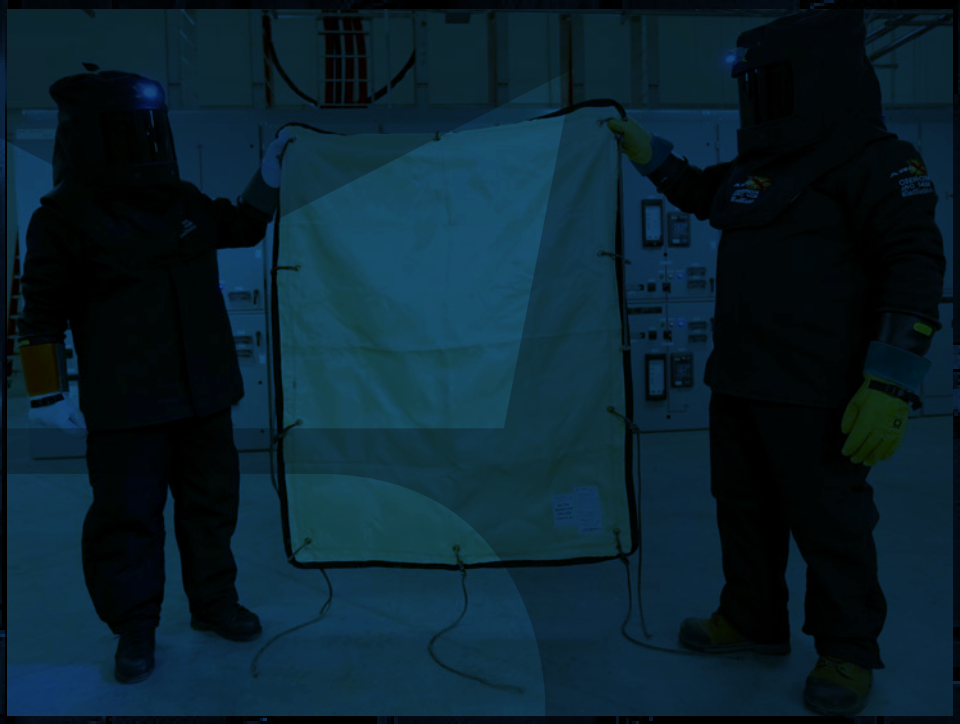

Arc Protective Blankets

Selection, Use, Care, and Maintenance Guide

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Arc Protective Blankets - User Guide

Reference Publications

- NFPA 70E-2024
- CSA Z462-2024
- ASTM F2676
- ASTM F3272
- NESC 2023
- CAN/ULC S801-14

Definition

Arc Protective Blanket - Flat assembly of fabric(s) with locations for attachment used as a barrier or barricade to protect workers from the effects of arc flash and arc blast.

Performance

Arc Protective Blankets are designed to contain or divert arc exposure energy during an arc flash and arc blast. Arc protective blankets can be used either as a barrier to protect workers (anyone inside or near the arc flash boundary), and/or as a barricade to obstruct access to hazardous work areas where the risk of an arc flash and arc blast hazard have not been adequately controlled.

Risk Assessment Requirements

When an arc flash risk assessment identifies the requirement for additional protective measures, arc protective blankets shall be considered as an engineering control that can mitigate the risk of worker exposure to an arc flash and arc blast hazard. As engineered solutions, arc protective blankets are more effective than other risk control methods, including the use of arc-rated personal protective equipment.

Hierarchy of risk control methods (NFPA 70E/CSA Z462):

1. Elimination;
2. Substitution;
3. Engineering controls;
4. Awareness;
5. Administrative controls; and
6. Personal Protective Equipment

Testing

Arc protective blankets are tested in accordance with ASTM F2676 standards. In this test an ejected arc flash and blast is directed towards the blanket. An arc rating is determined by the ability of the blanket to temporarily block and redirect arc exposure energy without breakopen.

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Additional test requirements include the ability to self-extinguish, limit afterflame time and the capability of the mechanical attachments to withstand exposure without failure. The test exposure is designed to simulate a worst-case scenario, and consists of the following:

- The ASTM F2676 test method simulates a condition in a vault or substation.
- Blankets are positioned vertically and anchored using attachment points to a blanket holding structure.
  - Metal frames are used when testing flat blanket assemblies consisting of floor to ceiling stanchions with cross supports to allow for attachment point assembly.
  - Other types of frames are used when testing protective wall assemblies where blankets are used as part of arc curtain cubes, portable barriers, and installed structures. Protective wall assemblies should be tested as sold to ensure the lab performance can be achieved in the field based on the installation application.

