Building and Implementing an FR Program for the Arc Flash Hazard

Introduction to FR/AR Clothing

Why is FR/AR Needed?

Most severe burn injuries and fatalities are caused by non-flame resistant clothing igniting and continuing to burn

Flame resistant clothing, on the other hand, will self-extinguish, thus limiting the injury

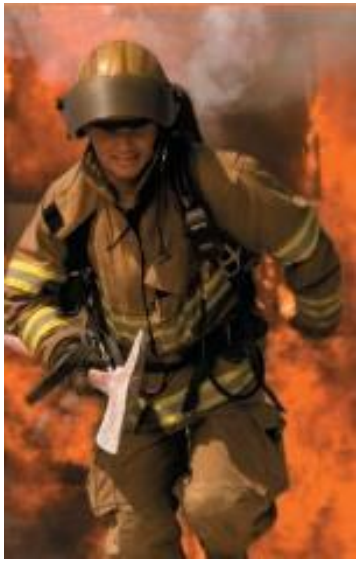
Introduction to FR/AR Clothing

What is Flame Resistant Clothing?

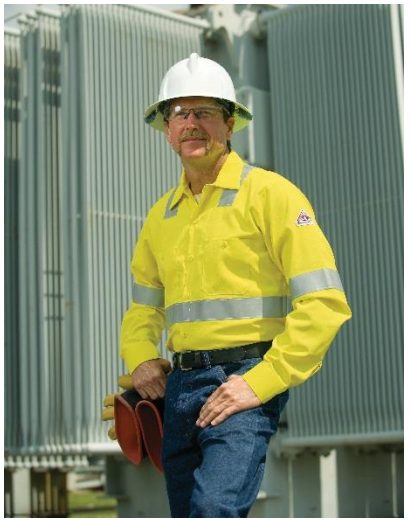
- Clothing made from fabrics that self-extinguish
- Fabrics may be natural or synthetic
- Designed to limit (not eliminate) burn injury
- Survival, extent of injury, recovery time and quality of life are all dependent on FRC performance

“Primary” vs. “Secondary”

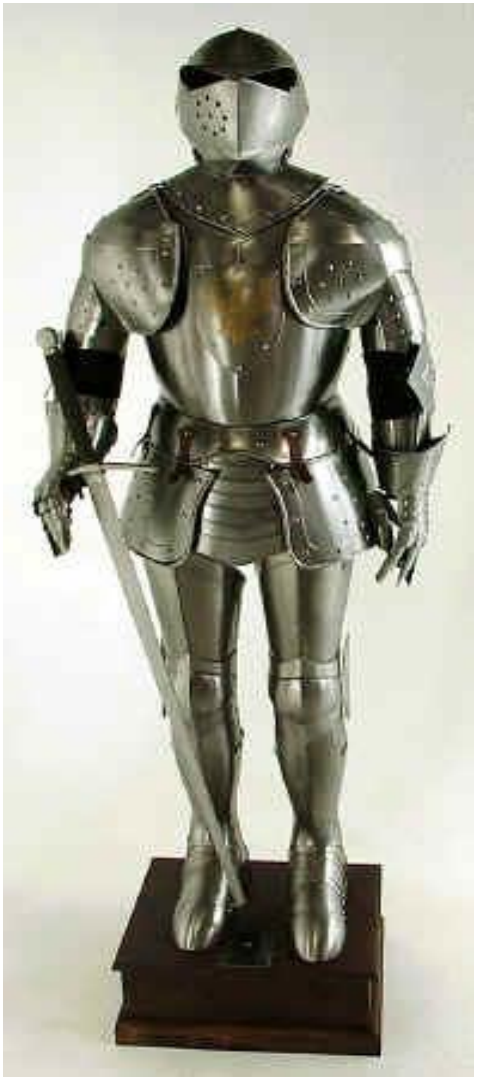
- **Primary Protective Clothing**
  - Definition; “Clothing that is designed to be worn for work activities where significant exposure to molten substance splash, radiant heat, and flame is likely to occur.” Example- Firefighter Turnout Gear



- **Secondary Protective Clothing**
  - Definition; “Clothing that is designed for continuous wear in designated locations where intermittent exposure to molten substance splash, radiant heat, and flame is possible.”



Introduction to FR/AR Clothing



What Flame Resistant Clothing is Not!

Hierarchy of Controls:

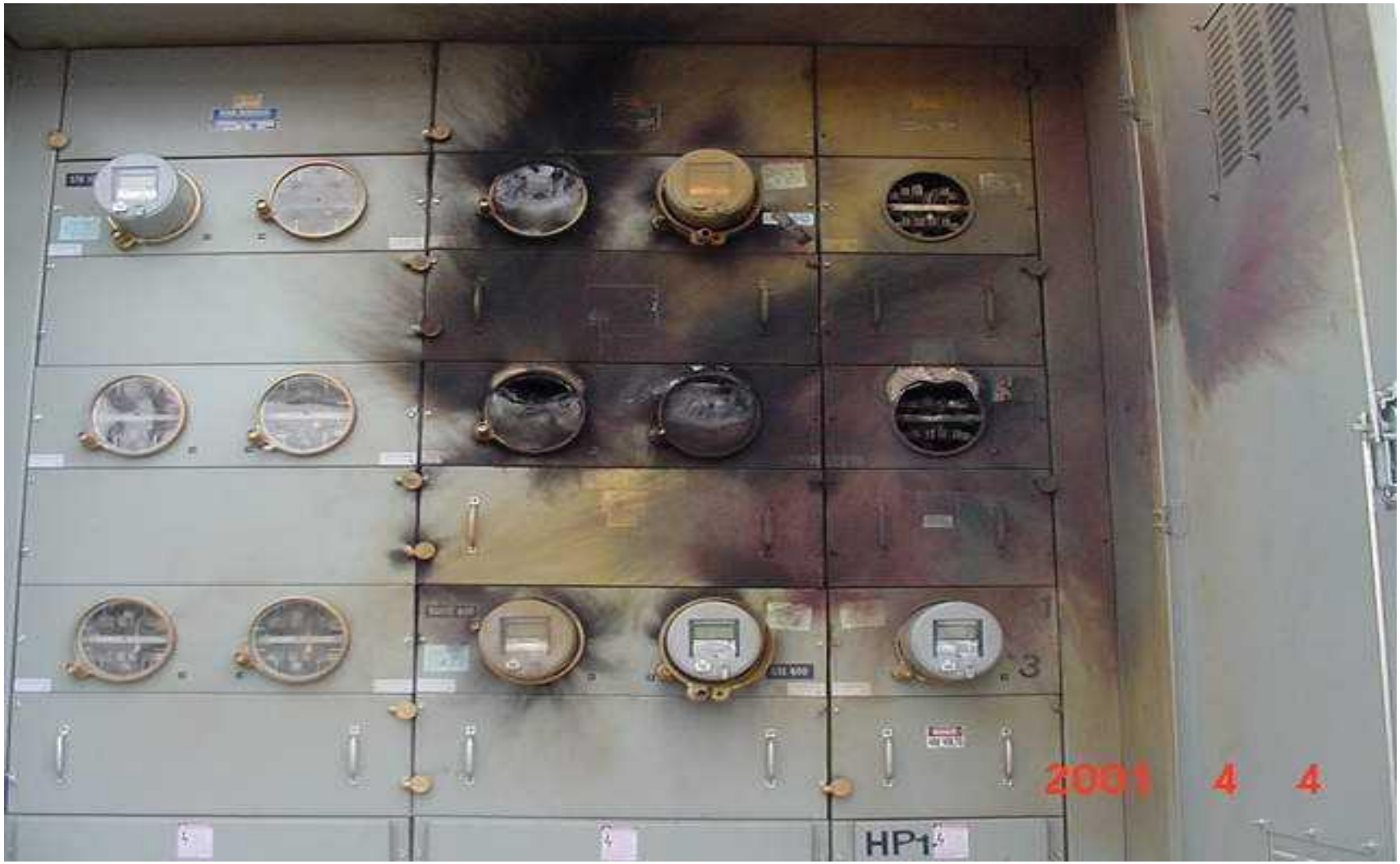
- Eliminate or replace
- Engineering
- Admin and/or policies
- PPE

