

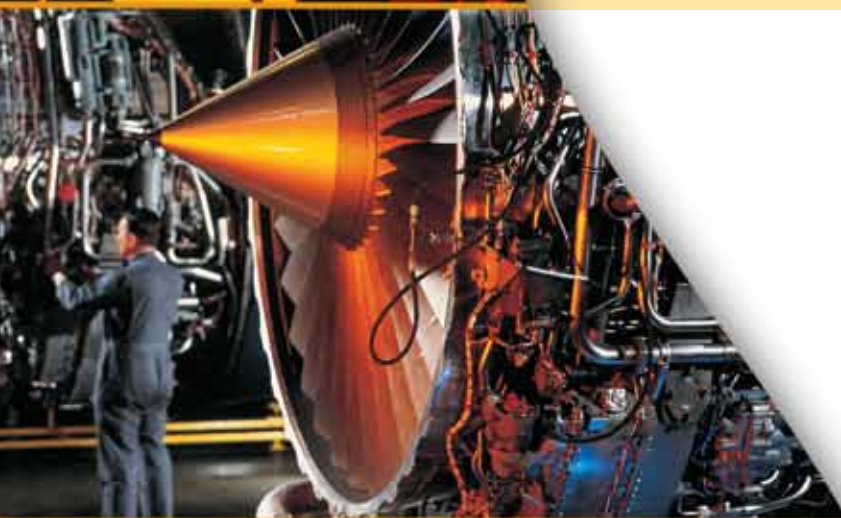


White Paper



How Protected Are Your Employees from Arc Flash and Flash Fire?

A guide to selecting the appropriate protective apparel to meet OSHA and NFPA requirements.



Introduction:

Each year, more than 2,000 employees are admitted to burn centers with severe burns resulting from arc flash accidents. To address this hazard, the National Fire Protection Association (NFPA) 70E standard (CSA-Z462 in Canada) contains detailed instructions

on how to protect workers from the heat of electric arc exposures in the workplace—including the use of protective clothing. For employee protection from flash fire, a similarly dangerous industrial hazard, the NFPA 2112 standard (CGSB-155.20 in Canada) acts as a means of certifying fabrics and findings suitable for use in flame-resistant clothing. In addition to these standards, both U.S. and Canadian safety codes require employers to ensure that workers exposed to flame or electric arc hazards do not wear clothing that would increase the severity of the burn injury.

These standards are used to instruct employers in the selection of the proper protective apparel for employees working in areas where arc flash or flash fire may occur. This selection process is complex and requires

a thorough understanding of both arc flash and flash fire, the rules of each related industry standard, the importance of the hazard risk assessment, and the types and qualities of flame-resistant fabrics available, as well as the importance of fabric care in ensuring garment performance.

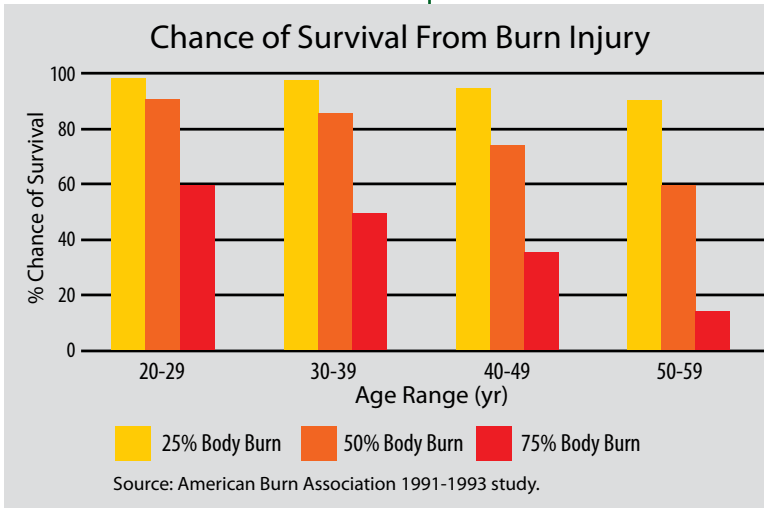
Causes and Consequences of Arc Flash, Flash Fire and Industrial Flame Hazards

Arc flash is an explosive blast of flame, debris, sound & force—the severity of which is determined by the distance from the arc and amount of voltage or amps involved. An arc flash usually lasts under one second but can reach up to 35,000° F, sending molten metals at high velocity.

This intense heat can ignite or melt clothing that is not designed for flame resistance. Up to 80% of all electrical injuries are burns resulting from an arc flash and ignition of flammable clothing. Energy generated by an electric arc is measured in calories; one or two calories/cm² will cause a second-degree burn on human skin.

