



PAPER

HOW TO CHOOSE THE RIGHT PROTECTION FOR
**FIRES, FLASH FIRES
AND ARC FLASHES**



How to Choose the Right Protection for Fires, Flash Fires & Arc Flashes

An employee in Arkansas is killed when an overhead crane spills molten metal. Two workers in Oklahoma die after an electric arc furnace explosion. Four technicians in Texas are hospitalized with severe burns after a flash fire.

According to the Occupational Safety and Health Administration (OSHA), workplace fires, explosions and other hot work incidents kill about 200 and injure more than 5,000 employees each year.

Fires, explosions, flash fires and arc flashes may have seemingly similar results, but the hazards faced and the controls that need to be put into place to protect employees exposed to any of these hazards are different. Understanding the differences between each of these hazards is vital for proper risk assessments.

In this PIG Paper, we'll look at the different types of fire hazards and the personal protective equipment (PPE) needed for each.

Types of Fires

Not all fire hazards are the same. Fires can be caused by equipment failure, flammable liquid or gas releases, spills, electrical malfunctions, combustible dusts, hot work, static electricity, carelessness and many other sources. The types of PPE needed to protect employees, as well as the engineering and other controls to prevent hazards, vary greatly depending on the specific types of fire hazards that are present.

Here are the three types of fires that employees are most likely to encounter on the job:

Type of Hazard	Definition	Characteristics
Fire	The result of igniting a mixture of fuel, heat and oxygen.	A fire will continue burning until all of the fuel is exhausted or until it is actively extinguished.
Flash Fire	A sudden ignition of fuel (gas, liquid vapor or solid) that is diffused in air.	Flash fires last no more than five seconds with temperatures ranging from 1,000 to 2,000 degrees Fahrenheit.
Arc Flash	An electrical fault or short circuit that passes through air.	Arc flashes are characterized by a brilliant light burst, loud noise and pressure waves. Arc flashes last less than three seconds with temperatures often reaching more than 35,000 degrees Fahrenheit.



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Flame Resistant (FR) Clothing

Fabrics made of untreated natural fibers and most synthetic fibers are combustible. They will ignite and continue to burn or melt until they are extinguished or until all of the flammable material that is available is consumed, which increases the extent and severity of burns.

FR clothing is different than regular clothing because it's made of fabrics that will not sustain a fire (continue to burn) once an ignition source has been removed. It's also designed to insulate the wearer from thermal hazards and limit second- and third-degree burn injuries to less than 50 percent of the body.



FR garments should be worn by anyone who could experience the risk of fires or ignition sources in the workplace. Examples include:

- Foundry or refinery workers
- Welders and flame cutters
- Firefighters
- Petrochemical, electrical and utility workers
- Chemical, oil, gas and mining industry workers
- Food processing, painting, or pulp and paper industry workers

Even though the PPE that's used to protect workers from fire hazards is collectively marketed as "flame resistant," simply purchasing an item because it says it's FR may not be enough to provide the proper protection. It's important that the garment is tested and passes the appropriate standards for the specific type of fire hazard that the wearer will face.



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Flame Resistant (FR) Clothing (continued)

FR fabrics can be either inherently FR or chemically treated to be FR. There is no “best” or “perfect” FR fabric, and inherently FR fabrics aren’t better or worse than chemically treated FR fabrics. What is important is whether or not the fabric will do the job that it needs to do when there’s an emergency.

In addition to choosing clothing that meets or exceeds the appropriate standards, it’s also important to consider the following aspects, especially for workers who will wear FR clothing daily:

- Comfort
- Ability to wick away perspiration
- Durability
- Stability
- Appearance
- Ease of laundering

Like more forms of PPE, FR clothing is specialized to protect people against specific types of fire hazards. For example, the turnout gear that keeps firefighters safe while they battle a structural fire won’t protect an electrician from arc flash hazards. Next, we’ll take a look at different fire hazards and the types of clothing that may be needed for each.