Introduction to FR/AR Clothing

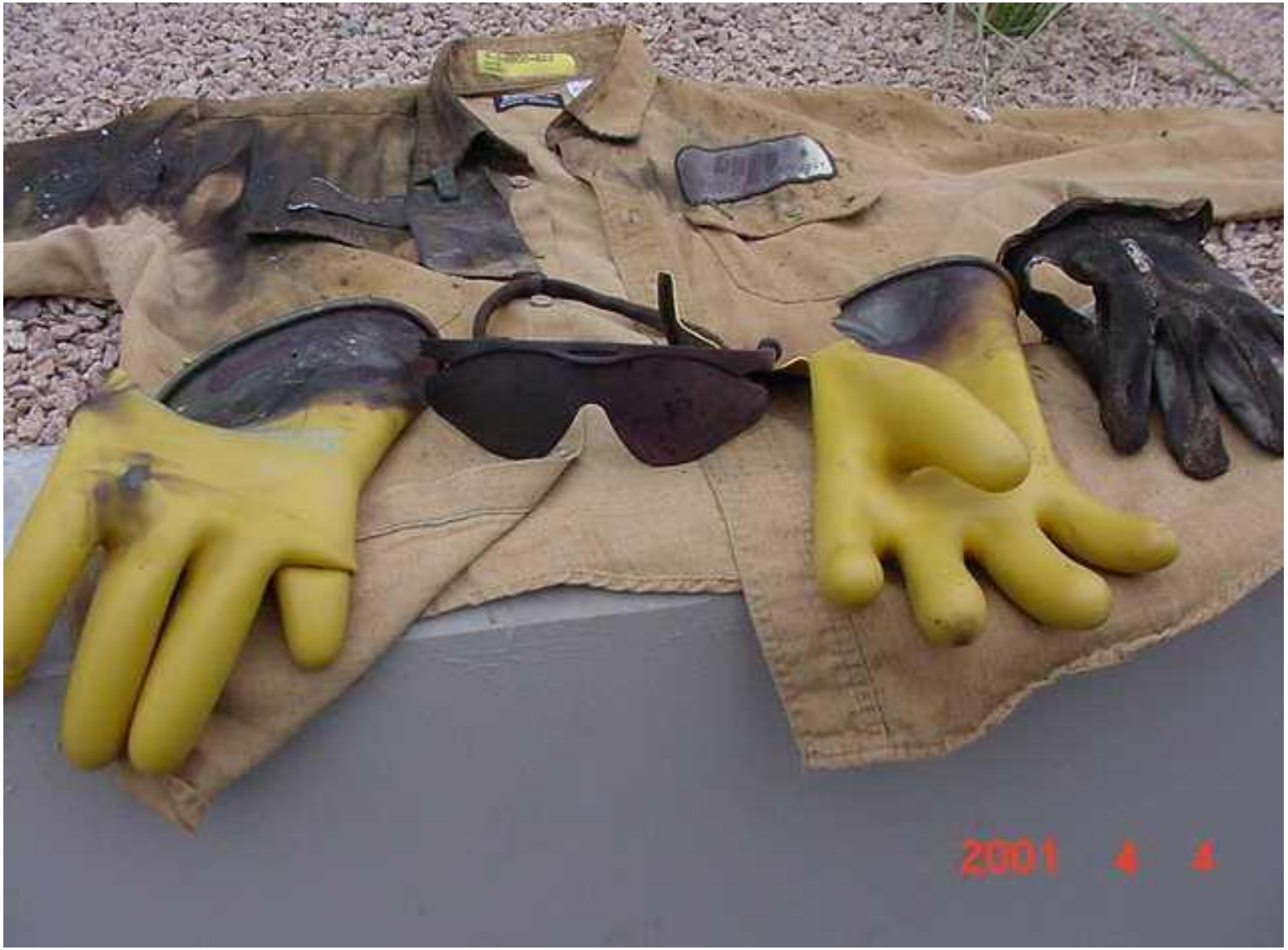
Introduction to FR/AR Clothing

Arc Flash Incident – Chicago April 18, 2004

When an Arc Flash happens…



When an Arc Flash happens…



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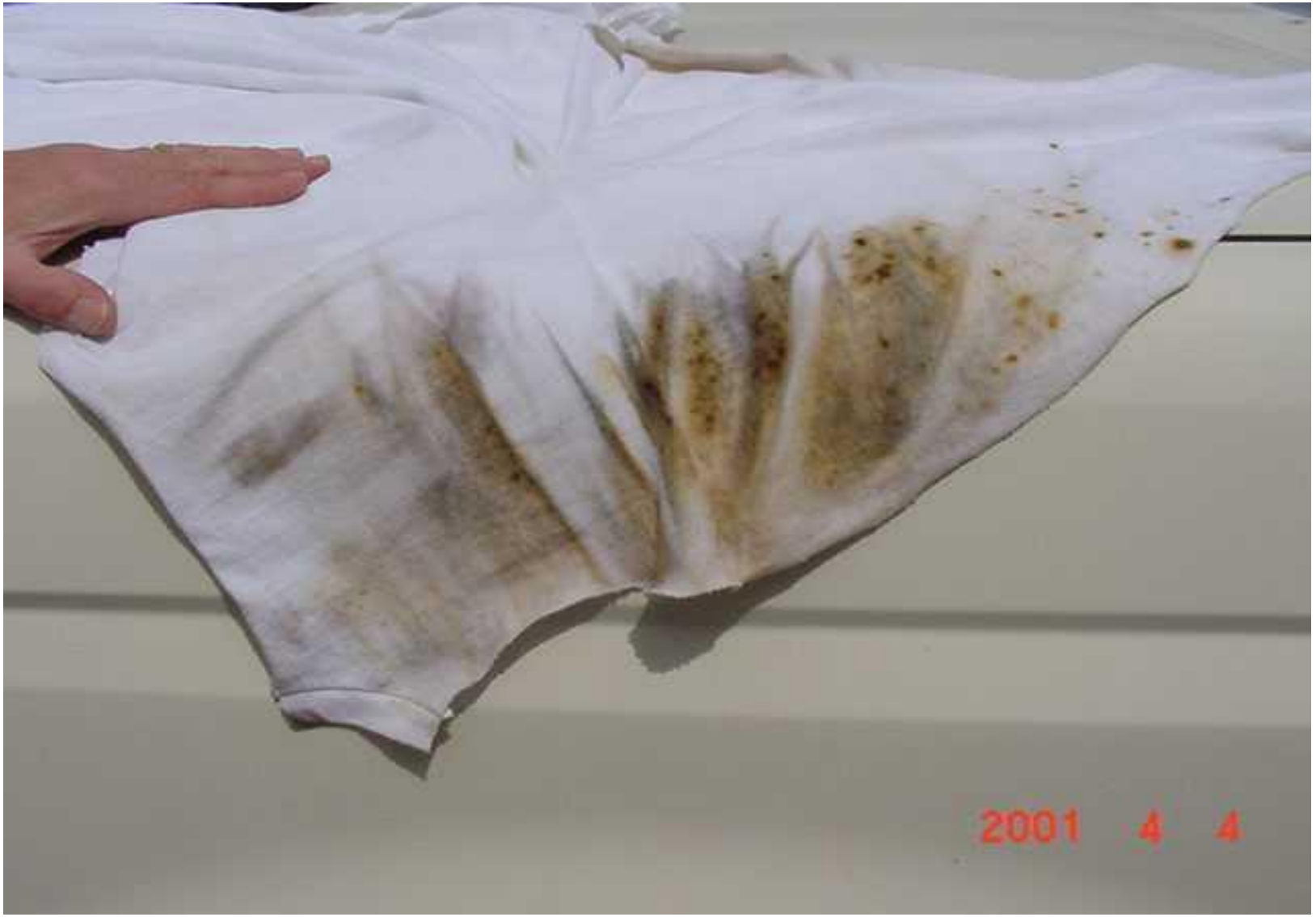


Arc Flash Hazard Standards & Regulations

How was FR clothing for arc flash protection addressed in past OSHA regulations?"

