Designation: F 1002 – 96

Standard Performance Specification for Protective Clothing for Use by Workers Exposed to Specific Molten Substances and Related Thermal Hazards[1]

This standard is issued under the fixed designation F 1002; 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 performance specification covers textile materials to be used for protective clothing.

1.2 Materials used for both primary protection and for secondary protection are covered.

1.3 Protective properties relate to contact with molten substances and hot surfaces, and exposure to open flame and radiant heat.

1.4 This performance specification covers clothing design characteristics that relate to the unique protective requirements of working with molten substances.

1.5 This performance specification describes the properties of specific textile materials in their fabric or garment composite form as tested by laboratory methods and should not be used to appraise the thermal hazard or fire risk under actual conditions. However, clothing made from textile materials conforming to this specification may be used as an element in thermal risk assessment which takes into account all factors pertinent to the thermal hazard of a particular end use.

1.6 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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

2. Referenced Documents

2.1 *ASTM Standards:*

D 123 Terminology Relating to Textiles[2]

D 434 Test Method for Resistance to Slippage of Yarns in Woven Fabrics Using a Standard Seam[2]

D 1424 Test Method for Tearing Strength of Fabrics by Falling Pendulum (Elmendorf) Apparatus[2]

D 2262-83 Test Method for Tearing Strength of Woven Fabrics by the Tongue (Single Rip) Method (Constant-Rate-of-Traverse Tensile Testing Machine)[3]

D 2724 Test Methods for Bonded, Fused, and Laminated Apparel Fabrics[2]

D 4108-87 Test Method for Thermal Protective Performance of Materials for Clothing by Open-Flame Method[4]

D 4157 Test Method for Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method)[5]

D 5034 Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)[5]

F 955 Test Method for Evaluating Heat Transfer Through Materials for Protective Clothing Upon Contact with Molten Substances[6]

NOTE 1—Standards cited with last approval have been withdrawn and no longer appear in the Annual Book of Standards. Copies are not available from ASTM but ASTM will direct to a copy source.

2.2 *AATCC Test Methods:*[7]

61 Colorfastness to Washing, Domestic and Laundering, Commercial:Accelerated

132 Colorfastness to Drycleaning

135 Dimensional Changes in Automatic Home Laundering of Woven and Knitted Fabrics

2.3 *Federal Standard:*[8]

Fed. Std. No. 191A, Method 5903.1, Flame Resistance of Cloth, Vertical

2.4 *Military Standard:*[9]

MIL-C-87076A Resistance of Materials to Radiant Heat

[1] This specification is under the jurisdiction of ASTM Committee F-23 on Protective Clothing and is the direct responsibility of Subcommittee F23.80 on Molten Substances.

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[2] *Annual Book of ASTM Standards*, Vol 07.01.

[3] Discontinued; see *1991 Annual Book of ASTM Standards*, Vol 07.01.

[4] Discontinued; see *1994 Annual Book of ASTM Standards*, Vol 11.03.

[5] *Annual Book of ASTM Standards*, Vol 07.02.

[6] *Annual Book of ASTM Standards*, Vol 11.03.

[7] AATCC Technical Manual, Current Edition available from American Association of Textile Chemists and Colorists, P.O. Box 12215, Research Triangle Park, NC 27709.

[8] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

[9] Available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Exposure, Adhesion of Coating, and Adhesion After Wet Flexing

3. Terminology

3.1 *Definitions*—For definitions of textile terms used in this specification refer to Terminology D 123.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *molten substances*—metals in their liquified, elevated temperature state, as well as related non-metallic substances also handled at elevated temperatures such as slag, dross, and salt. Excluded are liquid hot substances that may be associated with metal processing such as water, oil, and caustic solutions.

3.2.2 *primary protective clothing*—protective clothing designed to be worn for work activities during which significant exposure to molten substance splash, radiant heat, and flame is likely to occur.

NOTE 2—Such work activities include charging, tapping, and pouring, during which work is carried out in close proximity to molten substances and hot surfaces and contact with either is likely.

