



Designation: F 1358 – 00 (Reapproved 2005)

Standard Test Method for Effects of Flame Impingement on Materials Used in Protective Clothing Not Designated Primarily for Flame Resistance¹

This standard is issued under the fixed designation F 1358; 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 establishes a small-scale laboratory screening procedure for comparing the ignition resistance and burning characteristics of materials used in protective clothing where flame resistance is not the primary form of protection provided by the clothing.

1.1.1 It is more appropriate to evaluate materials used in applications where flame resistance is the primary form of protection provided by the clothing by other flammability test methods. This test method shall not be used to evaluate materials where flame resistance is the primary form of protection offered by the protective clothing.

1.1.2 This test method provides a means for comparing ease of ignition and burning behavior of materials which include plastic or elastomeric films, coated fabrics, flexible laminates, multilayer-material systems, or other protective clothing materials that are not designated for offering flame resistance as their primary form of protection.

1.2 This test method 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.

1.3 The values stated in SI units or other units shall be regarded separately. The values stated in each system may not be exact equivalents; therefore, each system must be used independently, without combining values.

1.4 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

¹ This test method is under the jurisdiction of ASTM Committee F23 on Protective Clothing and is the direct responsibility of Subcommittee F23.80 on Flame and Thermal.

Current edition approved January 1, 2005. Published January 2005. Originally approved in 1995. Last previous edition approved in 2000 as F 1358 - 00.

2. Referenced Documents

2.1 *ASTM Standards:*²

D 123 Terminology Relating to Textiles

D 4391 Terminology Relating to the Burning Behavior of Textiles

D 4723 Index of and Descriptions of Textile Heat and Flammability Test Methods and Performance Specifications

D 6413 Test Method for Flame Resistance of Textiles (Vertical Test)

F 1494 Terminology Relating to Protective Clothing

3. Terminology

3.1 *Definitions*—For definitions of terms used in this test method, related to the combustion of textiles, refer to the terminology contained in Terminology F 4391. For definitions of terms used in this test method, related to protective clothing, refer to the terminology contained in Terminology F 1494. For definitions of terms used in this test method, related to textile issues, refer to the terminology contained in Terminology D 123.

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

3.3 *after-flame 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 or after the cessation (natural or induced) of flaming of the material (see also *glow*).

3.5 *anisotropic, adj*—having different values for a specific property in different directions.

3.5.1 *Discussion*—When this test method is used to evaluate textile-based materials, this term refers to warp (wale) and

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.



filling (course) directions. When this test method is used for nonwoven materials, this term refers to machine and cross-machine directions.

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

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

3.7.1 *Discussion*—In evaluating the effects of flame impingement of materials used in protective clothing, this measurement applies to the folded material specimen when pressed flat and includes all areas partially burned, charred, embrittled, or melted, but not including areas sooted, stained, distorted, or discolored. Damage due to mechanical delamination or splitting of the specimen is not included in the burn distance unless the delaminated or split area includes damage due to combustion.

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

3.9 *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.

3.10 *dripping, n*—in testing thermal protective clothing, a material response as evidenced by flowing of the polymer.

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

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

3.12 *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.

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

3.13 *flame impingement, n*—direct contact between a flame and a material.

3.13.1 *Discussion*—In testing flame impingement of materials used in protective clothing, the flame is of a specified type and duration.

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

3.14.1 *Discussion*—In evaluating the effects of flame impingement of materials used in protective clothing, flammability is based on the relative number of specimens which ignite when exposed to flame either for a period of 3 or 12 s.

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

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

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

3.16.1 *Discussion*—In evaluating the effects of flame impingement of material used in protective clothing, ignition is determined by the presence of after-flame after the removal of the burner flame.

3.17 *melting, n*—in testing thermal protective clothing, a response to heat by a material resulting in evidence of flowing or dripping.

3.17.1 *Discussion*—In evaluating the effects of flame impingement 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 which involve a polymer coating or laminate combined with a normally flame-resistant fabric or substrate.