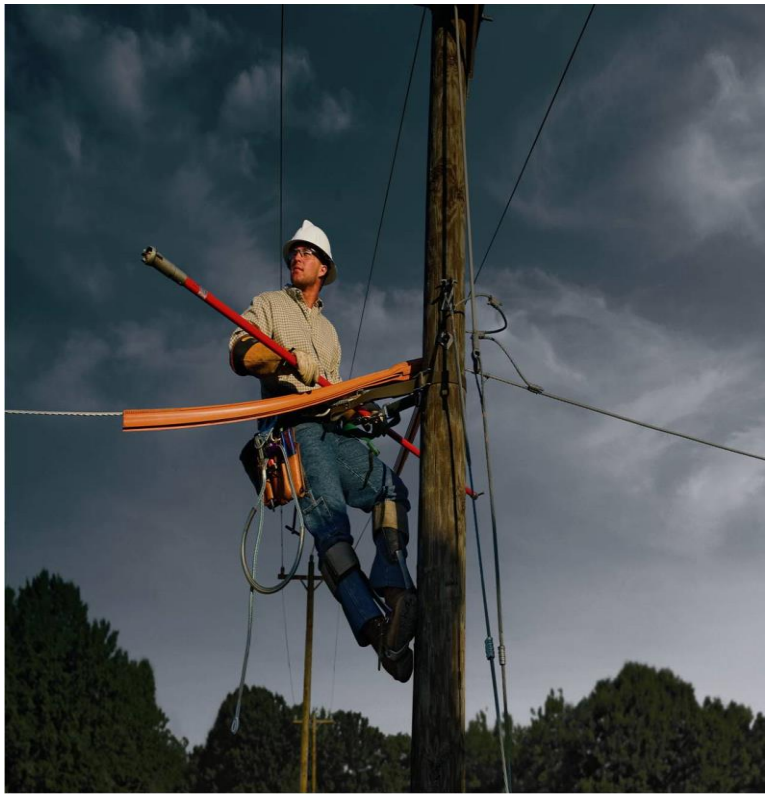
The previous version of this regulation (OSHA 1926 Subpart V) was issued in 1972. It didn't mandate the use of flame resistant/arc-rated clothing but did require that clothing worn by electrical workers not contribute to the burn injury caused by exposure to an electric arc. It even allowed the use of clothing made from heavy fabrics containing natural (non-melting) fibers.

Arc Flash Hazard Standards & Regulations

Standard for Electric Utilities Background

1994 - OSHA 1910.269

- Clothing cannot increase wearer injury (No polyester, rayon, nylon, acetate, etc.)
- 11.0 oz. or heavier untreated cotton/wool



Arc Flash Hazard Standards & Regulations

DEPARTMENT OF LABOR

Occupational Safety and Health Administration

29 CFR Parts 1910 and 1926

OSHA announced the long awaited final rule revising the standards for power generation, transmission and distribution on April 1, 2014.

Arc Flash Hazard Standards & Regulations

The Bottom Line:

- "This long-overdue update will save nearly 20 lives and prevent 118 serious injuries annually," said Dr. David Michaels, assistant secretary of labor for occupational safety and health. "Electric utilities, electrical contractors and labor organizations have persistently championed these much-needed measures to better protect the men and women who work on or near electrical power lines."

- OSHA said the final rule will result in estimated monetized benefits of $179 million annually, with net benefits equal to about $130 million annually.

Arc Flash Hazard Standards & Regulations

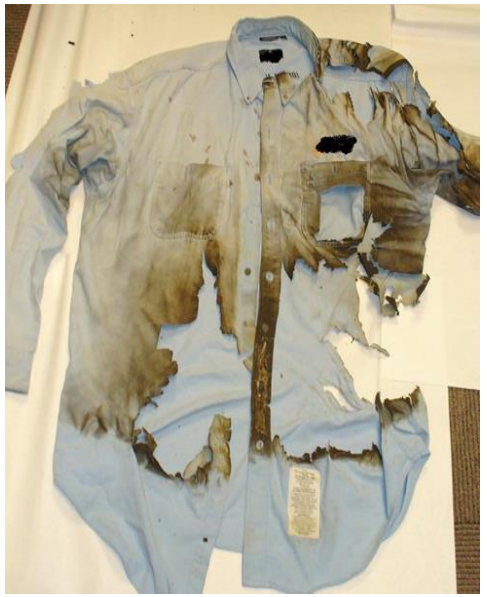
How Does This Affect FR Programs Today?

- The majority of single layer garments utilized today in both high and low voltage electrical provide an ATPV (Average Thermal Protection Value) of 8 cal/cm^2 or more
- There would be no need to change if all your estimates are less than 8 cal/cm^2
- For equipment that is greater than 8 cal/cm^2, you have some options:
  - Increase the distance to work on that equipment to such that it is less than 8 cal/cm^2
  - Provide additional layers of arc rated clothing to exceed the incident energy

Layering to Meet the Hazard

In the event of an arc flash, break-open is a real threat.

- The AR garment reaches its performance threshold and begins to fail, exposing either the naked skin or the lightweight non-AR undershirt to thermal energy. This can result in injury or worse—potential ignition adding to the injury.
- FR/AR base layers help your AR Clothing program achieve its overall goal: to minimize injury.
- Base layers also eliminate two major problems:
  - Meltable under garments
  - The need to police underwear



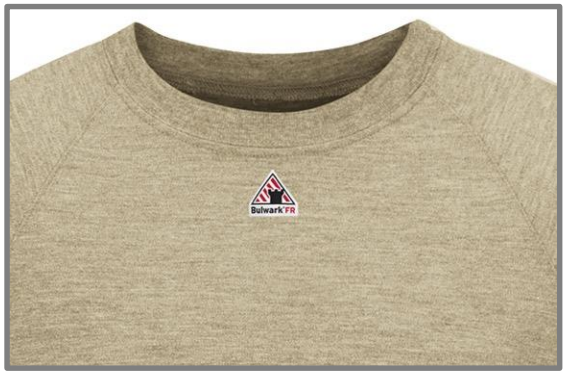
Layering to Meet the Hazard

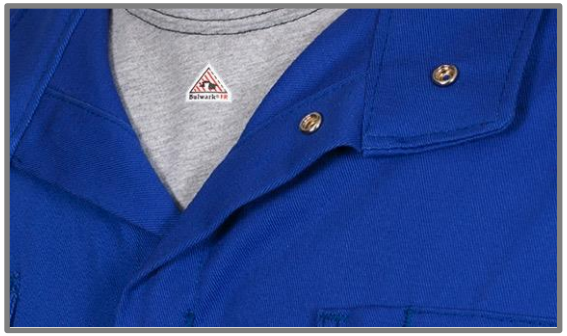
Eliminates the two major problems:

In an arc flash and/or a flash fire the threat of break open is real exposing either the naked skin or the lightweight non-FR/AR undershirt to thermal energy causing injury or worse potential ignition adding to the injury.

FR/AR base layers add an additional layer of protection and eliminate the potential of under garment ignition

Second eliminates the need to police under garments and attempt to insure that all employees are safe.





Layering to Meet the Hazard

- Regardless of the thermal hazard, only natural fibers are allowed as base layers per the standards
- Layering of non-melting flammable garments is permitted under AR/FR garments, as a form of added protection.
  - However, the system arc rating of the outermost AR/FR layer must be sufficient to prevent break-open and ignition of the flammable under layer.
- Only AR/FR layers within the layered system are used to determine system arc rating. Arc ratings of individual layers cannot simply be added together.
- Any garment worn as the outer layer, including rainwear, must be AR/FR.
- The only way to determine the total system arc rating is to conduct a multilayer arc test on the combination of all the layers assembled as they would be worn.

Layering to Meet the Hazard

1506 Appendix (Non-mandatory Information)

XI. GUIDELINES FOR PROTECTIVE WEARING APPAREL

XI.1 Although this performance specification for basic protection level wearing apparel for electrical workers is written for single-layer work clothing**, it is recognized that optimum protective performance to severe exposure (for example, high currents, closeness to the arc, long time periods) involves the use of an appropriate system.**

X1.1.l Garments worn as underlayers (underwear) that neither ignite nor melt and drip in the course of an exposure to the electric arc and related thermal hazard may provide additional thermal insulation.

X1.1.2 **Garments that meet this performance specification may be used for a layered system for added protection**. A typical layering system may include an undershirt, a shirt, trousers, and a flash jacket or may include a shirt and trouser and coverall. Specific tasks that may involve high-energy levels, for example switching, grounding, and jumpering, may require specialized clothing.

Layering to Meet the Hazard

NFPA 70E Annex M – Total System Arc Rating:

M.3.1 The total system arc rating is the arc rating obtained when all clothing layers worn by a worker are tested as a multilayer test sample.

M.3.2 It is important to understand that the total system arc rating cannot be determined by adding the arc ratings of the individual layers.