A flash fire is an unexpected, sudden intense fire caused by ignition of flammable solids, liquids or their vapors, gases, or dust. It is characterized by high-temperature, short-duration, considerable shock waves, and a rapidly moving flame front. This flame front can be a combustion explosion, spreading with unusual speed—witnesses may observe the flame racing across the surface of a flammable liquid or through a cloud of dust or gas.

Flash fire may occur in any environment where fuel and air become mixed in adequate concentrations to combust. Though a flash fire typically lasts less than three seconds, it results in a heat flux of approximately 84 kW/m².



Grinding, welding, machining, deburring and numerous other industrial processes also pose a risk of flames. Ordinary work apparel may ignite upon making contact with molten metals, sparks or slag from flame cutting or welding. Managers must carefully review all production processes to determine if the risks present require flame-resistant clothing.

Industry Standards Related to Arc Flash and Flash Fire

OSHA: Assigns Responsibility of Arc Flash and Flash Fire Protection to Employers

The Occupational Safety and Health Administration (OSHA) is a branch of the US Department of Labor established in 1970. Its mission is “to assure the safety and health of America’s workers by setting and enforcing standards; providing training, outreach, and education; establishing partnerships and encouraging continual improvement in workplace safety and health.”

Under paragraph 5a1 (OSHA 1910.132), the General Duty Clause, it is the employer’s responsibility to identify risks and hazards in the workplace and to seek out appropriate protective garments and equipment for the protection of workers. It states that each employer “shall furnish a place of employment which is free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees.”

In making this hazard risk assessment, the employer must consider the risks present and the most appropriate means of addressing those risks. Where ignition risks are present, flame-resistant protective apparel can become a prudent part of an action plan to address these concerns.

OSHA’s Final Rule on Electrical Protective Equipment (OSHA 1910.269) applies to electric utilities and co-generation plants where maintenance is performed on existing facilities. It states that the employer “shall ensure that each employee who is exposed to the hazards of flames or electric arc does not wear clothing that, when exposed to flames or electric arcs, could increase the extent of the injury that would be sustained by the employee.”

NFPA 70E: Addresses Electrical Hazards and Need for Flame-Resistant Apparel

The NFPA 70E Standard for Electrical Safety in the Workplace was developed by the National Fire Protection Association (NFPA) to meet OSHA’s need to address electrical hazards in the workplace. NFPA 70E (CSA-Z462 in Canada) contains detailed instructions on electrical safety-related work practices and procedures for safeguarding employees during activities such as operation, maintenance and demolition of exposed energized electrical conductors or circuit parts. The NFPA 70E standard states, “employees shall wear FR clothing wherever there is a possible exposure to an electric arc flash,” and provides comprehensive, multi-step instructions on how to protect electricians and maintenance employees from electric arc hazard.

Energy generated by an electric arc is measured in calories; one or two calories/cm² will cause a second-degree burn on human skin.

Important Things to Consider When Selecting Any Type of FR Program:

- Fully understand which of your employees needs to be outfitted in flame-resistant garments.
- Select a uniform supplier that is knowledgeable in flame-resistant garment care and handling.
- Know the calorie protection that will adequately protect your employees.
- Under paragraph a1, the General Duty Clause of the federal Occupational Health and Safety (OSHA) Act, it is the employer’s responsibility to identify risks and hazards in the workplace and to seek out appropriate protective garments and equipment for the protection of workers.





The current NFPA 70E standard is the 2009 Edition, which became effective September 5, 2008 and specifically addresses host employer and contract employer responsibilities. The host employer is responsible for advising the contractor of known hazards and other information about the work site. The contractor employer is responsible for instructing his or her employees on the hazards communicated by the host employers and for ensuring that the contract employees follow required rules and work practices. NFPA does not levy fines, and is not part of OSHA, but it is very influential as a best practices model. Additionally, NFPA codes are often cited by OSHA in the assessment of fines.

Virtually any facility housing electrical equipment falls under NFPA 70E/CSA-Z462 guidelines—especially in enterprises dependent upon heavy machinery operations, including:

- Aluminum
- Chemical
- Computers and Chips
- Hospitals
- Paint
- Pharmaceutical
- Pulp and Paper
- Automotive
- Commercial Printers
- Food Processing
- Metal Fabrication
- Petroleum
- Power Generation
- Transportation

Within each of these operations are workers that risk an electric arc flash within the flash protection boundary while performing tasks such as removing or installing circuit breakers, low-voltage testing, working on control circuits with energized parts exposed, racking circuit breakers or starters, and removing bolted covers of energized parts or equipment. As many as 10 arc flash accidents are estimated to occur in the U.S. per day, so it is critical for employers to ensure each worker is sufficiently protected from this risk.

