The Importance of Flame Resistant (FR) Station Wear

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Overview

For many industries, flame-resistant (FR) clothing has been widely adopted as a means of protecting employees from burn injury or even death. However, while the fire service community takes firefighter safety very seriously, it's estimated that only a quarter of fire departments require flame-resistant station wear.

This paper demonstrates why FR station wear should be considered an integral part of every firefighter's personal protective equipment (PPE)—clothing designed to be worn continuously in designated locations where intermittent exposure to radiant heat and flame is possible. While this definition was written with industry in mind, there are significant benefits to adopting a systematic approach to PPE for fire service, as well.

FR clothing is:

- Engineered to self-extinguish upon removal of the ignition source
- Made from natural or synthetic fabrics, like other clothing
- Designed to limit (not eliminate) burn injury
- Made to provide an additional layer of protection when incorporated with primary PPE and a minimal layer of protection when worn as the outermost layer

FR Station Wear in the United States

Based on customer feedback, we estimate that of the 345,000 career firefighters in the United States, nearly three quarters do not wear FR station wear under their turnout gear or on all-risk calls, and nearly 60% wear meltable synthetics or synthetic blends. There are many reasons for this, ranging from comfort and durability to style, but these reasons do not consider firefighter safety and protection.

In fact, there is much evidence to show that an extra layer of PPE is not only beneficial, but, in the firefighter's rapidly changing world, is crucial to providing protection from unexpected thermal exposure that could result in burns.

FR Station Wear: Four Perceptions that Prevent Use

Many firefighters believe there's no value in wearing an additional layer of FR clothing. Fire service professionals nationwide generally point to four primary perceptions that contribute to this assumption:

1. Turnout gear is nearly invincible—but any breach will inevitably lead to fatality.

The first perception regarding FR station wear is based on a deeply held belief that one's primary protective clothing is nearly foolproof, and that if it fails, the results will be fatal. Project Mayday, a recent fire service study, demonstrates that this is not necessarily true.

Project Mayday authors believe the project accounts for only about 8–10% of actual annual mayday incidents[1], but among 535 burn-injury reports gathered, authors found:

- 154 incidents of 3rd-degree burns covering 30–50% of the body
- 51 incidents of 3rd-degree burns covering 50–70% of the body
- 93 incidents of 3rd-degree burns covering more than 70% of the body
- 237 incidents of 2nd-degree burns covering more than 30% of the body

This data shows that turnout gear is not always foolproof. Though incidents may be rare, in some cases firefighters' turnout gear fails, and burn injury results. Importantly, however, these burns, while gravely serious, do not necessarily lead to death.

14% of the firefighters who voluntarily provided Project Mayday information had been burned under their turnout gear and survived.

[1] Project Mayday presentation

Project Mayday further reported that a majority of the firefighters studied were wearing non-FR garments under their turnout gear.[2] Of those burned under their PPE, only 30% wore FR pants and a mere 23% wore FR shirts. This practice not only fails to protect the wearer from burn, but can in fact exacerbate the injury. Synthetics and synthetic blends can and do melt onto the wearer's skin, causing additional burn injuries that may require extensive treatment at a burn center.

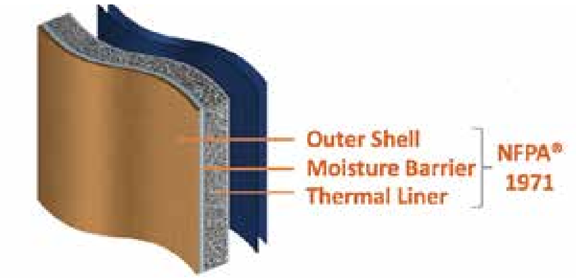
If, as the Project Mayday authors believe, mayday events are grossly underreported, then burn injuries have been underreported as well. What is reported, and widely circulated, is loss of life on duty (LOLD). These tragic accounts may perpetuate the myth that a failure of one's primary protective clothing results in certain death.

Project Mayday, a comprehensive study of "mayday" incidents, responses and recommended preventions, published in 2018, tracked reports from 5,102 career fire departments in 50 states between 2015 and mid-2018. The project accumulated data from 4,839 traffic audio and 710 dash/video tapes, along with tactical worksheets, notes, dispatch logs, SOPs, mayday training information, follow-up reports and internal investigation documentation.

