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An American National Standard

Standard Test Method for Thermal Protective Performance of Materials for Protective Clothing for Hot Surface Contact[1]

This standard is issued under the fixed designation F 1060; 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.

ε[1] NOTE—Section 15 was added editorially in October 1993.

1. Scope

1.1 This test method is used to rate textile materials for thermal resistance and insulation when exposed for a short period of time to a hot surface with a temperature up to 600°F (300°C). This test method is applicable to woven fabrics, knit fabrics, battings, and sheet structures intended for use as clothing for protection against short exposure to hot surfaces. It is not intended for use in evaluating materials exposed to any other thermal exposure such as radiant energy or open flames. This test method is currently useful as a research and development tool.

1.2 This test method should be used to measure and describe the properties of materials, products, or assemblies in response to heat under controlled laboratory conditions and should not be used to describe or appraise the thermal hazard or fire risk of materials, products, or assemblies under actual exposure conditions. However, results of this test method may be used as elements of a thermal risk assessment which takes into account all the factors which are pertinent to an assessment of the thermal hazard of a particular end use.

1.3 The values as stated in inch–pound units are to be regarded as the standard. The values in parentheses are given for information only.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 123 Terminology Relating to Textiles[2]

D 1776 Practice for Conditioning Textiles for Testing[2]

3. Terminology

3.1 *Definitions*—In testing thermal protection clothing material, the response to hot surface contact is indicated by the following descriptive terms:

3.1.1 *charring*—the formation of a carbonaceous residue as the result of pyrolysis or incomplete combustion.

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

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *heat flux*—the thermal intensity indicated by the amount of energy transmitted per unit area and per unit time (cal/cm^2·s) (watts/cm^2).

3.2.2 *human tissue heat tolerance*—in the testing of thermal protective materials, the amount of thermal energy predicted to cause a pain sensation or a second degree burn in human tissue.

3.2.3 *ignition*—the initiation and continuation of combustion.

3.2.4 *melting*—a response evidenced by softening of the material, resulting in a nonreversible change.

3.2.5 *shrinkage*—a response evidenced by reduction in specimen size.

3.2.6 *sticking*—a response evidenced by softening and adherence of the material to the hot surface or other material.

3.2.7 *thermal end point*—in the testing of thermal protective materials, the point at which the sensor response on the recorder chart intersects the human tissue burn tolerance criteria overlay.

3.3 For definitions of other textile terms used in this test method, refer to Terminology D 123.

4. Summary of Test Method

4.1 This test method measures the performance of insulative materials. A material is placed in contact with a standard hot surface. The amount of heat transmitted by the material is compared with the human tissue tolerance and the obvious effects of the heat on the material are noted.

4.2 The temperature of the hot surface is measured/controlled with a thermocouple and the heat transmitted by the test specimen is measured with a copper calorimeter. The calorimeter temperature increase is a direct measure of the heat energy received.

4.3 A contact pressure of 0.5 psi (3 kPa) is used to compare material performance under controlled conditions. A different pressure may be chosen to represent a specific use condition,

[1] This test method is under the jurisdiction of ASTM Committee F–23 on Protective Clothing and is the direct responsibility of Subcommittee F 23.80 on Molten Substances.

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

and where it is used should be noted under test conditions (13.1.2.3).

4.4 The material performance is determined from the amount of heat transferred by the specimen and the observed effect of the heat exposure on the specimen. The thermal protection is the exposure time required to cause the accumulated heat received by the sensor to equal the heat that will result in a pain sensation (see Table 1) or cause a second degree burn in human tissue (see Table 2), as predicted from comparison of heat transfer data with human tissue heat tolerance curves (see Table 1).

5. Significance and Use

5.1 This test method rates textile materials intended for use as protective clothing against exposure to hot surfaces, for their thermal insulating properties and their reaction to the test conditions.

5.2 The thermal protection time as determined by this test method will relate to the actual end-use performance only to the degree that the end-use exposure is identical to the exposure used in this test method, that is, conductive energy from hot surfaces up to 600°F (300°C) and under a pressure of 0.5 psi (3 kPa).

5.3 The procedure maintains the specimen in a static, horizontal position under a standard pressure and does not involve movement.

