RADIANS®

AR/FR WORKWEAR

FAST FACTS

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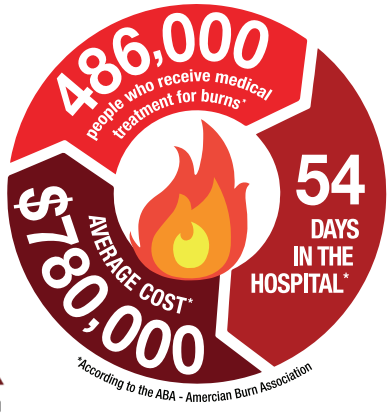
INTRODUCTION

According to OSHA*

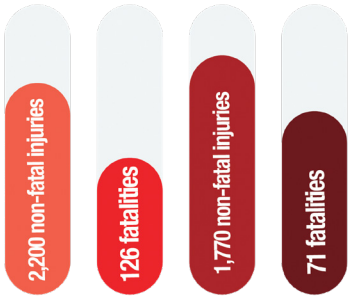
up to 45% of all burns occur at work

40% of workplace burn fatalities result from fire or arcs!

*OSHA - Occupational Safety and Health Administration

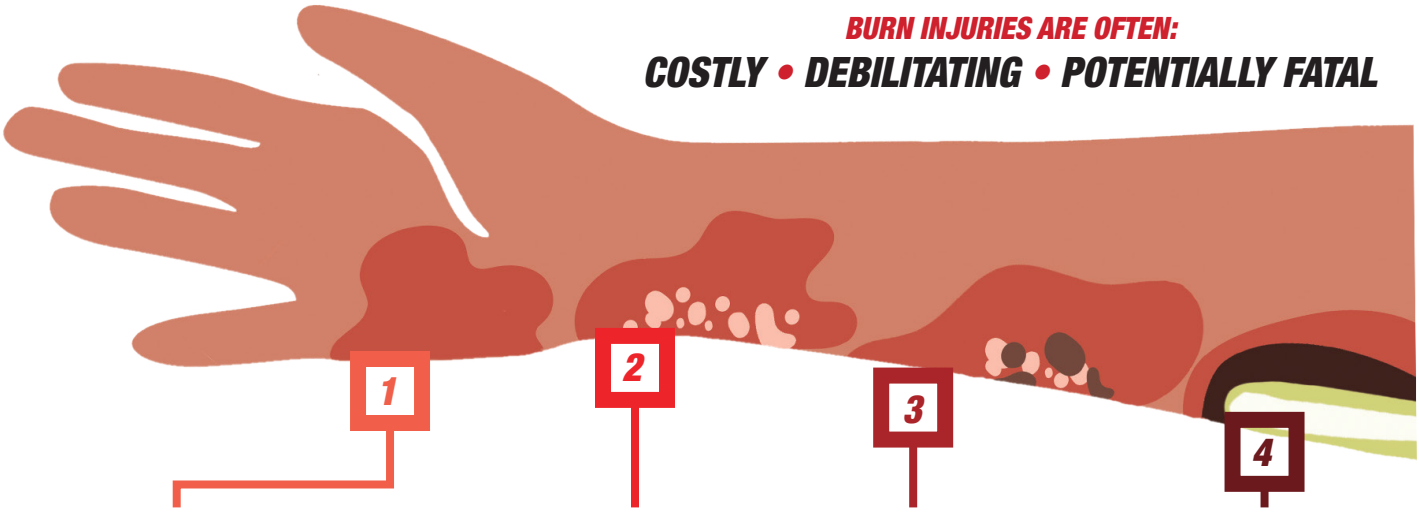


In 2020, the Bureau of Labor Statistics (BLS) recorded



BURN INJURIES ARE OFTEN:

COSTLY • DEBILITATING • POTENTIALLY FATAL



1ST DEGREE BURN	2ND DEGREE BURN	3RD DEGREE BURN	4TH DEGREE BURN
(SUPERFICIAL) **Affects:** 1st layer of skin **Color:** Red & dry **Blisters:** No **Swelling:** Minimal **Pain:** Minimal - Mild **Example:** Mild sunburn	**Affects:** 1st & 2nd layer of skin **Color:** Red & dry **Blisters:** Yes **Swelling:** Moderate **Pain:** Moderate - Severe **Example:** Contact with boiling water	**Affects:** All skin layers + fat tissues **Color:** White or Blackened **Blisters:** Yes **Swelling:** Severe **Pain:** Severe + Numbness (nerve endings destroyed) **Example:** Low-medium intensity fire (campfire) or low voltage electricity (household electrical outlets)	**Affects:** All skin layers, fat, tendons, nerves, muscles and bone **Color:** Charred w/ possible exposed bone **Blisters:** No **Swelling:** Severe **Pain:** Severe + Numbness (nerve endings destroyed) **Example:** High-intensity fires (flash fire) or high voltage electrical explosion (arc flash)

AR/FR FACTS

Arc-Rated (AR) and Flame-Resistant (FR) clothing can mitigate burn risks from thermal incidents.

