

PFAS and LION Turnout Gear Safety

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PFAS BASICS

- About 5,000 individual PFAS known to science
- They have different chemical and biological properties
- Used for over 60 years to resist heat, oils, grease, chemicals, and water
- Ideal properties for use in PPE fabrics
- Present at low levels and very hard to measure reliably
- Some of them can cause human health effects or ecological impacts
- Mostly from food and water, we all have PFAS in our bodies

All PFAS Are Not the Same

PFAS	Proposed Drinking Water Standard (ppt)
PFNA	6
PFOA	8
PFOS	16
PFHxS	51
GenX	370
PFBS	420
PFHxA	400,000



Exposure Assessment Can Tell Us

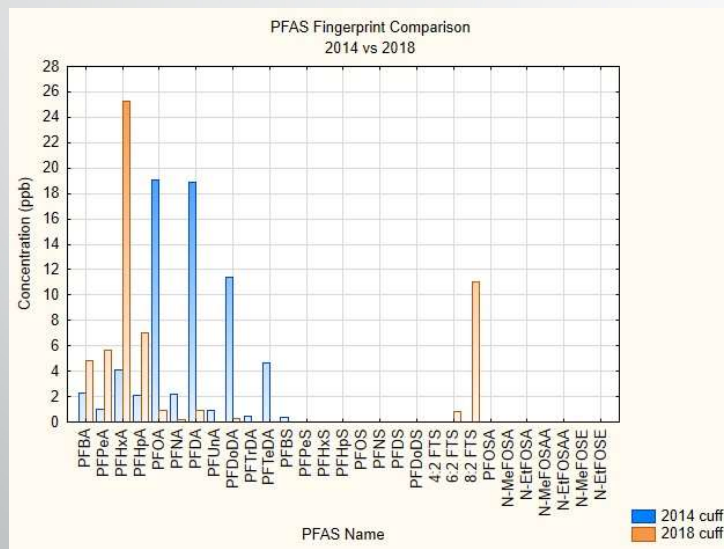
- What PFAS a person has contacted
- How much of a PFAS is in the bloodstream
- How fast will the PFAS leave the body
- How does a person or group of people compare to others
- Where did the PFAS come from

How Do We Know if Someone Was Exposed to PFAS?

- Blood Test
- Urinalysis/Hair
- Food, drinking water, consumer product testing
- Environment/workplace monitoring
- Mathematical modeling



Chemical Profiling Can Rule out Sources of PFAS



- Chemical profiling can rule out the source of PFAS in a sample
- Chemicals Profiles used for easy I.D.
- Old Turnout Profile= PFOA, PFDA
- New Turnout Profile = PFHxA, PFHpA
- AFFF Profile = PFOS, PFOA, PFHxS

PFAS in LION Turnout Gear*

Fabric Surface Samples

- Three wipe samples from 2018 production obtained by NIOSH method
- PFHxA and PFHpA only PFAS detected
- Maximum concentration 1.41 ng/100 sq cm (16 sq inches)
- There are about 58,000 ng in a grain of salt
- Compliant with European standards

Whole Fabric Samples

- 14 whole fabric samples from 2007-2018 tested by modified EPA method
- Older samples detected PFOA (up to 23.5 ppb)
- Newer samples detected PFHxA and PFHpA
- Newer samples max PFOA was 0.96 ppb
- One newer sample had no detectable PFAS
- Compliant with European standards

*Source: Exponent/AXYS Laboratories

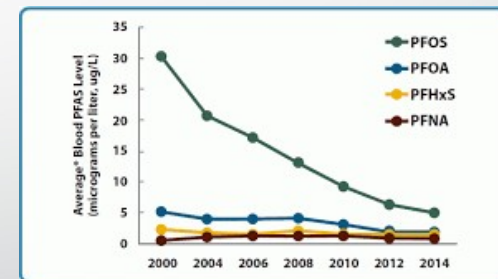
LION Aging and Laundering Study*

- Dr. Peaslee and others hypothesize that the fabric constituent Et-FOSE will break down into toxic PFAS like PFOA and/or PFOS.
- LION investigated this possibility by artificially aging 20 samples of commonly used fabrics with 2 different finishes
- Tests included washing & drying (up to 25 cycles), heat (285°F), abrasion, flexing (1,000 cycles), and accelerated simulated sunlight.
- PFAS were measured before and after fabric aging with no detectable PFOS or PFOA
- LION turnout gear is not breaking down to form PFOS or PFOA.