Layering to Meet the Hazard

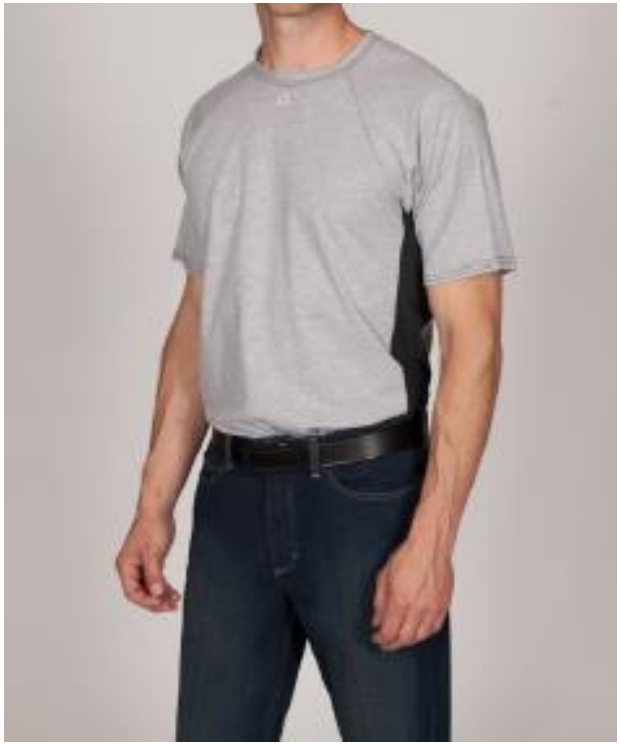
Dr. Thomas Neal testified in the final rule

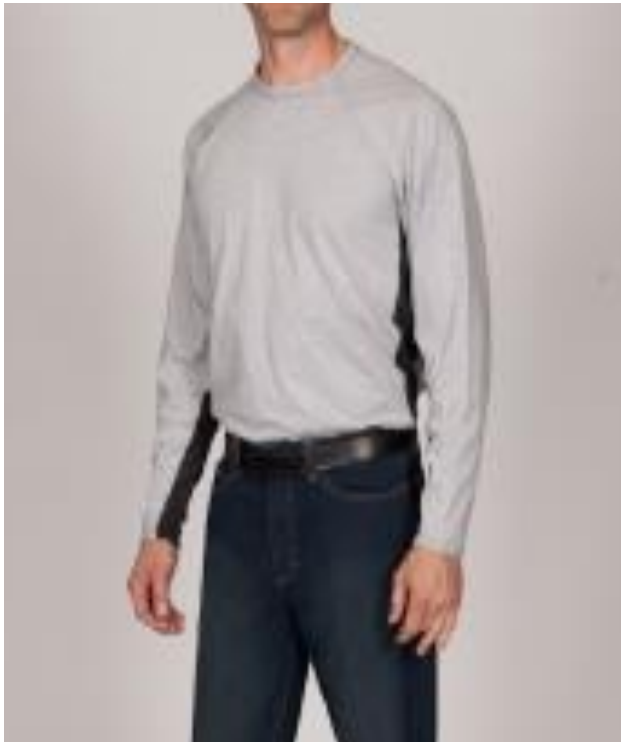
(pg 20500)

The only sure way [to obtain a rating for a layered clothing system] is to measure the arc rating for the system. [I]t's not [a] situation where you could have an arc rating for three different layers that you put those on top of each other, just add them together. That doesn't work. [Tr. 500]

Layering to Meet the Hazard

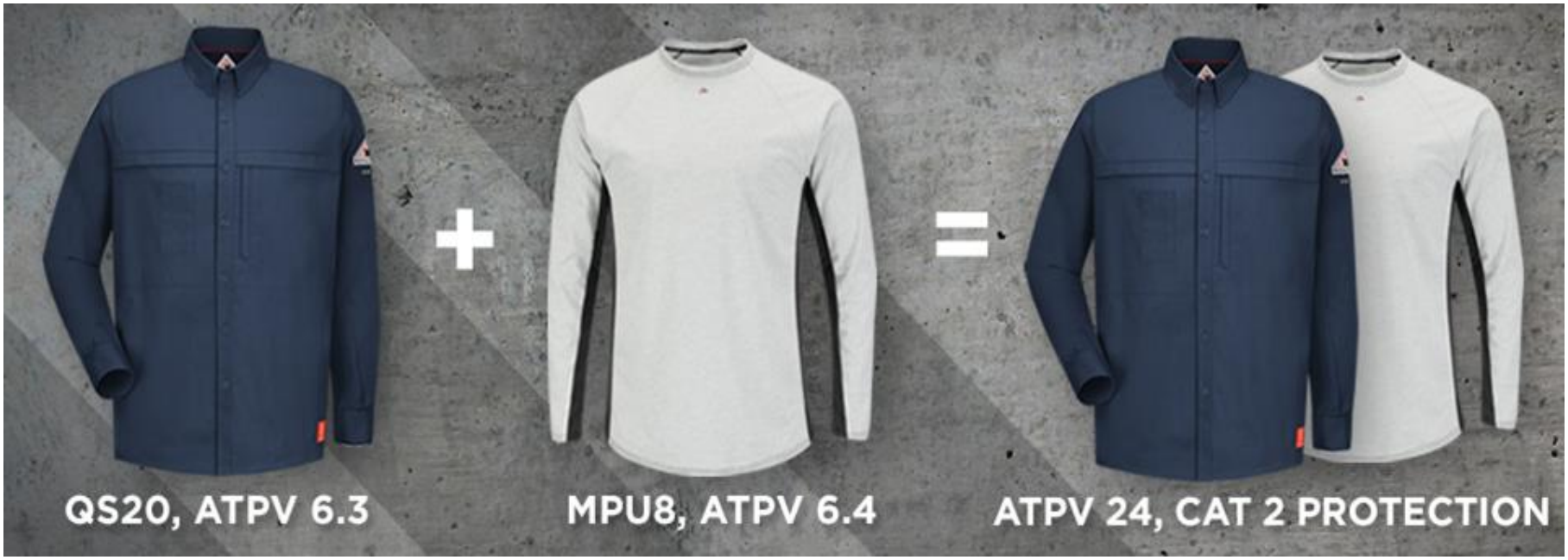
So which AR base layer is correct for You?





Layering to Meet the Hazard

Bulwark Arc Calculator



http://www.bulwark.com/Calculator

FR/AR Use & Training

Having selected the proper AR/FR Garment for your hazard is the first step. Properly training on the correct way to wear your PPE is equally important as it directly impacts how your PPE will preform

Training is required on PPE in all the regulations and standards

FR/AR Use & Training

TRAINING – 1910.132(F)(1):

The employer shall provide training to each employee who is required by this section to use PPE. Each such employee shall be trained to know at least the following:

1910.132(f)(1)(i) - When PPE is necessary;

1910.132(f)(1)(ii) - What PPE is necessary;

1910.132(f)(1)(iii) - **How to properly don, doff, adjust, and wear PPE;**

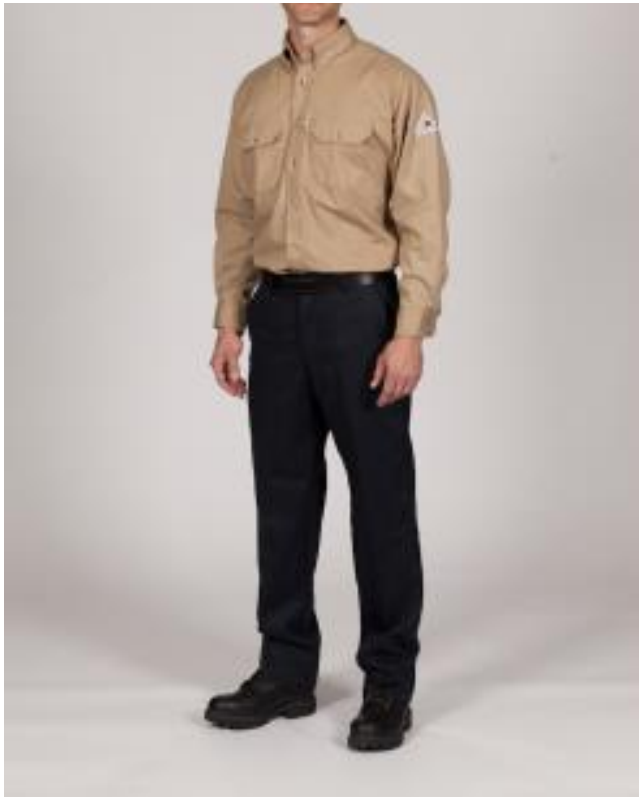
1910.132(f)(1)(iv) - The limitations of the PPE; and,

