Designation: D7016/D7016M – 14

Standard Test Method to Evaluate Edge Binding Components Used in Mattresses After Exposure to An Open Flame[1]

This standard is issued under the fixed designation D7016/D7016M; 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.

INTRODUCTION

Evaluation of raw material components is a vital and ongoing part of any manufacturing operation, especially when each item can contribute to the technical performance of the final product. Components used in a mattress construction govern the ultimate product performance, its comfort and durability, and also affect its flammability behavior.

The textile components used on the exterior of the mattress—mattress tape and sewing thread—are critical for holding the structure together. These components contribute to the aesthetics of the structure, and they are also susceptible to ignition when exposed to an open flame hazard. Data which indicate that these two components are able to meet minimum performance criteria when exposed to an open flame provides the mattress manufacturers with valuable information.

The value of these data increases when the behavior of components in a small scale test correlate to the behavior of these components in a full scale mattress burn test. The performance criteria require that: *(1)* the components do not support the combustion of the afterflame and, *(2)* that these components demonstrate post flame exposure characteristics which contribute to the retention of structural integrity and prevent seam rupture. This test method can be used as a quality control technique in a supplier quality assurance program.

1. Scope

1.1 This test method measures the flammability characteristics of mattress edge bindings and sewing threads during and after exposure to an open flame ignition source.

1.1.1 This test method is used to evaluate these components either independently or in combination for use in mattresses designed with a fire barrier fabric.

1.1.1.1 The test method is used to evaluate mattress edge binding and sewing thread when the design requires the use of these components.

1.1.2 This test method can be used as a screening test method to determine how sewing thread and mattress edge binding component combinations will perform.

1.2 This test method is used to measure and describe the response of materials, products, or subassemblies 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 Fire testing of products and materials is inherently hazardous, and adequate safeguards for personnel and property shall be employed in conducting these tests.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *This test method may involve hazardous materials, operations, and equipment. 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:*[2]

D123 Terminology Relating to Textiles

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

Current edition approved Dec. 15, 2014. Published January 2015. Originally approved in 2004. Last previous edition approved in 2009 as D7016–09$^{\varepsilon 1}$. DOI: 10.1520/D7016-14.

[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.

D204 Test Methods for Sewing Threads
D1683 Test Method for Failure in Sewn Seams of Woven Apparel Fabrics
D7138 Test Method to Determine Melting Temperature of Synthetic Fibers
D7140 Test Method to Measure Heat Transfer Through Textile Thermal Barrier Materials

2.2 *AATCC Method:*[3]
Standard Laboratory Practice for Home Laundering Fabrics Prior to Flammability Testing to Differentiate Between Durable and Non-Durable Finishes

2.3 *Federal Standards:*[4]
Code of Federal Regulations—Title 16—Commercial Practices Chapter II—Consumer Product Safety Commission Part 1615 Standard for the Flammability of Children's Sleepwear; Sizes 0 through 6X, Revision of January 1, 2001
Code of Federal Regulations, 16 CFR 1633 Standard for the Flammability (Open Flame) of Mattress Sets

2.4 *NFPA Standards:*[5]
NFPA 701 Standard Methods of Fire Tests for Flame Propagation of Textiles and Films (1999 Edition)

2.5 *ISO Standard:*[6]
ISO 17493 Test Method for Convective Heat Resistance Using a Hot Air Circulating Oven

2.6 *Military Standards, Commercial Item Description (CID):*[6]
A-A 55195 Thread Para-Aramid, Spun, Intermediate Modulus; Type I – Normal Performance; Type II – High Performance
A-A 55220 Thread, Para-Aramid, Intermediate Modulus

3. Terminology

3.1 *Definitions:*

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

3.1.2 *afterflame time, n*—the length of time for which a material continues to flame after the ignition source has been removed.

3.1.3 *char length, n— in measuring flame resistance of textiles*, the distance from the fabric edge, which is directly exposed to the flame to the furthest point of visible fabric damage.

3.1.3.1 *Discussion*—Char length represents the maximum length of a fabric specimen which can be consumed by a vertical flame.

3.1.4 *fire barrier composite, n*—a multilayer structure which consists of a non-flame resistant fabric that is secured to a flame resistant fabric.

3.1.5 *fire barrier fabric, n*—a single layer structure made of fibers which are either inherently flame resistant or chemically treated to be flame retardant.

3.1.6 *flame resistance, n*—the property of a material whereby flaming combustion is prevented, terminated, or inhibited following application of a flaming or nonflaming source of ignition, with or without subsequent removal of the ignition source.

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

3.2 For other terms used in this test method related to textiles refer to Terminology D123.

4. Summary of Test Method

4.1 Sewing thread is evaluated for break strength before and after exposure to air at an elevated temperature.

4.2 Flame resistance of edge binding tape is determined by char length measurements.

4.3 Specimens of fire barrier fabrics which are secured using sewing thread and edge binding tape are exposed to an open flame to determine if seam integrity is maintained.

