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PPE Update

# 2 ways to check firefighter gear cleanliness tested

## The challenge of testing how clean turnout gear is without destroying it is a big one; two techniques show some early promise

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The focus on cleaning firefighter clothing has never been as strong as it is today. Twenty-five years ago, routine cleaning was a rarity. But at about that same time, firefighters were beginning to realize that dirty gear was no longer a symbol of experience.

The transformation of the fire service culture from believing that smelling like smoke was just a part of the job to having a genuine concern that gear remain clean has been fueled by concerns that soiled clothing represents a threat to their long-term health.

This change has been solidified by the likelihood that continuing to wear contaminated turnouts is a contributing factor in the increased rates of firefighter cancer.

As a result, new practices are emerging. More fire departments are having their bunker gear cleaned, either internally or through independent service providers. Gear cleaning is extending to more than just coats and pants — attention is focusing on hoods, gloves, helmets and even SCBA.

A larger number of organizations are moving towards having two sets of clothing to ensure that the set used in a structure fire can be cleaned without reliance on spare gear.

Despite the acceptance that more cleaning is necessary, the missing element is judging just how effective cleaning is. We know that washing generally appears to remove soils and that clothing can look closer to its original appearance after being cleaned. In some cases, the clothing smells clean leading us to believe that washing really works.

Of course, there are those situations where difficult-to-remove stains remain and many times, older, frequently cleaned turnout gear looks dingy and faded. But we assume that most of bad stuff is gone, and hopefully we are right.

**Apples to oranges**

The chemistry of soil removal is relatively well studied. A lot of this science comes from commercial and domestic laundry practices from decades of machines, detergents and process evolution. Yet, much of this work has focused removing conventional soils and other common substances.

The contamination from structure fires is much different. First, the smoke particles generated by a fire are generally very small, many in the range of a hundredth of a micron in diameter. Second, these particles are present in very high concentrations and, given their size, easily penetrate small pores and openings in the clothing, as well as coat exposed surfaces.

Third, the carbon particles adsorb and hold gases created by the decomposition of materials in a fire, which lead to a myriad of different chemicals. High levels of heat and moisture further exacerbate the contamination process.

The complexity of turnout clothing contamination dictates that conventional methods for assessing cleanliness may not be accurate. Appearance and odor, while being telltale signs of continued soiling, are not enough to assess whether the clothing has been adequately cleaned, and more importantly, decontaminated.

While some cleaning processes impart fragrance to the laundered item, these may only mask any scent from a continuing contaminant. The reality is that the actual smell of clean is no odor at all.

**No magic wand**

Certainly, samples can be taken out of clothing item and extracted using established analytical methods to reveal any potential lingering substances of concern. But the trick is to be able to do this without taking the sample and destroying the gear.

Attempts at applying non-destructive techniques are fraught with difficulties. Some would like to think that it is just a matter of buying the right detector and pointing it at the clothing to get a reading that lists all of the contaminants.

As much as we would like to believe that this all-capable instrument exists, it doesn't.

Even if you were able to analyze the air space next to the clothing, the chemicals you'd find would not be those for which you should have long-term concern. Any chemical that is easily released back into the air under ordinary conditions is volatile, and these chemicals will dilute out of the clothing relatively quickly.

Instead, the problem lies with the heavier, more complex chemicals that don't evaporate easily. Several of these are linked directly to chronic health conditions or cancer.

**Two methods**
We have undertaken different studies to make these assessments. The approach involved getting samples from the clothing and then sending those samples to a qualified laboratory for analysis. The methods included using surface wipes and soaking the clothing in small volume of water with detergent.

These techniques can be easily applied anywhere, but have to be properly administered to get appropriate results. For example, in using a wipe, a relatively large area needs to be sampled to get enough contaminant to analyze.

Our research showed that pre-moistened laboratory wipes, normally used for lead sampling, are effective in capturing heavy metals like antimony, arsenic and chromium. Yet, similar wipes don't do a good job of picking the low-volatile compounds.

To capture the lower volatile chemicals, which tend to be persistent in clothing, one turnout cleaning company suggested we use a soak tank with a low volume of liquid. This approach works to a degree, but the contaminants can be significantly diluted in the soak liquid and it can be difficult to isolate substances of interest unless the analysis methods are fine-tuned.

This is important because most laboratories are used to evaluating soil, water or air samples, not turnout gear. Moreover, even clean gear has chemicals like dyes, finishes and body residues that have to be sorted in any type of complete analysis. Still there is promise in this direction.

**On-going research**
There is considerable additional research that is now ramping up within the fire service industry to examine cleaning effectiveness. Industry practices as well as the NFPA 1851 pose constraints on how gear is cleaned and it is unknown whether these limitations prevent removal of all contaminants or at least limit the efficiency of their removal.

One project being undertaken by the Fire Protection Research Foundation is working to create measurement tools to determine how well any cleaning process works in removing key contaminants. This research, which is just getting underway, is expected to open up a variety of new cleaning techniques. Updates for this project will be posted at the foundation's website.

Additional efforts in the project will be made to evaluate the effects of the cleaning processes on turnout clothing itself. After all, with the expectation that cleaning is applied more frequently, there will be the need to ensure that the cleaning itself does not degrade clothing prematurely.

Ultimately, within the next few years, new practices will be introduced that allow assessments for cleaning effectiveness, which in itself, will reinforce keeping gear clean.

While many questions still remain, the good news is that the fire service appreciates clean gear and will look towards that as one means for preventing unnecessary exposure to contaminants.

## About the author

*Sponsored by Globe*

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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