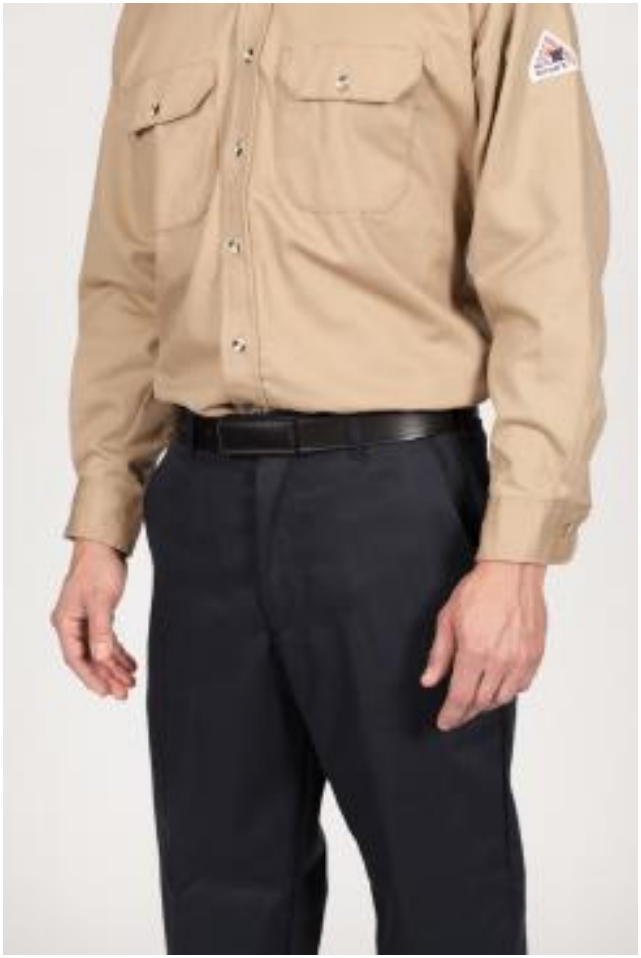
1910.132(f)(1)(v) - The proper care, maintenance, useful life and disposal of the PPE.

1910.132(f)(2) - Each affected employee shall demonstrate an understanding of the training specified in paragraph (f)(1) of this section, and the ability to use PPE properly, before being allowed to perform work requiring the use of PPE.