- The blanket test specimen is positioned 6” away from two protruding arc electrodes (4” apart) that initiate the arc exposure so that the arc blast projects directly at the blanket.

Blanket Arc Rating

Arc protective blankets are intentionally tested to the failure point to determine the energy and time required before the formation of one or more holes which may allow thermal energy to pass through, which is defined as breakopen.

- **Arc Rating:** Two ratings are determined:
  - Maximum arc current, I_{max}.
  - Breakopen threshold performance, BTP.
- **Arc Current:** Determining maximum arc current, I_{max}:
  - Three values of arc current are used: 15kA, 25kA, and 40kA. Testing requires that blankets shall withstand a minimum of 10 cycles without breakopen during three test exposures to at least one of the three arc current values. The highest arc current value a blanket can pass is assigned as the maximum arc current, I_{max}. In addition to I_{max}, blankets must also pass testing at two lower levels of arc current. For example, a blanket with an I_{max} of 40kA must also be tested and pass at 25kA and 5kA arc current levels. Refer to Table 1 in ASTM F2676 for more info on full BTP rating requirements, or the alternative Withstand Test Option for arc current levels and cycles (exposure time).
- **Breakopen:** Determining BTP.
  - Breakopen threshold performance (BTP) is determined by multiplying the arc current level

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by the exposure time (converted to cycles) measured as the interval between arc initiation and breakopen. This measurement requires a video review of the exposure captured using a high-speed camera with a sufficient frame rate to accurately determine the breakopen time. The BTP rating assigned to the blanket is the lowest of three average values resulting from exposures at three different arc currents.

- Each I_{max} amperage classification relates to a minimum BTP requirement:
  - 15kA = 150 BTP = 10 Cycles
  - 25kA = 250 BTP = 10 Cycles
  - 40kA = 400 BTP = 10 Cycles

Additional Test Requirements

In addition to BTP requirements, additional pass/fail criteria evaluated during testing include:

- **Mechanical strength** is the ability of the attachment points to sufficiently hold the blanket for the duration of the arc exposure. If any attachment point fails during testing the blanket shall receive no rating. Failing after the arc is extinguished is permitted provided the blanket remains suspended.
- **Afterflame** is permitted after the arc is extinguished but the time shall not exceed an average of 30 seconds across all tests, or any individual afterflame time shall not exceed 60 seconds, including the blanket and its attachments.

Blanket Specifications

Applicable standards and industry best practices provide guidance on the selection, procurement, and installation of arc protective blankets.

- **ASTM F3272 Standard:** Refer to the ASTM F3272 Standard Guide for Selection, Care, and Use of Arc Protective Blankets.
- **Test reports:** Ask for the manufacturer's test reports to validate marketing claims and review the results (i.e., observations, attachment types used, spacing of attachment points, etc.). Suppliers or manufacturers are required to provide a test report to the purchaser to verify compliance testing and certification (ASTM F2676). Test reports shall be dated within 5 years to be considered relevant (ANSI/ISEA 125).
- **Attachment types:** The style and type of materials (i.e., ropes, straps, etc.) used as attachments to anchor blanket test specimens in testing shall be the same material and

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construction as how the blanket is sold (ASTM F2676). Blankets shall never be sold without the original attachments used to determine the protective arc rating. Additional attachment materials shall be made available for purchase when additional alterations may be required during the blanket installation.

- **Suitable storage bag:** Arc protective blankets shall be stored as per the manufacturer's recommendations. Storage bags shall be included with purchase or made available separately.

Blanket Selection

Following a hazard-based risk assessment, arc protective blankets are selected based on the type of equipment that has been determined to require additional protection, worker positioning and installation requirements.

Blankets are available in a range of protection levels (maximum arc current, I_{max}) and breakopen threshold performance values (BTP), and a variety of application options (size, construction type, etc.).

Arc protective blankets can be used as a barrier to confine or divert an arc flash and arc blast or as a barricade to prevent access to areas with electrical equipment rated with dangerous incident energy levels.

A general overview of the selection process includes the following:

1. **Maximum fault current:** select an arc protective blanket with an I_{max} that exceeds your maximum fault current. Options include:
   - 15kA
   - 25kA
   - 40kA
2. **Break open performance (BTP):** ensure the arc protective blanket BTP rating exceeds the maximum clearing time of the upstream overcurrent protection device.
   - BTP = I_{max}*Cycles
   - Divide the BTP rating by the I_{max} to determine the blanket's performance expectation in cycles.
   - Examples based on Oberon arc protective blankets:
     - 15kA I_{max}, 181 BTP = 12.1 Cycles
     - 25kA I_{max}, 270 BTP = 10.8 Cycles
     - 40kA I_{max}, 517 BTP = 12.9 Cycles
3. **Highest rating:** Blankets with the highest BTP rating are the most protective at the assigned maximum arc current I_{max} because the product will withstand the arc energy for a longer

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duration of time, allowing the upstream overcurrent protective device time to clear the fault condition.

