

DON'T GET BURNED BY THE CONFUSION:

A Safety Manager's Guide to Understanding FR Rainwear

There could be a dark secret lurking in your workplace. While it isn't the kind of bombshell that you'd hear about on "60 Minutes" or "Dateline NBC," it's something that could undermine the safety of workers in the construction, petrochemical, telecommunication and utility industries, among others.

Your flame-resistant (FR) rainwear might not be FR rainwear after all.

Maybe it isn't the tantalizing type of exposé that's tailor-made for the tabloids. Still, it warrants a closer look by safety managers who are charged with protecting their workers against flame, arc-flash and flash-fire hazards.

"There's a lot of confusion in the marketplace regarding what FR rainwear really is and how



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FR rainwear relates to FR clothing," explains Brian Nutt, Product Director, Protective Clothing, for Piscataway, NJ.-based Tingley Rubber Corp. "Adding to the confusion is the fact that some vendors continue to market their rainwear as 'FR' even though they're citing an old test method that isn't appropriate for applications that involve arc-flash or flash-fire hazards. So safety managers who purchase 'FR rainwear' for arc-flash or flash-fire resistance might be surprised to find out that those products don't provide the right level of protection for their workers."

A Brief History

To gain a better understanding of why there's been so much confusion in the FR marketplace – and to equip you with the knowledge needed to purchase the right FR rainwear for your workers – it's helpful to get some perspective on how we arrived at this point.

Prior to the late 1990s, the industry-accepted criteria for FR rainwear – and FR clothing in general – was Federal Test Standard 191A Method 5903.1 (FTSM 5903.1), which specified how to test the resistance of materials to a vertical flame. If the tested materials showed no visible flame or glow after 2 seconds and had a char length (the length of the fabric destroyed by the flame) of 6 inches or less after the ignition source was removed, they were considered "flame-resistant."

Although FTSM 5903.1 has been phased out, its test method is alive and well. In 1999, the American Society for Testing and Materials (now known as ASTM International) published the first edition of ASTM D6413, *Standard Test Method for Flame Resistance of Textiles (Vertical Test)*. While ASTM D6413 replaced FTSM 5903.1, it uses the same vertical flame test to determine

if a fabric will continue to burn after the ignition source is removed. Consequently, ASTM D6413 is an appropriate test method to determine low-level flame resistance, but it doesn't apply to more intense thermal hazards such as arc-flash explosions and flash fires.

"If you're looking for a rain suit that won't catch fire and continue to burn after the flame source is removed, a D6413-tested garment might be fine," Nutt explains. "Welders, for example, might want something that keeps them dry and gives them protection from slag. If a D6413-tested rain suit gets hit with welding slag, it might melt a little bit, but the entire rain suit isn't going to catch on fire. We've also seen trash collectors wear D6413 rain suits for low-level flame resistance, in case they were to encounter sparks or some other limited flame hazard on their routes."

Addressing Arc-Flash and Flash-Fire Protection

In 1998, ASTM introduced the first standard to address requirements for rainwear designed to protect workers against arc-flash explosions: ASTM F1891, *Standard Specification for Arc and Flame Resistant Rainwear*. Although ASTM introduced a similar standard (ASTM F1506) four years earlier, ASTM F1506 applies only to FR clothing, as the standard doesn't include fabrics and coatings commonly used in rainwear products. ASTM F1891, on the other hand, provides test methods, performance criteria and purchasing information for rainwear designed to protect workers from exposure to electric arcs and open flames.



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When it was introduced, ASTM F1891 addressed a critical gap in the FR-rainwear marketplace: protection against dangerous electric-arc flashes. However, it didn't address the types of flash-fire hazards found in petrochemical plants and other operations that work with flammable or explosive materials. That changed in 2009, with the publication of ASTM F2733, *Specification for Flame Resistant Rainwear for Protection Against Flame Hazards*. The standard provides minimum requirements for flame-resistant rainwear designed to protect workers against flash-fire and other flame hazards.

