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Standard Guide for Selection, Care, and Use of Arc Protective Blankets[1]

This standard is issued under the fixed designation F3272; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide provides information for the selection, care, and use of arc protective blankets for personnel protection.

1.2 This guide covers positioning and securing arc protective blankets (tested to Test Method F2676) and channeling the thermal, ballistic, and concussive forces generated by an arc flash event using arc protective blankets.

1.3 This guide describes the use of the arc protective blanket to maximize its protective effectiveness to workers exposed to energized electrical equipment where complete de-energizing of the work zone cannot be achieved or for low-risk exposures with sufficient arc flash incident energy to warrant secondary protective means in the event of an arc flash.

1.4 The values stated in SI units are to be regarded as the standard. See IEEE/ASTM SI-10.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D4391 Terminology Relating to The Burning Behavior of Textiles

F819 Terminology Relating to Electrical Protective Equipment for Workers

F2676 Test Method for Determining the Protective Performance of an Arc Protective Blanket for Electric Arc Hazards

2.2 *IEEE/ASTM Standard:*[2]

IEEE/ASTM SI-10 American National Standard for Metric Practice

2.3 *NFPA Standard:*[3]

NFPA 70E-2018 Standard for Electrical Safety in the Workplace

2.4 *CSA Standard:*[4]

CSA Z462-2018 Workplace electrical safety

2.5 *OSHA Standards:*[5]

29 CFR 1910.269 Occupational Safety and Health Standards: Special Industries

29 CFR 1926.950-969 Safety and Health Regulations for Construction

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions relating to the burning behavior of textiles, see Terminology D4391 and for definitions relating to electrical protective equipment for workers, see Terminology F819.

3.1.2 *abnormal condition, n*—abnormalities such as but not limited to, oil or compound leaking from cable or joints, broken cable sheaths or joint sleeves, hot localized surface temperatures of cables or joints, or joints that are swollen beyond normal tolerance are presumed to lead to or be an indication of an impending fault.

3.1.3 *anchoring, n*—method of physical attachment for securing the blanket and all attached components (straps, stanchions, other hardware, etc.) in place for the duration of the protection level for which the blanket is rated.

3.1.4 *arc protective blanket, n*—a flat assembly of fabric(s) with locations for attachments used to protect workers from the effects of arc flash and arc blast.

[1] This guide is under the jurisdiction of ASTM Committee F18 on Electrical Protective Equipment for Workers and is the direct responsibility of Subcommittee F18.65 on Wearing Apparel.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.

[4] Available from Canadian Standards Association (CSA), 178 Rexdale Blvd., Toronto, ON M9W 1R3, Canada, http://www.csagroup.org.

[5] Available from Occupational Safety and Health Administration (OSHA), 200 Constitution Ave., NW, Washington, DC 20210, http://www.osha.gov.

3.1.5 *arc protective blanket maximum arc current Imax, n*—maximum value of RMS arc current that blanket can withstand without breakopen for no less than ten cycles of 60 Hz.

3.1.5.1 *Discussion*—Standard values of the maximum arc current for this test method are 16 kA, 25 kA, or 40 kA.

3.1.6 *arc protective blanket breakopen threshold performance (BTP), n*—the product of the arc current I, kA and arc duration in cycles required for breakopen to occur at this same arc current level.

3.1.7 *blistered insulation, n*—a condition in which electrical insulation exhibits visible signs of thermal deformation usually exhibited as a bubble on the insulation.

3.1.8 *conduit channel type construction, n*—a standardized formed structural system used in the construction and electrical industries for light structural support, often for supporting wiring, plumbing, or mechanical components such as air conditioning or ventilation systems. The strut is typically formed from sheet metal, folded over into an open channel shape with inwards-curving lips to provide additional stiffness and as a location to mount interconnecting components.

3.1.8.1 *Discussion*—The sizing and types of strut vary, but typically it is 14-gauge with half-inch hardware construction or equivalent for concrete construction. Rated blanket attachment straps with rated carabiners are used to hold the blankets in place. This construction method is also widely used when the integrity of the vault wall is questionable and the need to spread the load is necessary. Using this method, longer pieces of strut are used and more anchor bolts are used to attach it, thus spreading the load.

3.1.9 *fixed mechanical concrete anchor, n*—this type of anchor is produced in a variety of styles that includes standard fastening hardware and rated hardware and may come with torque indicators (shear bolts) notifying the user the anchor has been installed properly.