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Arc Flash

An arc flash is an electrical short circuit through air. It can be described as a loud explosion that includes a ball of fire, molten metal and a pressure blast capable of damaging hearing, altering brain function and throwing people and unsecured items across a room.

Arc flash explosions can be caused by:

- Dropped tools
- Accidental contact with electrical systems
- Buildup of conductive dust
- Corrosion
- Improper work procedures
- Equipment failure

To establish whether or not workers may be exposed to an arc flash, a flash hazard analysis needs to be performed for work activities that involve electrical conductors or equipment. The findings of this study can help prevent injury by determining the work practices and PPE needed to protect employees from arc flash hazards. The flash protection boundaries (the distance from an exposed electrical part that could cause second degree burns if an electric arc were to occur) will also be established from this analysis.

The National Fire Protection Association (NFPA) has created the [NFPA 70E Standard for Electrical Safety in the Workplace](#) to provide guidance and best practices for safeguards and procedures that can be put in place, as well as PPE to protect workers from arc flash hazards.

Arc Flash Facts:

- *Temperatures can reach up to 35,000 degrees Fahrenheit even though the entire event occurs in less than 3 seconds*
- *Arc flashes happen almost too quickly for a person to comprehend the situation*
- *More than 2,000 people are admitted to burn centers each year with severe burns due to arc flashes*

Arc Rating describes the performance level of clothing that will be worn to protect a worker from arc flash injury. Arc ratings are measured by:

- **Arc Thermal Protective Value (ATPV):** *the maximum amount of energy that a fabric can withstand before the person wearing it will experience excessive second or third degree burns*
- **Energy of Breakopen Time (EBT):** *used when the ATPV cannot be calculated because the fabric breaks open during the test*



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Arc Flash (continued)

The following test methods, regulations, codes, and standards are applicable to arc flash safety, procedures and/or PPE:

- ASTM D6413: Standard Test Method for Flame Resistance of Textiles (Vertical Test)
- ASTM F1506-10a: 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
- ASTM F1958: Standard Test Method for Determining the Ignitability of Non-Flame-Resistant Materials for Clothing by Electric Arc Exposure Method Using Mannequins
- ASTM F1959: Standard Test Method for Determining the Arc Rating of Materials for Clothing
- ASTM F2178: Standard Test Method for Determining the Arc Rating and Standard Specification for Eye or Face Protective Products
- IEC 61482-2: Protective clothing against the thermal hazards of an electric arc - Part 2: Requirements
- IEC 61482-2: Performance Requirements for Materials and Garments in an Electric Arc
- IEEE C2: National Electric Safety Code (2017)
- NFPA70E: Standard for Electrical Safety in the Workplace®
- NFPA 70: National Electrical Code®
- OSHA 1910.269(l)(8)(iii): "The employer shall ensure that each employee who is exposed to the hazards of flames or electric arcs does not wear clothing that... could increase the extent of injury that would be sustained... NOTE: Clothing made from the following types of fabrics, either alone or in blends, is prohibited by this paragraph... acetate, nylon, polyester, rayon..."
- "OSHA 1910.132(a): Application. Protective equipment, including personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used, and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact."



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Flash Fires

Flash fires happen when dusts, gases or vapors are ignited in air. They're extremely fast-moving, but don't produce a sound or pressure wave. The fuel in a flash fire is typically consumed in 5 seconds or less.

Because they occur in air, it can be hard to predict where a flash fire could happen. But, some of the variables that contribute to flash fires — such as dust or vapor density, temperature and ventilation — can be controlled.

In industries where combustible dusts present a flash fire hazard, the [OSHA 1910.307 electrical standard](#) and [NFPA 654 consensus standard](#) provide guidance and best practices for isolating processes, ventilation, fire protection systems, inspection, maintenance, good housekeeping and employee training. Analyzing risks and establishing a plan to prevent excessive levels of dusts from accumulating on surfaces and in the air is a proven way to help minimize risks.