5. Significance and Use

5.1 Evaluation of raw material components is a vital and ongoing part of any manufacturing operation, especially when each item can contribute to the technical performance of the final product.

5.2 This test method measures the behavior of mattress edge binding and sewing thread during and after exposure to an open flame ignition source.

5.3 Flame resistance of the components used to close the perimeter of a mattress is an important factor in limiting the potential of a bedding fire by preventing the chance for seam failure.

5.4 Data which show a correlation of behavior for both the sewing thread and edge binding tape, when tested as a subassembly according to this test method, and also when tested using a full scale composite mattress burn test, such as CFR 1633, can provide the manufacturer with important information. These data can be valuable when selecting components to be used in the manufacture of its products which are designed to use mattress edge binding and sewing thread.

5.5 The level of performance required for these components is *(1)* that they do not support the afterflame, and *(2)* that these components demonstrate post flame exposure characteristics which contribute to retaining the structural integrity of the subassembly.

5.6 In case of a dispute arising from differences in reported results when using this test method for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a

[3] American Association of Textile Colorists and Chemists, PO Box 12215, Research Triangle Park, NC 27709.Available from American Association of Textile Chemists and Colorists (AATCC), P.O. Box 12215, Research Triangle Park, NC 27709, http://www.aatcc.org.
[4] Government Printing Office, 732 N. Capital Street N.W., Washington, DC 20401.
[5] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org
[6] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

minimum, the two parties should take a group of test specimens which are as homogeneous as possible and which are from a lot of material of the type in question. The test specimens should then be sent to each laboratory for testing. The average results from the two laboratories should be compared using Student's *t*-test and an acceptable probability level chosen by the two parties before testing is begun. If a bias is found, either its cause must be found and corrected or the purchaser and the supplier must agree to interpret future test results with consideration to the known bias.

6. Sewing Thread

6.1 Using Test Method D204 determine the average initial break strength of the sewing thread.

6.2 Using Test Method D7138, evaluate the sewing thread to confirm that the fiber does not melt when exposed to a temperature of 285 ± 1°C [550 ± 3°F].

6.3 After determination that the fiber does not melt, cut six specimens of sewing thread to a length of 460 ± 3 mm [18 ± 0.125 in.] and suspend them in a hot air circulating oven as used in ISO 17493.

6.3.1 Expose specimens for 30 minutes at a temperature of 260 ± 1°C [500 ± 3°F].

6.3.2 Using Test Method D204, confirm that the average break strength after exposure to hot air exceeds 65 % of initial break strength.[7]

7. Edge Binding Tape

7.1 Measure the flame resistance and char length of the edge binding tape using the test procedure noted in Section 1615.4 Code of Federal Regulations—Title 16—Commercial Practices Chapter II—Consumer Product Safety Commission Part 1615, Standard for The Flammability of Children's Sleepwear; sizes 0 through 6X Revision of January 1, 2001 with the following modifications:

7.1.1 Test specimens both as received (unwashed), and after being washed five times in accordance with AATCC Standard Laboratory Practice for Home Laundering Fabrics Prior to Flammability Testing to Differentiate Between Durable and Non-Durable Finishes.

7.1.2 Cut specimens the full width of the binding used to cover the edges of the mattress to a length of 300 mm [12 in.]. Examples: 22.5 by 300 mm [0.875 by 12 in.]; 31.5 by 300 mm [1.25 by 12 in.]; and 36.5 by 300 mm [1.43 by 12 in.].

7.1.2.1 Apparatus as configured in Section 1615.4 will accommodate the listed edge bindings.

7.1.3 Test ten unwashed specimens and ten washed specimens.

7.1.3.1 Expose each of ten unwashed specimens to a 12 s vertical flame impingement. Specimens shall exhibit a char length no greater than 100 mm [4 in.].

7.1.3.2 Expose each of ten washed specimens to a 12 s vertical flame impingement. Specimens shall exhibit a char length no greater than 125 mm [5 in.].

8. Subassembly

8.1 Select a fire barrier fabric which has been tested using Test Method D7140.[8]

8.1.1 Make samples using the sewing thread shown to comply to Section 5 and edge binding tape shown to comply to Section 6.

8.1.1.1 Select the edge binding tape having the appropriate width to enclose the edge of the two sections.

8.1.2 Join two fire barrier sections. One section shall represent the fire barrier fabric used on the top panel of the mattress; one section shall represent the fire barrier fabric used on the side panel of the mattress.

8.1.2.1 Sew the fabric sections together using the same seam closing techniques used to manufacture mattresses.

8.1.3 Samples measure a minimum of 208 ± 0.50 cm [80 ± 0.75 in.] in width and 50 ± 0.50 cm [20 ± 0.75 in.] in length as shown in Figs. 1 and 2.