"Workers in the industries that will use ASTM F2733 often need to work outdoors during weather conditions involving heavy rain and wind, so they have a need for flame-resistant rainwear that provides the appropriate protection against their workplace hazards," said Thomas Neal, former chairman of Committee F23 on Personal Protective Clothing and Equipment, when the standard was published in 2009. "It is expected that most rainwear that meets the requirements of F2733 also will provide protection against hot-liquid splash hazards. Flame-resistant rainwear that meets ASTM F2733 can also be tested to ASTM F2701, *Test Method for Evaluating Heat Transfer through Materials for Protective Clothing Upon Contact with a Hot Liquid Splash*."

Why All the Confusion?

ASTM F1891 and ASTM F2733 require significantly higher levels of protection than the federal government's FTSM 5903.1, which for decades had been the industry-

accepted test method to determine flame resistance. And the two standards codify the distinction between FR rainwear that offers limited protection (rainwear that's tested to ASTM D6413) and FR rainwear that offers protection against more serious thermal hazards: arc flashes (ASTM F1891) and flash fires (ASTM F2733).

Here's where it gets confusing. Some manufacturers and distributors of FR rainwear tout their rainwear garments as "FR" simply because the garments have passed the vertical flame test in ASTM D6413.

The problem lies in the fact that "FR rainwear" means different things in different industries, based on the job hazards. For a welder, FR rainwear might mean basic protection against sparks and slag. For an electric utility company, FR rainwear means protection against arc-flash hazards, and for a petrochemical operation (or a gas utility company), it means protection against flash fires.

"The old vertical flame test in D6413 is a very gentle test method that establishes limited flame resistance. Yet companies still go around and call garments 'flame-resistant' if they have a flameout and afterglow lasting less than 2 seconds and a char length less than or equal to 6 inches," Nutt says. "The difference in performance between a low-level FR garment and a high-level FR garment is dramatic, and it's very confusing for the end user, because all the end user hears is: 'It's FR.'"

In the world of workplace safety, confusion can be dangerous.

TIPS FOR SELECTING THE RIGHT FR RAINWEAR

- ✓ Conduct a job-hazard analysis to determine the level of flame and thermal protection needed for each job application.
 - Does the job task expose the worker to potential arc-flash hazards? If so, look for F1891-compliant rainwear.
 - Does the job task expose the worker to potential flash-fire hazards? If so, look for F2733-compliant rainwear.
 - Does the job task expose the worker to low-level flame hazards such as sparks or welding slag? If so, look for D6413-tested rainwear.
- ✓ Only purchase FR rainwear from reputable, established vendors.
 - Conduct your due diligence. Make sure a third-party laboratory has certified the vendor's products as compliant with applicable standards. Ask to see the lab's test results.
- ✓ Ask your vendor to provide some examples of the types of job applications and companies in which the garments are being used.
- ✓ Ask your vendor or distributor to facilitate a wear trial with your workers so you can evaluate the performance, comfort and fit of the FR rainwear before making a purchase.



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“There are a lot of employers that will say, ‘I just want a flame-resistant rain suit,’ and a lot of distributors that will say, ‘OK, this one is flame-resistant; it’s tested to ASTM D6413,’” Nutt explains. “The D6413-tested rain suit is much cheaper than the rain suits that meet the specifications of ASTM F1891 or ASTM F2733, so the customer chooses the D6413-tested garment, because it’s cheaper and the distributor says it’s ‘FR.’ Then a worker goes out and gets burned, because he’s using the rain suit in an application that that product wasn’t designed for.”

Three Types of FR Rainwear

If you’re still a bit confused about the definition of FR rainwear, there’s a simple way to look at it. The flurry of standard-setting activity over the past two decades has created three distinct categories of FR rainwear. They are:

- Low-level FR rainwear that passes the vertical flame test in ASTM D6413 (showing no visible flame or glow after 2 seconds and a char length of 6 inches or less after the ignition source is removed). This type of rainwear provides limited flame resistance.
- Arc-resistant rainwear that meets the performance requirements of ASTM F1891. Rainwear that complies with F1891 will have an arc rating and a heat-attenuation factor, which help to quantify the level of protection that the rainwear will provide against the intense heat and energy generated by an arc-flash explosion.
- Flash-fire-resistant rainwear that meets the performance requirements of ASTM F2733. Rainwear that complies with F2733 must pass a laboratory test in which the garment is exposed to a three-second hydrocarbon flash fire. The garment must not melt, drip, ignite or shrink, and cannot allow more than a 40 percent average predicted body burn.