3.1.10 *inverse square distance formula, n*—heat and concussive energy/force decreases generally as the square of the distance.

3.1.11 *removable concrete anchor, n*—a removable securing device for securely attaching an arc protective blanket to walls made of concrete.

3.1.11.1 *Discussion*—This type of anchor is quick and easy to install and can be reused, thus holding down hardware costs. This type of anchor is produced in a variety of styles that include, but are not limited to, D-ring anchors with and without friction sleeve bolt attachments and are typically rated at 5000- and 10 000-lb (2268- and 4536-kg) maximum capacity.

4. Summary of Guide

4.1 This guide provides background understanding for selection, care and use of arc protective blankets as tested by Test Method F2676. The guide is not a work practice and does not require blankets be used in the conditions described.

4.2 The guide provides guidance for users to inform work practices, for development of blanket use schemes and ideas for testing efficacy of blanket configurations and practices.

4.3 The guide is based on the collective knowledge of the committee, published practices of committee members, testing, and OSHA testimony in 29 CFR 1910.269.

5. Significance and Use

5.1 This guide provides positioning, installation, and anchoring techniques that may be used to arrange arc protective blankets to confine or divert the energies found from a fault that may include plasma arcing, pressure wave, and projectiles.

5.2 Arc protective blankets may be used in an electrical application to confine or divert energy away from a work zone for electrical or other workers who may be exposed to an electric arc in the event of an equipment or conductor failure.

5.3 This guide provides information for working around cables, splices, and any equipment components that have historical failures deemed to require additional protection or engineering controls, which could benefit from added protection provided by an arc protective blanket.

5.4 This guide is designed for electrical engineers and qualified installers of arc protective blankets.

5.5 The practice is limited by the blanket protective value, the sturdiness of the installation, and the engineering assumptions of the hazard assessment.

5.6 These blankets do not typically provide dielectric protection.

5.7 These blankets do not eliminate the need for arc-rated PPE but may reduce the level of the hazard in some installations.

6. How Blankets Work to Help Protect from Arc Flash

6.1 An arc protective blanket is designed to direct heat, gasses, and projectiles away from the worker. While the arc protective blanket is tested to confine or divert an ejected arc up to the arc protective blanket breakopen threshold performance (BTP) level in the rating, it is always safer to channel energy away from the workers rather than challenge the energy. For example, putting slack in the center at the top of the blanket to allow the energy to be directed above the blanket may be more protective in some scenarios.

6.2 Tension in testing ensures full, worst case exposure to arc (the blanket is installed like a trampoline). This installation method is typically used only when installing the blanket like a wall. Installing blankets with other methods typically will allow better performance of the blanket but may compromise the area protected by the blanket by diverting the energy. Energy diversion away from workers is a key method to use in blanket installation. Some allowance for blanket movement away from arc can allow for greater protection.

6.3 Some blankets have a sidedness and the marked side should always be installed as recommended by the manufacturer.

7. Installation Practices

7.1 *General:*

7.1.1 Choose a blanket with a maximum rating greater than the predicted fault current at the location. Exceeding the

blanket rating or failure to secure the blanket by the method as tested may result in failure to completely protect or provide limited or no protection.

7.1.2 Use the largest blanket that will fit into the available space.

7.1.3 Use the attachments provided by or required by the manufacturer, which are typically flame resistant. If the manufacturer's connecting means are not used, any alternate connecting means should have tensile strength equal to or greater than the manufacturer's supplied means and not be affected by the thermal energy from the arc to ensure the efficacy of the connecting means. This is typically done through testing.

7.1.4 Install the top of blankets at a height ideally above the worker's head in a work situation to allow energy to be diverted above the worker's head. Secure the blanket at the top to prevent energy diverting into the area of the face.

NOTE 1—In the case of an arc flash suit, the torso typically has more protection than the head or the legs due to the overlap of the bib from the overalls and the hood bib that covers the top of the torso.

NOTE 2—When wrapping or installing in a horizontal, planar installation, tools, equipment, or parts placed on a blanket could be ejected in the event of a failure.

7.1.5 Ensure the blanket's rating is adequate for the anticipated fault current and predicted clearing time for the work location using the BTP of the blanket but not above the maximum rated current of the blanket. Use of a blanket beyond its maximum fault current or its maximum BTP may have unintended effects such as complete blanket failure or extensive after flame of the blanket. In an enclosed area, this effect can be dangerous. Some blankets may have harmful effects at higher levels but this is typically not discernable by standard test results. Contact the manufacturer for guidance on blanket use in unusual conditions (such as oil-filled cables or breakers, higher fault currents, enclosed spaces), or in abnormal conditions.