The project was funded in its first year by a private foundation grant to: CERT: Command Emergency Response Training, Glendale Arizona; Dr. Vinton Bennett, Dr. Jason Berbermeier, Dr. Albert Grisson, Dr. George Grant and Captain/Dr. Stuart Philip. It continues to be funded today by Don and Bev Abbott.

2. Every layer of turnout gear is constructed to be highly insulative—it doesn't matter what's worn underneath.

The second perception regarding FR station wear is the belief that turnout gear is comprehensively protective. In some ways, this is true: Today's turnout gear is comprised of three layers, all of which are required to be flame resistant as stipulated in National Fire Protection Association (NFPA®) 1971: *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting.*



This gear is rated for its Thermal Protective Performance (TPP) as gauged by the NFPA® TPP test, which exposes fabric composites to the thermal energy of a flashover scenario. Today's standard requires a minimum TPP of 35.

The TPP rating divided in half represents the number of seconds to 2nd-degree burn at a heat flux of 2 cal. This calculation assumes there is no preheating or stored energy in the fabric composite from the environment, time inside a burning building or other heat source prior to the flashover.

However, the protection provided by turnout gear does not eliminate the potential of synthetic or synthetic-blend layers from melting when worn under turnout gear. Tom Foley, retired Fire Chief for CAL FIRE conducted TPP tests on FR and non-FR station wear fabrics and found that polyester garments, when placed under turnout gear with the minimum acceptable TPP rating, began to melt in just 28 seconds. This melting would result in unnecessary and preventable burn injury to the firefighter.

3. Turnout gear alone has worked well in the past—it will work just as well today.

The third perception regarding FR station wear is the widespread belief that traditional turnout gear remains responsive to the hazards of today's working conditions.

[2] Project Mayday. Presentation, slide 168

> *"There is a tendency to believe that since a certain practice has thus far not killed us, that it is an acceptable practice." —Capt. John Peters [3]*

In fact, firefighters know firsthand that changes in both residential and commercial building contents, as well as in construction materials and methods, have had a significant impact on fire temperature and rate of burn. According to studies by Underwriters Laboratories (UL), fires can become uncontrollable in less than three minutes and can reach flashover eight times faster than in past, more traditional, built environments.[4]

The Project Mayday report cites seven factors that contribute to greater hazards in residential fires alone: larger homes, more open floor plans, void spaces, evolving fuel loads, changing building materials, smaller lots and new technologies.

These conditions can lead to:

- Faster fire propagation
- Shorter time to flashover
- Rapid changes in fire dynamics
- Shorter time to collapse
- Shorter escape times
- Exposure problems
- New and unknown hazards

Further, the nature of all-risk calls has changed drastically in recent years, exposing firefighters to potential dangers they may not anticipate.

Ultimately, under today's conditions, firefighters fight fires about 10% of the time. The other 90% of the time they're called on for nonfire hazard and technical rescue responsibilities, including roadway incidents, vehicle extrication, medical emergencies, hazmat, urban search and rescue, high/low angle rescue, swiftwater rescue and flood rescue. For many of these responses, typical structural PPE is not utilized or may be doffed mid-operation. However, the threat of an unforeseen accidental thermal incident may still exist, making FR station wear a critical layer of protection for firefighter safety.

4. The standards permit non-FR station wear.

The fourth perception associated with FR station wear is also a fact. The two standards that refer to station wear both permit the use of non-FR garments.

NFPA® 1975: *Standard on Emergency Services Work Clothing Elements* makes flame resistance optional for station wear. NFPA® 1500: *Standard on Fire Department Occupational Safety, Health and Wellness Program* supports NFPA® 1975 in the body of the standard, although appendix section A.7.1.5 clarifies:

> *Clothing made from 100 percent natural fibers or blends that are principally natural fibers should be selected over other fabrics that have poor thermal stability or that ignite easily.*
>
> *The very fact that members are fire fighters indicates that all clothing that they wear should be inherently flame resistant to give a degree of safety if unanticipated happenings occur that expose the clothing to flame, flash, sparks, or hot substances.*

Unfortunately, the NFPA® 1500 appendix carries less weight than the body of the standard and may be overlooked, and because these standards are voluntary, fire departments can choose which, if any, to follow.