8.2 Cut the samples into specimens for seam testing and open flame resistance testing.

8.2.1 For seam strength testing, before exposure to open flame test, cut five specimens in accordance with the requirements of Test Method D1683.

8.2.1.1 Test five specimens and determine average seam break strength.

8.2.2 For open flame resistance testing, cut seven specimens with a vertical dimension of 500 ± 6 mm [20 ± 0.25 in] and a horizontal dimension of 200 ± 6 mm [8 ± 0.25 in.] as shown in Figs. 2 and 3. The seam with the mattress edge binding should be horizontal and approximately midway between the top and bottom edge.

[7] The time and temperature requirements of Test Method 1534 were developed using data originally developed by the U.S. Air Force in 1968. These data were used to determine the melting point of synthetic fibers which would be made into yarns for fabrics and sewing threads and then used to manufacture protective clothing worn by military pilots, tank crew personnel, shipboard personnel, and space suits worn by astronauts. The testing threshold used to evaluate fibers was established as a benchmark for a wide array of textile products. Sewing threads which melt when exposed to high temperatures do not demonstrate any retained break strength. Those sewing threads which are able to withstand exposure at this elevated temperature retain measurable strength characteristics between 65 to 85 % of the original break strength.

[8] Fire barrier fabrics are made using a variety of technologies. In addition to fabrics made of inherently flame resistant fibers, these structures can be made of multifiber hybrids and also treated fabrics. The fabrics are manufactured as both woven and nonwoven structures. The synergy of the sewing thread and edge binding tape is intended to work in conjunction with every type of fire barrier fabric which can be used to successfully pass the requirements of an open flame test, such as 16 CFR 1633.

