



Designation: F2302 – 20

Standard Performance Specification for Labeling Protective Clothing Which Provides Resistance to Incidental Exposures to Heat or Open Flame¹

This standard is issued under the fixed designation F2302; 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 specification provides minimum requirements for labeling protective clothing offering heat, flame, and melting resistance for applications where the potential exists for incidental exposure to open flame, radiant heat sources, or hot surfaces which could melt or ignite materials.

1.1.1 Examples of possible applications for this specification include safety apparel, including high-visibility safety apparel, in situations where the possibility exists for accidental contact with hot surfaces, radiant heat sources, or an open flame; clothing worn by individuals for chemical, liquid, or particle protection where the possibility exists for clothing to similarly contact a burner or similar low-intensity flame source; or other clothing worn by individuals that comes in contact with torch flames, hot piping, or other surfaces that melt, degrade, or ignite clothing materials by proximity or contact.

1.1.2 This specification is not to be used for separate claims for flame resistance (“FR”), heat resistance, or protection against the transfer of thermal energy. Instead, clothing materials are required to be evaluated for the combination of flame and heat resistance tests.

1.1.3 This specification does not include a test for establishing protection levels against specific hazards where clothing insulation is needed such as from flash fires, exposure to high-energy electrical arc, or extended duration fires. This specification does not replace and shall not be used in lieu of existing standards where well-defined criteria are established for protection of workers from known characterized intense thermal hazards such as flash fires (NFPA 2112), high-energy electrical arc (Specification F1506), or wildland firefighting (NFPA 1977). See Appendix X1 for a list of standards for heat and flame-resistant protective clothing.

1.1.4 This specification includes requirements that define resistance to melting and combustion of materials used in personal protective clothing in a manner to limit the contribu-

tion of the clothing for causing injury to the wearer when exposed to low levels of heat or flame. The primary mechanisms by which a garment can contribute to injury are by the garment igniting and supporting combustion, and if the garment melts onto the wearer’s skin.

1.1.5 This specification is applicable to all materials used in the construction of the protective clothing, including lining materials and materials that contact the skin or underclothing of the wearer. Exclusions are permitted for some materials such as labels and small components that do not come in contact with the wearer’s skin or underclothing.

1.1.6 This specification does not include testing for the evaluation of the entire clothing item.

1.1.7 This specification does not include procedures for testing of gloves or footwear.

1.1.8 This specification does apply to hoods, balaclavas, shrouds, neck gaiters, cloth face coverings, and other items of apparel that are primarily worn on the individual wearer’s head.

1.2 This specification does not apply to protective clothing that is addressed in other standards for specific applications including electrical arc flash, flash fire, and various types of firefighting or emergency response. See Appendix X1 for a list of standards for heat and flame-resistant protective clothing.

1.3 The values stated in SI units or in other units shall be regarded separately as standard. The values stated in each system must be used independently of the other, without combining values in any way.

1.4 This standard measures and describes the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire hazard or fire risk assessment of the materials, products, or assemblies under actual fire conditions.

1.5 The following precautionary caveat pertains only to the test methods portion, Section 8, of this specification: *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 This specification is under the jurisdiction of ASTM Committee F23 on Personal Protective Clothing and Equipment and is the direct responsibility of Subcommittee F23.80 on Flame and Thermal.

Current edition approved Oct. 1, 2020. Published October 2020. Originally approved in 2003. Last previous edition approved in 2019 as F2302 – 19. DOI: 10.1520/F2302-20.

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

D123 Terminology Relating to Textiles

D4391 Terminology Relating to The Burning Behavior of Textiles

D6413/D6413M Test Method for Flame Resistance of Textiles (Vertical Test)

D7138 Test Method to Determine Melting Temperature of Synthetic Fibers

E171/E171M Practice for Conditioning and Testing Flexible Barrier Packaging

F1358 Test Method for Effects of Flame Impingement on Materials Used in Protective Clothing Not Designated Primarily for Flame Resistance

F1494 Terminology Relating to Protective Clothing

F1506 Performance Specification for Flame Resistant and Electric Arc Rated Protective Clothing Worn by Workers Exposed to Flames and Electric Arcs

F2101 Test Method for Evaluating the Bacterial Filtration Efficiency (BFE) of Medical Face Mask Materials, Using a Biological Aerosol of *Staphylococcus aureus*