4. **Application type:** Evaluate the equipment location to determine the arc protective blanket application type. The two most common options are:
   - Flat protective cover type blankets are selected based on the equipment type, size and worker location(s), then positioned between the worker and the electrical equipment. Traditional blanket sizes are 4’ x 5’ or 5’ x 8’. Custom sizes are available for larger installation requirements.
   - Portable or permanently installed structures using arc protective blankets as a protective wall are selected when the protective barrier needs to “stand alone” and be assembled further away from the electrical equipment. A variety of options are available including foldable arc curtain cube structures consisting of three or more panels each measuring 4’ wide by 6’ tall. Custom sizes are available with taller panels (may be required due to worker positioning).

Blanket Installation

Only qualified installers shall be permitted to install arc protective blankets and installation methods shall be verified and approved by an electrical engineer.
Installation methods shall consider the protective value of the blanket, attachment point strength, anchorage, and other engineering assumptions of the hazard assessment.
Installation requirements:

- **ASTM F3272 Standard:** Refer to the ASTM F3272 Standard Guide for Selection, Care, and Use of Arc Protective Blankets.
- **Engineering assessment:** An engineering assessment is required to determine installation requirements for positioning, attachment points and anchoring. The assessment shall consider blanket design, distance from the exposure, electrode geometry, anticipated performance based on the clearing time, operational limitations, and other applicable factors specific to the nature of the work tasks performed.
- **Safely secured:** Arc protective blankets installed as flat assemblies shall be sufficiently

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secured to anchors and withstand the forces generated by the arc energy.

- **Anchored:** Portable or permanently installed structures containing blankets used as protective walls shall be sufficiently anchored to achieve the desired results.
- **Product identification:** Refer to the product label to identify one-sided blanket labeling with a marking “This Side Toward Worker” that shall be placed toward the worker unless the blanket is identical from either side. Oberon arc protective blankets are identical from either side to help reduce human error during installation.
- **Do not disturb:** Cables and cable splices during installation. Disturbing energized electrical equipment can cause an arc flash.

Installation Recommendations

General advice based on applicable standards and field experience for installation methods includes:

- **Installation as tested:** For the most predictable BTP performance the arc protective blanket must be installed using the same spacing between attachment points that was used when the product was arc rated (ASTM F2676).
- **Worker height:** To maximize worker protection, arc protective blankets must be installed with the top of the blanket in a position where it provides maximum protection by diverting the energy over the worker’s head. Custom size blankets may be necessary depending on worker height and/or positioning.
- **Do not wrap:** Avoid tight wrapping when installing arc protective blankets. Arc energy is only temporarily contained by the blanket before diverting away from the energy source. For example, if an arc protective blanket were tightly wrapped around a cable splice the arc energy would be trapped and create a pressure vessel that could result in an explosion.

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Tension used to install blankets during testing ensures worst case scenario for the arc performance. In field performance of arc protective blankets may exceed lab testing results when installations consider how blankets can expand and direct arc energy away from workers and/or nearby equipment.

- **Slack vs taut:** By allowing slack when installing the blanket panel, the material can expand and move away from the arc to allow a path for the energy to travel. Loose wrapping can allow energy to shunt out the ends, following the path of least resistance. Arc protective blankets are primarily designed to redirect the arc exposure energy, not to contain. Consider the direction where the arc exposure energy will be directed when designing the installation and determining worker positioning.
- **Avoid gaps:** When multiple arc protective blankets are installed in a series (connected to span across a large area), such as panels used to construct a protective wall, it's important to ensure that no gaps are visible between the blanket and the blanket holding structure.
- **Anchors:** Use anchors with adequate strength based on installation requirements. Engineering methods are required to determine the necessary strength rating for anchors and attachment points. During arc testing, attachment points supporting fully stretched and taut (like a trampoline) arc protective blankets received in the range of 1,000 lbs of force. Anchor options used for temporary installations include floor to ceiling (or wall to wall) stanchions to create a blanket holding structure, magnets, or industrial strength suction cups that mount on smooth surfaces. Permanently installed anchor options include fixed mechanical or removable concrete anchors including D-rings, bolts, or other attachments typically rated from 5,000 lbs up to 10,000 lbs maximum capacity.
- **Building walls:** Protective barriers using blankets supported as walls is an effective way to protect workers and equipment from exposure to an arc flash incident. Wall sections consist of blankets installed like a trampoline on a frame structure that's adequately anchored, grounded if necessary, and can be temporary (portable) or permanently fastened to the floor and other structures. Sections of blankets can be installed as retractable curtain systems to allow blanket panels to be moved as needed for workers to gain access to equipment for work task requirements. Blankets can be ordered in custom sizes and attachment spacing.