7.1.6 Disturbing energized electrical equipment, especially cables and cable splices, can cause an arc flash. Exercise best practices when installing blankets for worker protection.

7.1.7 Engineering a blanket installation by using distance from the exposure, electrode geometry, the clearing time, and other applicable factors would be acceptable.

7.1.8 The complexity and arrangement of cable, cable splices, and other energized equipment; the variety of vault space, purpose, and configuration; the composition of each space's infrastructure; the wide variety of hardware used to hold and secure electrical components and devices found therein; and the deterioration exerted, as a result of both electrical and environmental stress, may require the use of more than one anchoring and shielding method outlined in this guide.

7.1.9 Stations, straps and buckles, carabiners, lugs, and other items used to install blankets can become a hazard if they cannot withstand the pressure from the arc fault.

7.2 *Shielding Methods:*

7.2.1 *"J" Type Shielding*—The "J" Type installation (Fig. 1) is so named because, upon placement of the blanket in front of the racks and splices, the bottom of the blanket is tucked back toward the vault wall and the top is arrayed in a "D" shape with the middle of the blanket bowed out so that the completed arrangement looks much like a sail. The potential arc blast is not allowed under the blanket and its energy is channeled away from the worker around the sides and up over the worker's head IF the installation is tall enough. Other applications may use the "J" installation when it is desirable to shunt energy upward. The straps at the top will be looser than those on the sides in this installation.

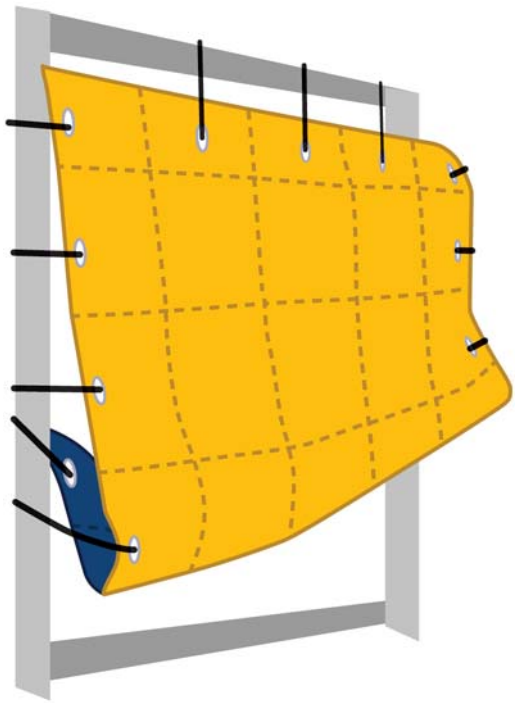


FIG. 1 "J" Type Shielding

7.2.2 *Clamshell "C"*—Individual splices may be enclosed using a clamshell type installation to shunt energy out the ends of the blanket or individual splice and prevent exposure to the worker.

7.2.2.1 This method may be used over a wrapped blanket as an additional protective layer and anchored top and bottom to the back of the vault wall with the open end of the "C" shape pointed to the vault wall (Figs. 2-4). The intent is to channel the

NOTE 1—Straps and anchors are not shown.

FIG. 2 Clamshell with Wrapped Cable Splice

FIG. 3 Blanket Installation (clamshell method over cable splices)

energy sideways away from the worker and, since the first wrapped blanket is lying directly on the splice, this second blanket system is arrayed as a precaution. This also prevents the wrapped blanket from dislodging and hitting workers.

7.2.2.2 Use extra attention when using this method to ensure no contact with energized parts and to prevent allowing metal or carabiners to contact energized parts.

7.2.3 *Suspended Blanket Wall*—This method was developed as part of the test method and used by some utilities. A device made of steel piping is assembled in the vault and attached to screw jacks (Fig. 5). The jacks are tightened, exerting pressure on the ends and thus, holding the structure in place, a blanket is attached to these stanchions creating a barrier wall. It can be used against the vault wall or away from it. Creating a clean and secure surface for the pressure pads is a challenge, but in testing it has performed well in the test vault including the management of 40kA/10-cycle shots. However, in some applications it has proven to be difficult to get the piping pieces into the manhole or vault.