When a thermal incident ignites non-FR clothing, the worker is at additional risk from the burning / melting of the garment increasing the degree of the burns and can also result in internal injuries, such as lung and airway damage.

Industries Requiring AR/FR:

- Oil & Gas
- Electric Power Utilities
- Metallurgy
- Mining
- Paper & Pulp
- Food Processing
- Paint
- Workers Around Energized Electrical Equipment

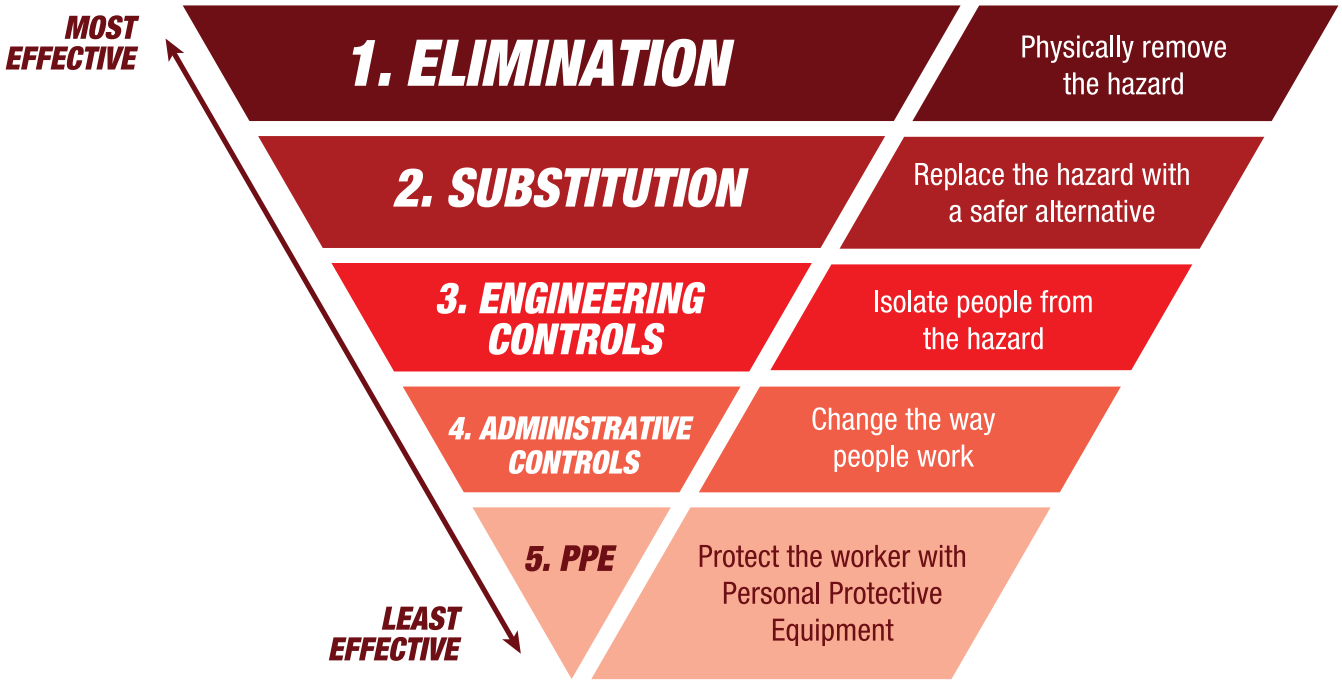
OSHA®
Tells what employers are **required to do** not how to do it

NFPA®
Industry specific experts that tell you **how to protect** employees

ASTM INTERNATIONAL
Tells you **how to test** the protective products

UL®
Certifies the protective products have been tested and are compliant

HIERARCHY OF CONTROLS



HOW DO INJURIES HAPPEN? HOW CAN WE REDUCE OR PREVENT THEM?