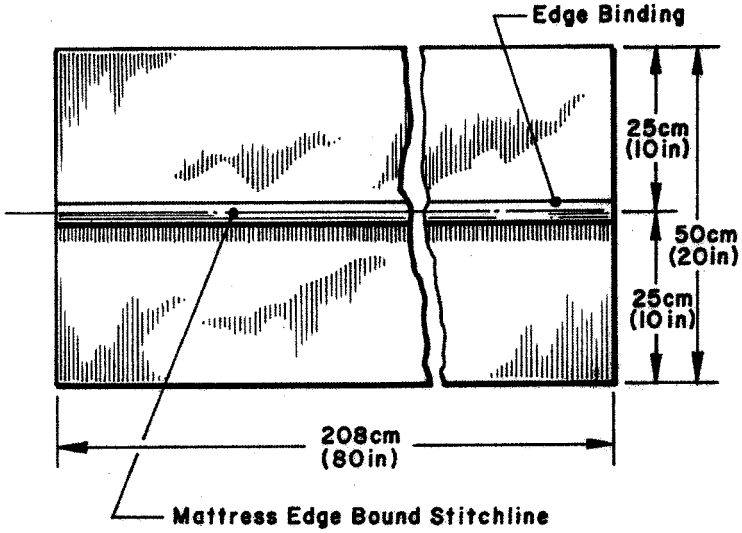

FIG. 1 Mattress Edge Bound Sample—Front View

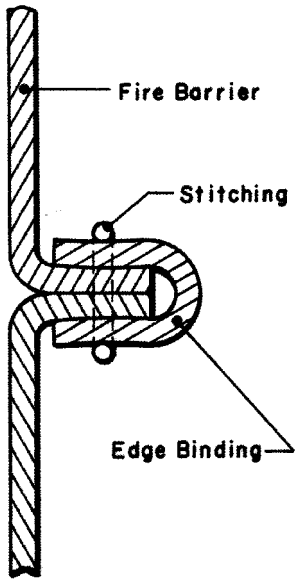

FIG. 2 Mattress Edge Bound Sample—Profile

8.2.3 When evaluating specimens which are made using a fire barrier fabric, dress cover fabric, and foam, remove the

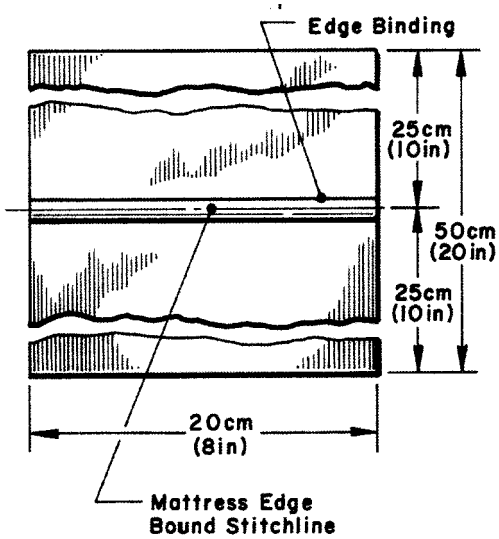

FIG. 3 Mattress Edge Bound Specimen—Front View

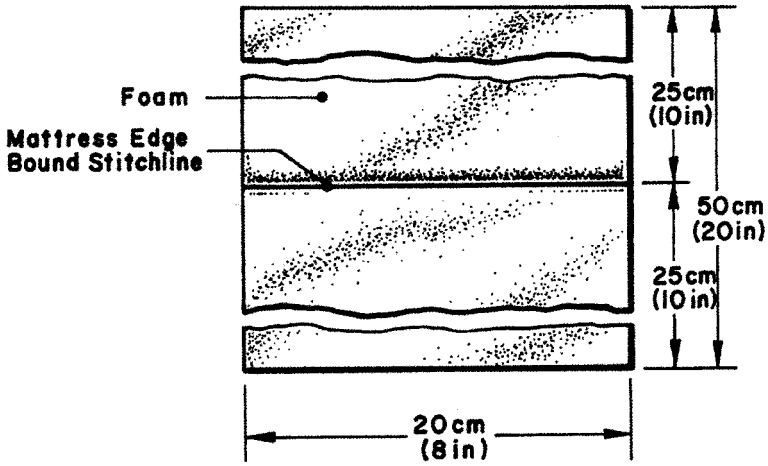

FIG. 4 Before Trimming—Back View

foam layer except for that foam which is encapsulated by the edge binding and sewing thread. (See Figs. 4-6.)[9]

8.2.3.1 The perimeter of cut specimens which have an unfinished raw edge shall be finished using the same sewing thread as evaluated in Section 5. The edge finish of the specimen can be completed as noted in Chapter 5 of NFPA 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films (1999 Edition), with exception of vertical (fifth) stitch line.

8.3 Measure the open flame resistance of the subassembly using the 45 ± 1 s open flame exposure, of Test Method 1, NFPA 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films (1999 Edition) with following modifications:

8.3.1 A photographic, videographic, or digital camera can be used to record the behavior of the sample during the exposure to the open flame.

8.3.2 The mounting of the specimen as specified in Chapter 2 requires that the specimen be suspended from a pin bar near the top of the cabinet.

8.3.2.1 After securing specimen to pin-bar near top of test cabinet, attach a weight, having a mass of 2 kg ± 25 g [70 ± 1 oz], to the portion of the specimen below the seam, approximately 50 ± 6 mm [2 ± 0.25 in.] from the bottom edge. (See Fig. 7.)

[9] In the manufacture of a mattress, the tape edge binding and stitching operations, when properly done by an experienced operator, performs three functions: *(1)* it secures the top or bottom perimeter of the mattress by joining the top panel component and the side panel component of the mattress, *(2)* it encapsulates the foam which is part of these structures, and *(3)* it keeps the fire barrier fabric positioned. A mattress is a "closed unit." As such, a fire barrier acts like a shield to prevent the flame from making contact with the encapsulated foam. Although the tape edge binding and stitching operation can effectively "close" the mattress, the spacing interval between each stitch, creates a potential point of entry for the open flame which can result in the encapsulated foam becoming a fuel source which supports combustion along the row of stitching until it self-extinguishes. Removal of all foam on the backside of the subassembly, except that foam which is encapsulated by the edge binding tape and sewing thread, creates a challenge which is similar to the hazard that these components are expected to overcome in a full scale mattress open flame test.

