ELECTRICAL SAFETY

PROTECTION AGAINST ELECTRIC ARC FLASH

by ***Doruk TÜRKUÇAR***

Electric arc originates from gas ionization where the electrodes at different potentials are the conductive electrical connection between the different phases. Electric arc can occur due to a technical or operator error. While galvanic contacts are required to trigger the electric arc in low-voltage areas, in high-voltage areas, live parts may be caused by an inconvenience in the relative distance.

An electric arc explosion is a very short-term electricity flow or discharge in the form of heat and light through air between two conductors that do not touch each other along an unintended path.

IEEE Std 100-1988 defines electric arc as a discharge of electricity through a gas, normally characterized by a voltage drop in the immediate vicinity of the cathode, approximately equal to the ionization potential of the gas and flashover as:

1) (general) a disruptive discharge through air around or over the surface of solid or liquid insulation, between parts of different potential or polarity, produced by the application of voltage wherein the breakdown path becomes sufficiently ionized to maintain an electric arc.

2) (high voltage ac cable termination) A disruptive discharge around or over the surface of an insulating member, between parts of different potential or polarity, produced by the application of voltage wherein the breakdown path becomes sufficiently ionized to maintain an electric arc.

3) (high voltage testing) Term used when a disruptive discharge occurs over the surface of a solid dielectric in a gaseous or liquid medium.

Air is not a good conductor, most of the current flows are through post-arc vapor (usually copper and aluminum vapor) and ionized particles in the air.

Effects of electric arc

Depending on the power and burning time of the electric arc, different physical effects can be seen due to the high temperature. Electric arc energy is discharged in multiple ways, such as electrical, thermal, mechanical, photonic or luminous energy. Mechanical energy usually occurs in the form of explosions. Many various factors affect the energy created by the electric arc.

The arcs can exceed over 10,000 °F and electrical fires are the likely outcome of these arc flashes. The material in the center of the arc evaporates and causes a conductive connection between the electrodes. The fact that the tip of a burning cigarette is 580 °C when not smoked, 700 °C when smoking, and the surface temperature of the sun is 6,000 °C reveals how dangerous arc explosions are. The temperature effect of an arc blast with a diameter of 20 cm at a distance of 50 cm is approximately 1300 °C.

It is very dangerous for the eyes as it may cause blindness. If the energy is too high, it may also cause ultraviolet burns. For protection, arc flash protective face shields or hoods with visors that are dark enough not to damage the eyes in the event of a blast and certified according to the relevant standards should be used.

Electric arc related hazards

There are many hazards that may occur from an arc flash such as thermal burns, burst pressure wave injury, hearing loss, harmful electromagnetic emissions, emission of high toxic gases, or shrapnel injury (blast).

An arc flash can cause fatal physical injuries. Severe trauma from massive burns can cause a general systemic failure. Burnt internal organs can shut down—causing death. Thus, the more critical the organ that is burnt, the higher the possibility of death. The pressure front from the blast can cause severe injury to the lungs, called blast-lung, resulting in death. Heart failure can also result from fibrillation and/or paralysis.

Some of the standards of PPEs for protection against electric arc

IEC 61482 standard has been published by IEC in order to determine the test methods of the materials as well as heat and flame resistant protective clothings to be used by workers who may be exposed to electric arcs. This standard is a mandatory standard for certification of the product and obtaining the CE mark includes two different test methods as explained below. It covers the performance values of the fabric and the ergonomic features of the suit:

IEC 61482 1-1 (Protective clothing against the thermal hazards of an electric arc - Part 1-1: Test methods - Method 1: Determination of the arc rating (ELIM, ATPV and/or EBT) of clothing materials and of protective clothing using an open arc): This standard specifies a test method procedure to determine the arc rating of flame resistant clothing materials and garments or assemblies of garments (layer system eg.) intended for use in clothing for workers if there is an electric arc hazard. An open arc under controlled laboratory conditions is used to determine the values of ATPV or EBT of materials, garments or assemblies of garments. The user can classify the arc protective performance into arc rating protection levels based on ATPV and/or EBT values which correspond best to the different hazards and risk levels that can result from the user's risk analysis.

ATPV : (Arc Thermal Performance Value)
This value is measured in calories per square centimeter and represents the maximum performance capability for an arc flash protection of a particular suit or fabric. It is the highest thermal accident energy that will prevent the user from being exposed to a second degree burn at a 50% rate. It expresses the maximum incident thermal energy per surface area, in units cal/cm2, that the fabric of the protective suit can withstand before a second degree burn occurs.

The higher the ATPV value of the product, the more energy will be required for a second degree burn to occur. The case energy resistance of the material will be high. In other words, the higher the ATPV value of a protective suit in cal/cm2, the higher the level of protection. Which ATPV protection level of a protective equipment is needed in a job should be determined as a result of an arc flash risk assessment.