FR/AR Use & Training

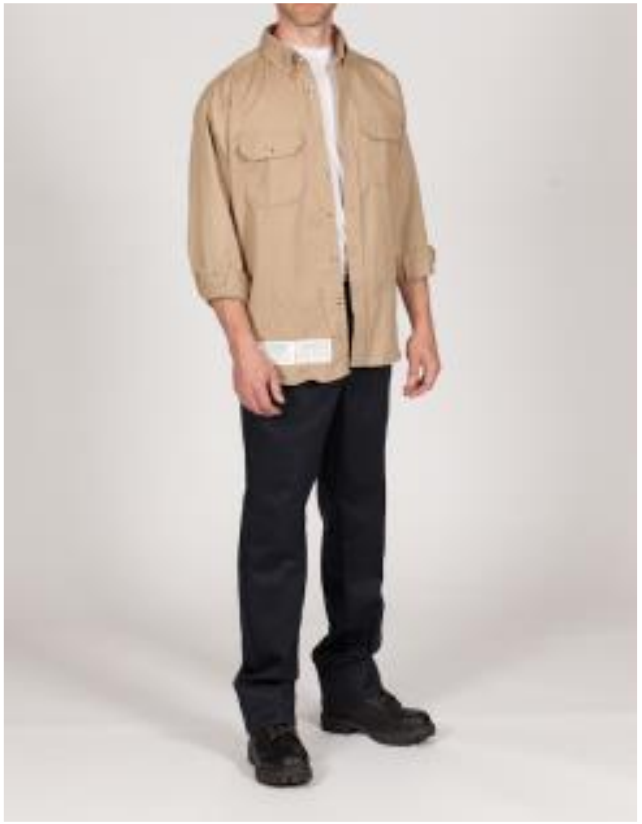
FR Do's

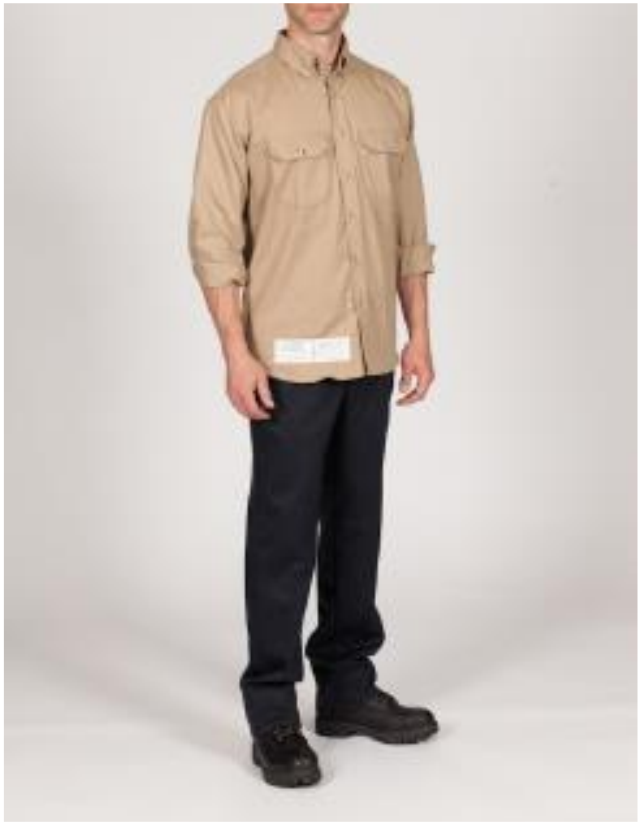




FR/AR Use & Training

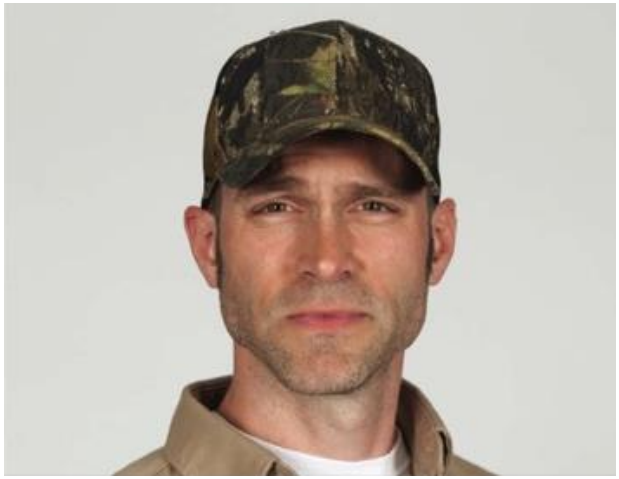
FR Don’ts

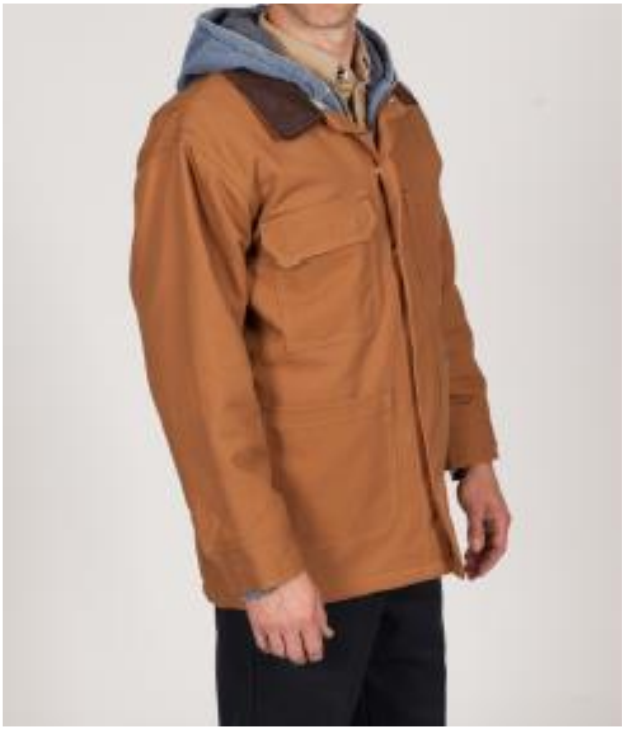




FR/AR Use & Training

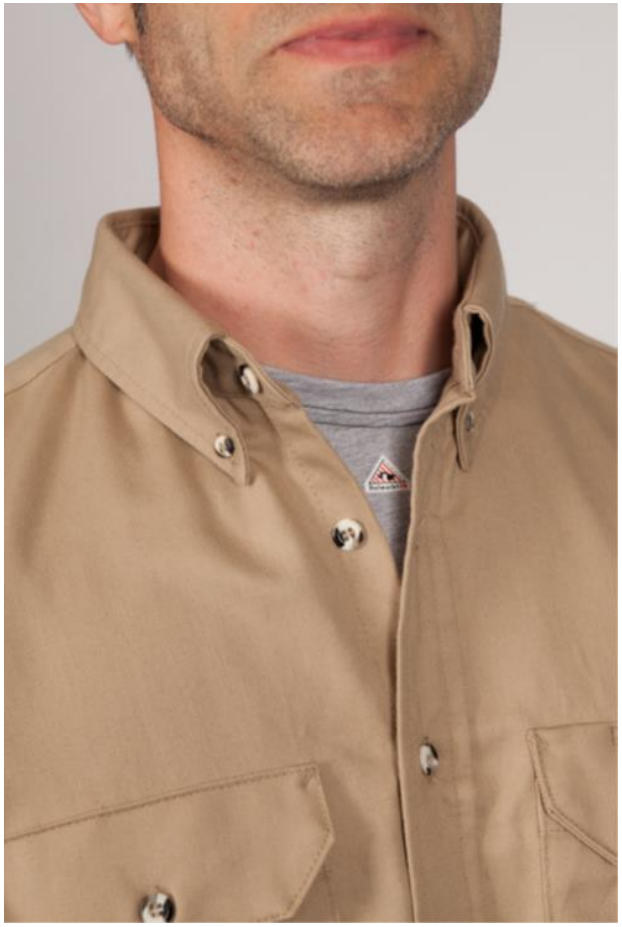
What could be wrong here???





FR/AR Use & Training

- Wearing the correct base layers under your FR/AR garments is important
- Wearing your FR/AR garments *correctly* is equally important
- 2 lightweight FR/AR garments *can be* more protective and more comfortable than a heavier single layer
- FR/AR base layers take away the potential for ignition of non FR undergarments
- Can be easier to monitor than non-FR base layers



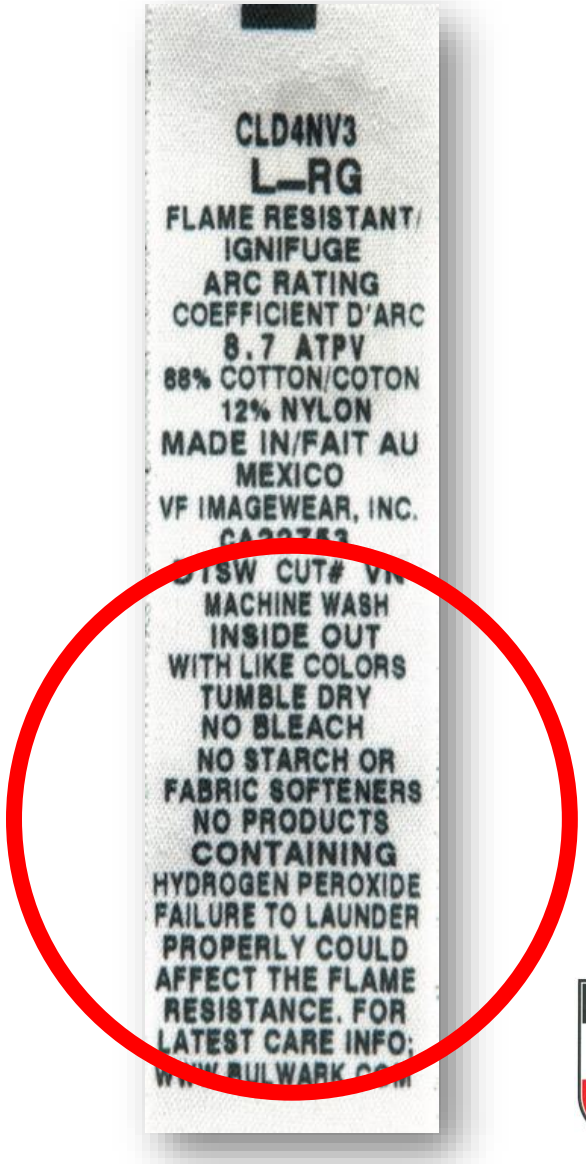
FR/AR Care & Maintenance

Essential to your PPE's performance and life expectancy is caring for your garments. In this section, you will learn:

- How to identify additives that cannot be used on your FR/AR garments
- How to understand and recognize the effect of stains and secondary accelerants on your FR/AR garments

FR/AR Care & Maintenance

- Important to read the manufacturers laundry instructions on the label
- Written care instructions are available for all employees
- They can also be accessed on companies websites



FR/AR Care & Maintenance

Laundering Guidelines:

- Wash FR/AR garments separately
- Turn FR/AR garments inside out to assist in both color-retention and appearance
- Use liquid detergent for best results
- Avoid the hottest temperature to reduce the impact of shrinkage
- For tough stains, apply liquid detergent or stain remover to the stain and allow garment to soak
- Bulwark FR/AR garments can be dry cleaned for tougher stains
- Tumble dry on low setting and do not over dry

FR/AR Care & Maintenance

Top Three Tips:

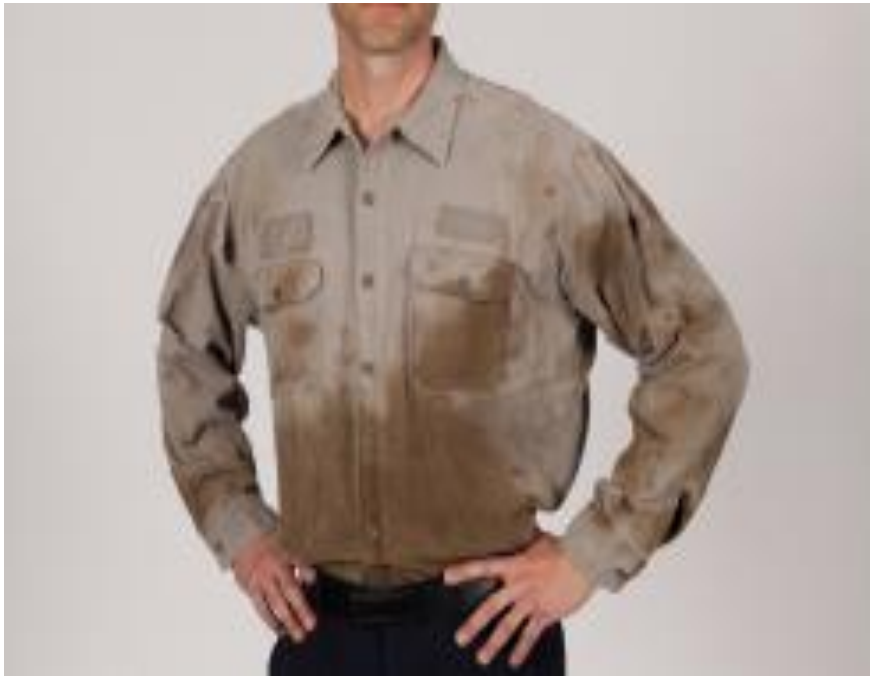
1. Do not use chlorine bleach, peroxide or fabric softener
2. Do not wear if soiled with flammable contaminants
3. Retire garment if worn out