Some FR-rainwear products – such as Tingley Rubber’s Eclipse line – conform to the requirements of F1891 and F2733, providing protection against arc and flash-fire hazards. If there’s ever any doubt as to the level of protection that a rainwear garment provides, read the label: Both F1891 and F2733 require rainwear manufacturers to clearly mark the product label if a garment complies with either standard.

For a rundown of the relevant standards and test methods for FR rainwear, see the sidebar on page 6.

Match FR Rainwear to FR Clothing

There’s another way to simplify the process of choosing FR rainwear: Look for rainwear that matches the characteristics of your FR clothing.

FR rainwear is secondary protection, and typically is worn over other protective garments such as FR shirts, pants, bibs and coveralls. F1891 and F2733 focus exclusively on rainwear; but each one has an equivalent protective-clothing standard:

- For F1891, the equivalent protective-clothing standard is ASTM F1506, *Standard Performance Specification for Flame Resistant and Arc Rated Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards*.
- For F2733, the equivalent protective-clothing standard is NFPA 2112, *Standard on Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire*.



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Looking for FR rainwear that complies with the equivalent protective-clothing standards is an excellent way to narrow your choices and simplify the selection process. But it's not necessary to choose FR rainwear that offers the equivalent arc rating or burn rating of your protective clothing.

"You're not trying to double your protection," Nutt says. "You're looking for a rain suit that will prevent the injury from being worse. If a worker is wearing arc-resistant clothing but he puts on a rain suit that isn't arc-rated, that rain suit could melt and drip like candle wax in an arc-flash explosion. If the worker has an open burn on his hand, and now all of a sudden there's molten polyurethane dripping into that burn, that's a very serious problem. So you want a rain suit that won't further the extent of the injury."

A Balancing Act for Safety Managers

Selecting rainwear that provides the right level of FR protection for the job hazard is half the battle. Safety managers also have to consider other factors, such as price, availability, comfort and fit. Choosing FR rainwear that's comfortable and properly fitting is particularly important, as it increases the likelihood that workers will comply with their employers' PPE requirements.

"If guys aren't comfortable in their FR rainwear – if it's too tight or restrictive, or if it's hot because the fabric isn't breathable – a lot of them will take it off when the safety manager isn't watching them," Nutt says.

To ensure that you're striking the right balance between

protection, comfort and fit, Nutt recommends working with your vendor or distributor to conduct a wear test, also known as a wear trial.

In a wear trial, workers receive samples of the FR garments that are under consideration, and they wear the garments while performing their job duties. The participants then provide their feedback – often through a combination of online or written surveys and one-on-one interviews – on factors such as comfort, flexibility, breathability and ease of donning and doffing the garments.

For more tips on navigating the selection process, see the sidebar on page 3.

Summary

Since the late 1990s, the creation of standards and test methods for rainwear designed to protect workers against electric arcs and flash fires has expanded the definition of FR rainwear. However, some manufacturers and distributors have continued to market their products as "FR rainwear" by citing a decades-old test method that establishes minimal flame resistance – and that has caused some confusion in the marketplace.

The simplest way to approach the selection process is to understand that there are three categories of FR rainwear, each of which offers a different type of protection. If your workers need protection against low-level flame hazards (such as occasional sparks or welding slag), then a garment tested to ASTM D6413 might be appropriate. If your workers perform job tasks that involve potential arc-flash hazards, then a rainwear garment that meets the requirements of ASTM F1891 likely will be the best choice. If your workers perform job tasks that involve potential flash-fire hazards, a rainwear garment that meets the requirements of F2733 likely will be the appropriate option.

Follow these and other best practices outlined in this whitepaper, and you'll minimize the chances that you – or more importantly, your workers – will get burned by the confusion. With the clarity and confidence to make an informed decision, you'll maximize the chances of selecting rainwear that keeps your workers dry, comfortable and safe.



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RELEVANT STANDARDS AND TEST METHODS FOR FR RAINWEAR

Key Definitions

Regulatory standard — A final rule published by an executive department or agency of the federal government. Listed in the Code of Federal Regulations (CFR). All OSHA standards are contained in Title 29 of the CFR.

Standard — A document that presents test methods, performance and design requirements and other information for a product. Also referred to as a “specification,” “performance specification” or “voluntary consensus standard.”