According to OSHA's 29 CFR 1910.132, the General Requirements for Personal Protective Equipment (PPE), employers are required to:

1. **Conduct Hazard Assessments** to identify all potential hazards.
2. **Hierarchy of Controls** to eliminate or reduce the risk of present hazards.
3. **Select & Issue Appropriate PPE** based on hazard assessments.
4. **Provide PPE at no cost**
5. **Provide Training** on the hazard, controls, and PPE

While OSHA 29 CFR 1910.132 establishes general requirements for hazard assessments and PPE, OSHA has additional standards to provide more specific guidance based on the hazard type.

ARC FLASH

Arc Flash occurs when an electric current passes through air between ungrounded and grounded conductors, causing temperatures reaching up to 35,000° F and an Arc Blast, a concussive pressure wave, reaching up to 2,100 PSI. Arc flash is a serious electrical hazard that can result in severe injuries and fatalities. Individuals who work around energized electrical equipment or are involved in the operation, maintenance, or repair of electrical systems should be concerned about arc flash.

Arc Flash Prone Industries:

- Electricians
- Electrical Engineers
- Maintenance Techs
- Utility Workers
- Electrical Contractors
- Industrial Electricians
- Linemen
- HVAC Technicians
- Industrial Technicians
- Inspectors
- Equipment Installers
- Facility Managers

PROTECTING AGAINST ARC FLASH HAZARDS

OSHA's 1910.269 standard and NFPA 70E work together to protect employees from arc flash hazards by providing a comprehensive framework for electrical safety in the workplace.

- OSHA 1910.269 sets out general requirements for electrical safety in the workplace.
- NFPA 70E provides specific guidance on electrical safety practices, such as PPE selection and use, and employee training.
- NFPA 70E helps employers comply with OSHA 1910.269 by providing guidance on arc flash hazard analysis, which involves identifying hazards, assessing risk, and determining appropriate PPE and safe work practices.

NFPA 70E: "ELECTRICAL WORKERS BIBLE"

NFPA 70E is a comprehensive standard that outlines safety requirements for employees working with or near energized electrical equipment. It covers various aspects of electrical safety, including safety-related work practices, safety training, and PPE.

- Workers must wear FRC when exposed to arc flash hazards.
- The type of FRC required depends on the potential incident energy of the task being performed, measured in calories per square centimeter (cal/cm²).
- The standard establishes four risk categories (known as PPE Category or CAT) that correspond to increasing levels of hazard and protection.

PPE CATEGORY RATINGS

PPE CATAGORY	Arc Rating (Cal/CM²)	Arc-Rated Clothing
CAT 1	4-7.9	*Arc-rated FR shirt and FR pants or FR coverall* ***(1 layer)***
CAT 2	8-24.9	*Arc-rated FR shirt and FR pants or FR coverall* ***(2 layers)***
CAT 3	25-39.9	*Arc-rated FR shirt and FR pants or FR coverall, and arc flash suit selected so that the system arc rating meets the required minimum* ***(2 or 3 layers)***
CAT 4	40+	*Arc-rated FR shirt and FR pants or FR coverall, and arc flash suit selected so that the system arc rating meets the required minimum* ***(3 or more layers)***

ASTM F1506: "NFPA 70E STANDARD" / STANDARD FOR ARC FLASH WOVEN APPAREL

ASTM F1506 is a crucial standard for arc flash-protective clothing, also known as the "Arc Standard" or "NFPA 70E Standard." It sets minimum performance requirements for three critical factors:

FLAME RESISTANCE	ARC RATING	MECHANICAL DURABILITY
ASTM D6413 determines whether a fabric is flame resistant. To pass ASTM F1506, the char length must be 6" or less after 25 launderings.	ASTM F1959 quantifies the thermal protection provided by the fabric during an arc flash.	ASTM F1506 has 5 tests, including the "Burst Test," "Elmendorf Tear Test," and "The Break Test," and the "Colorfastness & Laundering Test" to ensure garments will hold up to the rigors of the job

GARMENTS THAT MEET ASTM F1506 COMPLY WITH OSHA 1910.269, NESC, AND NFPA 70E.

ASTM F1891: "ARC FLASH RAINWEAR STANDARD"

ASTM F1891 is the established standard for arc flash protective rainwear, outlining test methods and minimum performance criteria to safeguard workers from arc flash exposure.

