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Standard Specification for Retained Sewn Seam Strength After Exposures to Hot Air and Open Flame[1]

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INTRODUCTION

Sewn seam strength of flame resistant textile products is a critical measurement of structural integrity. This is particularly important for flame resistant (FR) personal protective clothing and equipment (PPE), which is designed to provide safety to any worker who may, during the service life of the PPE, experience multiple short term exposures to high heat. While "new" FR protective clothing items can provide the wearer with protection that meets a specific performance requirement, it is useful to know what the cumulative effects of repeated exposures to high heat can do to the integrity of the sewn seams used to construct protective clothing items. In addition, it is useful to know how the cumulative exposures can affect the sewn seam strength performance of the PPE when exposed to an open flame for a short period of time.

During normal use, some FR specialized clothing items can, for short durations, be repeatedly exposed to high heat. While the cumulative effect of repeated short duration exposures to high heat is known to result in a loss of fabric strength, these same exposures can also result in a loss of sewing thread break strength. This loss of break strength can result in lower retained sewn seam strength that can put the wearer at potential risk of injury if the garment is too weak to maintain integrity of the structure.

While there are recognized minimum sewn seam strength values required for new FR garments, never exposed to heat or flame hazard, this standard is intended to measure the retained sewn seam strength after repeated exposures to high heat and a subsequent exposure to open flame.

These data may be useful as additional information for agencies that want criteria to establish selection, care, maintenance and retirement/replacement of FR protective clothing.

1. Scope

1.1 This specification covers the retained sewn seam strength of flame resistant fabric subassemblies after repeated short duration exposures to hot air or repeated short-duration exposures to hot air and subsequent short-term exposures to open-flame impingement.

1.1.1 This specification is used to determine minimum retained sewn seam strength after these exposures.

1.2 This standard is not intended to serve as a detailed manufacturing or purchasing specification, but can be referenced in purchase contracts to ensure that minimum performance requirements are met.

[1] This specification is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.52 on Flammability.

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1.3 Controlled laboratory tests used to determine compliance with the performance requirements of this standard shall not be deemed as establishing performance levels for all situations to which wearers of FR protective clothing are potentially exposed.

1.4 Mandatory requirements are indicated by use of shall; recommendations and advising information is indicated by should.

1.5 *This standard is used to measure and describe 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.*

1.6 *Fire testing is inherently hazardous. Adequate safeguards for personnel and property shall be employed in conducting these tests.*

1.7 *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.*

1.8 *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
D1683 Test Method for Failure in Sewn Seams of Woven Fabrics
D1776 Practice for Conditioning and Testing Textiles
D4391 Terminology Relating to The Burning Behavior of Textiles
D6193 Practice for Stitches and Seams
D7016 Test Method to Evaluate Edge Binding Components Used in Mattresses After Exposure to An Open Flame

2.2 *AATCC Test Methods:*[3]

~~TM 135~~LP 1 ~~Dimensional Changes of Fabrics after Home Laundering~~Home Laundering: Machine Washing

2.3 *ISO Documents:*[4]

ISO 17493 Clothing and Equipment for Protection Against Heat Test Method for Convective Heat Resistance Using a Hot Air Circulating Oven

3. Terminology

3.1 The following terms are relevant to this standard: critical sewn seams, retained sewn seam strength (RSS_{50}), seam engineering, sewn seam strength.

3.2 For all terms related to flammability of textiles see Terminology D4391.

3.3 For all terminology related to textiles, see Terminology D123.

4. Significance and Use

4.1 It is possible that the user of FR protective clothing will experience repeated exposures to hot air as part of the work environment. While these individual exposures are not likely to pose a catastrophic threat, the cumulative effect of these exposures are likely to reduce the level of retained sewn seam strength performance to a value that is measurably lower than the sewn seam strength performance requirement established for a new item.

[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 International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, http://www.iso.ch..

4.2 The assembly of textile structures requires that the seam engineering used to manufacture the product anticipate how to retain the maximum sewn seam strength during the anticipated life cycle of the product.

4.2.1 Initial sewn seam strength performance requirements of FR textile products measures sewn seam strength of a new (never exposed to heat environment) product.

4.2.2 Retained sewn seam strength (RSS_{50}) can be used to measure seam failure of FR protective clothing after repeated short duration exposures to high heat. RSS_{50} can also be used to measure seam failure of FR protective clothing when exposed to open flame after repeated short duration exposures to high heat.

4.3 These data about retained sewn seam strength are useful to establish criteria to determine when to repair, retire, or replace FR protective clothing.

5. Materials and Manufacture

5.1 Sewn seam assembly samples for testing shall be made using seams and stitches described in Practice D6193 and constructed with inherently flame resistant sewing thread.

5.2 Purchaser and supplier shall agree on the number of specimens to be tested. As a minimum, five specimens of each construction shall be tested.

5.3 For details about samples and conditioning see Section 6.

6. Sampling and Wash Conditioning

6.1 Prepare samples as described in Test Method D1683, Section 8, with the following modifications:

6.1.1 Cut twelve pieces of fabric sections so that each fabric section is 600 ± 2 mm (24.0 ± 0.1 in.) long by 125 ± 2 mm (5 ± 0.1 in.) wide.

6.1.1.1 Separate cut fabric sections into six sets of two pieces for sample sewing.

6.1.1.2 Stitch the two pieces of fabric together with the seam assembly normally used to attain critical sewn seam strength for an FR fabric having a specific mass, as identified in Section 10, in lengthwise direction. This will produce six seam samples. Each sample will measure 600 ± 2 mm (24.0 ± 0.1 in.) long by approximately 200 ± 2 mm (8 ± 0.1 in.) wide when opened. When measured from edge of fabric, the stitch line is approximately 100 ± 2 mm (4 ± 0.1 in.) from either edge.

6.2 Cut each of the sewn seams into six specimens for testing.

6.2.1 When opened, each sewn seam specimen will measure approximately 200 ± 2 mm (8.0 ± 0.1 in.) long by 100 ± 2 mm (4.0 ± 0.1 in.) wide with the stitching at midpoint; approximately 100 mm from either the top or bottom edge.

6.2.2 A total of 36 specimens will be made for testing. A minimum of 30 specimens will be needed to complete performance evaluations.

6.3 Specimens that are to be conditioned by washing shall be washed and dried five times using AATCC ~~TM 135, Table I, Machine Cycle (1); Wash Temp (V); Dry Procedure (Ai)~~LP 1, Home Laundering: Machine Washing per Table I (1) Normal cycle, Temperature (V), Drying per Table V (Ai).

7. Baseline Sewn Seam Strength

7.1 Five unwashed specimens shall be tested for sewn seam strength in accordance with Test Method D1683 to determine baseline sewn seam strength.