F2299/F2299M Test Method for Determining the Initial Efficiency of Materials Used in Medical Face Masks to Penetration by Particulates Using Latex Spheres

F2894 Test Method for Evaluation of Materials, Protective Clothing, and Equipment for Heat Resistance Using a Hot Air Circulating Oven

2.2 AATCC Standards:³

AATCC 132 Colorfastness to Drycleaning

AATCC 135 Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics

2.3 NFPA Standard:⁴

NFPA 1977 Protective Clothing and Equipment for Wildland Fire Fighting

2.4 European Standard:⁵

EN 14683 Medical Face Masks—Requirements and Test Methods

3. Terminology

3.1 *Definitions*—For definitions of terms used in this specification related to the combustion of textiles, refer to the

terminology contained in Terminology **D4391**. For definitions of terms used in this specification related to protective clothing, refer to the terminology contained in Terminology **F1494**. For definitions of terms used in this specification related to textile issues, refer to the terminology contained in Terminology **D123**.

3.2 *afterflame, n*—persistent flaming of a material after the ignition source has been removed.

3.3 *afterflame time, n*—the length of time for which a material continues to flame after the ignition source has been removed.

3.4 *afterglow, n*—a glow in a material after the removal of an external ignition source, after the cessation (natural or induced) of flaming of the material (see also *glow*).

3.5 *burn distance, n*—the measurement from the bottom edge of the specimen to the farthest point that shows evidence of damage due to combustion.

3.5.1 *Discussion*—In this specification, burn distance is used when testing is performed in accordance with Test Method **F1358**.

3.6 *burning behavior, n*—all the changes that take place when materials or products are exposed to a specified ignition source.

3.7 *char length, n*—in measuring flame resistance of textiles, the distance from the fabric edge which is directly exposed to the flame to the furthest point of visible fabric damage after a specified tearing force has been applied.

3.7.1 *Discussion*—In this specification, char length is reported when testing is performed in accordance with Test Method **D6413/D6413M**.

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

3.9 *cloth face covering, n*—an item of clothing, primarily covering the nose and mouth, designed to reduce the community spread of bioaerosols.

3.9.1 *Discussion*—These clothing items are primarily intended to attenuate the volume of bioaerosols that are exhaled or released during coughing and sneezing by the individual wearer to aid in lessening the transmission of airborne pathogens such as SARS-CoV-2, the virus responsible for COVID-19. These clothing items are not protective masks or medical masks and are not evaluated for their protective performance in accordance with this standard.

3.10 *combustion, n*—a chemical process of oxidation that occurs at a rate fast enough to produce heat and usually light either as glow or flames.

3.11 *dripping, n*—a material response evidenced by flowing of the polymer.

3.11.1 *Discussion*—In evaluating the effects of flame contact or heat exposure of materials used in protective clothing, dripping may be the formation of liquid droplets from melted surface or substrate material during flame impingement or high heat exposure.

3.12 *embrittlement, n*—the formation of a brittle residue as the result of pyrolysis or incomplete combustion.

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 American Association of Textile Chemists and Colorists (AATCC), P.O. Box 12215, Research Triangle Park, NC 27709, <http://www.aatcc.org>.

⁴ Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

⁵ Available from British Standards Institution (BSI), 389 Chiswick High Rd., London W4 4AL, U.K., <http://www.bsigroup.com>.

3.13 *flame, n*—as related to ignition of textiles, a controlled hot luminous zone of gas or matter in gaseous suspension, or both, of constant size and shape that is undergoing combustion as evidenced by a low-intensity heat source of less than 1 kW, such as a candle flame or match flame.

3.13.1 *Discussion*—Examples are flames from a match, candle, or bunsen burner. The burner flame in this specification produces relatively low heat flux and should be constant in size and shape.

3.14 *flame application time, n*—the time interval for which the ignition flame is applied to a material.

3.15 *flame resistance, n*—the property of a material whereby flaming combustion is prevented, terminated, or inhibited following application of a flaming or nonflaming source of ignition, with or without the subsequent removal of the ignition source.

3.15.1 *Discussion*—In this specification, flame resistance is demonstrated by testing to Test Method **D6413/D6413M** or Test Method **F1358** and meeting specific performance criteria.

3.16 *flammability, n*—those characteristics of a material that pertain to its ignition and support of combustion.

3.17 *glow, n*—visible, flameless combustion of the solid phase of a material.