Test method — A definitive procedure that produces a test result. Determines whether a product meets the specifications prescribed in a standard.

Standards

ASTM F1506 — *Standard Performance Specification for Flame Resistant and Arc Rated Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards*. Identifies performance specifications for protective clothing worn by electrical workers exposed to momentary electric arcs and related thermal hazards. Does not cover fabrics commonly used in rainwear.

ASTM F1891 — *Standard Specification for Arc and Flame Resistant Rainwear*. Includes test methods, minimum physical and thermal performance criteria, a suggested sizing guide and suggested purchasing information for rainwear designed to protect workers from the hazards of momentary electric arcs and open flames. Equivalent protective-clothing standard: ASTM F1506.

ASTM F2302 — *Standard Performance Specification for Labeling Protective Clothing as Heat and Flame Resistant*. Provides minimum requirements for labeling protective clothing as heat and flame resistant for applications in which there is the potential for flame contact or high heat exposure. Does not provide requirements that establish the level of protection provided by the clothing, nor does it cover fabrics commonly used in rainwear.

ASTM F2733 — *Standard Specification for Flame Resistant Rainwear for Protection Against Flame Hazards*. Includes test methods, minimum physical and thermal performance criteria, a suggested sizing guide and suggested purchasing information for rainwear designed to protect workers from potential exposure to industrial hydrocarbon fires or other petrochemical fire hazards (flash fires). Equivalent protective-clothing standard: NFPA 2112.

NFPA 1977 — *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*. Establishes requirements for protective clothing and equipment designed to protect wildland fire fighters against external heat sources. Recent updates have added cold-weather outerwear, chainsaw protectors, load-carrying equipment and goggles, and revised the tables on minimum sizing requirements for protective upper- and lower-torso garments and one-piece garments.

NFPA 2112 — *Standard on Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire*. Specifies the minimum design, performance, certification and testing requirements for flame-resistant fabric and garments for use in areas at risk from flash fires, with the intent of reducing the severity of flash-fire burn injury and increasing the odds of survival. For a garment to pass, the total body burn must be less than 40%.

Test Methods

ASTM D6413 — *Standard Test Method for Flame Resistance of Textiles (Vertical Test)*. A test method that measures the response of materials to heat and flame in controlled laboratory conditions. Often specified in standards (such as F1891) as a prerequisite for additional testing. Adopted from Federal Test Standard 191A Method 5903.1.

ASTM F1930 — *Standard Test Method for Evaluation of Flame Resistant Clothing for Protection Against Fire Simulations Using an Instrumented Manikin*. A test method used to measure the thermal performance of materials, garments, clothing ensembles and systems when exposed to a laboratory simulation of a flash fire. Referenced in ASTM F2733.

ASTM F1959 — *Standard Test Method for Determining the Arc Rating of Materials for Clothing*. A test method that measures the arc rating of materials used in FR clothing for workers potentially exposed to electric-arc hazards. Typically, the arc rating is expressed in calories per square centimeter (cal/cm²). Referenced in ASTM F1891.

Regulatory Standards

29 CFR 1910.269 — *OSHA Electric Power Generation, Transmission and Distribution Standard* (general industry). In April 2014, OSHA updated this standard — and its construction-industry counterpart, 29 CFR 1926 Subpart V — with new requirements to protect workers from arc-flash hazards. Both standards now require employers to assess their worksites for arc-flash hazards, estimate the incident energy of electric-arc hazards and ensure that workers exposed to electric-arc hazards have PPE with arc ratings greater than or equal to the estimated heat energy.

Other Related Standards

NFPA 70E — *Standard for Electrical Safety in the Workplace*. Describes safety requirements for workers exposed to major electrical hazards. The 2015 edition includes detailed tables for identifying arc-flash hazards and selecting arc-resistant PPE.

ANSI/ISEA 107-2015 — *American National Standard for High-Visibility Safety Apparel and Headwear*. Provides guidelines for the selection and use of high-visibility safety apparel such as shirts, rainwear, outerwear, safety vests and headwear. The 2010 edition requires rainwear marketed as high-visibility and flame-resistant to be compliant with ANSI/ISEA 107-2010 and ASTM F1891 or ASTM F2733. The garment label must have the letters “FR” followed by the ASTM standard that it meets.