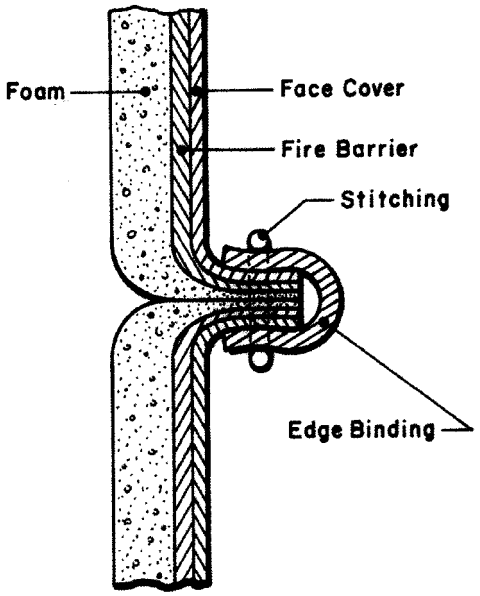

FIG. 5 Before Trimming—Profile

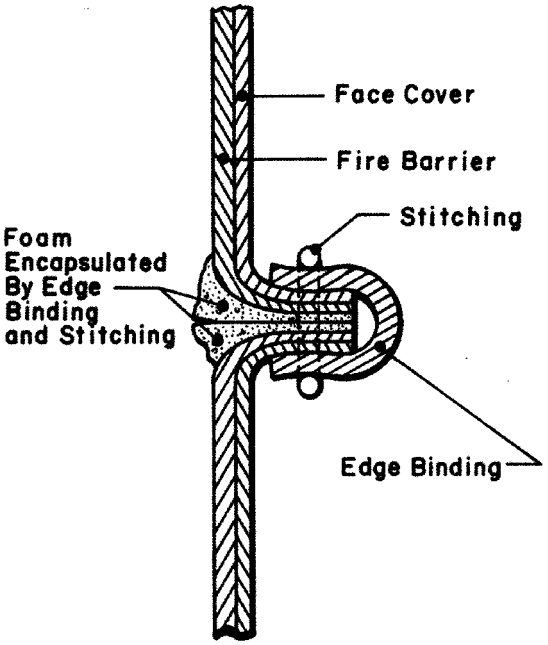

FIG. 6 After Trimming—Profile

NOTE 1—The attached weight keeps the specimen under tension, similar to that demonstrated by a composite structure.

8.3.3 Using the specified gas flame and burner design as indicated in Chapter 3; position the burner so that the flame impinges at the junction encapsulated by the edge binding and sewing thread.

8.3.3.1 The burner shall be placed so that it is 25 ± 2.5 mm [1 ± 0.10 in.] and centered on the horizontal sewn seam. (See Fig. 7.)

8.3.3.2 Rupture of the seam during exposure to open flame or during afterflame constitutes failure.

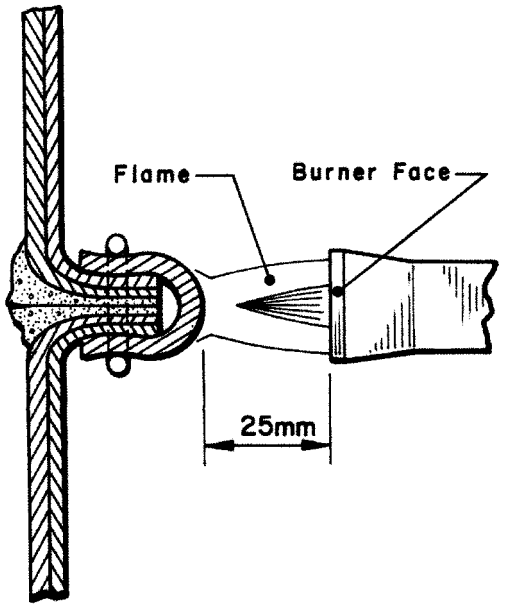

FIG. 7 Position of Burner and Flame

8.4 After removal of specimens from test cabinet, visually examine the area of specimen exposed to flame to determine if the edge bound seam and stitching retains its integrity across the width of the specimen.

8.4.1 A photographic, videographic, or digital camera can be used to visually record the integrity of the specimen prior to any post exposure seam strength testing.

8.4.2 Trim the specimen so that the area impinged by flame can be centered on clamp used to hold specimen.

8.4.2.1 Using Test Method D1683, determine the post flame exposure seam strength. Indicate the mode of seam failure: seam rupture, thread rupture, fabric failure.

NOTE 2—While the edge bound seam and stitching may retain its integrity, the fire barrier fabric may have been significantly weakened by the exposure to open flame. Consequently, it may become too brittle and weak to permit a seam strength value to be determined.

9. Report

9.1 Report the initial break strength of sewing thread.

9.1.1 Report average break strength of sewing thread after exposure to hot air circulating oven.

9.2 Report the average afterflame time and char length of unwashed specimens.

9.2.1 Report the average afterflame time and char length of washed specimens.

9.3 Identify the fire barrier fabric.

9.3.1 Report average seam break strength of subassembly before exposure to open flame.

9.3.2 Report configuration of specimen before exposure to open flame test.

9.3.3 Report mode of seam failure post-flame exposure.

9.4 A sample report form is shown in Appendix X1.

10. Precision and Bias[10]

10.1 An interlaboratory test program was conducted to obtain precision data. Five laboratories were supplied specimens for testing. The purpose of the study was to evaluate different combinations of sewing thread and edge tape used with commercial fire barrier fabrics used in the manufacture of mattresses that meet the requirements of 16 CFR 1633.

10.1.1 Five laboratories were able to complete the test.

10.2 *Sewing Thread:*

10.2.1 Tensile properties were determined on five thread types, both pre-exposure and post-exposure to hot air. Breaking force (BF) data for straight break strength and loop break strength, for all thread types, were obtained. Results are reported in Table 1.

10.3 *Edge Tape:*

10.3.1 During the earlier interlaboratory study (RR:D13-1118) the testing of edge tape was conducted. Edge tape was tested for afterflame (in seconds) and char length (in inches). Samples were tested with and without FR treatment, and either unwashed or washed. Five laboratories performed the testing, with eight replicates measured per test. Results are reported in Table 2 and Table 3.

