

## GLOVE TESTING MEMORANDUM

In 2013, ASTM F2675 *Standard Test Method for Determining Arc Ratings of Hand Protective Products Developed and Used for Electrical Arc Flash Protection* was published. Since the inception of the document, there have been evolutions in the arc flash hand protection market, and glove designs have become increasingly complex. As a result, we have received an influx of glove products for testing that are not adequately addressed by the test method. There are efforts underway, by both ArcWear and Kinectrics, at the ASTM F18 technical committee level to adapt the standard to fill the gaps on how to reasonably test complex gloves with added components.

It is important to us to perform testing that is repeatable, fair, and safe. In such cases where a testing standard does not guide our laboratory on how to test certain materials or components (for example, TPR's or thermo-plastic rubber bumpers), we must use our knowledge and experience to make decisions on how to address these items in a way that helps end users, manufacturers, and our laboratory to be confident with the products put on the market and the protection values they offer as determined through testing. Currently, the ASTM standard does not account for the margin of safety when ignition is demonstrated on glove components.

With the current gap between gloves on the market and how to properly evaluate them in published testing standards, ArcWear and Kinectrics have implemented internal procedures to address products that do not currently fit into the standard test procedure. See Table 1 of this document for a summary of the newly implemented procedures, and Table 2 for an example of what may now be included on test reports.

These procedures will remain in place until published standards are updated to address testing of complex products that are in development and on the marketplace. Our staff of technical experts are working diligently to lead and inspire change in these documents, and in the industry, based on our many years of experience.

ArcWear and Kinectrics are proud to serve as your testing partners and while we work to get updated standards published, we commit to maintaining your best interest by helping you to test and market products you can be confident are effective and non-contributory at tested protection levels with the understanding that all competitors have been tested on a level playing field using the same rules and procedures. We look forward to continuing to serve you, and we encourage you to join us at the discussion at ASTM F18.



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Hugh Hoagland, President, ArcWear

**Table 1. Explanation of Updated Glove Testing Procedures**

What?	How?	Why?
Glove Base Ratings	<p>Gloves shall be tested as a finished product “as sold” except for gloves having components that are added over the test sensor for special function such as reinforcements and TPR. The arc rating must be of the base glove material(s) that cover the entirety of the hand. Trim around the cuff should be included in testing (see Figure 1). Gloves having TPR or other reinforcements covering the sensor must first be tested without the added materials. The “as sold” glove is then tested above the arc rating to evaluate the added covering for ignition.</p> <p>Gloves with coated palms for anti-slip must be submitted as-sold with coating. Both the base and coated side will be evaluated; the side with the lowest thermal protection will be fully tested. The coating will be evaluated for ignition and melting/dripping.</p>	<p>Unless reinforcements, TPR, or other components completely cover the hand, they do not add extra protection that can be relied upon in an arc rating.</p> <p>PVC or other coating materials may affect rating.</p>
Knit Wristlets	Knit wristlets will not be evaluated for an arc rating, but will be evaluated for ignition.	The standard is for hand protection, and knit wristlets cover the wrist. When worn properly, wristlets would be covered by a long-sleeve shirt.
Required Number of Samples	<p>For base glove Arc Rating: 15 pairs are required.</p> <p>For as-sold evaluation of gloves with additional materials not in base glove: Ignition threshold and proposed rating limit: 8 pairs are required</p> <p>Note: If the base glove is identical to “as sold” (no added TPR or reinforcement materials). Ignition evaluation is performed during determination of Arc Rating, no additional samples required.</p> <p>Please note: For gloves having TPR, it is preferred to evaluate base gloves and as-sold gloves at the same test interval. If a design is changed and as-sold gloves are submitted after the base glove was rated, 2 pair of base gloves will be required to be submitted for verification testing in addition to the 8 as-sold pairs for scouting evaluations.</p>	Required for analysis
Size of Gloves	Sample shall be 10-10.5 inches around the hand. Knit gloves are subject to stretch which may affect the arc rating. See Figure 2 for drawing of the glove testing apparatus.	Sample must be snug on the test fixture like a hand fit.