7.2.3.1 A variation of this may be a permanent installation (see Fig. 6).

7.2.3.2 This is a variation of the "J" installation.

7.2.3.3 Stanchions, if not tested, installed, and designed to withstand the blast pressure of the arc, can become a hazard.

7.2.4 *Arc Cube Method* (Fig. 7)—This method uses a dielectric cube installed in place around the worker position to shield the worker from an arc flash while leaving all equipment in place. This method does not use pre-installed anchors but does require a blanket designed for use on the cube, and the cube itself needs to be anchored or tightly installed in the vault so that movement is limited to prevent destruction to the cube.

7.2.4.1 This method may allow the cube to move or block the cube in place to prevent movement from the arc blast. The cube may be to protect the work zone only and be far away from the potential blast to prevent the worker from being inside the arc flash boundary or to lessen the effect of the energy from inside the arc flash boundary. The structure may be anchored to prevent movement, depending on energy level needs.

7.2.4.2 This method does not shield the worker in Fig. 7 from an arc flash in the voltage testing in front since there are no blankets installed in that side, but would serve to shield from arc flash energy from the two protected sides.

7.2.5 *Portable Barrier Method* (Figs. 8 and 9)*:*

7.2.5.1 This method uses a heavy, weighted frame and blanket assembly to shield the worker from an arc flash while leaving all equipment in place. This method does not use pre-installed anchors but does require the frame be designed for use with a specific sized blanket and the blanket be installed properly. The frame must be designed to withstand the pressure from the blanket in an arc event. This design allows venting on the sides in some installations and venting upward with the bowed design. The frame must be adequately weighted to prevent capsizing onto a worker. The utility that developed this portable barrier method uses it when equipment is uncovered to protect workers passing by.

7.2.5.2 Another use of this portable barrier method could be to make the blanket with a hole in the location of a switchgear racking point to allow a racking screw to be inserted and used for additional protection when racking a breaker.

7.2.6 *Woven Method*—The attachment points for the blanket would be behind the splices, which are located on racks (Fig. 10). In the testing, the suspension wall device was used against the vault wall and fitted around the splices. Of the three splices in the figure, the middle would be de-energized while the top and bottom would be energized. The blanket is attached at the top in the same manner as the "J" method and then woven behind the dead circuit and then back into the front of the rack and draped down the rest of the racks and splices. At the bottom, the blanket is folded back toward the vault wall and secured.

7.2.7 *Wrapping*—This installation method is used primarily when there are energized cables below the de-energized cable that is to be worked on and using the "J" method would channel the energy up at the worker and when other methods are not found acceptable or practical. This method is a loose wrap of a large blanket tied loosely at the ends of the blanket to the cable or a loose wrap to allow energy to be directed out the ends of the wrapped blanket. Ensure that this installation method does not increase the risk of faulting by the installation process (such as disturbing energized splices or cables wrapped in arc proofing or asbestos).

7.2.7.1 Loose wrapping with a minimum of two layers of the blanket with loose strapping connections at the ends only to allow the blanket to expand in the middle and to allow energy to escape at the ends.

7.2.7.2 It is further strongly recommended not to move cables or cable splices during the installation process.

7.2.7.3 Wrapping may be used as a last resort when the geometric constraints at the worksite allow no other choice.

7.2.7.4 Wrapping tests have shown as little as one cycle failures of the blanket during faults due to the pressure increase at the arcing point and extreme temperatures of the arc plasma on the wrapped blanket. Tight wrapping is not recommended as the blanket will fail quicker and may focus arc flash energy toward and through the failure point.