*Source: Emergency Response TIPS, August 2020

PFAS in the General Population

- Virtually entire population blood has detectable PFAS
- Levels of PFOS have been declining
- PFHxA (found in turnout gear) not detected
- Sources are mostly drinking water, food, consumer products



PFAS in Firefighters

- “C8 study group”—PFOS elevated in firefighters compared to unemployed people but not compared to other occupations
- U.C. Berkeley Tubbs Fire—PFOS, PFHxS higher in deployed firefighters compared to those not deployed
- Fox Study—PFOS in firefighters same as general population
- San Francisco Women firefighters—no detectable PFHxA or PFHpA. Other PFAS consistent with those in office workers

LION Turnout PFAS Profile ≠ Firefighter PFAS Profile

- For recent Lion production, detected PFAS are PFHxA and PFHpA
- In the general population, PFOS, PFOA, PFHxS, PFNA, PFDA are most common PFAS.
- Among firefighters, PFOS is most common PFAS
- Recent turnout gear PFAS profile does not match reported firefighter or general population chemical profiles

Dermal Exposure

- Can PFAS come off turnout gear and be absorbed through the skin?
- No human studies—only study on mice
- PFOA was absorbed at significant amounts only when the PFOA concentration was very high (3,000 ug/mL) and dissolved in acid (pH=2.25).
- Very low absorption for higher pH values. pH of sweat 5.9-6.2 (women) 6.2-6.9 (men)
- Absorption coefficient for PFOA lower than that of 201 chemicals studied by EPA. Absorption of PAHs 10,000 times higher than PFOA
- Skin is not a significant exposure route.

Latest Research Findings on Exposure

- Hazard Assessment of Fluorochemicals Present on Firefighter Gear” Cody P. Zane. Ph.D. Dissertation, North Carolina State University 2020.
- Measured PFOA and PFOS in numerous samples of turnout gear collected over a 20-year period. PFOS not detected and PFOA detected in some gear but at low levels.
- Concluded “Ultimately it was determined that firefighters have minimal risk of exposure to PFCs from their gear”, and “The levels found on gear would be more of a concern if firefighters were using their gear as napkins or if they were licking their gear”.

What About Peaslee's New Publication?

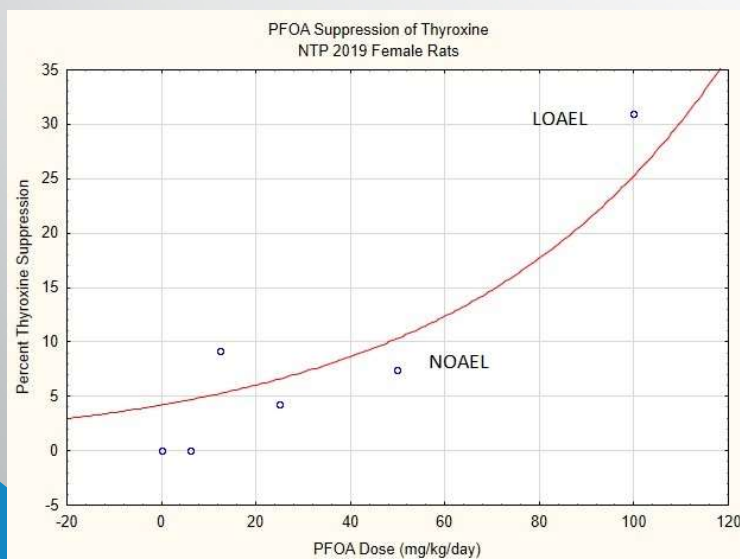
- Dr. Peaslee's 2020 Article: "Another pathway for firefighter exposure to per-and polyfluoroalkyl substances: firefighter textiles"
- Used non-standard and unvalidated testing methods without appropriate quality control/quality assurance
- Used incorrect statistical tests to interpret results
- Drew conclusions not supported by the data
- Failed to demonstrate a complete exposure pathway from turnout gear to people

Toxicity Assessment Tells Us

- Is a PFAS toxic and at what dose
- What toxic effects are associated with a PFAS
- Are there special susceptibilities (infants, elderly, men or women)
- Have PFAS actually been shown to cause adverse health effects in people

“The Dose Makes the Poison”

Dose-Response: Thyroid Hormone from NTP Study



Effects of Toxic Substances Depend on Dose/Exposure

- NOAEL = No observed adverse effect level = safe
- LOAEL = lowest observed effect level = concern
- PFAS dose-response relationships experimentally determined
- No evidence of unusual or atypical dose-response

How do we know if a chemical causes a disease?