EBT : (Energy Break-open Threshold) The incident energy on a material that results in a 50% probability of breakopen, in units cal/cm2. It represents the highest incident energy exposed in the fabric of the protective suit, causing a 50% probability to break open the fabric. Holes in the fabric caused by breaking open lead to heat or flame entering inside the suit. Breakopen is defined as any open area of at least 1.6 cm^2. The fabric did not overheat to the point that caused the burn reading on the sensor and there is only a very small hole in it.

The arc rating of a protective suit's fabric is equal to ATPV or EBT. ATPV is 50% probability of second degree burn in the 8kA arc test on a flat panel. EBT is the 50% probability of a one inch crack in the material.

IEC 61482 1-2 Protective clothing against the thermal hazards of an electric arc - Part 1-2: Test methods - Method 2: Determination of arc protection class of material and clothing by using a constrained and directed arc (box test): This standard specifies a procedure to test materials and garments intended for use in heat and flame resistant clothing for workers if there is an electric arc hazard. A directed and constrained electric arc in a test circuit is used to classify material and clothing in two defined arc protection classes. This international standard is not dedicated toward measuring the arc rating values (ATPV or EBT). Procedures determining these arc rating values are prescribed in IEC 61482-1-1, using an open arc for testing. Other effects than the thermal effects of an electric arc like noise, light emissions, pressure rise, hot oil, electric shock, the consequences of physical and mental shock or toxic influences are not covered by this standard.

It has been published to determine the safety requirements for the low and high protection classes specified in the standard for the whole clothing and the fabric layer system, and to determine whether protection is provided against the heat where the electric arc occurs. An electric arc for a duration of 500 ms is applied on the test sample from a distance of 30 mm. With the help of the calorimeter placed behind the protective clothing and/or fabric layer system, the curve formed by combining the points on a graph of the temperature increase occurring after the arc flash is drawn.

It is widely used in Europe and the arc rating is not specified in ATPV as mentioned above. Instead, products are classified as Class 1 or Class 2. Samples are exposed to 4 kA for Class 1 (158 kJ) and 7 kA for Class 2 (318 kJ) for 0.5 seconds from a distance of 300 mm. These kilojoule values define the intensity of the electric arc flash created in the laboratory. It is proven that a PPE that has passed the box test successfully will prevent second degree burns if these kilojoule values are not exceeded.

As a result of the test, melting is not allowed, burning should be 5 seconds or less. The hole can be seen in the outer layer, but is allowed for a maximum of 0.5 cm in the inner layer.

Arc flash protective clothings (arc rated suits)

Preventing clothing and underwear from ignition often ensures survival. Limiting burns to a small surface area provides better results. Prevention of all burns is of course the best option, however it is also very important to survive from an accident with non-fatal burns of various sizes. Protective equipment must be used for this reason.

Clothings made of acetate, nylon, silk or their mixture should never be worn in hazardous workplaces. In environments where there is a risk of burning, clothings and/or underwears made of flame retardant fabrics should be used. Flame retardant fabrics are divided into two according to the production technique.

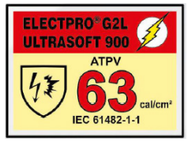
Finished fabrics with chemical FR treatment

Fabrics, such as cotton, cotton/polyester blends, cotton/polyamide blends, whose flame is delayed by various chemical treatments, do not lose their flame retardant properties until a certain number of washes. When washing in accordance with the manufacturer's instructions, there are flame resistant fabrics up to 30-50-100-150 washes, depending on the process applied.

Inherently flame retardant fabrics

Fabrics produced from various fibers such as metaaramid or paraaramid, viscose FR are inherently flame retardant. Even if washed many times, they never lose their flame-resistant properties. However, they are technical fabrics with higher costs compared to finished fabrics.

All of our ELECTPRO® series electric arc flash protective clothings produced by our company, IST Safety Ltd, are manufactured in accordance with the latest (EU) 2016/425 PPE regulation and have EU type examination certificates and passed the relevant tests of IEC 61482 standards.



ELECTPRO® G2L ULTRASOFT 900 High Level Electric Arc Flash Protective Suit protects the user's body against the negative effects of electric arc such as heat, flame, or molten particles. The protective hood is certified according to GS ET 29 standard and carries the CE mark. The visor of the hood is dark enough to protect the eyes from the flash. The protective suit consists of three parts which are the jacket, bib trousers and hood with visor, and all of them are made double-layered. The suit is Class 2 (7 kA) according to IEC 61482 1-2 standard. According to the IEC 61482 1-1 standard, the ATPV value of the suit and the whole layer system is **63 cal/cm2**.

Doruk TÜRKUÇAR
IST Safety Ltd
Export Manager
HSE Professional

https://www.ist.com.tr
https://linkedin.com/in/dorukturkucar