NFPA 2112: Dictates Flame-Resistant Apparel for Flash Fire Protection

The NFPA 2112 Standard on Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire acts as a means of specifying FR fabrics suitable for protection against possible flash fire exposure. Its purpose is to specify “the minimum design, performance, certification requirements, and test methods for flame-resistant garments for use in areas at risk from flash fires.” Along with its companion standard, the NFPA 2113 Standard on Selection, Care, Use and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire, this standard addresses design, performance, certification requirements, and test methods for flame-resistant garments for use in areas at risk from flash fires. The standard also required certification of garments by a third party, such as UL®.

Today, NFPA 2112 is the standard for all FR fabrics in the United States. In addition to the usual fabric performance requirements for flame resistance, heat resistance and thermal shrinkage, this standard addresses testing the flame resistance of each fabric layer as well as Thermal Protective Performance (TPP) testing—including both “spaced” and “contact” TPP requirements. FR fabric must demonstrate a predicted body burn

of less than 50% in a mannequin test. NFPA 2113 provides guidance in the selection and specification of flame-resistant garments, including workplace hazard assessment. Other sections cover use, care and maintenance recommendations.

Canadian General Standards Board (CGSB) CAN/CGSB155.20 Workwear for Protection Against Hydrocarbon Flash Fire is the Canadian flash fire standard. In addition to flame resistance, heat resistance and thermal shrinkage requirements, this standard also requires that the garment label be in both English and French, as well as contain specific TPP values for both “spaced” and “contact” tests (single layer garments only).

ASTM F 1506: Specifies Proper Flame-Resistant Materials for Electrical Workers

The ASTM F 1506 Specification for Flame-Resistant Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electrical Arc and Related Thermal Hazards covers performance properties of textile materials to be used for wearing apparel by electrical workers exposed to electric arcs. This includes a general requirement that thread, findings, and closures used in garment construction not contribute to the severity of wearer injuries in the event of an electric arc exposure.

Employees must wear FR clothing that both conforms to the requirements of ASTM F 1506 and has an appropriate arc rating (Arc Thermal Performance Value (ATPV), or Breakopen Threshold Energy (EBT) if the ATPV cannot be calculated because of fabric break open. Garments conforming to the requirements of ASTM F 1506 must be labeled with a tracking code, a statement that the garments meets the requirements of ASTM F 1506, the manufacturer’s name, size information, care instructions and fiber content, and the arc rating (ATPV or EBT).

In order to comply with ASTM F 1506, knit or woven fabrics must not melt, drip, or have more than 2.0 seconds afterflame or 6.0 inches char length when tested as received and after 25 launderings or dry cleanings. FR fabrics of any type cannot have more than 5.0 seconds afterflame in an electric arc exposure test.

Essential Qualities of Flame-Resistant Garments

Flame-resistant (FR) garments are designed for continuous wear in designated areas where intermittent exposure to flame or heat is possible, or where the potential for arc flash or flash fire is present. Whereas normal work apparel will ignite and continue to burn if exposed to an ignition source, such as flame or electric arc, FR fabrics and garments are intended to resist ignition and prevent the spread of flames away from the immediate area of high heat impingement. These garments are also designed to self-extinguish almost immediately upon removal of the ignition source.

FR garments may be comprised of either treated or inherently flame-resistant fabrics. In inherently flame-resistant fabrics, flame resistance is an essential characteristic of the fiber from which the textile is made. Because the actual structure of the fiber itself is not flammable, the protection it affords is permanent—it can never be worn away or washed out. Treated fabrics are treated with a flame-retardant chemical to make them flame-resistant. The fibers used in these fabrics, such as cotton, are not normally considered protective and become flame-resistant because of the treatment.





Unlike fabrics made with inherently FR fibers, chemically treated FR fabrics may have their flame resistance properties diminished or removed completely depending on how these fabrics are laundered. Chemical exposure in the work environment may also influence these properties. However, fabrics made from treated synthetic fibers—which are extruded with a flame retardant chemical in the fiber-forming process—become flame-resistant for the life of the garment because the flame retardant cannot be removed by wear or laundering.

The two main garment performance standards for FR clothing, NFPA 2112 and ASTM F1506 (used for NFPA 70E), only specify minimum performance levels for fabrics and garments. These standards do not address all factors related to durability of the flame resistant properties. It is the end-user's responsibility to determine if these minimum standards provide an appropriate performance level for their particular application.

How to Select the Proper FR Garments

FR garments are specified based on the employer's evaluation of workplace hazards.