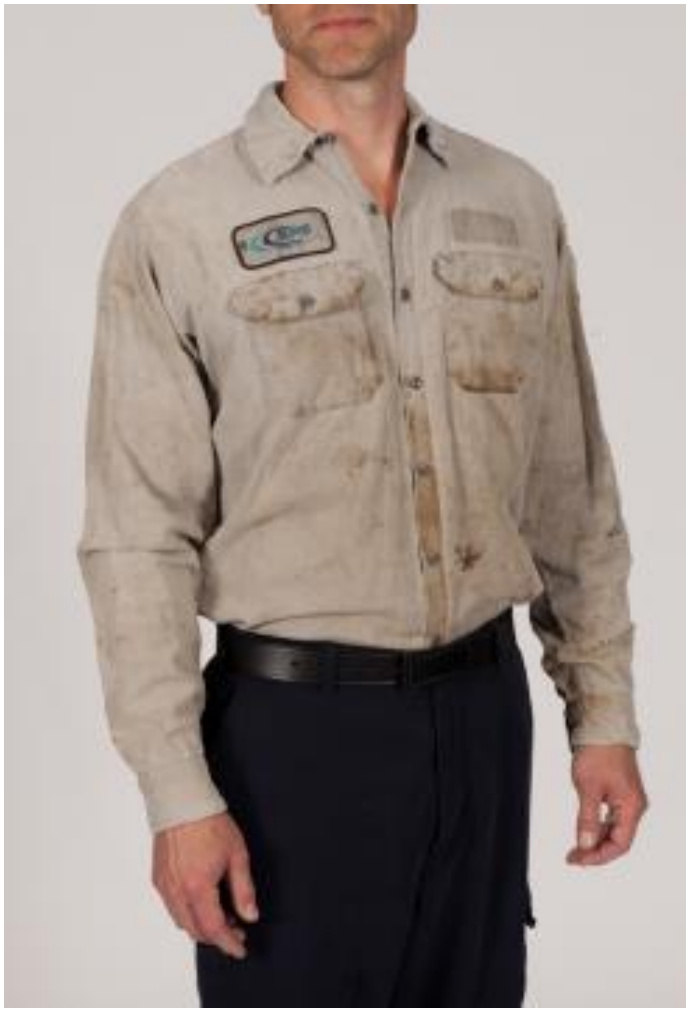
FR/AR Care & Maintenance

Soiled Garments:

- Monitor the accumulation of secondary accelerants on your garments through out the day.
- After laundering make sure accelerants are removed. If your garments still have a hydrocarbon/petroleum odor, a flammable contaminant may still be present. Rewash the garment until the odor is gone. If flammable soils are not completely removed, the protective qualities of the garment may be compromised.
- Discoloration/stains alone are not an indicator of reduced protection.

FR/AR Care & Maintenance





FR/AR Care & Maintenance

So, what *can* you use to clean your FR/AR?

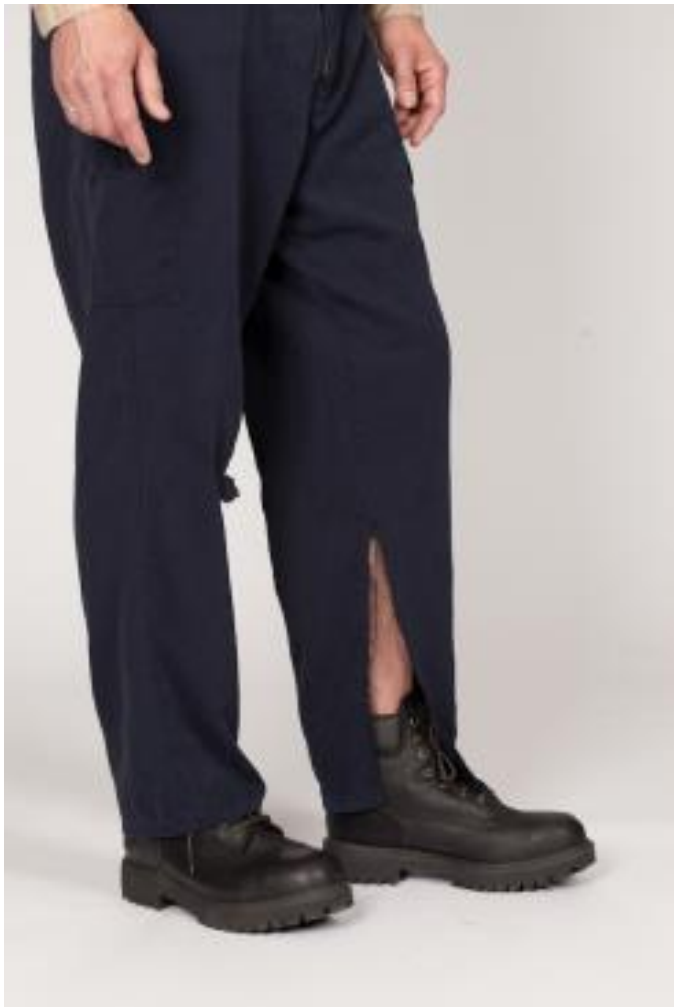
FR/AR Care & Maintenance

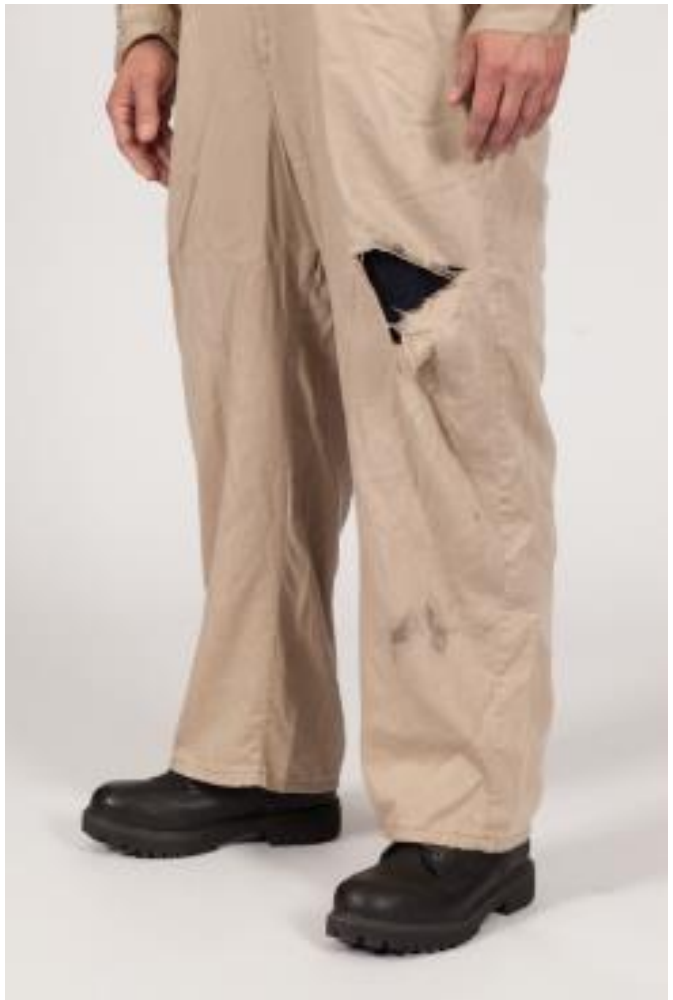
Inspect Garments Daily:

- Check for holes, rips and tears
- Check for areas of heavy wear such as elbows and knees where the fabric may be worn thin
- Check the integrity of the seams

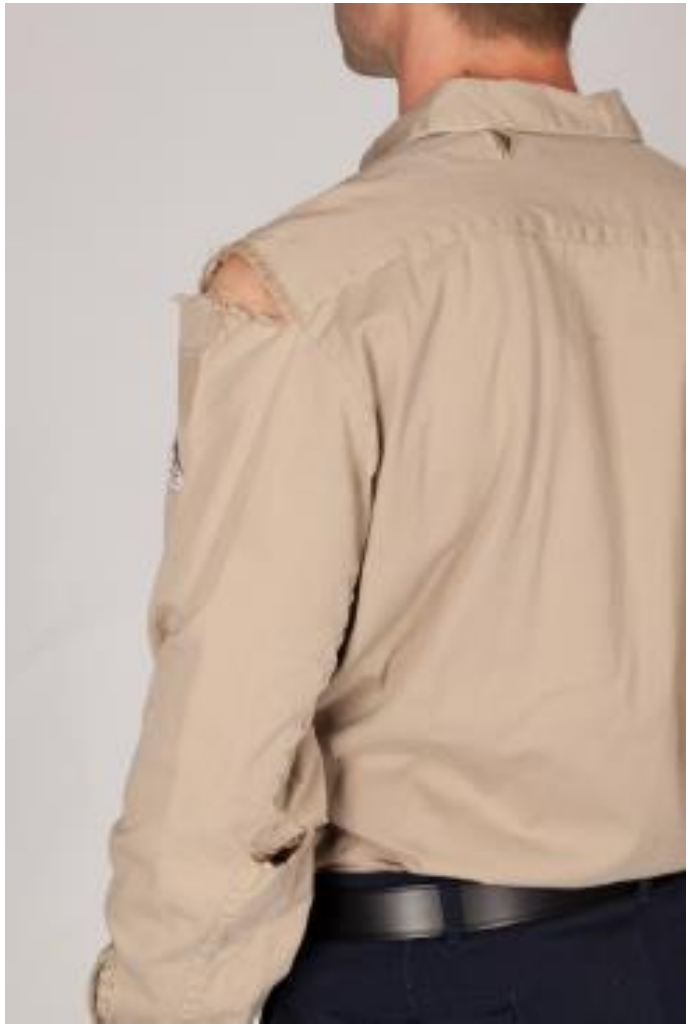
In general, check the integrity of the garment and repair or replace accordingly

