Designation: F2675/F2675M – 23

Standard Test Method for Determining Arc Ratings of Hand Protective Products Developed and Used for Electrical Arc Flash Protection[1]

This standard is issued under the fixed designation F2675/F2675M; 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 test method is used to determine the arc rating of hand protective products in the form of gloves, glove materials, glove material systems, or other protective products designed to fit on the hand and specifically intended for electric arc flash protection use as protective accessories for workers exposed to electric arcs. The arc rating is determined in the test with an arc that has a heat flux value of 2100 kW/m^2 [50 cal/cm^2/s].

1.2 This test method will determine the arc rating of hand protective products made of materials that meet the following requirements for flame resistance: less than 150 mm [6 in.] char length, less than 2 s afterflame and no melt and drip when tested in accordance with Test Method D6413, receive a reported 50 % probability of ignition of a material or flammable underlayer (see definition of ignition$_{50}$) by this method, or that have been evaluated and pass the ignition withstand requirements of this test method.

1.2.1 It is the intent of this test method to be used for hand protective products that are flame resistant or that have an adequate flame resistance for the required hazard (see 1.2). Non-flame resistant hand protective products may be used as under layers in multiple-layer systems or tested for ignition probability or ignition withstand.

1.2.2 Hand protective products tested by this test method are new and ratings received by this method may be reduced or eliminated by hydrocarbon loading (gasoline, diesel fuel, transformer oil, etc.), sweat, dirt, grease, or other contaminants. The end user takes responsibility for use of hand protective products tested by this method when contaminated in such a manner that could reduce or eliminate the arc rating of the hand protective products.

1.2.3 This test method is designed to provide information for gloves used for electric arc protection only. This test method is not suitable for determining electrical protective properties of hand protective products.

1.3 This test method is used to measure and describe the properties of hand protective products in response to convective and radiant energy generated by an electric arc under controlled laboratory conditions.

1.4 This test method does not apply to electrical contact or electrical shock hazards.

1.5 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined

1.6 *This standard shall not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire assessment that takes into account all of the factors, which are pertinent to an assessment of the fire hazard of a particular end use.*

1.7 *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.* For specific precautions, see Section 7.

1.8 *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]

D123 Terminology Relating to Textiles

D4391 Terminology Relating to The Burning Behavior of Textiles

[1] This test method 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.

D6413 Test Method for Flame Resistance of Textiles (Vertical Test)
E457 Test Method for Measuring Heat-Transfer Rate Using a Thermal Capacitance (Slug) Calorimeter
F819 Terminology Relating to Electrical Protective Equipment for Workers
F1494 Terminology Relating to Protective Clothing
F1959/F1959M Test Method for Determining the Arc Rating of Materials for Clothing

2.2 *ANSI/IEEE Standard:*[3]
Standard Dictionary of Electrical and Electronics Terms

3. Terminology

3.1 *Definitions:*

3.1.1 *arc rating, n*—value attributed to materials that describes their performance to exposure to an electrical arc discharge.

3.1.2 *arc thermal performance value (ATPV), n—in arc testing*, the incident energy on a material or a multilayer system of materials that results in a 50 % probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree skin burn injury based on the Stoll[4] curve, cal/cm^2.

3.1.3 *breakopen, n—in electric arc testing*, a material response evidenced by the formation of one or more holes in the material which may allow thermal energy to pass through the material.

3.1.3.1 *Discussion*—The specimen is considered to exhibit breakopen when any hole is at least 3.2 cm^2 [0.5 in.^{2}] in area or at least 2.5 cm [1.0 in.] in any dimension. Single threads across the opening or hole do not reduce the size of the hole for the purposes of this test method. In multiple layer specimens of flame resistant material, all the layers must breakopen to meet the definition. In multiple layer specimens, if some of the layers are ignitable, breakopen occurs when these layers are exposed.

3.1.4 *breakopen threshold energy (E_{BT}), n*—the incident energy on a material or material system that results in a 50 % probability of breakopen.

3.1.4.1 *Discussion*—This is the value in J/cm^2 [cal/cm^2] determined by use of logistic regression analysis representing the energy at which breakopen of the layer occurred.

3.1.5 *charring, n*—formation of carbonaceous residue as the result of pyrolysis or incomplete combustion.

3.1.6 *dripping, n—in testing flame-resistant clothing*, a material response evidenced by flowing of a specimen's material of composition.

3.1.7 *finished product, n*—a representative product as sold.

3.1.7.1 *Discussion*—A base product is tested for determination of arc rating; additional tests to verify compliance with ignition withstand (Table 1 or Table 2) are then required on the finished product(s).

3.1.8 *glove, n*—a covering for the hand which has separate sections for the thumb and fingers or a mitten which has separate sections for the thumb and multiple fingers.

3.1.9 *ignitability, n (ignitable, adj)—in electric arc exposure*, the property of a material involving ignition accompanied by heat and light, and continued burning resulting in consumption of at least 25 % of the exposed area of the test specimen.

3.1.10 *ignition$_{50}$, n—in arc testing*, the incident energy on a material or flammable underlayer that results in a 50 % probability of ignition of a material or flammable underlayer.

3.1.11 *ignition withstand, n—in arc testing*, an arc testing protocol for evaluating ignition of a material used for arc flash protection when the material cannot be evaluated by a flame test or when a material cannot pass a flame test.

3.1.12 *material response, n*—material response to an electric arc is indicated by the following terms: breakopen, melting, dripping, charring, embrittlement, shrinkage, and ignition.

3.1.13 *melting, n—in testing flame resistant clothing*, a material response evidenced by softening of the material.

3.1.14 *mix zone, n—in arc testing*, the range of incident energies, which can result in either a positive or negative outcome for predicted second-degree burn injury, breakopen or underlayer ignition. The low value of the range begins with the lowest incident energy indicating a positive result, and the high value or the range is the highest incident energy indicating a negative result.

3.1.14.1 *Discussion*—A mix zone is established when the highest incident energy with a negative result is greater than the lowest incident energy with a positive result.

3.1.15 *peak arc current, n*—maximum value of the AC arc current, *A*.

3.1.16 *RMS arc current, n*—root mean square of the AC arc current, *A*.

3.1.17 *shrinkage, n—in testing flame resistant clothing*, a material response evidenced by reduction in specimen size.

3.1.18 *Stoll*[4] curve, *n*—an empirical predicted second-degree skin burn injury model, also commonly referred to as the *Stoll Response*.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *attachments, n*—an additional material applied to a specific area of protective product to make the portion of the protective product more resistant to wear, to fit better, such as a cinch or elastic, or to add protection, such as impact protection.

3.2.2 *base product, n*—a representative specimen of the finished product; specimens are as close as possible to the finished product but may exclude trims, labels, coatings or accessories located in the area of the calorimeter (palm or dorsal).

3.2.2.1 *Discussion*—The base product specimen does not

[3] Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., Piscataway, NJ 08854, http://www.ieee.org.

[4] Derived from: Stoll, A. M. and Chianta, M. A., "Method and Rating System for Evaluations of Thermal Protection," *Aerospace Medicine*, Vol 40, 1969, pp. 1232-1238 and Stoll, A. M. and Chianta, M. A., "Heat Transfer through Fabrics as Related to Thermal Injury," *Transactions—New York Academy of Sciences*, Vol 33 (7), Nov. 1971, pp. 649-670.