Flash fires can occur any time a sufficient amount of fuel is suspended in air and encounters an ignition source, but hazards are especially prevalent in:

- *Combustible dust industries (food processing, woodworking, pharmaceuticals, etc.)*
- *Natural gas utilities*
- *Mining*
- *Oil and gas drilling, servicing, refining and processing*



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Flash Fires (continued)

In addition to work practices and safety procedures, workers who may be exposed to flash fire hazards can also be protected with FR clothing that meets the [NFPA 2112 consensus standard](#) on Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire.

NFPA 2112 provides minimum performance criteria for FR garments. To be NFPA 2112 compliant, a garment must be made of FR fabric and findings (zippers, buttons, etc.) and protect the worker from greater than 50 percent of second- and third-degree burns. [NFPA 2113 is a companion standard](#) that addresses the standards for care, use and maintenance of FR garments.

The following test methods, regulations, codes, and standards are applicable to arc flash safety, procedures and/or PPE:

- ASTM F2733: Standard Specification for Flame Resistant Rainwear for Protection Against Flame Hazards
- ASTM F1930: Standard Test Method for Evaluation of Flame Resistant Clothing for Protection Against Fire Simulations Using an Instrumented Manikin
- ASTM F2733: Standard Specification for Flame Resistant Rainwear for Protection Against Flame Hazards
- ASTM D6413: Standard Test Method for Flame Resistance of Textiles (Vertical Test).
- NFPA 654: Standard for the Prevention of Fire and Dust Explosions From the Manufacturing, Processing, and Handling of Combustible Particulate Solids
- NFPA 2112: Standard on Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire
- NFPA 2113: Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire
- OSHA 1910.269(l)(8)(iii): "The employer shall ensure that each employee who is exposed to the hazards of flames or electric arcs does not wear clothing that...could increase the extent of injury that would be sustained...NOTE: Clothing made from the following types of fabrics, either alone or in blends, is prohibited by this paragraph... acetate, nylon, polyester, rayon..."
- OSHA 1910.132(a): "PPE for eyes, face, head, and extremities, protective clothing...shall be provided, used and maintained...whenever it is necessary by reason of hazards...capable of causing injury"
- OSHA 1910.333(a): This clause is intended to be all-encompassing, ensuring that employees have a safe work environment



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Fires

Uncontrolled fires can cause injuries and property destruction. Identifying flammable liquids and other fire risks in a facility, and having procedures to minimize spills and maintain safe distances between incompatible materials and other items that could fuel fires will help minimize the chance for fire incidents.

All employees need to know their role during a fire event — even if their only response is to pull an alarm and evacuate. If employees will be trained to be part of an on-site fire brigade or other fire response team, they need to be properly trained and equipped with appropriate turnout gear to protect themselves from fire conditions.

Properly identifying fire risks is essential for creating plans and providing the right type of personal protective equipment to employees who have the potential to be injured by hazardous energy sources or who are responding to a fire in progress. Wearing the wrong thing to social functions may be embarrassing, but when it comes to fires, flash fires and arc flash, wearing the wrong thing can literally be a matter of life or death.



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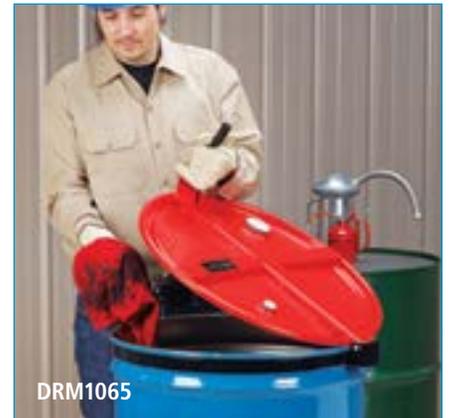
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