CAVEAT 1: PFAS is only one type of surfactant in AFFF – the other surfactants and solvents may be responsible for the higher acute toxicity (being explored by ongoing work)

CAVEAT 2: Dosages tested were above recorded serum levels in firefighters (ongoing work is reducing dosage to sub-toxic levels)







Methods Development Ongoing

Air Sampling and Biological Monitoring to support other/future studies

Project Leads: Jen Roberts and Cynthia Striley

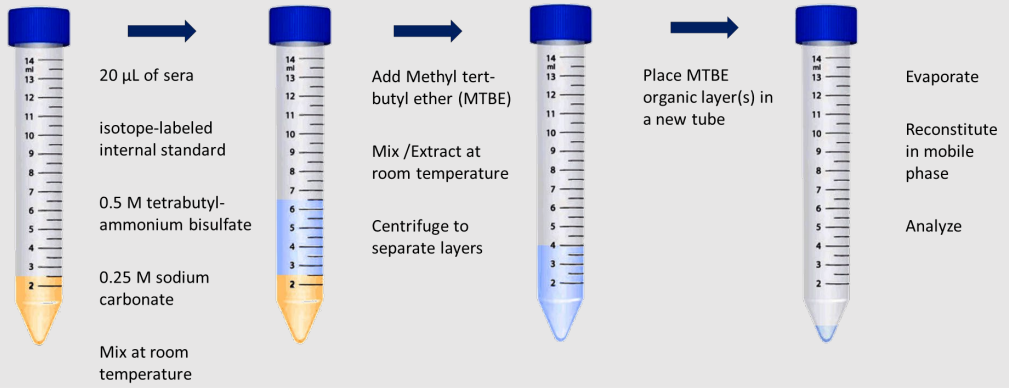
Air sampling: develop standardized method; differentiate PFAS forms; 12 targeted PFAS analytes

Biological monitoring (animal study): support toxicology studies; high and low PFAS concentrations

Air sampling (custom OVS-2 sampler) & analysis (LC/MS/MS)

SKC, Inc.

Biological monitoring: liquid extraction from mouse serum



Technical Assistance and Health Hazard Evaluations Ongoing

Project Leads: Jess Rinsky and Jessica Li

Requests for Technical Assistance

ATSDR –recommendations to improve training materials for public safety staff (mainly firefighters) in Pennsylvania

EPA –possible PFAS exposure during field inspections

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Project Leads: Jess Rinsky and Jessica Li

Requests for Health Hazard Evaluations

2016 – acute firefighter exposure to AFFF (no PFAS-specific monitoring)

New (n=2) – airport and aerospace occupational settings

HHE Health Hazard® Evaluation Program

NIOSH-funded extramural outputs since 2015

Monitoring Technology

ELSEVIER

Chemical Engineering Journal

Volume 417, 1 August 2021, 129133

Review

Sensors for detecting per- and polyfluoroalkyl substances (PFAS): A critical review of development challenges, current sensors, and commercialization obstacles

Colorado Ag Center at CSU (U54OH008085-17)

Exposure

ELSEVIER

Environmental Research

Volume 187, August 2020, 109686

Perfluoroalkyl substances exposure and hearing impairment in US adults

ELSEVIER

Environmental Research

Volume 175, August 2019, Pages 186-199

Determinants of per- and polyfluoroalkyl substances (PFAS) in midlife women: Evidence of racial/ethnic and geographic differences in PFAS exposure

Michigan ERC (T42OH008455-18)

Currently funded extramural projects

Exposomic Approach to Identifying WTC Exposures and Effects in Survivor Youth.

Project Number	Contact PI/Project Leader	Awardee Organization
1U01OH012472-01	HERBSTMAN, JULIE BETH	COLUMBIA UNIVERSITY HEALTH SCIENCES