5.4 This test method for materials for thermal protective performance is intended for use in comparing the relative performance of various materials. Because information on the possible biases that could exist between various laboratories and their specific test fixtures is limited, this test method is not recommended for direct comparison of results between laboratories. If use of this test method is desired for acceptance testing of commercial shipments, it is recommended that each laboratory involved perform the test on a series of duplicate specimens drawn from the same material samples so that the statistical bias can be computed and any disagreements arising out of the differences can be resolved.

6. Apparatus

6.1 *General Arrangement*—The arrangement of the individual components of the test apparatus is shown in Fig. 1.

6.2 *Hot Plate*—Shall have a flat heated surface with the smallest dimension, a minimum of at least 8 in. (200 mm) and have the ability to achieve a temperature of at least 700°F (371°C) and to permit temperature control within ± 5°F (2.8°C).

6.3 *Surface plate*— The flat plate shall be ¼ in. (6.4 mm) thick, 5.5 by 5.5 in. (140 by 140 mm) wide, with a 3⁄32-in. (2.4-mm) hole drilled from the edge to the center of the plate (Fig. 2). Either electrolytic copper or T-1100 aluminum surface plates may be used. The surface plate must be flat, smooth, and free from pits and cavities. (Flatness is indicated by negligible light passing between a straight edge and the plate surface.) Loss of the original mill finish (as judged with the naked eye) or warping, or both, may result in failure to achieve calibration with the reference standard.

6.4 *Sensor*—A copper calorimeter mounted in an insulating block with added weight and constructed as shown in Figs. 3 and 4. The calorimeter must fit securely in the insulating block and its surface must be flush with the face of the insulating block.

NOTE 1—**Caution:** Surface variations may result in failure to achieve calibration with the reference standard.

6.5 *Calibration Specimen*—Six new, not previously tested sheets of ordinary newspaper with total thickness of 0.021 ± 0.002 in. (0.53 ± 0.05 mm).

6.6 *Recorder*—Any strip chart recorder with full-scale deflection of at least 300°F (150°C) or 10 mV and sufficient sensitivity and scale divisions to read sensor response to ±2°F (1°C) or ±0.05 mV. A chart speed to read exposure time to ±0.1 s is required, 0.5 in./s (13 mm/s) is satisfactory.

7. Hazards

7.1 Perform the test in a hood or a ventilated area to carry away degradation products, smoke, and fumes. Exercise care to prevent contact with hot surfaces. Use protective gloves when handling hot objects. Have an appropriate portable fire extinguisher nearby.

8. Sampling

8.1 *Lot Size*—For acceptance sampling purposes, a lot is defined as a single shipment of a single style of fabric. A lot may constitute all or part of a single customer order.

8.2 *Lot Sample*—As a lot sample for acceptance testing, take at random the number of rolls of fabric directed in an applicable material specification or other agreement between the purchaser and the supplier.

8.3 *Laboratory Sample*—As a laboratory sample, take from the outside of each roll in the lot sample a full width swatch of fabric 1 yd (1 m) long after discarding a full width length of at least 1 yd (1 m) from the very outside of each roll.

TABLE 1 Human Tissue Tolerance to Pain Sensation

Exposure Time	Heat Flux		Total Heat		Calorimeter Equivalent		
	cal/cm²·sec	W/cm²	cal/cm²·s	W sec/cm²	ΔT°, F	ΔT°, C	ΔmV
1.0	0.640	2.70	0.640	2.70	8.53	4.74	0.250
1.5	0.475	2.00	0.713	3.00	9.51	5.28	0.275
2.0	0.385	1.61	0.770	3.22	10.27	5.71	0.293
3.0	0.280	1.17	0.840	3.51	11.20	6.22	0.322
5.0	0.195	0.82	0.975	4.08	13.00	7.22	0.375
7.0	0.155	0.65	1.085	4.54	14.47	8.04	0.420
10.0	0.118	0.49	1.180	4.94	15.73	8.74	0.458
20.0	0.076	0.32	1.520	6.36	20.27	11.26	0.582
30.0	0.060	0.25	1.800	7.53	24.00	13.33	0.690
50.0	0.060	0.25	3.000	12.55	40.00	22.22	1.150