3.17.1 *Discussion*—Although a solid may glow, it can also produce combustible discharge that will cause a flame. These two phenomena are not necessarily interdependent.

3.18 *heat resistance, n*—the extent to which a material retains useful properties as measured after exposure of the material to a specified temperature and environment for a specified time.

3.18.1 *Discussion*—In this specification, heat resistance or the heat stability of the material is demonstrated by testing in accordance with Test Method **F2894** at a temperature of 260 °C [500 °F] for 5 min without ignition, melting, dripping, or separation of the material and without material shrinkage greater than 20 %.

3.19 *ignition, n*—the initiation of combustion.

3.19.1 *Discussion*—In evaluating the effects of flame contact or heat exposure of materials used in protective clothing, ignition is determined by the presence of afterflame after the removal of the burner flame or when observing the condition of the specimen(s) inside the oven after opening the oven door.

3.20 *melting, n*—a material response evidenced by softening of the polymer.

3.20.1 *Discussion*—In evaluating the effects of flame contact or heat exposure of materials used in protective clothing, melting may occur at surface layers or in combination with the substrate fabric(s) or other polymer layers. Melting may be observed for protective clothing materials that involve a polymer coating or laminate combined with a flame-resistant fabric or substrate.

3.21 *protective clothing, n*—an item of clothing that is specifically designed and constructed for the intended purpose of isolating all or part of the body from a potential hazard; or, isolating the external environment from contamination by the wearer of the clothing.

3.22 *separation, n*—in testing thermal protective clothing, the partial or full detachment of one or more layers comprising a material

3.22.1 *Discussion*—In evaluating the effects of heat exposure, separation occurs when the face cloth detaches from the batting for quilted material or if a film or coating lifts from a substrate fabric.

3.23 *shrinkage, n*—a decrease in one or more dimensions of an object or material.

3.23.1 *Discussion*—In evaluating the effects of flame contact or heat exposure, these changes in dimensions are caused by heat from the flame source or convection within the oven.

4. Significance and Use

4.1 This specification is used to establish the minimum performance requirements for labeling protective clothing as providing both heat and flame resistance where the clothing is intended not to contribute to burn injury by continued burning or melting onto the wearer's skin. Testing is performed on the product in both an "as-received" condition and after ten laundering or dry cleaning cycles using standardized procedures. Users of this specification are also permitted to use laundering or dry cleaning procedures for conditioning samples as specified in the manufacturer's care instructions for a minimum of ten cycles. Procedures in this standard also permit the testing of single-use garments materials in an as-received condition only.

4.1.1 For the purposes of this standard, clothing flame and heat resistance is intended to provide an indication that the materials used in the construction of the clothing are less likely to contribute to burn injury or worsen its severity by continued flaming if ignited and melting onto the wearer's skin after coming in momentary contact with an isolated high heat or open flame heat source. It is still possible that individuals wearing clothing meeting this specification will still be burned because the clothing item has not been evaluated for its capability to provide insulation to different types of high-energy heat sources

4.2 This specification does not replace standards that have already been developed for specific types of flame and heat-resistant protective clothing, including clothing for protection from flash fire, clothing for protection against electric arc flash, and protective clothing for various firefighting and emergency response applications. Only use the standard specific to the application for which the protective clothing is to be used. See **Appendix XI** for a list of specifications for specific types of heat and flame-resistant protective clothing.

4.3 This specification does not address all areas of protective clothing performance for heat and flame exposure. For example, this specification does not address any thermal insulation properties provided by these garments. Rather, this specification is designed to provide an assessment of the potential of the clothing itself to become a hazard to the wearer if exposed to flame and high heat under limited conditions such as those encountered as incidental exposures.

4.4 This specification does not provide an evaluation of the overall protective clothing's flame or heat resistance. Instead,

small-scale heat and flame resistance tests of the primary materials used in the construction of the clothing are used representatively to assess clothing heat and flame resistance. This specification permits excluding testing of clothing components that are not in direct contact with the body during normal wearing. Therefore, it is important that users of this specification recognize that certain components, based on their composition, size, and location, could contribute to burn injury in the event of a high heat or flame exposure.

4.5 This specification does not provide specific procedures for the evaluation of gloves or footwear.

4.6 This specification requires that thread used in the construction of the garment be evaluated for melting resistance at the same temperature applied for heat resistance testing (260 °C [500 °F]).

