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PPE Update

Is faded, stained firefighter turnouts dangerous?

Depending on the type of stains and discoloration, wear signs may mean its time to retire the gear; here's how to tell normal from dangerous wear

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Firefighter turnout gear gets dirty, really dirty. On any given response, turnout clothing is exposed to an array of soils and contaminants. During structural fires these exposures are at their worst; although, firefighters can encounter many solids, liquids or gases on other responses that will affect how the clothing looks.

In general, discoloration and staining are expected. However, some types of discoloration go beyond fading. Likewise, some types of stains can be indications of issues beyond ordinary wear and tear.

The outer shell of the turnout clothing will receives the brunt of any exposure. When firefighters contact surfaces, are splashed or are exposed to various particles, gases and aerosols, these substances get onto the exposed surfaces, and in some cases penetrate the outer layer to reach interior layers.

Common materials include soot, drywall and a variety of dusts stirred up during the fire or suppression activities. Water at the scene can entrain these materials and deposit some substances over a larger part of the clothing. Other liquids at the scene can be encountered if containers are broken open or burst from heat.

Likewise, during an extrication event, firefighters can be exposed to fuels, oils, hydraulic fluid and other liquids. There also can be blood and body fluids from rescue and patient care. A variety of fire

gases are present and while most of these are spurious to the fire scene, there are several ways these can get into clothing and remain there.

And, just wearing the clothing will result in the interior absorbing sweat and picking up body soils.

What's clean?
The key issue here is how does the clothing appears after it is cleaned and what constitutes any problems for continued use based on its visual appearance.

We are strong advocates of cleaning clothing whenever there is any soiling or presumed exposure to contaminants during firefighting operations. Initial cleaning should take place at the scene immediately after the incident to remove the worse of the soils and as many contaminants as possible.

On scene cleaning by brushing off and rinsing clothing with water will remove much of the dirt, but usually just from the surface. Full gear cleaning in a washing machine using prescribed procedures will provide deeper, more effective cleaning that can only be achieved by extraction using appropriate water temperatures, detergents and other cleaning conditions.

Effective cleaning is most often judged by the appearance of the clothing after laundering. If properly undertaken, cleaning should remove visible soils and contaminants, and there should be no residual odor.

Contrary to some opinions, the "smell of clean" is no odor at all, although some cleaning and care companies use fragrances that can mask residual odors. Discerning a clean appearance is a little more difficult, which in part will depend on the original color of the clothing.

Black vs tan
Outer shells that are yellow, tan or brown more evidently show differences in comparison with black exteriors. Some departments may even choose black clothing because it better hides staining and discoloration that can take place over continued use of the clothing.

Yet, clothing color fading can be a factor in judging if it has been properly cleaned. For light colored clothing, reduced color brightness is a natural and is not necessarily an indication of any specific clothing problem.

On the other hand, if there are persistent dark areas that differ from others, then further investigation is warranted.

One of the best ways for determining color change of the outer shell is to compare cleaned gear against new gear. Another way, particularly if a new set of gear is not handy, is to look on the interior of the outer shell. These areas are more protected from soiling.

Any deep darkening of a light-colored outer shell may be a sign of incomplete cleaning. For black or very dark outer shell materials, coloration patterns are much more difficult to observe; it sometimes takes a cleaning expert to help make this assessment.

Persistent staining
Interior layers, particularly the fabric side of the moisture barrier, which is the outer layer of the lining and intermediate layer of the overall clothing element is subject to soiling and discoloration as dirt and contaminants penetrate through the outer shell. This layer, which can also be light or dark, is assessed the same way.

Its comparison to new clothing or to a protected area provides the basis of cleaning judgment. It is often possible to see the outline of the exterior trim by their appearance as relatively clean areas on the lining versus those that are more readily exposed.

Persistent staining is a frequent problem with turnout clothing. This staining can be caused by a number of substances and may or may not be removed by cleaning depending on the nature of the substance.

One of the more common types are greases and oils or hydrocarbon mixtures such as diesel oil. Some of these liquids have tar-like properties and can be extremely difficult to remove through laundering, even with spotting agents and pretreatments.

If cleaning does not remove the substance or large, clearly noticeable stains, then that clothing may need to be retired. While the very volatile substances in these mixtures are likely long gone having evaporated from the clothing area, the remnant stains or residual contaminants are added fuel that can make it possible for the clothing area to ignite (despite the flame resistant textiles used in the clothing's construction) and be more conductive of heat.

Bloody mess
Bloodstains also can be persistent, but generally can be removed when the correct washing techniques are applied. For blood, the reddish or brown coloration of the stain is a signal that the substance has not been completely removed.

This coloration is due the hemoglobin proteins in the blood that remain in the textile. While these proteins are not necessarily hazardous, the larger concerns are pathogens associated with blood or body fluids. Many viruses such as HIV and hepatitis are readily inactivated through the chemical, physical and thermal actions of laundering.

This is also true for harmful bacteria such as MRSA and C. diff., which increasingly are showing up on clothing textiles. Yet, the combination of residual protein and moisture in clothing can give way to continued persistence of some microorganisms.

Stains caused by flammable substances, like oils and greases, reduce clothing insulation and can be prone to unexpected ignition. Stains caused by substances that create known health hazards such as being an irritant, skin absorbing substance or carcinogen, like creosote, should not be present in any clothing for continued service.

In some cases, the chemicals in the stain can leach out when the clothing becomes wet, which in turn can cause exposure to the wearer.

Fabric degradation
Stains from substances that are not flammable or do not constitute a health hazard may be acceptable, but only if no degradation of the clothing has taken place.

While chlorine is a hazardous substances, the chemical will not remain in the clothing. Yet, discoloration as might appear from bleaching can be a serious indication that the textile has been adversely and irreversibly affected.

Sometimes, there can be unusually colored stains. In most cases, these stains result from inorganic chemicals that are either colored or somehow react with other present substances.

For example, recently a fire department complained of purple stains on some of their turnout clothing after responding to a fire at a water-treatment plant. From an investigation of the incident, it was speculated that the stain was due to the reaction of chlorine stabilizing compound with copper either at the site or present in an algaecide that caused the formation of a purple colored compound. The compound turned out to be harmless and would generally wash out over time.

Some clothing discoloration is not staining at all, but occurs as the result of high heat exposures. Colored materials can lose dye through a process known as dye sublimation.

Essentially, when heated to sufficiently high temperatures, the dye evaporates out of the clothing leaving the material discolored. This often is evident for black outer shell materials because the contrast in colors is relatively stark.

When dye sublimation of a shell has occurred, it is best confirmed by looking at the underside of the material because the same discoloration will be present on both sides of the fabric.

While very small spots of dye sublimation of the outer shell can be acceptable, this characteristic is not reversible and means that the clothing has been subject to a very high heat.

Dye sublimation occurs before other forms of heat degradation take place so if wide spread on clothing (spots larger than ½ inch in diameter), then the clothing should be extensively evaluated by an experienced individual and often will be repaired or retired.

Hopefully, it is possible to clean your turnout clothing and keep it free from stains and discoloration. If there are persistent stains or unexplained discoloration, it is important to have your clothing inspected with a determination made for the continued serviceability and use.

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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