FLAME RESISTANCE	ARC RATING	LIQUID PENETRATION	TEAR RESISTANCE
ASTM D6413 determines whether a fabric is flame resistant. To pass ASTM F1506, the char length must be 6" or less after 25 launderings.	ASTM F1959 quantifies the thermal protection provided by the fabric during an arc flash.	Fabric and seams undergo testing (ASTM D3393 / FED Standard 191A – Method 5516) to ensure rainwear is waterproof.	ASTM D1117 evaluates nonwoven fabrics for tear resistance by measuring the energy required to propagate an existing tear, ensuring rainwear durability.

RAINWEAR MEETING THE ASTM F1891 STANDARD COMPLIES WITH OSHA 1910.269, NESC, AND NFPA 70E REQUIREMENTS.

FLAME RESISTANT CLOTHING (FRC) BASICS

FLAME RESISTANT

- Made from engineered fibers that inherently inhibit fire spread or self-extinguish
- Consist of synthetic fibers designed for flame resistance
- Examples: Dupont Nomex, DH (Dual Hazard), and Modacrylic

VS

FLAME RETARDANT

- Made from fabrics treated with flame-retardant chemicals
- Flame-retardant properties may diminish over time
- Use natural fibers like cotton combined with chemical additives
- Examples: Westex Indura and UltraSoft

ARC/FRC FABRIC TYPES

INHERENTLY AR/FR

- Made from synthetic materials engineered to resist ignition
- Offer higher thermal protection
- Lighter in weight
- More rigid
- Less breathable
- Greater durability
- Higher initial cost
- Lower total life cycle cost

VS

FR TREATED / SELF-EXTINGUISHING

- Made from non-FR materials treated to be flame resistant or made from flammable fibers and then chemically treated
- Higher in weight
- Softer / more flexible
- More breathable
- Less durable
- Lower initial cost
- Higher total life cycle cost

FLASH FIRE

Short-duration fires (3 sec. or less) that can spread rapidly through a diffuse fuel, such as gas or the vapor of an ignitable liquid, without producing damaging pressure and reach up to 1900°F.

Effects: Can cause severe burns, injuries, and fatalities.
Prevention: Workers should wear flame-resistant clothing to prevent severe burn injuries, as most injuries from flash fires result from clothing ignition or melting.

Flash Fire Prone Industries:

- Oil and Gas Industry
- Chemical Manufacturing
- Fossil Fuel Power Generation
- Plastics Manufacturing
- Tobacco Manufacturing
- Pesticides Manufacturing

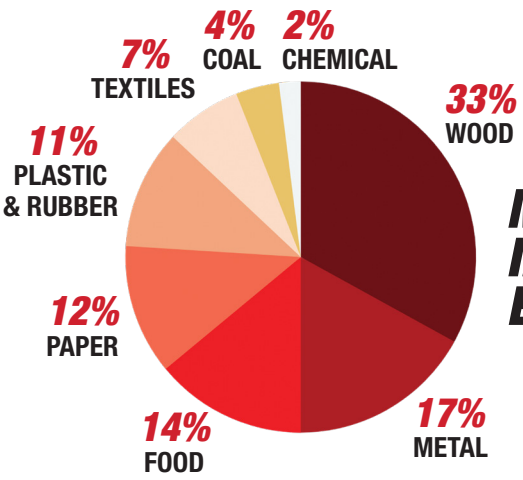
COMBUSTIBLE DUST

Fine particles (fabric, wood, metals, plastics, chemicals, food products) that can cause fire / explosion when suspended in air.

Production: occurs during material processing, handling, or storage.
Ignition: airborne particles form a dust cloud; if exposed to a spark or heat, it can ignite and explode.
Impact: explosions can cause significant damage and injuries.

Combustible Dust Prone Industries:

- Textile Mills
- Apparel Manufacturing
- Lumber Mills
- Paper / Pulp Manufacturing
- Wood Products Manufacturing
- Grain Mills
- Food Processing
- Machinery Manufacturing
- Rubber And Plastics Product Manufacturing
- Fabricated Metal Product Manufacturing



MATERIAL INVOLVED IN EXPLOSION

DIFFERENCE BETWEEN FLASH FIRE AND COMBUSTIBLE DUST

TYPES	FLASH FIRE	COMBUSTIBLE DUST
ORIGIN	Ignition of a flammable gas or vapor	Ignition of fine particles of combustible material
FUEL	Fueled by gases or vapors	Fueled by fine particles of combustible material, such as dust or fibers
SPREAD	Spreads quickly and violently	Spread slower but can cause larger explosions due to more fuel
IGNITION	Require a specific concentration of flammable gas or vapor to ignite	While combustible dusts can ignite at much lower concentrations
PREVENTION	Can be prevented by eliminating sources of ignition or controlling the release of flammable gases or vapors	Require the implementation of specific measures to control the accumulation and dispersion of dust, such as proper ventilation, dust collection systems, and proper housekeeping procedures