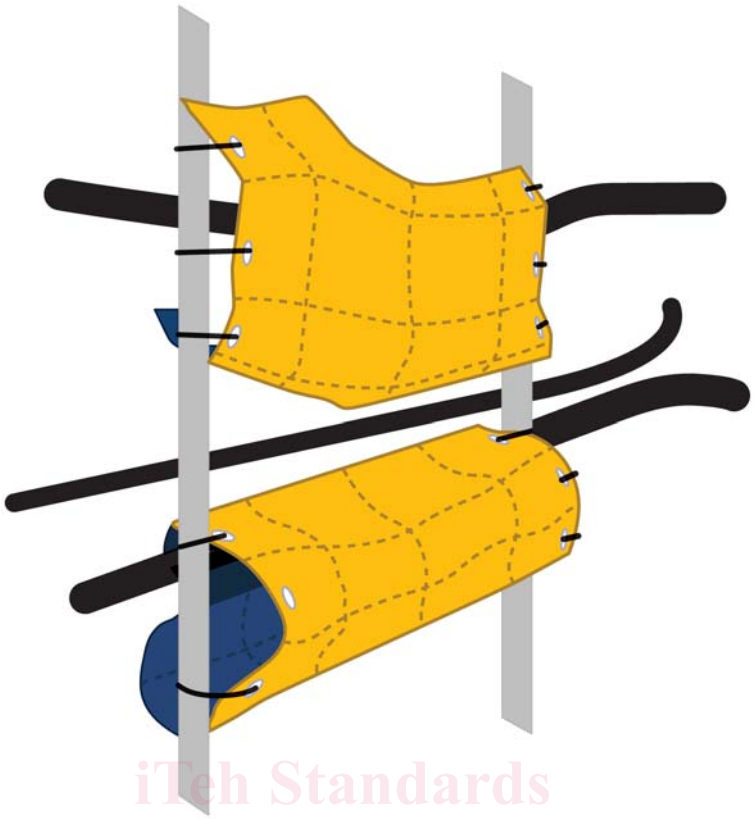


FIG. 4 Double Clamshell without Wrapping Blanket Shown (exposed splice is deenergized)

7.2.7.5 Loose wrapping has been shown to shunt energy out the ends of the blankets. If wrapping is used, the company training on the procedure and subsequent testing and failure modes will be communicated to those using the method and affected by the method so that workers will be aware of the failure mode and location of potential increased hazard. In testing, best performance with wrapping included a second blanket in the clamshell configuration of the "J" configuration.

8. Installed Space Management

8.1 *General:*

8.1.1 Consider maneuvering the blanket (positioning) in and around the cables, the splices, the rack arm, and the racks.

8.1.2 Consider blanket placement relative to the worker.

8.1.3 Consider blanket capability relative to its proximity to specific energized components.

8.2 *Anchoring:*

8.2.1 Anchoring is recommended for holding blanket in place to contain or shunt arc energy away from the worker but also to keep blanket, carabiners, or straps from harming workers during an arc event.

8.2.2 Identify a reliable point to secure the blanket.

8.2.2.1 Channel iron.

8.2.2.2 Install anchor points into the walls.

8.2.2.3 Install a cage or stanchions.

8.2.2.4 Other suitable method for installation.

8.2.3 Construction limitations of surfaces such as the walls, ceilings, floors, inside of the vault/manhole, and in some cases outside may require use of various permanent and temporary devices and work methods.

8.2.4 *Suitability*—Consider reliability issues of anchoring and the effects of water, salts, and climate degradation on walls and anchoring points.

8.2.5 Carabiners should effectively fit the place of installation so that they remain attached securely during an arcing event. Double locking carabiners are recommended since a carabiner opening during an arc flash event can increase worker exposure. They may not be required since they will not be used to support human weight.

8.2.6 In testing to date, each of the anchor points has received in the range of 1000 lb of force when the blanket is taut and all anchor points have been used.

8.3 An electrical safety program establishes safety practices to determine if equipment can be de-energized and to prevent work that can safely be de-energized without additional hazards or risk to employees or the public. The electrical safety program should include a hazard assessment with fault current levels for the blanket installation.

