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PPE Update

How to rid firefighting PPE of contaminants

What you can't, and can, see on your PPE will hurt you; follow these steps to avoid exposure to cancer-causing agents

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Every emergency response represents a possible contamination event. If there is exposure to gases or vapors, liquids, or particles, these substances will get onto clothing. In many cases, they will remain on the clothing until adequately cleaned.

We have previously described the manner in which this contamination occurs, but there are some subtleties worth going over.

Gases and vapor generally easily penetrate any textile component. Coated or laminated materials such as trim or moisture barriers together with hard surface items such as helmet shells will physically retard gases and vapors, but many of the substances can still permeate materials on a molecular basis.

This is also true for leather and rubber materials. While leather is porous like fabric, many chemicals are soluble in rubber.

Point of entry

Liquids will enter any gap in the material or clothing, particularly through interface areas. For textile fabrics, once the outer surface is wet, the liquid will penetrate.

Moisture barriers, coated materials, and rubber prevent liquid penetration, but many non-water liquids will penetrate gaps more easily than water. Liquid that soaks a material will spread to other areas of the clothing by wicking, spreading contamination beyond the point of entry.

Particulates can range from asbestos fibers to drywall dust, but the largest contributor of particulate contamination at the fire scene is the carbon particles from incomplete combustion. Carbon particles adsorb and hold fire gases, making them more dangerous than plain carbon.

While many particles are visible, many are submicron sized and easily get into any porous surface or gaps in the clothing ensemble where there is no barrier.

Like a magnet

Longer exposures produce higher levels of contamination. Yet the extent of contamination is also heavily dependent on the nature of the substances involved. For example, oily, tarry substances created by high heat will tend to bond to clothing materials more readily, particularly as the clothing cools.

Soiled clothing picks up more contamination. Clean clothing may offer more surfaces for contamination, but many forms of contamination on clothing offer compromised materials that can become more soiled or readily pick up other forms of contamination.

This is most often seen when soot in fabrics continues to pick up gases and vapors from the fire environment. In essence, it is easy for dirty clothing to be more soiled than clean clothing.

The soils on clothing often negate whatever repellent properties a clothing fabric might have. The finishes placed on clothing fabrics and some other components can also wear down over time, making soiling more likely to occur.

Routine cleaning

After being exposed it is essential to clean your gear before continuing to use it. This is not the easiest process as firefighters are generally tired from the response and just want to move on. Also, unless your department provides a second set of gear, this approach can be difficult if you still need your gear and it is wet.

NFPA 1851, which is the standard that governs selection, care, and maintenance of turnout clothing prescribes "routine cleaning," which is principally hand washing. Some organizations will hose down gear after an incident; others have employed the Hazmat decon showers at the site to get rid of the worst of the contamination.

Of course, these processes require time for the gear to dry. However, the alternative is equally problematic — wearing dirty gear continues your exposure to whatever stays on and in your gear.

So, to avoid exposure, some cleaning has to take place as soon as possible after the event and preferably before you have to wear the gear again. Remember, it is not just your clothing that has to be cleaned, but also gloves, helmets (including the ear covers), footwear and especially hoods.

Station wear

It is important to recognize that your station uniform and underclothes also have become contaminated by any substance that may have bypassed your turnout clothing. This clothing must be removed and cleaned.

Generally, use the cleaning methods prescribed by the clothing label unless some known substance has penetrated to your work clothing. Nevertheless, in all cases wash this clothing separate from other personal items to prevent cross contamination.

Lastly, while your skin is a good barrier to many substances, it too will be contaminated. Unfortunately, wearing of heavy clothing under hot, humid conditions only enhances how some chemicals can be absorbed through your skin.

Thus, taking a shower immediately after the fire event is critical in getting totally clean and preventing any continued contamination exposure.

Advanced cleaning

NFPA 1851 also defines advanced cleaning as form of clothing care. This type of cleaning must be done at least once a year and whenever gear is exposed to soiling at a fire. The frequency for cleaning is a judgment call, but if the clothing is visibly soiled or contaminated, then it must be cleaned.

In addition, if your clothing has been exposed where there is any concern about continued contamination, it must be cleaned. Laundering is not necessary decontamination, but most laundering processes specified by clothing manufacturers are designed to remove soils, which include soot particles and many chemicals.

This does not mean that all chemicals will be removed. There is active work to learn just how effective current procedures are, but prior research has shown that a great deal of contamination can be removed using appropriate washing procedures or an independent service.

In some cases, fire departments realize that they have encountered particularly hazardous substances and specialized cleaning is needed. This form of cleaning is not defined. It may be a presoak, spotting treatment, or special detergent. It also may be an entirely different process altogether.

Current research

Here, the matter becomes even more difficult because industry offers very little guidance on this topic. Such decisions for how to clean and whether the cleaning itself will be effective are made on a case-to-case basis. In some cases, the knowledge of the contaminant and the potential dangers for reuse will warrant disposal.

But the problem in making that decision is how to assess the cleaning as providing decontamination. This problem has existed for some time and is now being addressed through current NFPA committee work and related research.

Firefighters find themselves in the most dangerous of conditions. While the most obvious hazards are burns and physical injuries, the more incipient hazard of exposure to contaminants that include carcinogens is an equally serious threat. Hopefully, the fire service, with the assistance of groups like the Firefighter Cancer Support Network, can consistently apply these practices and promote other forms of protective clothing design and care technology improvements to further create reductions for cancer-causing agent exposures.


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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