- **Grounding:** Blanket supporting structures made of conductive material shall be grounded when

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installed inside the limited approach boundary.

- **Avoid UV light:** Most arc protective blankets are constructed using aramid fiber including DuPont Kevlar® that can be vulnerable to strength degradation resulting from UV light exposure. When installations are exposed to direct sunlight the installer must consider the duration of the exposure and if necessary, use protective coverings to prevent UV light exposure. UV exposure can cause discoloration of the aramid materials that would provide a visual indication that a blanket has been negatively affected and needs to be replaced.

Care, Use & Storage

Arc protective blanket care, use, and storage requirements are critical to maintaining product performance and life cycle expectancy.

- **Use PPE:** Use of arc protective blankets do not eliminate the need for arc-rated protection but may reduce the level of the hazard in some installations.
- **Cleaning:** Refer to the product label for instructions on how to clean the arc protective blanket. The most important requirement when using blankets is to avoid hydrocarbon contamination that can negatively affect performance by fueling extended afterflame conditions that can result in a failure to protect workers or nearby equipment.
- **Inspection:** Arc protective blankets shall be inspected before each use, including the fabric portion, attachments, support structures, and anchors. When workers identify issues during inspection the arc protective blanket shall be removed from service. Inspection criteria includes:
  - **Fabric:** Inspect both sides of arc protective blankets for visible signs of damage including contamination with flammable substances, excessive wear, tears, ripped seams around the edges, fraying, holes, or other issues that may negatively affect product performance.
  - **Attachments:** Verify structural integrity by inspecting for signs of wear, damaged or missing grommets, attachment ropes, straps, buckles, carabiners, and other products used for fastening the blanket.
  - **Support:** When supporting structures are used as part of the installation, such as portable arc curtain cubes, inspect the frame to ensure all components are securely connected and there are no signs of damage including cracks or broken materials.
  - **Anchors:** Confirm all anchoring mechanisms are secure, that suction cups are fully engaged, bolts are tight, and ensure all attachment points are safely connected. Attachment points not connected can become an additional hazard for a worker in the event of an arc flash incident.

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  - **Discoloration:** Inspect the fabric portion of arc protective blankets for visible discoloration. Fabrics constructed using DuPont Kevlar® are sensitive to UV light and can change color, going from yellow to a darker shade of brown. Discoloration is an indicator for when a blanket needs to be taken out of service due to the decrease in fiber strength. Blankets need to be labeled with sufficient warning and recommendations to store out of sunlight or to replace after an amount of time of use in sunlight.
- **Storage:** Arc protective blankets shall be stored as per manufacturer recommendations when not in use. Recommendations include storage bags, containers, cabinets or lockers. Large portable structures including arc curtain cubes used as protective walls shall be covered when not in use to prevent soiling and UV exposure.

Maintenance & Repair

Arc protective blankets shall only be repaired by the manufacturer. Blanket supporting structures used as portable or permanently installed protective walls can be repaired by a qualified installer provided an updated engineering assessment is completed. Attachment points can be replaced by a qualified installer. Only manufacturer approved attachment materials shall be used.

Use Case Examples

Various use case examples have been demonstrated throughout a variety of industries by employers with sufficient knowledge and expertise to understand and install arc protective blankets to mitigate risk for workers exposed to the thermal, ballistic, and concussive forces generated by an arc flash event.

The following are common use case examples for both low and high-risk mitigation techniques using arc protective blankets:

- **High Risk:** Provide primary protection when workers are exposed to energized electrical equipment where complete de-energizing of the work zone cannot be achieved. Typical examples include (ref. ASTM F3272):
  - Vaults
  - Cable splices

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  - Transformers
  - Bare disconnects
  - Switchgear
  - Motor Control Centers (MCC)
  - Electrical Rooms
- **Low Risk:** Provide secondary protection due to high arc flash incident energy that could result in the event of an arc flash.
  - Protective structures to encapsulate electrical equipment.
  - Portable arc curtain cubes used as barricades to prevent access to work areas.

References in Workplace Electrical Safety Standards

NFPA 70E and CSA Z462 do not address the use of arc protective blankets. Only blankets used for shock protection are currently covered. When arc protective blankets are used as a barricade to restrict access to high-risk areas, the existing language from the standards prohibits installation of conductive blanket holding structures inside the limited approach boundary and arc flash boundary.