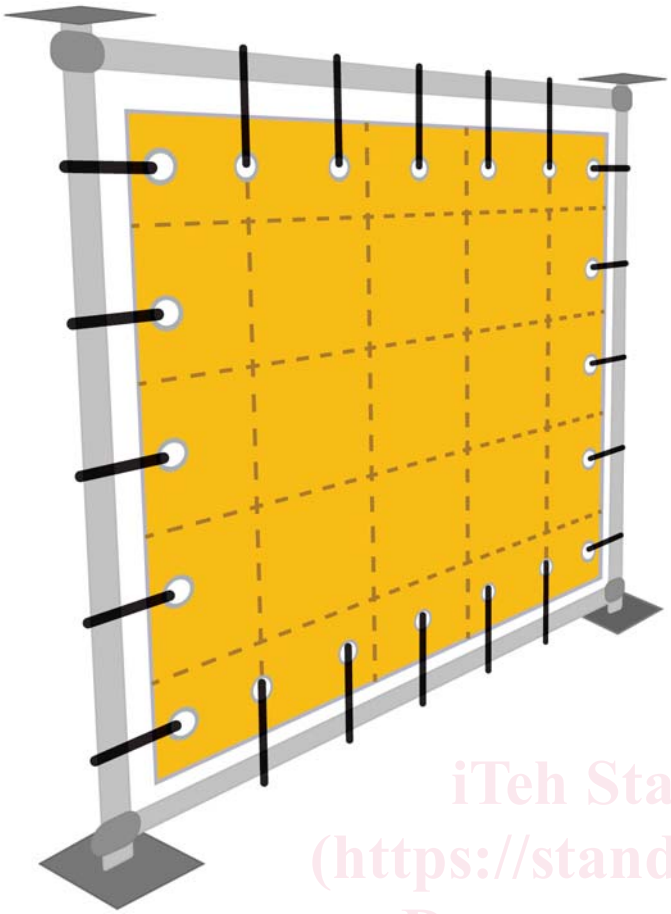
9. Applications

9.1 Manholes and vaults.

9.2 Cable splices (common use).

9.3 Transformers.

9.4 Bare disconnects.



NOTE 1—If all straps are not used, blanket should be tested in the used configuration.

FIG. 5 Protective Wall Using Stanchions

9.5 Switchgear.

9.6 Pad mount gear.

9.7 Switchgear rooms.

9.8 Other installations and equipment.

10. Care and Maintenance

10.1 Follow manufacturer's care and maintenance instructions.

10.2 Blankets should be kept free from flammable materials. While common dirt and dust will be unlikely to affect performance, hydrocarbon contaminants will affect performance.

10.3 *Inspection:*

10.3.1 Inspect the blanket before each use. Tears require repair or replacement. Ripped seams around the edges may be repaired with a para-aramid thread. Other seams cannot typically be repaired since center seams are a stress point and should only be repaired at the direction of the manufacturer or by the manufacturer. Badly soiled blankets should be cleaned, especially if the soiling is determined to be flammable. Inspect the carabiners and the straps. Straps are typically nylon or para-aramid and shall be replaced when worn. Missing grommets or other missing components are a sign for rejection. The damaged blanket shall be marked for repair or replacement.

10.4 *Cleaning:*

10.4.1 Follow manufacturer's instructions when available.

10.4.2 Use detergents only unless specifically prohibited by manufacturer's instructions.

10.4.3 Do not use flammable solvents or any conductive cleaner.

10.4.4 Typically, use a laundry detergent for textile type blankets and a dish detergent for silicone.

10.4.5 Rinse thoroughly and hang to dry.

10.5 *Shelf Life:*

10.5.1 Typically, blankets have no shelf life limitations unless stored improperly.

10.5.2 Discoloration of para-aramid fabric blankets (browning) can be an indication of exposure to ozone or too much UV light and be a sign for replacement.

10.6 *Limits of Blankets:*

10.6.1 Blankets are typically tested for 10 cycle minimum protection but this is with proper anchoring and within the fault current limits of the blanket rating expressed in kA·cycles. Longer exposures at lower current are allowed. Blankets have been tested to contain the arc up to the kA·cycles limit of the blanket design.

10.6.2 Blankets may be conductive when wet or otherwise contaminated. They are typically not designed for electrical insulation unless otherwise rated.

10.6.3 Blankets are flame resistant so splicing torch burn exposures will not cause the blanket to ignite and continue to burn, but burned blankets must be evaluated for replacement.

10.6.4 Some blankets are sensitive to UV degradation. Use outside is allowed, but discolored blankets should be evaluated for replacement. Blankets shall be labeled if sensitive to UV degradation.

10.6.5 Arc blankets are typically not designed for protection from electrical shock and shall not be used as an insulating barrier unless specifically rated for such. The arc blanket standard Test Method F2676 has no testing for shock prevention.

10.7 The style and materials for attachments shall be of the same material and construction as for the testing of the arc protective blanket.

10.7.1 End users may design attachments, as long as they have been tested for the conditions used.

10.7.2 Spacing between attachment points shall be the same as for the production arc protective blanket.

10.8 Use of flame resistant para-aramid straps (when straps are used) help ensure the proper performance if the strap is exposed to the arc in the installation.

10.9 Moving the blanket further from the arc, while predicted to positively affect performance, cannot be predicted without further testing.

11. Keywords

11.1 anchors; arc blast blanket; arc flash blanket; arc protective blanket; concrete; electric arc hazards; electrical protective equipment; fire hazards; masonry; masonry units;