NFPA 2112: "THE FLASH FIRE STANDARD"

Sets minimum performance criteria and testing guidelines for FRC aimed at protecting workers against flash fires. NFPA 2112 outlines 17 test methods, including 4 pass/fail tests:

FLAME RESISTANCE	THERMAL SHRINKAGE	HEAT RESISTANCE	LABELING / UL CERTIFIED
ASTM D6413 aka "Vertical Flame Test" • Must not melt, drip • or have <2 second afterflame • or 4" char length when tested after 25 launderings **ASTM F1930 aka "Mannequin Test"** • FRC exposed to 3-sec flash fire at 2 cal/cm2 • >50% predicted 2nd & 3rd degree body burn	**ASTM F2894 aka "Thermal Shrinkage & Heat Resistance Test"** Thermal Shrinkage: 15" fabric sample, washed 3 times, 500°F oven for 5 minutes, pass = <10% garment shrinkage Heat Resistance: 6" fabric sample, same apparatus, can't ignite, melt, drip, or separate as a result of the heat exposure.	**ASTM F2700 aka Heat Transfer Performance Test** • Convective / in-contact: Must achieve >3 cal/cm2 • Radiant / spaced: Must achieve > 6 cal/cm2	**All garments must:** • Easily visible, permanent product labels • UL certified • UL mark must be on, in, or near the product label

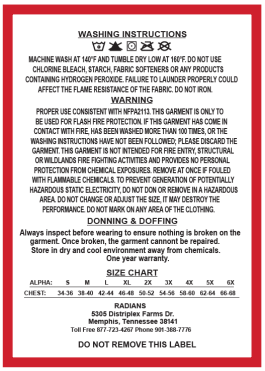
THE OTHER TESTS ARE REPORT-ONLY; THAT IS, DATA IS COLLECTED AND REPORTED, BUT IT IS NOT USED TO PASS OR FAIL A FABRIC.

NFPA 2113: "NFPA 2112 COMPANION STANDARD"

Guides employers and workers on the proper selection, care, use, and maintenance of FR garments and helps ensure maximum protection and longevity of FR garments.

Key components include:

- Hazard assessment to determine appropriate level of protection.
- Selection of FR garments based on hazard assessment and NFPA 2112 compliance.
- Training employees on the proper use and care of FR garments
- Regular inspection, maintenance, and replacement of FR garments


WASHING INSTRUCTIONS

MACHINE WASH AT 140°F AND TUMBLE DRY LOW AT 140°F. DO NOT USE CHLORINE BLEACH, STARCH, FABRIC SOFTENERS OR ANY PRODUCTS CONTAINING HYDROGEN PEROXIDE. FAILURE TO LAUNDER PROPERLY COULD AFFECT THE FLAME RESISTANCE OF THE FABRIC. DO NOT IRON.

WARNING

PROPER USE CONSISTENT WITH NFPA2113. THIS GARMENT IS ONLY TO BE USED FOR FLASH FIRE PROTECTION. IF THIS GARMENT HAS COME IN CONTACT WITH FIRE, HAS BEEN WASHED MORE THAN 100 TIMES, OR THE WASHING INSTRUCTIONS HAVE NOT BEEN FOLLOWED, PLEASE DISCARD THE GARMENT. THIS GARMENT IS NOT INTENDED FOR FIRE ENTRY, STRUCTURAL OR WILDLANDS FIRE FIGHTING ACTIVITIES AND PROVIDES NO PERSONAL PROTECTION FROM CHEMICAL EXPOSURES. REMOVE AT ONCE IF FOULED WITH FLAMMABLE CHEMICALS. TO PREVENT GENERATION OF POTENTIALLY HAZARDOUS STATIC ELECTRICITY, DO NOT DON OR REMOVE IN A HAZARDOUS AREA. DO NOT CHANGE OR ADJUST THE SIZE, IT MAY DESTROY THE PERFORMANCE. DO NOT MARK ON ANY AREA OF THE CLOTHING.