3.2.3 *secondary protective clothing*—protective clothing designed for continuous wear for work activities in designated locations in which intermittent exposure to molten substance splash, radiant heat, and flame sources is possible.

NOTE 3—Secondary protective clothing is designed so that it will not continue to burn after exposure to and removal of a source of ignition. Protection against metal splash and radiant heat are secondary in intent.

3.2.4 *radiant heat*—heat communicated by energy propagated through space and transmitted by electromagnetic waves.

3.2.5 *thermal hazard*—relates to the laboratory test methods employed to measure thermal characteristics and to predict burn injury potential.

4. Significance and Use

4.1 This specification provides performance properties for textile material and design characteristics for clothing that represent minimum initial requirements for primary and secondary protective clothing.

4.1.1 The initial performance properties have been selected based on state-of-the-art materials in use and have been compared with commercial standards which take into consideration durability in use for specific apparel items.

4.2 Although the specifications for primary protective clothing are written for outer garments, it is recognized that optimum protective performance to severe exposure involves the use of an appropriate system including work clothing underlayers and undergarments.

4.3 For special designated purposes of the ultimate user of protective clothing, one or more of the requirements in Table 1 may be modified upon agreement between the supplier and the seller.

4.3.1 In such cases, any references to the specification shall specify that: "This fabric meets Performance Specification F 1002 except for the following characteristic(s)."

TABLE 1 Specification Requirements, Woven Fabrics

Characteristic	Primary		Secondary		Section Reference
	Non-Coated	Coated	Shirt	Pants	
Breaking strength, min, N (lbf)	223 (50)	334 (75)	134 (30)	223 (50)	8.1
Tearing strength, N (lbf), min	22 (5.0)	45 (10.0)	11 (2.5)	22 (5.0)	8.2
Seam slippage	...	...	6 mm at 134 N (0.25 in. at 30 lbf)		8.3
Colorfastness					
Laundering shade change, min	...	...	Class 3	Class 3	8.4.1
Dry cleaning shade change, min	...	...	Class 3	Class 3	8.4.2
Dimensional change, max	...	...	3.0 %	3.0 %	8.5
Reflectivity after abrasion	...	no discoloration of blotting paper; no aluminum flaking	...	...	8.6
Adhesion	...	no evidence of separation	...	...	8.7
Adhesion after wet flexing	...	no delamination or cracking		...	8.8
Flammability					
Initial					
Char length, max, mm (in).	127 (5.0)	127 (5.0)	152 (6.0)	152 (6.0)	8.9
After flame, max, s	3	3	5	5	
After 25 washes/dry cleaning					
Char length, max, mm (in.)	127 (5.0)	127 (5.0)	152 (6.0)	152 (6.0)	8.9
After flame, max, s	3	3	5	5	8.9

Note—Certain treated fabrics exhibit afterglow during the flammability test. This has been judged not a serious hazard. When afterglow occurs, extinguish it after 10 s. Then measure char length and note either the actual time or greater than 10 s for afterglow on the report.

5. Design and Materials

5.1 Clothing design shall be such to cover potentially exposed areas as completely as possible by proper interfacing of related items.

5.2 Garment design shall permit easy and rapid removal.

5.3 Garment design shall be such as to interfere the least with work function and still provide the necessary protection.

5.4 *Closures*:

5.4.1 Closure design should be appropriate for easy removal of garment (see 5.2).

5.4.2 Materials for closures shall be compatible with thermal resistance of fabric used and the protective characteristics required.

5.5 Trim, pocketing, and other auxiliary materials used in garment construction shall meet the flammability requirements of this specification (see 8.9) and shall not melt upon thermal exposure.

5.6 *Pockets*:

5.6.1 Garment design shall be appropriate as to not trap or retain molten metal.

5.6.2 Primary protective clothing shall not have external pockets.

6. Requirements

6.1 The properties of materials for primary and secondary clothing shall conform to the specification requirements in Tables 1 and 2, as tested in accordance with Section 8.