NOTE 3—The untreated, unwashed sample was completely consumed, hence the 12 in. char length and zero standard deviation. The treated samples showed no afterflame, hence their zero standard deviations.

10.4 *Sub-Assembly Testing:*

10.4.1 Sewn seam break strength integrity of subassemblies was measured before and after exposure to open flame.

[10] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:D13-1128.

TABLE 1 Sewing Thread - Summary Analysis Of Straight And Loop Break Strength

Material	Mean (Str BS BE)	Mean (Str BS AE)	Straight BS % Retained	Mean (Loop BS BE)	Mean (Loop BS AE)	Loop BS % Retained
T40 – A-A-55220	16.19 lbf	12.51 lbf	77.3	8.67 lbf	6.90 lbf	79.6
T50 TYPE II	17.69 lbf	13.04 lbf	73.7	14.66 lbf	12.61 lbf	86.0
T50 TYPE II	18.68 lbf	15.13 lbf	81.0	13.43 lbf	11.91 lbf	88.7
T50 TYPE 1	9.70 lbf	6.42 lbf	66.2	13.62 lbf	9.50 lbf	69.8
T50 TYPE I	10.76 lbf	8.48 lbf	78.8	12.73 lbf	10.45 lbf	82.1

T 40 MONO = TEX 40 PARA-ARAMID, Natural, Soft Finish, complying to A-A-55220
T 50, Type II = TEX 50 PARA-ARAMID, Natural, Glazed, complying to A-A-55195, Type II
T 50 Type II = TEX 50 PARA-ARAMID, Natural, Glazed, complying to A-A-55195, Type II
T 50 SP = TEX 50 SHORT STAPLE, PARA-ARAMID, Natural, complying to A-A-55195, Type I
T50, Type I = TEX 50 PARA-ARAMID, Natural, complying to A-A-55195, Type I
Str BS BE = Straight Break Strength Before Exposure in Hot Air Circulating Oven
Str BS AE = Straight Break Strength After Exposure in Hot Air Circulating Oven
Straight BS % Retained = Straight Break Strength Percent Retained After Exposure in Hot Air Circulating Oven
S Loop BS BE = Loop Break Strength Before Exposure in Hot Air Circulating Oven
Loop BS AE = Loop Break Strength After Exposure in Hot Air Circulating Oven
Loop BS % Retained = Loop Break Strength Percent Retained After Exposure in Hot Air Circulating Oven
lbf = pounds force

TABLE 2 Edge Tape Vertical Flame Exposure

Treated?	Washed?	N	Mean AF	Mean CL	S AF	S CL
no	no	20	55.77	12.00	9.38	0.00
no	yes	30	34.83	8.26	17.97	2.84
yes	no	30	0.00	2.67	0.00	0.74
yes	yes	30	0.00	2.97	0.00	0.82

Treated = untreated tape/FR treated tape,
Washed = unwashed/washed,
N = number of tests,
Mean AF = mean afterflame,
Mean CL = mean char length,
SAF = standard deviation—afterflame, and
SCL = standard deviation—char length.

TABLE 3 Edge Tape

Treated?	Washed?	AF_r	AF_R	SAF_r	SAF_R	CL_r	CL_R	SCL_r	SCL_R
no	no	20.09	26.00	7.25	9.38				
no	yes	48.50	49.79	17.50	17.97	6.76	7.88	2.44	2.84
yes	no			0.00		1.14	2.04	0.41	0.74
yes	yes			0.00		1.53	2.26	0.55	0.82

AF_r = afterflame repeatability,
AF_R = afterflame reproducibility,
SAF_r = standard deviation afterflame repeatability,
SAF_R = standard deviation afterflame reproducibility,
CL_r = char length repeatability,
CL_R = char length reproducibility,
SCL_r = standard deviation char length repeatability, and
SCL_R = standard deviation char length reproducibility.

10.4.1.1 While this method allows for the testing of various subassembly constructions, such as with or without ticking; with or without foam; etc, it was determined that the focus of the interlaboratory study be limited to the performance of the junctions that secures the following three components: FR sewing thread, edge tape, and fire barrier fabric.

10.5 *Data and Analysis:*

10.5.1 *Sewing Thread:*

10.5.1.1 The repeatability (r) of this test method is noted for each respective item.

10.5.1.2 The reproducibility (R) of this test method is noted for each respective item.

10.5.1.3 Tables 4-7 relate to the testing of sewing thread both pre-exposure and post-exposure to hot air.

10.5.1.4 These data indicate that all of the FR sewing thread being used to manufacture mattresses retained greater than 65% of the original straight break strength and loop break strength after exposure in a hot air circulating oven.