PROJECT SUMMARY Pregnant women and children who lived, worked or attended school near the World Trade Center (WTC) on September 11, 2001 experienced a variety of psychological and chemical exposures with potential adverse consequences for later health and development. In contrast to psychological effects, physical health effects of early life exposure to the World Trade Center (WTC) disaster remain poorly understood. This is particularly important as the well-known developmental origins of health and disease (DoHAD) concept indicates that exposures occurring during sensitive developmental windows may lead to adverse health outcomes in later life. We have recently demonstrated that neonates and children exposed to chemicals (e.g., dioxins, perfluoroalkylsubstances (PFAS)) known to be associated with WTC experience adverse health outcomes including adverse birth outcomes, altered lipid levels, and asthma. However, characterizing the totality of WTC exposure—including both psychologicial and chemical exposures—has been challenging, limiting our ability to identify WTC-related health effects, which are likely to emerge as exposed children age. Here, we employ advances in molecular laboratory technology, which have enabled high-resolution methods to measure thousands of exogenous chemicals and their endogenous biological responses to these exposures. These powerful exposomic and metabolomic approaches have been used to enhance disease prognosis and diagnosis as well as provide insight into disease pathogenesis in neonates, children and adults. Using two cohorts of WTC- exposed neonates and youth, we can 1) identify an exogenous chemical signature that is associated with conventional WTC exposure measures including proximity-based exposure metrics and targeted biomarkers associated WTC exposure indices (Aim 1); 2) identify a metabolomic signature that reflects the biological response to both conventional WTC exposure measures and psychological stressors associated with WTC exposure (Aim 2); and 3) determine if WTC-exposure related exogenous chemical signatures (Aim 3a) and metabolomic signatures (Aim 3b) are associated with adverse health outcomes in children. If confirmed, the exogenous chemical and metabolomic signatures we identify in blood stored from these two vulnerable WTC-exposed populations will provide unique fingerprints that can be used to predict adverse WTC-related outcomes that may emerge as exposed children age into adulthood.

1U01OH012472-01 (funded FY22)

WTC Populations

Prenatal WTC Chemical Exposures, Birth Outcomes and Cardiometabolic Risks-Resubmission-1

Project Number	Contact PI/Project Leader	Awardee Organization
5U01OH011299-04	TRASANDE, LEONARDO	NEW YORK UNIVERSITY SCHOOL OF

Project Summary NYU School of Medicine, the Mailman School of Public Health, the Wadsworth Laboratories of the NYS Department of Health, and Cincinnati Children's Hospital Medical Center respond to PAR-16-098, proposing to leverage two unique and contemporaneous cohorts to examine chemical and psychosocial stressors in relationship to proximity to the WTC site and self-reported exposures, and evaluate birth, neurodevelopment and cardiometabolic outcomes. The first is comprised of mothers who delivered in one of three lower Manhattan hospitals in the months after the disaster, and the other is the northern Manhattan-based Columbia Children's Environmental Health Center (NM) cohort. The NM cohort includes children born just before and after September 11, 2001 permitting nested evaluations of stress-related exposures. Except for cardiometabolic outcomes, the data are already available including freshly obtained measurements of POPs, which we will extend to include PFCs with NIOSH support. In both populations, neurodevelopmental outcomes have been assessed through 6-7 years of age. Taking advantage of temporal and geographic differences in these cohorts, we will compare both psychosocial and chemical exposures and their association with outcomes among children who were and were not prenatally exposed to the WTC disaster. This study leverages previously measured biomarkers and prospectively collected data on psychosocial stress. In addition, we will be the first to examine physical health of adolescents exposed in utero to the WTC disaster. While other studies have examined non-invasive measurements of central and peripheral arterial stiffness, ours is one of the first to examine chemical exposures in relation to these endpoints in adolescence. Preclinical measures included in the proposed project may be more sensitive cardiovascular endpoints reflecting environmental influences in homogeneous populations such as young children and adolescents. The study is led by an international leader in children's environmental health who has conducted the only in-depth physical health studies of children exposed to the disaster (Trasande) with leaders of two large birth cohorts, one including children born in three lower Manhattan hospitals; and another of upper Manhattan children that will serve as a comparison (Herbstman, Perera, and Rauh). If WTC chemical exposures are associated with these outcomes, the study findings could facilitate proactive interventions such as treatment with antihypertensive medications which have been documented to prolong survival among adults with suboptimal cardiovascular profile.

5U01OH011299-04 (wrapping up, COVID-19 delay)

NIOSH Priorities

Management groups, labor organizations, and consensus standard bodies use NIOSH information to prevent exposures to known or suspected carcinogens among public safety workers

Updated "Need" to include, "Research assessing newer, emerging, and unstudied sources of PFAS exposure are needed to address gaps in exposure assessment, toxicology, and worker protection for the fire service."

Changes adopted

Changes on hold pending NIOSH PFAS Research Agenda

Consensus standard bodies, labor organizations, and management groups use NIOSH information to reduce risk factors to cardiovascular disease among public safety workers.