Employees must wear FR clothing wherever there is a possible exposure to an electric arc flash above the threshold incident-energy level for a second-degree burn

(1.2 cal/cm²). Additionally, any flame- and thermal-protective fabric must provide the wearer with the expected degree of protection for the useful life of the garments.

The NFPA 70E standard provides Table 130.7(C)(9) as a guideline for the selection of protective apparel. Table 130.7(C)(9) is used to determine the hazard/risk category (HRC), which is a term for categories of clothing/ personal protective equipment (PPE) based on the expected arc energy and the risk of arc in the particular job or task or equipment. Clothing/PPE worn

in the category may exceed the category requirement, but it may not be less than that required by the category.

When referencing this chart, special attention must be paid to the calorie minimum, or arc thermal performance value—the energy level with 50 percent probability that second-degree burns would occur. Each HRC level covers a large minimum calorie range; e.g., HRC 2 is 8 calories through 24 calories. When selecting protective apparel, employees must keep in mind that not all HRC level 2 FR clothing/PPE would be adequate for all HRC 2 applications.

Layering of non-melting flammable garments is permitted to be worn under FR garments for added protection. However, if Table 130.7(C)(9) is used to determine the HRC category, only 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 FR.

NFPA 70E Hazard/Risk Category (HRC)



| Hazard/Risk Category | Clothing Description | Required Minimum Arc Rating of PPE (cal/cm ²) |
|----------------------|--|---|
| HRC 1 | Arc-rated FR shirt & pants or FR coverall | 4 |
| HRC 2 | Arc-rated FR shirt & pants or FR coverall | 8 |
| HRC 3 | Arc-rated FR shirt & pants or FR coverall and arc flash suit selected, so the system arc rating meets the required minimum | 25 |
| HRC 4 | Arc-rated FR shirt & pants or FR coverall and arc flash suit selected, so the system arc rating meets the required minimum | 40 |

NFPA 70E provides a Hazard/Risk Category chart to assist employers in the selection of protective garments suitable for the environmental risks present.



The Importance of Clean, Properly Maintained FR Garments

Proper cleaning and maintenance of FR garments is necessary to remove potentially hazardous soils and avoid a buildup of materials that could mask performance. However, incorrect laundering can reduce the useful life of the garment or—in the case of treated FR fabrics—reduce the garment’s flame-resistance properties.

Chlorine bleach, when used for multiple washes, can compromise the flame-resistant properties of a treated FR garment made from FR cotton or FR cotton/nylon fabrics. While simple laundering cannot jeopardize the flame resistance properties of an inherently FR garment, chlorine bleach can reduce the garment’s usable life. Repeated use of chlorine bleach in the laundry can affect fabric color and weaken fabric strength.

Additional factors that may affect the flame resistance properties of a treated FR garment include:

- A combination of hydrogen peroxide (a type of oxygen bleach) with ‘hard’ water during laundering
- Exposure to oxidizing (e.g., chlorine-containing) chemicals in the workplace

It is for this reason that, once the proper FR apparel is determined, employers select a uniform provider knowledgeable in best practices for laundering such garments. This selection ensures that the FR garments retain all flame resistance properties throughout their usable life.

Summary:

OSHA dictates it is the employer’s responsibility to protect employees from workplace hazards, including electric arc flash and flash fire. NFPA 70E (CSA-Z462) provides guidelines regarding when protective apparel is required, as well as a hazard/risk category (HRC) chart to determine the type of protective garments that should be used. NFPA 2112 (CGSB-155.20) and NFPA 2113 specify the qualities required of flame-resistant fabrics to be acceptable for use as protective apparel. These fabrics are available as either treated or inherently flame-resistant, and laundering of these fabrics must be performed properly in order to retain flame resistance properties and optimize usable life.



AmeriPride WorkStyle® offers the protective apparel solutions to meet your needs.

AmeriPride flame-resistant (FR) work apparel is designed for continuous wear in designated areas where intermittent exposure to flame or heat is possible. Our partnership with leading FR fabric and garment manufacturers Bulwark® Protective Apparel and Westex Inc. has yielded a superior line of FR jeans, shirts, pants, coveralls and lab coats designed to serve as secondary protective clothing in areas where the potential for arc flash or flash fire is present.

AmeriPride offers rental, lease and purchase programs for all FR apparel. FR garments provide comfort and flame resistance protection—all while maintaining a clean, professional appearance. AmeriPride also launders these items according to specific standards for each FR garment, ensuring the fabrics maintain FR properties throughout the garment's life. Visit www.ameripride.com today to learn more about how you can protect your employees through FR apparel.