



**Jeffrey O. and Grace G. Stull**

PPE Update

## **Firefighting gear: Can we measure clean?**

**Researchers are taking on the monumental task of finding a verifiable, measurable method for removing contaminants for firefighting turnout gear**

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Cancer awareness in the fire service has risen to new levels. The slate of new studies connecting the increased incidence of certain cancers among firefighters, particularly at younger ages, is placing emphasis on a variety of new practices related to post-fire hygiene.

Among these is that turnout clothing is a continuing exposure to potential carcinogenic substances encountered during structure fires unless it is properly cleaned. That in itself is a significant challenge because many fire departments are simply not used to or prepared for cleaning turnout gear on a regular basis.

Even those departments that have the luxury of multiple sets of gear to rotate out after a fire often cannot perform cleaning at the frequency now being demanded. Other emerging procedures such as gross decontamination performed outside the fireground are being implemented to help reduce contamination and limited its transfer to the apparatus, fire station or an individual's vehicle if used to transport the gear.

The fire service has a long way to go for implementing new hygienic procedures and philosophies; however, the directions being taken in several organizations are very promising.

Yet, one of the key industry needs is to ensure that all these practices are working as intended. Currently, there is no easy way to verify that cleaning is targeting all the key contaminants and is complete.

## Where we are

The cleaning of turnout clothing has evolved over the past two to three decades as fire departments have come to embrace the need to have regular cleaning. Work originated by several firefighter safety groups including **FIERO**, **NAFER**, **CAFER**, and **SAFER** back in the early 1990s led to the development of **NFPA 1851, Standard on Selection, Care, and Maintenance of Structural Firefighting Protective Ensembles**, which set cleaning requirements.

Those early experiences established parameters for how turnout clothing was cleaned, in terms of the procedures for handling, types of machines, detergent pH and temperatures used in washing and drying. Surprisingly, very little information has been added to the standard to further qualify the different cleaning processes.

This is despite that there have been very large changes in the laundering industry that we all observe whenever we go out to buy a new washer and dryer. Further, there are emerging new processes such as the use of ozone, carbon dioxide-based dry cleaning, and a variety of different machines and cleansing agents that are being touted for better removal of soils from turnout clothing.

We listen to the claims provided by these new technologies and wonder how effective are they?

## Measurable process

The industry for proper cleaning of turnout clothing cannot properly advance until the metrics are in place to gauge the effectiveness of any particular process. The ability to measure and verify that cleaning has taken place and in particular the removal of contaminants is needed to ensure that all the existing and new practices work as expected.

Finally, some progress is being made in this area. The **Fire Protection Research Foundation**, which is associated with the National Fire Protection Association, formally **launched a project** in May to establish methods for verifying cleaning of turnout clothing and specifically show the removal of harmful contaminants.

While this effort may seem like a science project for chemistry majors, it is actually a relatively difficult problem.

Part of this problem stems from the fact that in any given fire, there can be thousands of different combustion products given the construction and contents of the structure. Some of these chemicals pose serious problems and others do not.

And since no two fires are alike, trying to look for certain chemicals can be confounded by the vast number present and, without a Star Trek tricorder, there is no universal method and instrument for their analysis.

## Sampling

Further complicating the matter is sampling the clothing. To precisely measure low levels of contaminants in clothing, pieces must be removed. And since the contamination is not uniform over the entire item, some logic has to be applied as to where to take the pieces from and then generalize the results for the overall item.

Most of the techniques that are applied by analytical laboratories are usually applied to soil or water samples to quantify environmental contaminants, some of the same substances that are carcinogens in fire smoke, but these methods are not entirely effective for testing turnout clothing.

The new project is based on developing a methodology that can be applied anywhere for assessing whether key fireground contaminants have been removed by whatever machine, cleaning agent or process.

For this to work, they must develop a means for contaminating clothing samples uniformly in the laboratory with a set of representative substances, inserting these samples into surrogate full clothing items and then washing the full clothing using whatever cleaning procedures are to be applied.

The previously contaminated material samples can then be removed from the clothing and analyzed for contamination levels to determine if the substances have been removed.

### **Replicating the fireground**

The key part of this is to contaminate the material samples in the laboratory in a way that simulates how clothing is typically exposed — especially to the array of fire gas chemicals and carbon particles in smoke — rather than just simply soaking the material in a liquid chemical mixture.

To this end, the research foundation contractor has proposed using pellets comprised of known chemical substances and carbon and burning these pellets in a high-temperature furnace with the effluent swept over the material samples. A significant amount of validation work must be done to demonstrate that these procedures represent field contamination and also can be consistently applied to determine cleaning effectiveness.

If successful, specific cleaning equipment, agents and processes can be evaluated to determine which wash conditions are best at removing specific carcinogens or skin-absorption toxins. Just as important, differences in equipment type, wash temperature and detergent chemistry can be evaluated to identify the optimum conditions.

Having these procedures can bring us closer to an envisioned time when independent service providers can be qualified for having appropriate equipment and procedures to remove turnout clothing contamination in the same manner that these organizations are now verified for repair capabilities.

### **Collateral damage**

One of the consequences of more frequent cleaning, even verified cleaning, is that turnout clothing will be subjected to more wear and tear that will likely shorten its service life. Although it seems difficult to accept, laundering can shorten the life of turnout clothing relatively rapidly and in some cases adversely lower its performance.

This means that not only must cleaning processes be verified for removing soils and contamination, they also must be evaluated to show that unusual clothing degradation does not occur when the cleaning process is applied regularly — more than once or twice a year.

Clearly, keeping clothes clean is not the overall answer for minimizing firefighter exposures to carcinogens. These exposures occur in a variety of different ways.

Still, by ensuring the removal of persistent contamination that is possibly linked to adverse health effects, at least one avenue of firefighter hygiene is dramatically improved.

## About the author

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Jeffrey and Grace Stull are president and vice president, respectively, of International Personnel Protection, Inc. They are members of several NFPA committees on PPE as well as the ASTM International committee on protective clothing. Mr. Stull was formerly the convener for international work groups on heat/thermal protection and hazardous materials PPE as well as the lead U.S. delegate for International Standards Organization Technical Committee 94/Subcommittees on Protective Clothing and Firefighter PPE. They participate in the Interagency Board for Equipment Standardization and Interoperability and have authored the book, "*PPE Made Easy*." Send questions or feedback to the Stulls via [email](#).

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