

Power Arc Testing of Fabrics for Personal Protective Equipment



Kinectrics has been providing High Current (HC) testing in its advanced HC Lab facility for nearly 40 years. This important work began with services performed as part of the former Ontario Hydro, a company that underwent provincial reorganization and demerger into a group of smaller companies during the 1990s. Kinectrics emerged from this transition in 1999 as a strong independent consulting company.

Today, Kinectrics continues to build on its outstanding reputation for technical excellence in providing electrical testing services to Canadian and U.S. utilities as well as manufacturing companies worldwide.

In addition to High Current testing services for Distribution, Transmission, and other industrial equipment, Kinectrics conducts power arc testing for the evaluation of materials and garments. This type of testing is done in accordance with the latest ASTM standards or to comply with client specifications.

Standard tests include:

- **ASTM F1959** Arc Rating on FR fabrics
- **IEC 61482-1-1:2009** Arc Rating on FR fabrics using flat panels and Method B for finished garments
- **ASTM F2621** Characteristics and Design Integrity of Arc Rated Finished Products in an Electric Arc Exposure
- **ASTM F1891** Arc and Flame Resistant Rainwear
- **ASTM F2178** Determining the Arc Rating and Standard Specification for Face Protective Products
- **ASTM F2676** Arc Protective Blanket for Electric Arc Hazards
- **ASTM F887** for arc exposure on fall-arrest systems (harness) using mannequins
- Misc other tests such as electrical accident replication



ASTM F1959 or IEC 61482-1-1:2009 Method A, Flat Panels

These methods are designed to obtain the Arc Rating (ATPV or Ebt) and Heat Attenuation factor (HAF) of Fire Retardant (FR) fabric.

Obtaining the Arc Rating on flat panels is economical and provides an accurate thermal response for the test fabric. Flat panel samples are uniform and in direct contact with the sensors on the panels. No air cushion, pockets, zippers, logos, or other obstructions are present. This is understood to be representative of a tight fit to the body for clothing being worn in work areas subject to potential arc flash. This type of direct contact for fabric testing is difficult to obtain on a mannequin, due to loose fit. Full garments also typically incorporate pockets, buttons, zippers, logos, and overlaps etc., which can produce false sensor readings if located over a sensor.

Flat panels also allow developmental fabric work to be performed more economically. Material construction and composition can be evaluated without the added cost of making full garments.

A standard fabric sample should be 30 cm x 66 cm after laundering, in accordance with the subject standard or other specification. A minimum of 27 samples is requested by the test laboratory to ensure a sufficient supply of samples for the test. More samples are required for multi-layer systems. The Arc Rating can be obtained on a single layer fabric or multi-layer system. See the laundering and sample preparation for difference between IEC and ASTM requirements.

The test is done at 8,000 A with a 30 cm arc length, and the fabric at a 30 cm distance. By keeping all these parameters the same, all fabrics can be evaluated under the same conditions. The incident energy is varied by changing the duration (time) of the arc.

Laundering and Sample Preparation

All materials—either flat panels or garments—must be laundered before testing. The number of laundering cycles varies depending on the standard or other requirements. The sample preparation instructions from ASTM F1959 are as follows:

8.1 Test Specimens for Two-Sensor Panel Test—From the material to be tested, make the post-laundered specimen size at least 61.0 cm [26 in.] long and at least 30.5 cm [12 in.] wide. Refer to Section 11, to determine number of samples required for the test.

8.1.1 The length direction shall be cut in the warp or wale direction of the material.

8.2 Laundering of Test Specimens:

8.2.1 Launder the required amount of test material for the test specimens allowing for fabric shrinkage in the laundering procedure using AATCC Test Method 135, Procedure 3, IV, A, iii.

8.2.1.1 Launder three times following this procedure.

8.2.1.2 Following the three laundry cycles, tumble dry following the prescribed procedure. Do not over dry.

8.2.1.3 Samples may be restored to a flat condition by pressing.

8.2.1.4 If an alternative laundry procedure is employed, report the procedure used (see 13.1.4).

8.2.2 For those materials that require cleaning other than laundering, follow the manufacturer's recommended practice using three cleaning cycles followed by drying and note the procedure used in the test reports (see 13.1.4).

NOTE 1—Drying is not required following the first two launderings.

Full Garment Evaluation on Mannequin, ASTM F2621

The finished garment can be evaluated for electric arc exposure once the Arc Rating is established. The exposure of the finished garment will help to identify weakness in the design or components that may compromise the fabric Arc Rating.

This test is usually done on a few samples at either the ATPV level or higher, depending on the requirements of the client. With the full garment test, different current levels, arc durations, and arc lengths can also be selected to more closely match the client's application.

During the test, the incident energy is measured using calorimeters placed on each side of the mannequin. The mannequin can be positioned to evaluate different areas of the garment, including exposures for front mid-chest, front mid-waist, side, or back.

Kinectrics' test facility is very accommodating. Our staff can provide assistance to clients in the configuration and performance of various tests to simulate field conditions.

A digital video recording is made of all tests performed, with a copy being provided to clients.