NOTE 4—Physical characteristic tests and values in Section 8.1-8.5 (for Table 1) are based on experience from woven fabrics in use currently and may not be applicable to other fabric types. (For example, knits and non-wovens.)

6.2 Characteristics of protective garments for both primary and secondary clothing shall conform to the specification requirements in Section 5.

7. Sampling

7.1 Material tests shall be performed on fabrics as they are delivered to the clothing manufacturer.

7.2 Garment requirements shall be met by finished garments because these garments will reach the end user.

7.3 Lot size for fabric tests shall be 4 572 m (5 000 yds) of manufactured fabric or the manufactured yardage, whichever is less. One sample shall be taken from each lot.

7.4 A lot size for garments shall consist of a single style (prototype) that reflects accurately the garment characteristics specified in Section 5.

TABLE 2 Insulative Performance

	Secondary Protective Clothing	Primary Protective Clothing
Metal sticking	(P/F)	(P/F)
Flame propagation	(P/F)	(P/F)
Fabric integrity	(P/F)	(P/F)
Heat transfer	not applicable	[A]

[A] Selection shall be based on a purchaser/supplier agreement in accordance with Test Methods D 4108 – 87 or F 955, or a future test method to be developed by Subcommittee F23.80.

8. Test Methods

8.1 *Breaking Strength (load)*—Determine the breaking strength as directed in Test Methods D 1682 using a constant rate of traverse (crt) tensile testing machine with the speed of the pulling clamp at 300 ± 10 mm/min (12 ± 0.5 in./min).

8.2 *Tear Strength*—Determine the tear strength for materials for primary protective garments as directed in Test Method D 2262, and for materials for secondary protective garments as directed in Test Method D 1424.

8.2.1 Optionally for selected materials for secondary protective garments, Test Method D 2262 may be employed. However, correlation between this method and Test Method D 1424 is not expected.

8.3 *Seam Slippage*—Determine the seam slippage as directed in Test Method D 434.

8.4 *Colorfastness*:

8.4.1 *Laundering*—Determine the colorfastness to laundering as directed in AATCC Method 61, 2A.

8.4.2 *Dry Cleaning*—Determine the colorfastness to dry cleaning as directed in AATCC Method 132.

NOTE 5—Launderable fabrics are expected to be dry-cleanable except where all or part of the fabric is not dry-cleanable and is so labeled. Goods labeled“ Dry Clean Only” are to be only dry-cleaned.

8.5 *Dimensional Change*—Determine dimensional change for materials as directed in AATCC Method 135 using Conditions 3, IV, Aiii, five washes.

NOTE 6—This procedure should not be employed for fabrics marked “Dry Clean Only” or “Do Not Wash”.

8.6 Determine the reflectivity after abrasion of coated primary materials as directed in MIL-C-87076A paragraph 4.5.1.

8.7 Determine the adhesion of coated primary materials as directed in MIL-C-87076A, paragraph 4.5.4.

8.8 Determine the adhesion after wet flexing of coated primary materials as directed in MIL-C-87076A, paragraph 4.5.5.

NOTE 7—Test Method D 4157 is cited in MIL-C-87076A.

8.9 *Flammability*—The flammability shall be tested as specified in FTMS 191 A, Method 5903for samples both initially and after washing as specified in 8.9.1 or dry cleaning as specified in 8.9.2. No melting or dripping of the test material is permitted.

8.9.1 *Wash Durability*—Fabrics suitable for washing should be washed 25 times using the method AATCC 135, 3, IV, A iii. Use AATC 1993 Standard Reference Detergent (low phosphate).

NOTE 8—AATCC 124 detergent is being discontinued and may not be available on a future order.

8.9.2 *Dry Cleaning Durability*—Fabrics labeled “Dry Clean Only” shall be dry cleaned 25 times using the procedure in Methods D 2724.

8.10 *Insulative Performance*:

8.10.1 Report pass/fail (P/F) observations of fabric performance in accordance with Table 2.

9. Keywords

9.1 molten substances; protective clothing; thermal hazards