

Global standards on arc rated personal protective equipment – Part 1

Information from JAS Consulting

As installed infrastructure is operated beyond its design life, maintenance budgets are downsized and the interval between outages is ever increasing, electrical failures are becoming more prevalent in the global context. Electrical failures most often result in an electrical arc flash phenomenon.

As a result electrical arc flash safety requires special discussion. The electrical arc differs from conventional industrial fires quite substantially. Typical flash fires can reach temperatures in the range of 300°C for a few seconds. The duration of an electrical arc, although only a few ms, can reach temperatures well over 30 000°C. Typical personal protective equipment (PPE) is not effective against electrical arcs. Highly specialized clothing has been developed to offer electrical workers protection against this often fatal phenomenon.

In order to protect the end user, complex scientific test methods have been developed to separate fabrics which can perform in an electrical arc from those which just burn and disintegrate. This paper aims at introducing these standards and providing guidelines which can help the end user procure the correct PPE for their electrical workers.

Specifications

A specification outlines the minimum requirements of fabric to be met before being assigned the "arc rated" title. Specifications contain a number of test requirements and outline the pass/fail criterion. The test requirements are discussed in separate standards known as test methods. The test method states how the test should be performed and does not contain a pass/fail criterion. This explanation and the applicable standards are summarised in Table 1a and 1b.

ASTM and IEC standards

Specifications

ASTM F1506, Standard performance specification for flame resistant textile materials for wearing apparel for use by electrical workers exposed to momentary electric arc and related thermal hazards. IEC 61482-2, Live working – Protective clothing against the thermal hazards of an electric arc – Part 2: Requirements.

Test method

ASTM F 1959, Standard test method for determining the arc rating of materials for clothing. IEC 61482-1-1, Live working – Protective clothing against the thermal hazards of an electric arc – Part 1-1: Test methods – Method 1: Determination of the arc rating (ATPV or EBT50) of flame resistant materials for clothing.

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Table 1a: Relationship between test specifications and test methods.

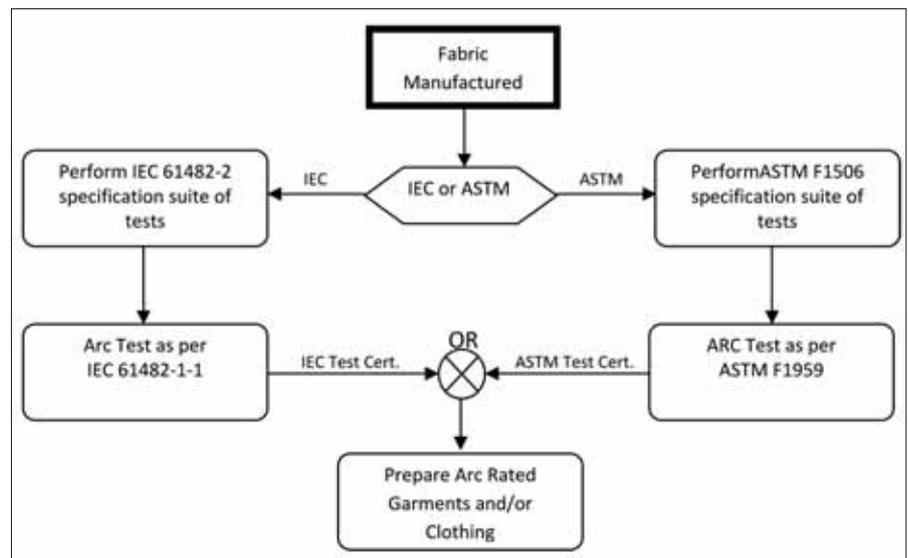


Table 1b: Relationship between test specifications and test methods.

Although there are many pass/fail criterion in the specifications, two requirements are discussed to illustrate the relationship between a specification and a test method. ASTM F1506 requires that single layered fabrics not display more than 5 s after-flame when tested using ASTM F1959 test method. ASTM F1959 is the electrical arc flash exposure test. Single layered fabrics which burn for more than 5 seconds cannot be arc rated.

The vertical flame test ASTM D6413, shown in Fig. 1, is also a requirement of ASTM F1506. After exposure to a flame (not an arc), the char length shall not exceed 152 mm and the after-flame shall not continue for more than two seconds. The fabric shall then be laundered or dry

cleaned for 25 cycles thereafter the test shall be repeated and the same criterion achieved. The most common arc exposure test method used globally is the method described in ASTM F1959.

ASTM F1959 test method

Due to the intense energy generated by an electrical arc flash, the testing of arc rated fabrics becomes a complex exercise in terms of generating an arc and accurately measuring the arc energy.

The arc generating rig consists of a thin wire connecting two electrodes. As soon as the system is energized, approximately 8000 A of current flows through the thin wire, instantaneously vaporising it and creating an arc between the two



Fig. 1: The ASTM D6413 vertical flame test.

conductors. The arc energy is adjusted by controlling the duration of the current flow. Hence the energy to test specimen is varied according to the arc exposure time.

The energy through the fabric is measured through copper calorimeters and compared to the energy of the arc. Data points are in the form of a "burn" or "no burn". A "burn" point is when sufficient energy penetrates the fabric to result in a human burn. A "no burn" point is when the fabric blocked sufficient energy to prevent a human burn. These data points are the inputs to a statistical linear regression analysis. This analysis method produces an "S" curve. The statistical probability of a 50% burn is plotted against the corresponding

energy value. This energy value is then assigned the arc rating of the fabric.

Exclusions

Some electrical workers are supplied with thermoplastic fabrics such as polyester, spandex and rayon amongst others. These fabrics are typically found in winter jackets, hair/beard nets, inner wear and t-shirts. Such materials fail the requirements of the ASTM F1506 specification. Not only will these not protect in the event of an arc exposure, but will increase the severity of the burn. This is due to the fact that these fabrics retain heat, melt and adhere to the skin. More than 80% of global fatalities are due to the ignition of such clothing types. It is therefore imperative that sufficient attention be given to the PPE used by electrical workers and operators.

Conclusion

Arc rated PPE is manufactured using highly specialised textile processes. As a result the testing requirements for such PPE are complex. The ASTM F1506 specification provides for the test criteria and sets the limits on whether fabric can be classified as arc rated or not.

The test method used to create the electrical arc and measure the energy generated is described in the ASTM F1959 test method. This test method also provides

details on the interpretation of results and the arc rating designation a fabric would receive. As the electrical arc flash phenomenon becomes more prevalent across the world, many manufacturers assume that traditional PPE would suffice as arc rated PPE. This is not true as many fabrics have not been arc tested. Often incorrect PPE may exacerbate burn wounds rather than offer protection to the end user.

References

- [1] ASTM F1506 - 08 Standard Performance Specification for Flame Resistant Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards
- [2] IEC 61482-2 Edition 1.0 2009-04 Live working - Protective clothing against the thermal hazards of an electric arc - Part 2: Requirements.
- [3] ASTM F 1959, Standard test method for determining the arc rating of materials for clothing.
- [4] SANS 61482-1-1/IEC 61482-1-1, Live working - Protective clothing against the thermal hazards of an electric arc - Part 1-1: Test methods - Method 1: Determination of the arc rating (ATPV or EBT50) of flame resistant materials for clothing
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