NFPA 70E/CSA Z462 Standard Definitions

Arc protective blankets are not well defined in standards. Arc protective blankets can be described as both a barricade and a barrier installed as a physical obstruction capable of containing or diverting an arc flash hazard. Blankets used as protective wall structures can be used to limit access to high-risk work areas with electrical hazards.

Related definitions from NFPA 70E/CSA Z462:

- **Barricade** – A physical obstruction, e.g., tape, cones, or an A-frame-type wood or metal structure, intended to provide a warning about and to limit access.
- **Barrier** – A physical obstruction that is intended to prevent contact with equipment or energized electrical conductors and circuit parts.
- **Enclosure** – A case or housing of apparatus, or a fence or walls surrounding an installation, intended to prevent persons from unintentionally coming into contact with energized electrical conductors or circuit parts, or to protect electrical equipment from physical damage.
- **Guarded** – Covered, shielded, fenced, enclosed, or otherwise protected by suitable covers,

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casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger.

Related articles/clauses from NFPA 70E/CSA Z462:

Anticipating Failure

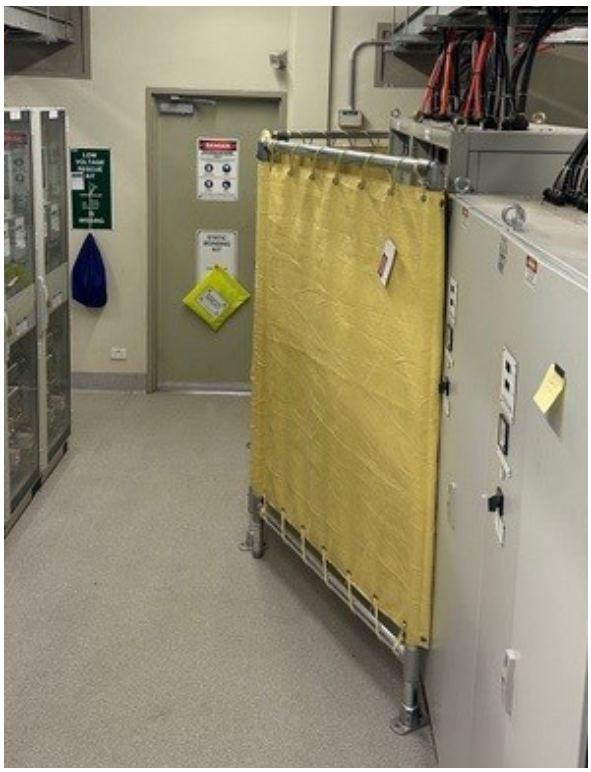
Electrical equipment that could fail and injure workers shall be de-energized, unless de-energizing introduces increased risk or additional hazards, or is infeasible because of equipment design or operational limitations. Until the equipment can be de-energized or repaired, workers shall be protected by suitable barricades and other alerting techniques necessary for the safety of the workers.

Barricades

Suitable barricades shall be used where it is necessary to limit access to work areas containing energized electrical equipment.

- Barricades shall not be placed closer than the limited approach boundary or arc flash boundary, whichever is further.
- Conductive barricades shall not be used where they increase likelihood of exposure to an electrical hazard.

Note *Arc protective blankets used as a barricade by assembling a protective wall can be used to avoid the requirement to station an attendant*.



Attendants

An attendant shall be stationed to warn and protect workers when barricades do not provide sufficient protection from electrical hazards.

• Responsible to keep unqualified persons outside a work area.

• Shall be posted as long as there is a potential for workers to be exposed to the electrical hazards.

Barrier Application

Existing workplace electrical safety standard language describes barriers as a physical obstruction to prevent exposure to electrical hazards: exposed energized electrical conductors or circuit parts to prevent shock hazards (contact) or an arcing fault (arc flash).

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References in Standards for Electric Utility Workplace Electrical Safety for Generation, Transmission, and Distribution

Arc Protective Blankets are recognized as engineered controls that shall be applied to protect workers from an arc flash (ref. CAN/ULC S801-14).

- Engineered controls – arc-flash blankets.
- Administrative controls – safe work methods.
- PPE – based on risk assessment.

IEEE C2-2023 National Standard

Arc protective blankets are not referenced in the NESC 2023 – National Electrical Safety Code.

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Oberon
375 Faunce Corner Road
North Dartmouth, MA 02747 USA
P: 800.322.3348
F: 508.999.4443
oberon-service@surewerx.com
www.oberoncompany.com