INTERNATIONAL ASSOCIATION OF FIRE FIGHTERS

Potential Toxins in Station Wear and Uniforms

PRELIMINARY REPORT

Last Update: April 2023

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Table of Contents

Introduction

The International Association of Fire Fighters (IAFF) is committed to ensuring that fire fighter equipment, apparatus and workplaces are free of unnecessary hazards.

As has been done with bunker gear and PPE, the IAFF has taken the lead with respect to investigating and understanding risks posed by unreported chemicals, metals, and other hazards associated with products marketed and/or mandated for use by fire fighters. We have not been able to rely on voluntary reporting from industry and manufacturers to communicate to us the hazards within our equipment and garments. As such, the IAFF has been committed to the task, as large as it is, to report on the safety of a wide array of products. The IAFF will always attempt to promote the safest products for use by their members, and as products are developed and information becomes available, our recommendations may change.

The following Preliminary Report communicates the tests done on station wear and uniforms that are acquired and worn by fire fighters and paramedics within our membership. These findings are not exhaustive, nor do they capture the wide offering of apparel and garments in the market and in use. These findings can serve as being representative of station wear used and serve to form generalizations for the purpose of initiating informed discussions, until further research is completed. These findings also should assist local leaders who are involved in the recommendation, procurement, and acquisition of uniforms and station wear to investigate your specific uniform products as well as take precautionary approaches in the use of current station wear until proof of safety is established.

Overview

Over the last year, the IAFF has been investigating the potential for chemicals and metals of concern being present in fire fighter issued station wear, duty uniforms, and other non-fire suppression garments. This endeavor continues today, as the market has a wide array of offerings for departments to acquire and wear. Several standards are used to certify a segment of uniforms and duty-wear our members are issued and use. These standards often influence what additives are applied to textiles to meet the desired performance requirements. Understanding the potential risk from the additives within these garments is vital to ensuring the health and wellness of our membership.

Standards

Some departments are required, either through statutes or contracts, to follow specific certification standards for station uniforms and garments. These standards may serve as an impediment to acquiring the safest forms of station wear and uniforms. The chronic long-term exposure to some of the chemicals and metals found in some NFPA compliant station wear, may contribute to carcinogenesis and can pose a substantive risk to members' health, exceeding any performance benefits they may contribute to the base garments.

NFPA 1975 – Standard on Emergency Service Work Apparel

This standard requires basic performance for Work Apparel, including:

- Heat and Thermal Shrinkage Resistance
    - o Tested to 500 degrees F.
- Thermal Stability
    - o Tested to 510 degrees F.
- Seam Strength
- Labelling

This standard also includes optional requirements such as:

- Flame Repellency
- Water Repellency
- Insect Repellency

The required performance dictated by this standard results in coatings, treatments, finishes, and additives being applied to the fibers, yarns, and finished textiles to be able to pass the tests and receive certification.

NFPA 1977 – Standard on Protective Clothing and Equipment for Wildland Fire Fighting and Urban Interface Fire Fighting

Testing of garments will include:

- Radiant heat protective performance
- Flame resistance
- Thermal shrinkage
- Evaporative heat transfer

ISO 13688 & NFPA 2112 – Flame-Resistant Clothing for Protection of Industrial Personnel Against Short-Duration Thermal Exposure from Fire

Some jurisdictions and industries may require protective clothing certifications. These garments may conform to department criteria and may be found in use by our members. These garments may have had to meet tests such as:

- **ASTM D6413 —** Standard Test Method for Flame Resistance of Textiles (Vertical Test)
- **ASTM F1506 —** Standard Performance Specification for Flame Resistant and Electric Arc Rated Protective Clothing Worn by Workers Exposed to Flames and Electric Arcs
- **ASTM F1930 —** Test Method for Evaluation of Flame-Resistant Clothing for Protection against Fire Simulations Using an Instrumented Manikin
- **ASTM F2700 —** Standard Test Method for Unsteady-State Heat Transfer Evaluation of Flame-Resistant Materials for Clothing with Continuous Heating
- **ISO 11612 —** Protective clothing - Clothing to protect against heat and flame - Minimum performance requirements
- **ASTM F1002 —** Standard Performance Specification for Protective Clothing and Materials for Use by Workers Exposed to Specific Molten Substances and Related Thermal Hazards

The testing and certification requirements associated with the previously mentioned standards result in certain materials being the primary textile components in garments carrying these certifications. Such materials include:

• **Meta-aramids** o Nomex™ o Conex™	• **Para-aramids** o Kevlar™ o Technora™ o Twaron™
• **Polyamide / Polyimide** o Kermel™ o P84 o Nylon™	• **PBO** o Zylon™
• **FR Cotton** o Flame resistant (FR) o Cotton	• **FR Polyester** o Flame resistant (FR) o Polyester
• **Modacrylic** o Protex™	• **Non-FR Cotton**

Preliminary Findings

The IAFF tested 13 samples, including commonly worn station wear shirts, 1/4-zip, coat, pants, and flight suits to determine if there are any chemicals of concern present.