> ***Cotton:*** *Unlike FR fabrics, cotton is a fuel and can ignite if exposed to an ignition source, ultimately contributing to firefighter burn injury.*
>
> ***Synthetics:*** *Although none of the standards today allows synthetic or synthetic blend fabrics to be worn, for many fire departments they are the station wear fabrics of choice. Unlike FR fabrics, synthetics easily melt, drip and unnecessarily add to firefighter injury.*

[3] Project Mayday. Presentation, slide 27.

[4] Draeger. "The Flashover Phenomenon." Understanding the Nature of Flashover and Recognizing Its Warning Signs. 2004. https://legacy.draeger.com/r_assets/forms/Segments/US/Fire-Services/Flash%20Over/flashover-wp-9045484-us.pdf

Legal Requirements and Standards

In the United States, the OSHA General Duty Clause stipulates that the responsibility for worker safety rests squarely and solely with the employer, in this case, the fire department.

The OSHA General Duty Clause states:

Each employer (1) shall furnish to each of his employee's employment and a place of employment which are free from recognized hazards that are causing or likely to cause death or serious physical harm to his employees; (2) shall comply with occupational safety and health standards promulgated under this Act.[5]

To determine how employers comply with this law, OHSA looks to the established national consensus standards developed by organizations such as the NFPA®.

It is the responsibility of fire departments to read and understand the standards, determine applicability of the standards, refer to the standards, find PPE suitable to meet the standards, ensure that PPE is compliant with the standards and ensure employees know how to use and care for PPE properly and in accordance with the standards.

The relevant standards for FR station wear are summarized below.

NFPA® 1975: *Standard on Emergency Services Work Clothing Elements* allows for the use of 100% cotton garments, which, as discussed above, can function as fuel and contribute to burn injury. In addition, while cotton may feel comfortable and cool, it is prone to shrinking and fading, and it does not offer the longevity of FR fabrics. For safety reasons alone, cotton should be avoided.

NFPA® 1500: *Standard on Fire Department Occupational Safety, Health and Wellness Program* supports NFPA® 1975 and suggests natural fibers over fabrics with poor thermal stability. However, as discussed above, its appendix states that fire fighters should wear FR in case of unanticipated exposure to fire hazards.

NFPA® 1971: *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting* defines the minimum performance requirements for all elements of PPE needed by structural firefighters, including turnout coats and pants, boots, helmets, gloves, proximity gear and more. It was established to protect firefighters from thermal, physical, environmental and bloodborne pathogen hazards. Fire departments are already familiar with this standard and take these requirements very seriously. To help support the protection offered by NFPA® 1971 compliance, the same level of consideration should be extended to the layers worn under turnout gear.

NFPA® 1977: *Standard on Protective Clothing and Equipment for Wildland Fire Fighting* defines the minimum performance requirements for PPE required in fighting wildland fires. As with NFPA® 1971, this standard does not reference base layers.

NFPA® 1951: *Standard on Protective Ensembles for Technical Rescue Incidents* pertains to those with technical rescue responsibilities. It provides minimum performance requirements for garments worn by personnel assigned to search, rescue, treatment, recovery, decontamination, site stabilization and extrication. These garments could provide the benefits of flame resistance if designed correctly and using FR components.

The Safest Approach Is a Systems Approach

Firefighters already know that compliance with standards cannot always mitigate all dangers. As Project Mayday demonstrates, turnout gear failure is rare but is a real risk, and it can expose base-layer garments to extreme heat and/or flame. Beyond failing to protect from injury, non-FR fabrics can ignite, melt and/or drip, intensifying the severity of injury.

The proper use of FR station wear can add an additional layer of protection and mitigate the potential of station wear to contribute to injury. The protective function is enhanced when FR garments are worn consistently and correctly. Today, FR garments that meet firefighters' style, comfort, durability and affordability requirements make it easier to ensure consistent, correct wear.

[5] Occupational Safety & Health Act (OSHA). 29 USC §654 (1970).

Guidance for Good, Better and Best Options

Good: At a minimum, fire departments should consider moving away from synthetics and synthetic blends. These fabrics pose the additional hazard of meltability when exposed to heat and/or flame.