10.5.2 *Sub-Assemblies:*

10.5.2.1 Data show that all of the FR sewing thread types used to manufacture subassemblies that retained a measurable seam strength, after exposure to an open flame, demonstrated a loss of original seam strength equal to approximately 55 %.

10.5.2.2 Fig. 8 and Fig. 9 show that the predominant contribution to total variability in subassembly seam strength measurements, both before (88 %) and after (37.6 %) exposure to an open flame is the type of fire barrier fabric.

(1) Data show that subassemblies made with certain types of commercial fire barrier fabrics exhibit break strength in excess of 40 lbf both before and after exposure to an open flame; other commercially available fabrics exhibit a break strength of 4 – 6 lbf.

10.6 *Bias:*

10.6.1 Bias is the difference between an average test value and the reference (or true) property value. Reference values do not exist for this test method since the value of the test property is defined exclusively by the test method. Bias cannot be determined.

11. Conclusion

11.1 The interlaboratory study (ILS) shows how edge closing components can influence the performance of subassemblies when tested using D7016. Additionally, the data disprove the premise that all flame resistant barrier fabrics, after exposure to an open flame, have sufficient integrity so that seam strengths can be measured along the stitchline.

11.2 The ILS identifies a significant difference in sewn seam break strength values in subassemblies made using hi-loft non-woven fire barrier fabrics (0.6 osf and 0.8 osf) and those made with needlepunched non-woven fabric. The data show that hi-loft fire barrier fabrics exhibit poor fabric integrity when stressed by a mean breaking force of 7 lbf before exposure to an open flame.

11.3 The data generated in this ILS indicate that a force as little as 7 lbf can result in the loss of integrity of a fabric, such as the hi-loft fire barrier fabrics used by mattress manufacturers and included in this study, and could result in a higher potential for failure when exposed to open flame.

TABLE 4 Straight Break Strength Before Exposure To Hot Air

Material	s_r	Repeatability	s_R	Reproducibility
T40 – A-A-55220	1.03 lbf	2.88 lbf	1.39 lbf	3.90 lbf
T50 TYPE II	1.25 lbf	3.50 lbf	1.35 lbf	3.78 lbf
T50 TYPE II	1.33 lbf	3.74 lbf	1.52 lbf	4.25 lbf
T50 TYPE I	0.76 lbf	2.12 lbf	0.92 lbf	2.57 lbf
T50 TYPE I	0.88 lbf	2.47 lbf	1.05 lbf	2.94 lbf

TABLE 5 Loop Break Strength Before Exposure To Hot Air

Material	s_r	Repeatability	s_R	Reproducibility
T40 – A-A-55220	0.78lbf	2.17 lbf	0.95 lbf	2.67 lbf
T50 TYPE II	1.15 lbf	3.21 lbf	1.20 lbf	3.37 lbf
T50 TYPE II	1.13 lbf	3.16 lbf	1.30 lbf	3.65 lbf
T50 TYPE I	1.20 lbf	3.36 lbf	1.26 lbf	3.53 lbf
T50 TYPE I	1.18 lbf	3.30 lbf	1.21 lbf	3.38 lbf

TABLE 6 Straight Break Strength After Exposure To Hot Air

Material	s_r	Repeatability	s_R	Reproducibility
T40 – A-A-55220	0.69 lbf	1.92 lbf	3.64 lbf	10.19 lbf
T50 TYPE II	0.74 lbf	2.07 lbf	3.01 lbf	8.44 lbf
T50 TYPE II	1.00 lbf	2.80 lbf	3.00 lbf	8.41 lbf
T50 TYPE I	0.51 lbf	1.43 lbf	2.48 lbf	6.96 lbf
T50 TYPE I	0.78 lbf	2.19 lbf	2.66 lbf	7.43 lbf

TABLE 7 Loop Break Strength After Exposure To Hot Air

Material	s_r	Repeatability	s_R	Reproducibility
T40 – A-A-55220	0.70 lbf	1.95 lbf	1.17 lbf	3.29 lbf
T50 TYPE II	1.13 lbf	3.16 lbf	1.97 lbf	5.51 lbf
T50 TYPE II	1.23 lbf	3.43 lbf	1.83 lbf	5.12 lbf
T50 TYPE I	0.82 lbf	2.29 lbf	3.25 lbf	9.10 lbf
T50 TYPE I	1.09 lbf	3.05 lbf	2.67 lbf	7.49 lbf

S_r = repeatability standard deviation (pooled within-laboratory standard deviation),
Repeatability = 2.80 S_r
S_R = reproducibility standard deviation (laboratory-to-laboratory standard deviation),
Reproducibility = 2.80 S_R