These samples were composed of various combinations of:

- Modacrylic
- Lyocell
- Aramid
- Cotton
- Polyester
- Nomex™
- Anti-static fiber
- Kevlar™

Testing was done through X-ray fluorescence as well as elemental screening via particle-induced gamma-ray emission (PIGE) and particle-induced X-ray emission (PIXE), and targeted analysis – via liquid chromatography tandem mass spectrometry and inductively coupled plasma optical emission spectroscopy. This testing was done by the California Environmental Protection Agency Department of Toxic Substances Control Environmental Chemistry Laboratory as well as the University of Notre Dame Center of Environmental Science and Technology. This list does not cover all station wear products IAFF members wear but is a snapshot of the common brands and materials that are NFPA certified and are commonly purchased.

Some samples showed high concentrations of **PFAS**. Others showed low levels of several targeted PFAS. Furthermore, results from elemental testing identified the following within the samples provided by the IAFF:

- Chlorine*
- Copper
- Zinc
- Lead*
- Bromine*
- Strontium
- Antimony*
- Titanium
- Calcium
- Phosphorus

Chemicals of concern from the above list include: chlorine, bromine, lead, and antimony.

NOTE:

1. Phosphorous may be associated with oganophosphate flame retardants and were found in some samples in concentrations up to 1,730 ppm.

2. Bromine may be associated with polybrominated diphenyl ethers (flame retardants).

3. Chorine may be associated with TDCPP or chlorinated TRIS (flame retardants) or chlorinated Azo dyes.

4. Wherever antimony is found, trace amounts of lead are also found (about 3%). Antimony was found in concentrations up to 42,900 ppm, and these high levels were confirmed by both independent labs.

5. Titanium dioxide is often added to assist with resisting fading from UV light exposure.

6. Zinc borate is found in select flame retardants and may be the source of this signature.

7. PFAS was found in a few samples. It was found in “background” levels, likely not associated with an intentional application, as well as in very high concentrations similar with what would be found in the outer shell of a set of turnout gear, which is consistent with a water-repellent application.

Initial Interpretation

Cotton:

- Generally, no fluorine signature, therefore no PFAS.
- High bromine signature. Possibly from flame retardant (e.g., decBDE, a flame retardant) or dying process (brominated Azo dye). Both are chemicals of concern from a health risk perspective.

Nomex:

- High levels of fluorine were found at concentrations typical of PFAS application, and at levels seen only on turnout gear outer shells.
- High antimony levels were identified. This may be from a catalyst used in manufacturing or from a flame retardant treatment. Antimony is toxic and leaches out of textiles in sweat.
- Elemental lead was also found. This may be an impurity originating from the antimony used in the polymerization process in the manufacture Nomex.
- High chlorine levels were found. A flame-retardant origin may be possible.

Recommendations

Station wear with low concentrations of chemicals of concern is important to the health and safety of those wearing it. Here are some recommendations for IAFF members to move away from contaminated station wear and towards safer options.

- It is important for local affiliates to determine whether certified performance requirements are necessary for the use and application of the garments within their respective departments, and whether any risks associated with the additives contained within are worth the performance characteristics these certified garments provide.
- Any use of station wear identified as containing known carcinogens and toxins should be curtailed and replaced with safer varieties of uniforms on the market.
- It is important to assess whether alternatives exist that pose less risk, and yet provide suitable performance for fire fighters.
- Local leaders should consider ways to acquire reliable information from applicable manufacturers.
- Locals should act to revise/amend contracts and collective agreements where uniform purchasing language exists to ensure the safest options are available to members.

Conclusion

Initial findings from a select number of uniform offerings prove concerning levels of PFAS, chemicals, and metals in fire fighter uniforms and duty-wear. The IAFF advises local leaders to investigate the uniforms issued to your members and use the initial findings we have provided to make sound choices and remove from service garments that could pose a risk of illness, including cancer.

Much like the topic of PFAS in turnout gear, chemicals in some uniforms and duty-wear could pose a significant risk of illness. But unlike turnout gear, safer options exist today for apparel that has a reduced toxic profile. Additionally, the use of station wear and uniforms containing these listed chemicals and metals is not necessary for fire fighters to safely perform the functions of the job.

The lead found in some samples exceeds the 2008 The Consumer Product Safety Improvement Act limits for Children's Products.

Some states have legislation, and others are developing legislation, that may prohibit the use of PFAS within fire fighter station apparel (dependent on their classification as PPE or otherwise — California The Safer Clothes and Textiles Act Assembly Bill 1817, Colorado HB22-1345, etc.). As such, local leaders within the IAFF must determine if uniforms issued to your members violate state/provincial laws.

PFAS, and the other chemicals and metals addressed, pose a significant risk to fire fighter health, including cancer. The IAFF remains steadfast that, in the effort to lead on this issue and serve the health of our members, decisions must be made immediately to curtain unnecessary exposure risk.