Better: Departments can adopt and enforce an all-FR policy for station wear. These garments add a layer of protection under turnout gear and can meet other intangibles such as:

Style: FR fabrics resist shrinking, fading and wrinkling, and maintain their crisp, professional appearance longer than cotton or synthetics. Reputable manufacturers generally have a range of popular styles to choose from.

Comfort: Different fabric blends meet different comfort demands. Some FR fabric blends possess qualities such as softness, stretch and breathability that help make consistent and correct wear easier to ensure.

Durability: When maintained properly, FR garments typically last much longer than cottons and synthetics. In fact, properly maintained FR garments retain qualities of protection and comfort, as well as appearance, over years of wear.

Cost/Value: FR clothing costs more than cotton or synthetics. However, FR clothing also offers protective benefits that far surpass cotton and synthetics. That, in addition to garment longevity, means FR garments provide superior value over time.

Best: For those departments with urban interface or technical rescue responsibilities, dual- and tri-certified garments should be considered.

Dual-certified garments pertain to wildland firefighting and meet both NFPA® 1975 and NFPA® 1977 requirements.

Tri-certified garments pertain to technical rescue and meet NFPA® 1971, NFPA® 1975 and NFPA® 1951 requirements.

Purchaser Responsibility

According to OSHA, after selecting the appropriate FR clothing, it is the responsibility of the employer (the fire department) to verify that the garments match the identified hazard. Proper labeling is one indicator that manufacturers have maintained due diligence when constructing a compliant garment.

It is helpful to consider a label evidence of a garment's pedigree: Labels briefly name and describe the regulations, standards and tests with which the garment complies.

To verify garment compliance, first identify the standard associated with the specific hazard. Then check the garment's label to make sure it correctly indicates the garment's compliance with the appropriate standard. Purchasers should be aware that although NFPA® labeling requirements are strict, not all manufacturers follow them.

NFPA® 1975 dictates that FR garment labels must be printed legibly in letters at least 1.6mm (0.063 in.) high and include the following language:

This garment meets the optional flame resistance requirements of NFPA® 1975-2019.

NFPA® 1975 also requires the following information:

1. Manufacturer's name
2. Manufacturer's garment identification number, lot number or serial number
3. Country of manufacture
4. Model name, number or design
5. Date of manufacture
6. Size
7. Cleaning and drying instructions, including applicable warnings, regarding detergents. soaps, cleaning additives and bleaches
8. Fiber content and composition

Labels may include a URL to additional care information online. Because proper care and maintenance of FR garments help to ensure garments' protective qualities and longevity, firefighters should be made aware of care information and where to find further information.

While labeling requirements are strict, manufacturers do not always follow them, so purchasers should always ask for additional proof of compliance:

- Ask for test data (reputable fabric suppliers can readily supply these results)
- Ask to see the certification(s) for each garment
- Work with a proven supply chain partner to help determine proper garments for the hazards and conditions identified in the employer's hazard risk assessment
- Work with a proven supply chain partner that ensures every garment can be traced to where and when it was made, what bolt of fabric was used, and when and where it was shipped

Conclusion

As this paper outlines, today's firefighters are exposed to new and unforeseen hazards. Project Mayday data shows that for the incidents gathered in 2015 through mid-2018, fireground firefighter fatalities were down 4.4%, but fireground injuries were up 136%.[6] Although burn injuries may be mitigated by consistent and proper use of FR station wear, long-held beliefs and current standards language contribute to decision-making around its purchase and use.

Consistently and properly worn, FR station wear adds an important layer of protection in fire and nonfire emergencies. It also offers ideal solutions for the style, comfort, durability and cost efficiencies desired by many fire departments.

NFPA standards can help purchasers choose the appropriate FR station wear and comply with OSHA regulations. For these reasons, fire departments should:

- Work with reputable manufacturers and supply chain partners to ensure all garments comply with established certifications
- Understand that NFPA® standards outline the *minimum* criteria for performance
- Adopt good, better and best solutions that meet their unique requirements and conditions

[6] Project Mayday. Presentation, slide 70.

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To learn more about OSHA regulations, occupational hazard assessment, and FR outfitting standards, contact:

Customer Care
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