



Designation: F2894 – 12

Standard Test Method for Evaluation of Materials, Protective Clothing and Equipment for Heat Resistance Using a Hot Air Circulating Oven¹

This standard is issued under the fixed designation F2894; 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 covers quantitative measurements and subjective observations that characterize the performance for evaluating the heat resistance of materials, protective clothing and equipment when exposed in a hot air circulating oven.

1.2 This test method is intended to evaluate physical changes in materials, protective clothing and equipment at a specified heat exposure.

1.2.1 The specified heat exposure in the hot air circulating oven is a combination of convective heat and radiant heat.

1.3 Materials, protective clothing and equipment are evaluated for visible changes or subjected to a material property measurement following a specified heat exposure.

1.4 This test method enables the quantitative measurement of shrinkage that occurs as a result of a specified heat exposure in a hot air circulating oven.

1.5 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to other units that are commonly used for thermal testing.

1.6 *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.*

NOTE 1—Flame resistant and heat resistant materials are described in a range of different standards and meet a range of different requirements. For materials tested in accordance with this test method, the applicable standard shall be used to establish preconditioning, conditioning and testing conditions and requirements.

2. Referenced Documents

2.1 ASTM Standards:²

D123 Terminology Relating to Textiles

¹ This 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.

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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.

D1776 Practice for Conditioning and Testing Textiles

E145 Specification for Gravity-Convection and Forced-Ventilation Ovens

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

F1494 Terminology Relating to Protective Clothing

2.2 AATCC Standard:

Test Method 135 Dimensional Changes in Automatic Home Laundering of Woven and Knit Fabrics³

2.3 NFPA Standards:

NFPA 1975 Standard on Station/Work Uniforms for Fire and Emergency Services⁴

3. Terminology

3.1 Definitions of Terms

3.2 For definitions of terms used in this test method, use the following documents: If the terms are related to textiles refer to Terminology **D123**; if the terms are related to protective clothing refer to Terminology **F1494**.

3.2.1 *convective heat, n*—heat transferred by the motion of a fluid.

3.2.2 *degradation, n*—a deleterious change in one or more properties of a material.

3.2.2.1 *Discussion*—In thermal testing of materials, protective clothing and equipment, degradation is a material response evidenced by a change in either or both the visual properties and the performance properties of the test specimen.

3.2.2.2 *Discussion*—Degradation generally is associated with a chemical composition change that can result in a change in a visual property, for example, color, or it can result in a change in a performance property including but not limited to strength, hand, flammability, penetration resistance, water repellency and air permeability. A test specimen that changes in one property does not necessarily change in other properties. Evidence of degradation in performance properties usually requires additional measurements related to properties of

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.

specific interest. Discoloration is a visible material response related to degradation. When discoloration is observed, it shall be reported.

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

3.2.4 *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.

3.2.5 *protective equipment, n*—a non-clothing item of equipment 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 user of the equipment.

3.2.6 *radiant heat, n*—heat communicated by energy propagated through space and transmitted by electromagnetic waves.

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

3.3 *Definitions of Terms Related to Thermal Testing of Materials, Protective Clothing and Equipment:*

3.3.1 *deformation, n*—in thermal testing of materials, protective clothing and equipment, a material response evidenced by a change in shape of the test specimen that is irreversible at room temperature.

3.3.1.1 *Discussion*—A change in shape caused by the specified heat exposure such as distortion of woven or non woven fabrics or curling of knit fabrics shall not be identified as deformation as long as these changes are reversible at room temperature.

3.3.2 *delamination, n*—in thermal testing of materials, protective clothing and equipment, a material response evidenced by the separation of two or more layers of the test specimen in whole or in part.

3.3.3 *dripping, n*—in thermal testing of materials, protective clothing and equipment, a response evidenced by flowing of the polymer and by the formation of droplets from the flowing material.

3.3.4 *flaking, n*—in thermal testing of materials, protective clothing and equipment, a material response evidenced by the unassisted loss of visible particles of material from the test specimen when the test specimen is removed from the oven for inspection.

3.3.4.1 *Discussion*—The specimen shall not be abraded, flexed or impacted to generate flaking.

3.3.5 *hole formation, n*—in thermal testing of materials, protective clothing and equipment, the appearance of a visible aperture during the test exposure.

3.3.5.1 *Discussion*—The specimen is considered to exhibit hole formation when a visible hole is produced as a result of the thermal exposure that is approximately 3 mm (0.12 in.) in diameter or greater, or if the hole is rectangular in shape approximately 3 mm (0.12 in.) in width and length or greater. Single threads across the hole do not reduce the size of the hole for the purposes of this test method.

3.3.6 *melting, n*—in thermal testing of materials, protective clothing and equipment, the liquefaction of material under the influence of heat.

3.3.7 *separation, n*—in thermal testing of materials, protective clothing and equipment, a material response evidenced by splitting or delaminating.

3.3.8 *splitting, n*—in thermal testing of materials, protective clothing and equipment, a material response evidenced by the test specimen breaking into two or more pieces in whole or in part.

3.3.9 *sticking, n*—in thermal testing of materials, protective clothing and equipment, a material response evidenced by the test specimen adhering to itself or to other surfaces.

3.3.9.1 *Discussion*—This test method is conducted in a manner that avoids the contact of test specimens with oven surfaces or with adjacent test specimens. However, it is still possible for test specimens to stick to the mounting hooks or clamps and this observation shall be reported. Another evaluation of sticking specific to fabrics is described in 7.2.1 and 8.3 of NFPA 1975. The NFPA 1975 test method evaluates the thermal stability of specimens by assessing the blocking of folded specimens placed between glass plates under weight inside an oven meeting the same characteristics as the oven used in this test method.

4. Summary of Test Method

4.1 The test method evaluates the heat resistance of materials, protective clothing and equipment using a hot air circulating oven.

4.2 Specimens shall be exposed in the test oven at a specified temperature for a specified oven exposure time as required by the applicable material or product specification.

4.2.1 If no material or end product specification requirements for the oven temperature and oven exposure time are provided, the oven temperature shall be 260 +8/-0°C (500 +14/-0°F) and the oven exposure time shall be 5 minutes +15/-0 seconds.

4.3 Following heat exposure, the test specimen is removed and examined for evidence of one or more of the following phenomena: ignition, melting, dripping, separation, etc., see 11.5.

4.4 If specified, test specimens are evaluated for shrinkage as a result of the convective heat exposure.

5. Significance and Use

5.1 This test method is used to evaluate the heat resistance of materials, clothing and equipment when exposed to combination of convective heat and radiant heat in a hot air circulating oven. The principal findings of this test method are observations of the specimen response to the heat exposure.

5.1.1 The majority of procedures specified in this test method apply to the evaluation of flat material specimens.

5.1.2 When evaluating non-flat materials, alternative procedures are required for mounting specimens and interpreting the effects of the heat exposure.

5.2 If specified, this test method is used for the measurement of material shrinkage following a convective heat exposure in a hot air circulating oven.

5.3 This test method is not intended to simulate the actual exposure of material, clothing or equipment in high heat conditions such as a fire environment.