4.7 A hazard and risk assessment is recommended to determine the suitability of this specification for the intended application. Recommended elements of the hazard and risk assessment include a determination of the specific flame and heat hazards that are likely to be encountered, the consequences of exposure, and if protective clothing meeting other existing standards (including those listed in [Appendix X1](#)) offers a more suitable level of protection.

4.8 While not part of this specification, the selection of materials used in the construction of cloth face coverings should account for the ability of the material to filter bioaerosols, to offer levels of acceptable breathing resistance, and to not create any hazards from extended contact with the nose or mouth. Materials that are very porous may have low efficiencies to prevent the passage of bioaerosols and particulates, while relatively tightly woven fabrics or multiple layers of fabrics could create resistance to breathing that forces the passage of inhaled and exhaled air around the edges of the cloth face covering rather than through the material. Useful measurements of filtration performance can be performed in accordance with Test Method [F2101](#) (bacterial filtration efficiency) and Test Method [F2299/F2299M](#) (latex particulate filtration efficiency). The measurement of breathing resistance can be performed in accordance with Annex C of EN 14683:2019. It is important to note that measurement of cloth face covering performance in accordance with these test methods does not connote that these clothing items are protective masks or medical masks, but instead provide useful benchmarks for relevant areas of performance. Further, consideration must be made for any specific hazards that may occur for extended contact with the individual wearer’s mouth and nose and in passing air through the material for inhalation and exhalation.

5. Requirements

5.1 Test all of the materials used in the construction of protective clothing items for both heat and flame resistance as specified in Section 8. This testing is to include liners and other major material layers used in the construction of clothing, such as retroreflective materials. Elastic, hook-and-loop fasteners, closures, emblems, patches, embroidery, and other small clothing components, when not in contact with the wearer’s body in

the normal wearing of the garment, are permitted to be excluded from testing. Labels on both the interior and exterior of the clothing item are not required to be tested. All tested materials are required to meet the minimum criteria provided in [Table 1](#).

NOTE 1—While this specification permits excluding elastic, hook-and-loop fasteners, closures, labels, emblems, patches, and other clothing components from testing, users of the specification are cautioned that these components could contribute to burn injury depending on their composition, size, and location on the protective clothing item being labeled.

5.2 Test each type of thread used in the construction of the protective clothing for melting resistance as specified in Section 8. None of the thread types shall melt at a temperature less than 260 °C [500 °F].

6. Sampling

6.1 Testing shall be performed on material specimens removed from manufactured protective clothing.

6.2 Testing shall also be permitted to be performed on material samples representative of the materials used in the construction of the garment.

7. Conditioning

7.1 *General*—Subject material samples to both room temperature and laundering (or dry cleaning) conditioning prior to testing. For disposable protective clothing or protective clothing intended only for a single use, do not launder or dry clean. For protective clothing indicated or labeled as washable, subject material samples to room temperature and laundering conditioning specified in [7.2](#) and [7.3](#), respectively. For protective clothing indicated or labeled as dry clean only, subject material specimens to room temperature and dry cleaning conditioning specified in [7.2](#) and [7.4](#), respectively. For protective clothing indicated or labeled for washing and dry cleaning, subject separate material samples to room temperature, laundering, and dry cleaning conditioning specified in [7.2](#), [7.3](#), and [7.4](#), respectively.

7.2 *Room Temperature Conditioning*—Condition garment or material samples at a temperature of 21 ± 3 °C [70 ± 5 °F] and at a relative humidity of 65 ± 5 % for at least 24 h in accordance with Practice [E171/E171M](#).

7.3 *Laundering Conditioning*—Launder garment or material samples in accordance with AATCC 135 using Machine Cycle 1, Washing Temperature III, and Drying Procedure Ai for a

TABLE 1 Minimum Criteria for Tested Materials

| Property | Measurement | Requirement |
|------------------|--|---|
| Flame Resistance | Afterflame | ≤2 s |
| | Char length ^A or burn distance ^B | ≤150 mm [6 in.] |
| | Burning behavior | No melting and dripping |
| Heat Resistance | Observation of material condition | No ignition, melting, dripping, or separation |
| | Thermal shrinkage | ≤20 % |

^A Char length is provided when testing is conducted in accordance with Test Method [D6413/D6413M](#).

^B Burn distance is provided when testing is conducted in accordance with Test Method [F1358](#) for materials that have different interior and exterior sides.