- Criteria for Causation
 - Timing
 - Strength of association
 - Dose-response relationship
 - Biological plausibility
 - Alternative explanations
 - Stopping exposure
 - Consistency with other knowledge
 - Specificity

PFAS and Cancer

- Like other effects, the ability of a chemical to cause cancer depends on the dose
- Some studies have shown evidence of cancer associated with PFOA exposure to some laboratory animals at high doses
- There is evidence that PFHxA is **not** associated with cancer in lab animals
- There is weak evidence and statistically non-significance that kidney cancer and possibly testicular cancer was associated with high PFAS exposures around manufacturing facilities.
- There is limited evidence of an association between PFOS (only) and breast cancer in young women and a possible link between exposure to some PFAS and heritable prostate cancer.
- No clinical case of cancer has been shown to have been caused by exposure to PFAS and PFAS do not meet causation criteria.

How Does Toxicity Work?

- Highly technical terms (oncogenes, epigenetics, promoters) are being discussed out of context
- Interactions between chemicals (food, medications, natural products, or synthetic chemicals) and the human body are complex
- Scientists use sophisticated techniques of molecular biology to study these interactions to probe mechanisms of toxicity using biomarkers
- Firefighters are exposed to many toxic substances (PAHs, aldehydes, arsenic, cadmium, butadiene, asbestos, flame retardants, fine particulates) on the job
- Preliminary studies found several biomarkers in firefighters that had been exposed to smoke or fire compared to unexposed new recruits
- There is currently no evidence to link these biomarkers to PFAS as opposed to other toxics.

IARC Carcinogen Designation

- PFOA (only) is categorized in IARC Group 2B = possibly carcinogenic in humans
- Limited evidence in humans for the carcinogenicity of PFOA in testis and kidney (from C8 Study)
- Limited evidence of other cancers in experimental animals
- Weak evidence for PFOA relevance to reproductive hormone associated cancers
- IARC did not evaluate causation
- Dr. Ricardo Arrieta-Cortes and colleagues have analyzed the same data and believe that IARC should have placed PFOA in Group 3 = unclassifiable

PFAS and Other Health Effects (ATSDR)

Potential Effects

- Increase cholesterol levels
- Decrease how well the body responds to vaccines
- Increase risk of thyroid disease
- Decrease fertility in women
- Increase risk of high blood pressure or pre-eclampsia in pregnant women
- Lower infant birth weights

Rank of Toxicity (NTP Studies)

- Highest=PFDA, PFNA
- High intermediate=PFOA, PFOS
- Low=PFHxA, PFHxSK
- Lowest=PFBS

Summary and Conclusions

- Thousands of PFAS in hundreds of applications
- Their properties are widely different from each other
- Some sources of PFAS can be ruled out using chemical profiling
- We all have PFAS in our bodies, but levels are generally declining
- Levels in firefighters similar to general population and not linked to turnout gear
- Older long-chain PFAS that were phased out are more toxic than short-chain PFAS
- PFAS in turnout gear dominated by low concentrations of short-chain and below thresholds for toxic effects.
- Attention to PFAS should not distract the Fire Service from attention to more toxic fire chemicals such as PAHs



Appendix – Supplementary Slides



Sources of PFAS Health Data

Government or Peer-reviewed Publications

Not Social Media

- Occupational and community epidemiology
- Laboratory animal toxicology—pathology, clinical chemistry
- Laboratory bench studies
- Exposure assessments—environment/workplace or blood
- Computer modeling
- Clinical practice
- Lot of mis-information found on the Internet

PFAS Present at Low Levels and Hard to Measure

Parts per Billion, Parts per Trillion

- Surface – nanogram per square centimeter
- Solid - nanogram per kilogram (ng/Kg) *often reported in parts per billion or nanograms per gram (ng/g)*

Conceptual:

- One drop in 500,000 barrels of water
- 6-Inches in the 93 million mile journey to the sun
- A square foot of floor tile on a floor as big as Indiana

Challenges:

- *Laboratory (measurement / analyses)*
- *Sample collection procedures and checks*
- *Potential introduction of PFAS into samples*
- *Total organofluorine (PIGE) is not PFAS*

PFAS in Female Firefighters Compared to Control Group