FR/AR Care & Maintenance





FR/AR Care & Maintenance



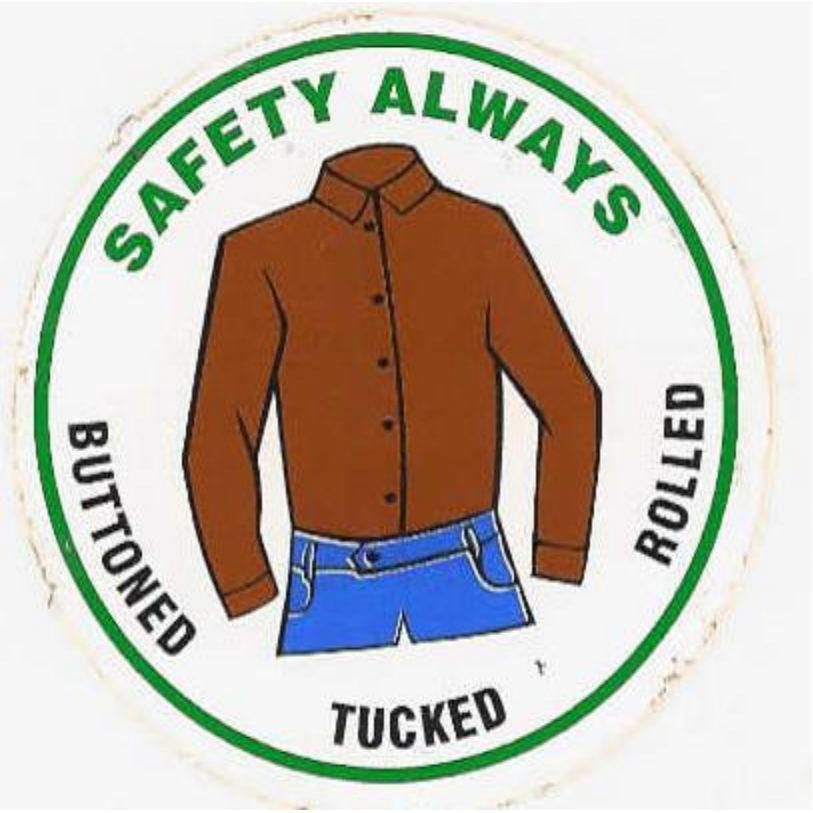
FR/AR Care & Maintenance

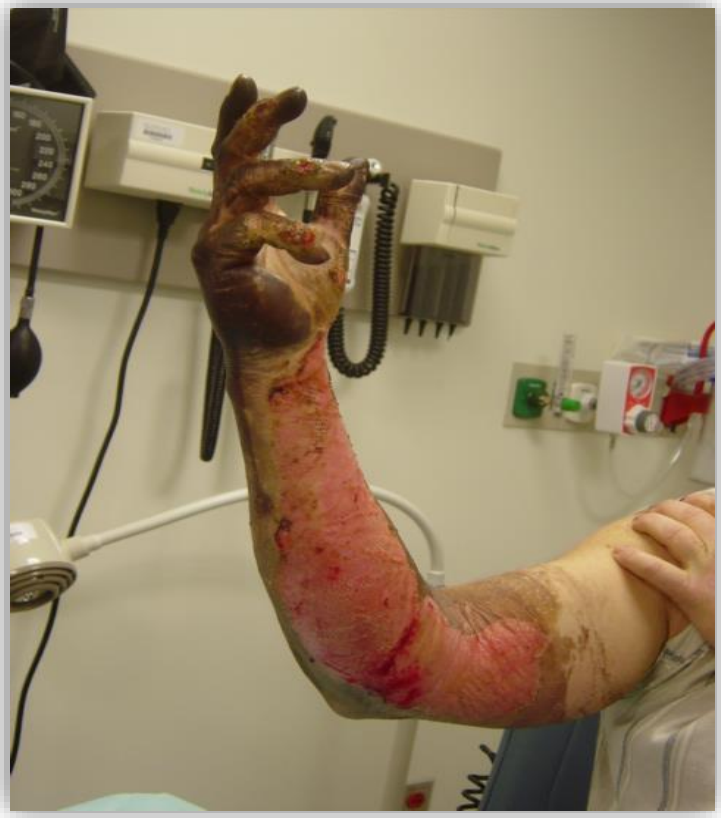
Proper Use, Simplified:

- AR/FR should be appropriate to hazard
- Always the outermost layer
- Worn correctly; zipped, buttoned, etc.
- All natural, non-melting undergarments
- Clean, no flammable contaminants
- Repaired correctly and removed from service when needed

FR/AR Care & Maintenance

Always – rolled, tucked and buttoned!



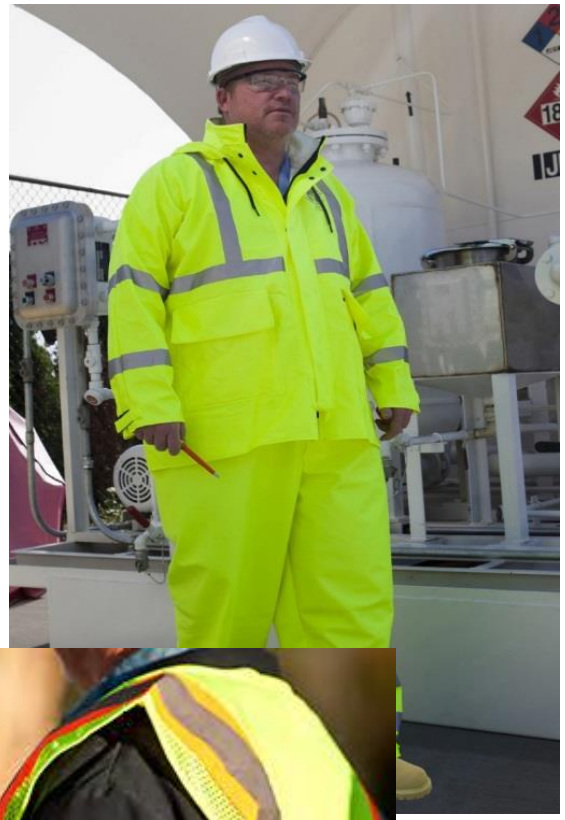


Bonus….

SOME STANDARDS ALONE ARE NOT ENOUGH; SOME ARE JUST WRONG

Non compliant rainwear and vest can pose a serious problem to an otherwise solid FR/AR clothing program

- ASTM F2302 – STANDARD IS WITHDRAWN
- ASTM D6413 –NOT A PERFORMANCE STANDARD
- NFPA 701 - NOT A GARMENT STANDARD

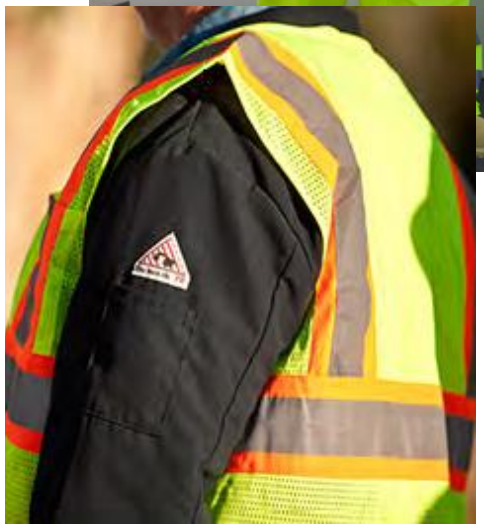


Rainwear has specific standards for Arc Flash and Flash Fire

ASTM 1891 – for arc flash

ASTM 2733 – for flash fire

For vests – look for ASTM 1506 and an Arc rating in the label



Webinar Summary

- Ask for the manufacturers guarantee in writing on letterhead and signed
- Ask for the test data for the hazard (fabric suppliers can readily supply these results)
- Ask to see the garments certification(s) (has every garment been tested to your hazard?)
- Specify that only certified compliant garments for your hazard(s) are allowed on site
- Work with proven supply chain partners
- Periodically police your program for compliance

Thank You!

Questions & Discussion

Bulwark Protective Apparel

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