DONNING & DOFFING

Always inspect before wearing to ensure nothing is broken on the garment. Once broken, the garment cannot be repaired. Store in dry and cool environment away from chemicals. One year warranty.

SIZE CHART

ALPHA:	S	M	L	XL	2X	3X	4X	5X	6X
CHEST:	34-36	38-40	42-44	46-48	50-52	54-56	58-60	62-64	66-68

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DO NOT REMOVE THIS LABEL

ASTM F2733: "FLASH FIRE RAINWEAR STANDARD"

ASTM F2733 outlines the minimum requirements for flame-resistant rainwear designed to protect workers from flash fire hazards in wet conditions. It works alongside other flash fire standards such as NFPA 2112 & 2113.

FLAME RESISTANCE	THERMAL PROTECTION	LIQUID PENETRATION	TEAR RESISTANCE
Rainwear material shall be flame resistant and shall not melt and drip when tested in accordance with ASTM D6413/D6413M and shall exhibit no more than a 2-second afterflame time and less than a 4" char length.	Rainwear material shall be tested in accordance with ASTM F1930, a design test, after 1 washing and 1 drying. Testing parameters are set at heat flux of 84 2.0 +/- 0.05 cal/cm2 and an exposure time of 3 +/- 0.1 seconds.	Material must withstand water pressure of 30 psig without leaking. The seams of the rainwear must not exhibit any evidence of leakage when exposed to water at 3 psig for (2) two minutes.	Material shall have a trapezoidal tear resistance of 6 lbs. in the warp direction and 6 lbs. in the fill direction.

NFPA 652:

Outlines fundamental principles and practices for managing fire and explosion risks from combustible dusts. This standard covers the full lifecycle of dust hazard management, including identifying hazards, conducting dust hazard analysis (DHA), managing identified fire, flash fire, and explosion hazards, and educating and training personnel involved.

HAZARD IDENTIFICATION	DUST HAZARD ANALYSIS	MANAGING HAZARDS	FR PROTECTIVE APPAREL
• Identify presence of combustible dust • Classify type and properties of the dust • Evaluate hazard severity and likelihood • Recognize dust accumulation areas	• Identify all potential dust-related hazards • Review entire facility • Pinpoint potential ignition sources • Examine equipment interconnections • Document, review, and update findings	• Set measures to avoid dust ignition • Establish a dust control program • Create a dust-related incident response plan • Implement safe equipment / building designs • Maintain dust prevention systems	• Provide FR garments when a flash fire hazard is identified • Comply with NFPA 2112 for FR clothing • Train employees on FR clothing use and care • Regularly inspect FR clothing • Replace worn-out or damaged FR clothing

CHEAT SHEET

All AR Clothing is FR but not all FR Clothing is AR

NFPA 70E aka "Electrical Workers Bible": Comprehensive safety standard for electrical workplace practices aimed at reducing the risk of arc flash incidents.

ASTM F1506 aka the "NFPA 70E Standard": Performance specification for arc rated woven FRC to protect workers from electrical hazards, as required by NFPA 70E.

ASTM F1891 aka the "Arc Flash Rainwear Standard": Performance specification for arc rated (AR) rainwear to protect workers from electrical hazards, as required by NFPA 70E.

NFPA 2112 aka the "Flash Fire Standard": Performance specification for FRC to protect workers from flash fire hazards.

NFPA 2113 aka "NFPA 2112 Companion Standard": Describes the selection, care, use, storage, & maintenance of FRC to protect workers from flash fire hazards.

ASTM F2733 aka the "Flash Fire Rainwear Standard": Performance Specification for FR Rainwear to protect wearer from Flash Fire Hazards.

UL: Most renowned independent organization that certifies compliance with NFPA 2112.

ASTM D6413 aka the "Vertical Flame Test": Test method for determining if a fabric is FR.

ASTM F1959 aka the "Arc Rating Test": Test method for determining the arc rating (ATPV & EBT) of a fabric.

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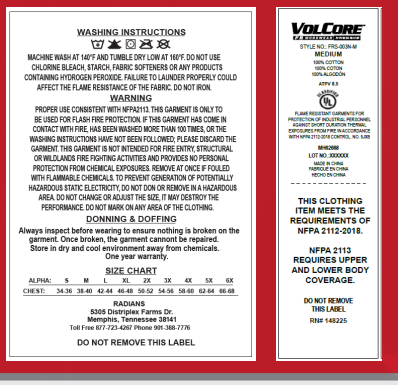
FR LABELING REQUIREMENTS



NON-FR

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