3.18 *protective clothing, n*—a product which is specifically designed and constructed for the intended purpose of isolating parts of the body from a potential hazard; or as a barrier to prevent the body from being a source of contamination.

3.18.1 *Discussion*—In this test method the potential hazard is *flame impingement* on protective clothing where flame resistance is not the primary form of protection offered by that clothing.

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

3.19.1 *Discussion*—In evaluating the effects of flame impingement, these changes in dimension are caused by heat from the flame source.

4. Summary of Test Method

4.1 A conditioned specimen of a protective clothing material is folded in half and placed in a sample holder with the folded edge suspended over a gas flame.

4.2 The specimen is exposed to the flame for a 3-s interval.

4.2.1 If the material ignites during this exposure, the after-flame time, afterglow time, and burn distance of the specimen are measured and reported. Any observations of burning behavior are also reported. The test is then terminated.

4.3 If the material does not ignite after the first exposure, the same specimen is exposed to the flame for a 12-s interval. The after-flame time, afterglow time, and burn distance of the specimen are measured and reported. Any observations of burning behavior are also reported.

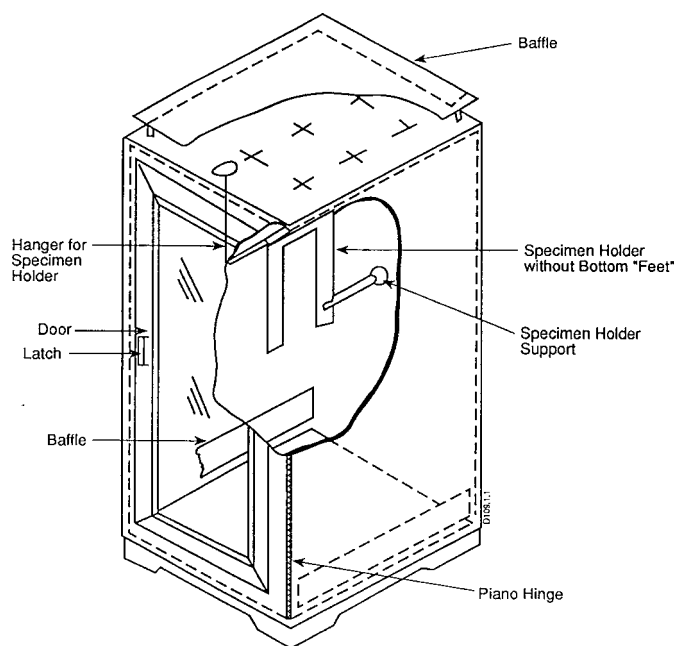
4.4 An alternative procedure is provided for conducting the 12-s exposure only.

5. Significance and Use

5.1 This test method is intended to determine the ignition resistance and burning characteristics of materials used in protective clothing, where flame resistance is not the primary form of protection designated.

5.1.1 Flame resistance is a distinctive property of clothing items designated for isolating parts of the body from anticipated flame hazards. It is possible that protective clothing designated for isolation from other hazard, such as those for chemical or biological protection, neither have flame resistance nor isolate the wearer from flame hazards. This test method can be used to evaluate the effects of flame impingement on protective clothing where flame resistance is not the primary objective of protection.





NOTE 1—The specimen holder may be positioned so that the specimen faces the door.

FIG. 1 Test Cabinet

5.1.2 When flame resistance is the primary protection offered by the protective clothing, alternative test methods can be used. A test method that is useful for evaluating flame resistance of textiles is Test Method D 6413. Index D 4723 contains descriptions and guidance on other flammability test methods for textiles.