What?	How?					Why?	
As-sold gloves containing reinforcements, TPR, etc.	Material evaluation: After a base glove is rated, an as-sold glove will be evaluated at a level above and up to 2x the arc rating (ATPV or EBT) for evaluation as shown below:					Arc flash calculations are performed at 18" away. The hands are often closest to the hazard when it strikes, and the energy near hands may be much higher than the calculation. TPR is commonly made of materials that do have an ignition point, and if the higher energy in real-life causes ignition of the glove, the protection value may become obsolete under certain conditions.	
	Table 1						
	Group	Base ATPV/EBT range (cal/cm <sup>2</sup> )	PPE Levels	Ignition/Breakopen (BO) evaluation level	Criterion		Proposed Glove Arc Rating Limit (cal/cm <sup>2</sup> )
	0	<8	<8	Not considered a PPE Level			none
	1	8 to 13.9	8 (NFPA 70E CAT 2, NESC Level)	20-25 cal/cm <sup>2</sup> min.	No ignition < 20 cal/cm <sup>2</sup>		8
	2	14 to 19.9	14 (OSHA 1910.269)	30-40 cal/cm <sup>2</sup> min.	No ignition < 30 cal/cm <sup>2</sup>		14
	3	20 to 24.9	20 (NESC Level)	40-50 cal/cm <sup>2</sup> min.	No ignition < 40 cal/cm <sup>2</sup>		20
	4	25 to 39.9	25 (NFPA 70E CAT 3)	50-60 cal/cm <sup>2</sup> min.	No ignition < 50 cal/cm <sup>2</sup>		25
	5	40 to 49.9	40 (NFPA 70E CAT 4, NESC Level)	50-65 cal/cm <sup>2</sup> min.	No ignition < 65 cal/cm <sup>2</sup>		40
6	50-60	ASTM F2675 Max	65-75 cal/cm <sup>2</sup> min.	No ignition < 75 cal/cm <sup>2</sup>	50		

Table 1 Notes: The present glove test apparatus built according to ASTM F2675 can only accommodate arc exposures for group 6 or approximately 70 cal/cm<sup>2</sup>. A new arc test apparatus will be built to accommodate higher arc ratings and proposed to the ASTM committee for approval in 2018.

Non-FR linings or battings (such as polyester) are prohibited due to possible injury to workers but non-FR outer components will be evaluated.

Rubber gloves used for dielectric protection and leather gloves used for protectors are excluded from the scope of the standard but can be evaluated by the test method and will include ignition evaluation. The laboratory makes no claim of safety for any ignitable glove but will report results per the standard with the caveats discussed above.

If breakopen of glove is reached, or if ignition occurs, observations will be present on the test report. If ignition of the TPR or added component occurs below or near the ATPV arc rating, the material will be rejected, and no arc rating given.

For non-FR gloves where ignition may be observed prior to ATPV/EBT, a probability of ignition will be determined. The proposed Arc Rating will follow the ignition Criteria in Table 1.

ASTM does not currently account for “derating” a glove based on the limits of TPR or limiting component. Provided the ignition of the TPR or other component is not near the ATPV of the glove, the customers may choose to accept the liability to market the glove at the ATPV thermal rating established and not consider the ignition above the thermal rating, at this time. Alternately, the customer may consider derating as proposed on the test report; however, this value could not be notated as an EBT or ATPV value. The laboratory will suggest a “derating” factor according to the criteria in Table 1 until a safe margin of ignition can be determined and published in the test method.

**Table 2. Information you can expect to see on test reports moving forward (example only)**

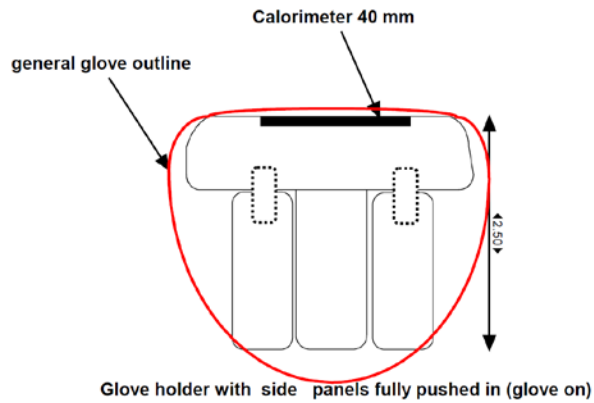
<b>FR Knit Glove with TPR:</b>	
Thermal Performance of Base Material: ATPV	24 cal/cm <sup>2</sup>
Thermal Performance of Base Material: EBT	Not Determined (will be reported if observed)
Ignition: (non-FR gloves or non-FR components only)	Not Determined
Material evaluation up to 2x Thermal Performance Level, (performed on as-sold product)	
Melting and Dripping:	Observed After Ignition
Afterflame Time:	NA (of base material or any component)
Threshold of Ignition:	35 cal/cm <sup>2</sup> , TPR Material
Breakopen:	None Observed
Proposed Arc Rating Limit:	14 cal/cm <sup>2</sup> (based on derating factor due to ignition threshold) see Group 2

Figure 1. Base Glove Example



This glove would be arc rated without the patch as it does not cover the entirety of the glove and cannot be used to increase the protection value of the glove.

Figure 2. Measurements of Glove Testing Apparatus (TOP VIEW)



The circumference (red outline) measured with a plastic tie wrap is 12 3/4" around uncompressed and 11" around when compressed.