Component	Var Component	% of Total	Plot %	Sqrt (Var Comp)
Fabric Type	4448.2652	88.0		66.695
Thread	4.0142	0.0794		2.004
Fabric Type*Thread	32.7202	0.6474		5.720
Tape	0.0000	0.0		0.000
Fabric Type*Tape	15.6085	0.3088		3.951
Thread*Tape	0.2630	0.0052		0.513
Fabric Type*Thread*Tape	6.6605	0.1318		2.581
Lab	135.8867	2.7		11.657
Fabric Type*Lab	247.0583	4.9		15.718
Thread*Lab	0.0000	0.0		0.000
Fabric Type*Thread*Lab	8.5205	0.1686		2.919
Tape*Lab	0.0000	0.0		0.000
Fabric Type*Tape*Lab	10.2016	0.2018		3.194
Thread*Tape*Lab	0.0000	0.0		0.000
Fabric Type*Thread*Tape*Lab	21.3974	0.4233		4.626
Within	123.7396	2.4		11.124
Total	5054.3356	100.0		71.094

FIG. 8 Subassembly Seam Break Strength Variance Components Before Exposure To An Open Flame

Component	Var Component	% of Total	Plot %	Sqrt (Var Comp)
Fabric Type	775.3204	37.6		27.845
Thread	0.8683	0.0421		0.932
Fabric Type*Thread	0.0000	0.0		0.000
Tape	0.5042	0.0244		0.710
Fabric Type*Tape	0.0000	0.0		0.000
Thread*Tape	0.0000	0.0		0.000
Fabric Type*Thread*Tape	4.0625	0.197		2.016
Lab	431.5218	20.9		20.773
Fabric Type*Lab	642.8131	31.2		25.354
Thread*Lab	0.7911	0.0384		0.889
Fabric Type*Thread*Lab	0.0000	0.0		0.000
Tape*Lab	0.0000	0.0		0.000
Fabric Type*Tape*Lab	0.0000	0.0		0.000
Thread*Tape*Lab	0.0000	0.0		0.000
Fabric Type*Thread*Tape*Lab	32.3519	1.6		5.688
Within	174.3754	8.5		13.205
Total	2062.6088	100.0		45.416

FIG. 9 Subassembly Seam Break Strength Variance Components After Exposure To An Open Flame

APPENDIX

(Nonmandatory Information)

X1. SAMPLE REPORT FORM

X1.1 Report for Test Method D7016— Standard Test Method to Evaluate Edge Binding Components Used in Mattresses After Exposure to An Open Flame:

Report Form

1. Component—Sewing Thread
Type: _____ Size: _____ Identification: _____

a. Initial Break Strength (in lb) (Re: section 6.1)
1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ Avg _____

b. Melting Test (yes/no) (Re: section 6.2)
1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____

c. After Heat Aging Oven Test (in lb) (Re: section 6.3)
1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ Avg % Retained _____

2. Component—Edge Binding Tape
Type: _____ Size (width): _____ Identification: _____

a. Afterflame Time (unwashed tape) (in seconds) (Re: section 7.1)
1 _____ 2 _____ 3 _____ 4 _____ 5 _____
6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Avg _____

b. Char Length (unwashed tape) (in mm) (Re: section 7.1)
1 _____ 2 _____ 3 _____ 4 _____ 5 _____
6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Avg _____

c. Afterflame Time (washed tape) (in seconds) (Re: section 7.1)
1 _____ 2 _____ 3 _____ 4 _____ 5 _____
6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Avg _____

d. Char Length (washed tape) (in mm) (Re: section 7.1)
1 _____ 2 _____ 3 _____ 4 _____ 5 _____
6 _____ 7 _____ 8 _____ 9 _____ 10 _____ Avg _____

Subassembly
Fire Barrier Identification (Re: section 8.1)

a. Seam Break Strength—Pre-Flame Exposure (in lb force) (Re: section 8.2)
1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ Avg _____

b. Configuration of Specimens before Exposure to Open Flame Test (Re: section 8.2.3)
1. Fire Barrier/Edge Binding/Sewing Thread _____
2. Ticking Quilted to Fire Barrier/Edge Binding/Sewing Thread _____
3. Ticking/Fire Barrier/Encapsulated Foam/ Edge Binding/ Sewing Thread _____

c. Visual Condition of Seam Joint after Exposure to Open Flame Test (Re: section 8.4)
(1) Joint Intact (2) Thread destroyed (3) Tape consumed (4) Seam broke open
1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ Avg _____

d. Seam Strength after Exposure to Open Flame (Re: section 8.4.1)
Mode of Failure
(1) Sewing thread rupture at junction (required force)
(2) Rupture of fabric adjacent to stitch line (required force)
(3) Rupture of fabric away from stitch line (required force)
(4) Fabric too fragile to obtain value
1 _____ 2 _____ 3 _____ 4 _____ 5 _____ 6 _____ 7 _____ Avg _____