Requested to add content about PFAS link to CVD

Employers, workers, professional associations, policy-makers, researchers, and consensus standard organizations use NIOSH information to prevent transmission of infectious disease among public safety workers

Requested to add content about PFAS link to immune suppression

Employers, workers and their representatives, researchers, safety and health professionals, and authoritative bodies use NIOSH information to prevent

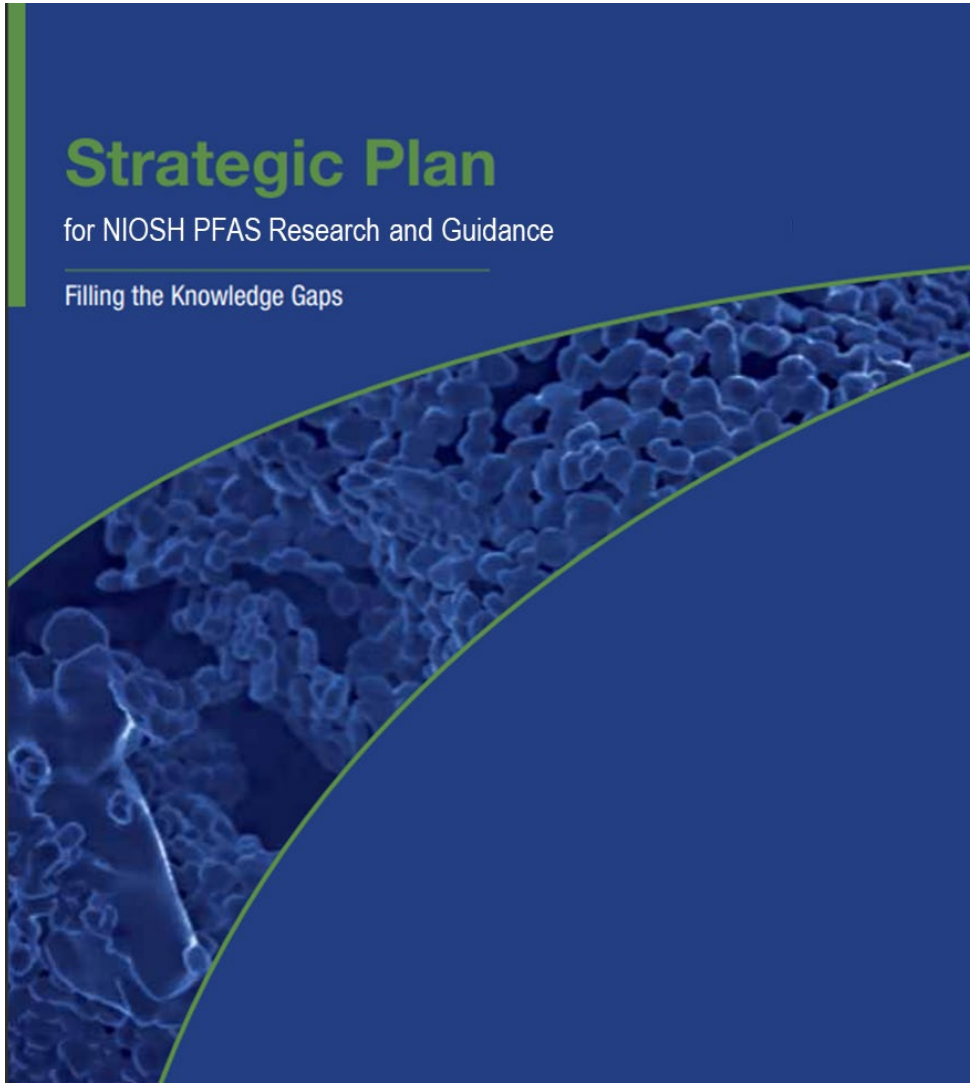
- exposures to known or suspected carcinogens among manufacturing workers
- adverse reproductive outcomes among manufacturing workers

Challenge: insufficient burden data to explicitly name PFAS
lack of data ≠ lack of an issue

Employers, policy-makers, trade associations, and manufacturers use NIOSH information to prevent immune and dermal diseases among manufacturing

Program leaders planning to request PFAS be added as example exposure leading to immune suppressive disorders (extramural research)

Changes on hold pending NIOSH PFAS Research Agenda



In January 2023, NIOSH initiated an effort to develop PFAS Research Agenda to focus future NIOSH investments

For more information, contact

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NIOSH PFAS Workgroup Chair
MCalkins@cdc.gov

Susan M. Moore, PhD
NIOSH PFAS Workgroup Co-Chair
SMMoore@cdc.gov

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

Questions to the BSC

With PFAS being incrementally phased out, what are the key areas of impact that can be addressed with high-quality research?

What unintended worker health or safety consequences may be created as PFAS are phased out?

What else should we consider to assist employers and protect workers against exposure to PFAS?