Specification for Arc Resistant Rainwear, ASTM F1891

The manufacturer must review and comply with all the requirements of ASTM F1891. The thermal performance is specified in Section 9.3. This section states that an electrical arc exposure test must be performed on the material with flat panel samples to determine the ATPV, HAF, and break-open threshold (E_{BT}), in accordance with ASTM F1959.

To determine the arc rating on rainwear material, up to 40 samples may be required to determine both the ATPV and E_{BT} . Up to eight yards of fabric may be required for the full test series.

Test Method and Specifications for Face Protective Products, ASTM F2178

To obtain an Arc Rating for face protective products, it must be meet the requirements and be tested according to ASTM F2178. The Arc Rating is obtained on the finished product using instrumented head forms with sensors in the eyes, mouth, and chin locations. This test is specifically designed to measure the energy through the window (lens or shield) of the product. The arc rating relates to the burn of the skin, not the retinal damage that may occur to the eyes.

If the product is a face shield without a hood, it is tested with a hardhat and mounting clips as are normally worn on the head. If the product is a lens that is used within a hood assembly, the complete assembly must be provided for each shot. The fabric used in the construction of the hood must also have an arc rating. This testing is done separately and is normally performed before the final assembly is tested. The fabric for the hood is tested according to ASTM F1959 as flat panels. The arc rating of the lens can be determined within the assembly of the hood. The final arc rating assigned to the finished product must be the lower of the two arc ratings (hood and lens).

The samples for this test must be fully assembled prior to shipping to Kinectrics. Two samples are tested at one time. A minimum of 10 shots (20 samples) will be tested. Kinectrics requests that 24 samples be available for the test. All samples will be destroyed after the test series. Some tested samples and the untested samples can be returned to the client if requested subject to shipping charges.

This test will not provide an arc rating of the hood; testing of the fabric for the hood must be done according to ASTM F1959.

Standard Test Method for Arc Protective Blankets , ASTM F2676

This test evaluates the ability of the arc protective blanket to withstand the effects of an arc blast. The test method determines resistance to break-open and mechanical strength under directional arc exposure where the blanket is hung in front of energized equipment to provide protection from the thermal effects and pressure wave.

The test method determines two ratings for the arc protective blanket: Maximum Arc Current (*I_{max}*) and Breakopen Threshold Protection (BTP). To be considered arc rated, the blanket shall withstand three times at least one of the nominal values of *I_{max}* without breakopen for a duration of 10 cycles. The three nominal values of current (*I_{max}*) are 15 kA, 25 kA and 40kA.

Specification for Personal Climbing Equipment, ASTM F887

To obtain an Arc Rating on a harness or lanyard, the product must comply with the requirements of ASTM F887. Section 22 specifies the requirements for electrical arc performance and is applicable to both safety harness and lanyards.

The finished product is exposed to an electrical arc installed on mannequins. The test is performed in two parts. First, the samples are exposed to an electrical arc to verify if the product can withstand an incident energy level of 40 cal/cm² and have no melting and dripping or ignition of any component. Second, these samples are subjected to the ANSI Z359.1 drop test. All samples must pass the test to be assigned the electrical arc rating. Kinectrics will perform the electrical arc exposure and send the samples back to the client for the drop test. The client must arrange to have the drop test performed as soon as practically possible.

Kinectrics Testing Deliverables

The price for arc testing and rating varies, depending on the test and the number of layers or arc energy required. Each type of test is also priced differently, depending on the quantity and exposure level. Multi-layer systems (such as for winter garments or switching coats) may require 50 to 100 cal/cm². This type of exposure is very severe and causes considerable wear on the test apparatus. These higher levels of arc exposure also require extra time to allow the test panels or mannequins to cool down before the next shot. Therefore, these tests are priced higher than the lower exposure tests.

The services provided by Kinectrics include the test waveforms, video and photographs on CD or DVD. Depending on the arrangements and requirements of the client, a test report can be prepared if arranged prior to the test date.

If the sample preparation is performed by Kinectrics, this will be noted in the report. Samples are discarded unless otherwise requested by the client. Please notify Kinectrics at the time of quotation request if samples are to be returned. Shipping charges for return of samples are extra.

Please e-mail your test requirements along with your company information and details regarding samples and a quote will be prepared.

Quality Management

Our Quality Management System is registered to ISO 9001 by QMI, a division of SAI Global and North America's leading QMS registrar. Our adherence to this standard provides one of the strongest assurances of service quality available.

As a minimum, all work at Kinectrics is performed to meet the requirements of ISO 9001. Supporting technical work is controlled through documented procedures. Quality is maintained through regular review, independent verification where required, and frequent internal audits.

Specific services are provided under supplementary quality assurance programs. For example, our Analytical Services and Electrical / Mechanical Testing & Certification Laboratories are accredited by the Standards Council of Canada as conforming to ISO Standard 17025.

For arc testing services, accreditation to CAN-P-4E (ISO/IEC 17025:2005) include ASTM F1959-06ae1, ASTM F2178-08, IEC61482-1-1:2009.

For more information about High Current Lab testing, Transmission & Distribution services or Kinectrics' other technical capabilities, please contact:



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