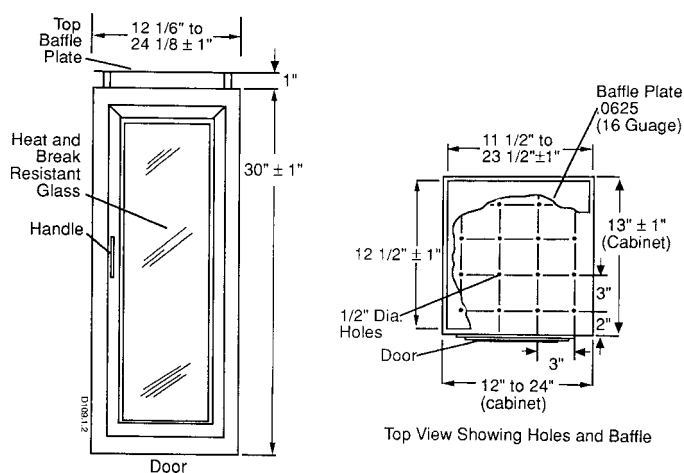
5.1.3 This test method is useful to determine the ignition resistance and burning characteristics of materials used in protective clothing not designated for flame resistance when the outer material surface is exposed to the flame. As such, it is particularly suited to protective clothing materials which are composed of different layers such as coated fabrics, laminates, or multilayer clothing systems.

5.2 Correlation of data from this test method with the ignition resistance and burning characteristics of protective clothing (not designated for flame resistance) under actual use conditions is not implied.

6. Apparatus

6.1 *Cabinet*,³ and accessories, fabricated in accordance with the requirements specified in Fig. 1, Fig. 2, and Fig. 3. Use galvanized sheet metal or other suitable metal.

6.1.1 Provide a means for suspending the sample holder that permits adjustment of its height for positioning the specimen over the burner. One means of suspending the sample involves



NOTE 1—All dimensions are in inches (1 in. = 25.4 mm).

FIG. 2 Cabinet Front and Top Detail

modifying the hanger for the specimen holder shown in Fig. 1, in such a way that the hanger allows the specimen holder to be lowered or raised as required to accommodate the thickness of the specimens to be tested.

6.2 *Burner*, equipped with a variable orifice to adjust the flame height, a barrel having a 10-mm [$\frac{3}{8}$ -in.] inside diameter and a pilot light (Fig. 4).

6.2.1 One method for constructing the burner is to combine a 10-mm [$\frac{3}{8}$ -in.] inside diameter barrel 75 ± 6 mm [$3 \pm \frac{1}{4}$ in.] long from a fixed orifice burner with a base from a variable orifice burner.

6.2.2 Use a pilot light tube with an inner diameter of approximately 2 mm [$\frac{1}{16}$ in.] which is spaced 3 mm [$\frac{1}{8}$ in.] away from the burner edge.

6.2.3 Make the necessary gas connections and provide the applicable plumbing as specified in Fig. 5. Attach either a solenoid or stopcock to the burner. The control valve (stopcock or solenoid) shall be capable of being fully opened or fully closed in 0.1 s.

6.2.4 On the side of the barrel of the burner, opposite the pilot light, use a metal rod of approximately 3-mm [$\frac{1}{8}$ -in.] diameter spaced 13 mm [$\frac{1}{2}$ in.] from the barrel and extending above the burner. The rod shall have two 8-mm [$\frac{5}{16}$ -in.] prongs marking the distances of 19 mm [$\frac{3}{4}$ in.] and 38 mm [$1\frac{1}{2}$ in.] above the top of the burner.

6.2.5 Fix the burner in a position so that the center of the barrel of the burner is directly below the center of the specimen.

6.3 *Gas Regulator Valve System*,⁴ with a control valve system with a delivery rate designated to furnish gas to the burner under a gage pressure of 17.2 ± 1.7 kPa [$2\frac{1}{2} \pm \frac{1}{4}$ psi] at the burner inlet. The manufacturer's recommended delivery rate for the valve system shall include the required pressure.

³ The sole source of supply of the test cabinet known to the committee at this time is U.S. Testing Co., 1941 Park Avenue, Hoboken, NJ 07030; or the Govmark Organization, Inc. P.O. Box 807, Bellmore, NY 11710. This is the same test cabinet specified in Test Method D 6413. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee¹, which you may attend.

⁴ The sole sources of supply of the regulator valve system known to the committee at this time are Matheson Gas Products, P.O. Box 85, East Rutherford, NJ 07073 and Air Products and Chemicals, Inc., P.O. Box 538, Allentown, PA 18105. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee¹, which you may attend.