

to assess their burn performance. Also, they passed the proposed Textile Coalition test, but had marginal to poor results in the proposed TB 117 mockup test, even with the use of flame-blocking barriers. API study fabrics were chosen to allow possible correlation of small scale and proposed 117 test data to other research data generated earlier by API and the Bureau. The fabrics were placed over filling substrates in a TB 133-sized mockup configuration, constructed to resemble an actual furniture article with a seat and back cushion.

Two full-scale mockup tests were performed on Fabric A and one test was performed on Fabric B to compare to the 45 degree tests and proposed 117 mockup tests done earlier. The mockups were constructed using the same layering construction as the proposed TB 117 mockup tests. Each mockup consisted of a seat piece and back piece (each 18 inches by 18 inches by 4 inches) and contained approximately the amount of polyurethane foam typically found in a small, finished furniture article. Sizes of the mockups for Fabric A and Fabric B were standardized, to allow direct comparison of performance. A small open flame source was applied for 20 seconds to the seat cushion to initiate the test.

The full-scale mockup constructed from Fabric A, API Test #3, generated an average peak heat release rate of 199 kW at 6 minutes, 55 seconds. The mockup constructed with Fabric A, API Test #4, produced negligible heat release due to the protection provided by the added barrier, which was not used in the first Fabric A full-scale test.

The full-scale test of Fabric B, API Test #7, produced an average peak heat release of 180 kW in 13 minutes, 27 seconds. Use of the barrier slowed the development of heat, but did not prevent a fairly substantial heat release from this sample. A heat release versus time curve is shown in the graph (Full Scale Test Results, page 11) for one test of each fabric fill mockup, Tests # 3, 4 and 7. Also, color photographs of the three "Full Scale Mockup Tests" are shown.

The full-scale test results for these three fabric-fill combinations tended to correlate with their performance in the proposed TB 117 mockup test but did not correlate with the 45 degree results obtained when these fabrics were tested by themselves with a 5 second flame impingement and were rated as passed. This tends to further invalidate the 45-degree protocol as a predictive test for upholstery fabric performance.

Based on these results, the Bureau concludes that an upholstery fabric test method, of the scale described in the Feb. 2002 draft of Technical Bulletin 117, is needed to provide correlation to actual furniture fire performance. Use of this composite fabric test method, employing the actual mockup construction of furniture, is superior to a small-scale test such as the current TB 117, Section E in predicting actual performance. The Bureau has spent considerable time attempting to identify a simple, small-scale test method to predict the fire performance of fabrics in upholstered furniture or to screen out worst performing fabrics. The proposed TB 117 test method (Feb. 2002 draft) for fabric uses a standard, flame-resistant polyurethane foam (SFRPUF) as underlying substrate. Use of this flame-resistant foam underneath the fabric allows for good to moderate performing fabrics to be qualified for furniture, but still screens out worst-performing fabrics, since these will still tend to burn vigorously, even when in contact with a flame-resistant foam. Testing over a non-FR foam increases the tendency of a

fabric to burn. However, it is not as realistic in terms of current actual furniture constructions in the United States, where many manufacturers voluntarily employ the use of current TB 117 foam. Also, testing over non-FR foam will require more fabrics to be FR-backcoated or treated to comply.

Also, we recommend that the test protocol use a weight loss versus time curve as a means of determining open flame performance, as opposed to a test using only subjective pass/ fail criteria such as "did not ignite" or "time to burn to top edge", as employed in the current TB 117, Section E. Use of weight loss versus time allows a straightforward measurement, offers more flexibility in the setting of failure criteria and makes establishment of precision and bias values easier to develop in an inter-laboratory study. Weight loss is a substitute for heat release measurement, a critical hazard-related parameter in a burn room test, but is substantially cheaper.

FILLING MATERIALS

There is no set construction geometry included in the proposed 117 standard that would mandate that barriers be used above or around more flammable fillings, except for the composite test requirement for worst case fabrics. Thus, many articles of furniture could be constructed without barriers and without testing of a composite sub-assembly, and still comply with the California proposal. Nor does it mandate testing of finished products. Therefore, it would be possible to comply simply by using components that comply with their applicable standard. Thus, it is important that the filling materials meet specific flame resistance standards to provide some redundancy in fire safety for furniture products. Without this requirement, the flame resistance of upholstered furniture may degrade over time, as fabric becomes frayed, worn, split or torn.

FIBERS

Fiber pads and battings are typically found in the first fill layer of upholstered furniture to provide resiliency, and are sometimes used to act as a smolder-barrier to meet Upholstered Furniture Action Council (UFAC) and/or California Technical Bulletin 116 smoldering standard guidelines. Most fibrous pads and battings meet the fiber tests for the current TB 117, but once exposed to small open flame, may represent a severe melting and pooling hazard in a real furniture product. The proposed TB 117 draft standard, Part 1, Section 2, minimizes melting and pooling in fiber battings, Fiber pads and battings meeting this standard may also act as flame-blocking barriers in addition to providing resiliency and resisting smoldering sources. The standard thus promotes the use of battings that provide some barrier protection from transfer of heat and flame into underlying fills such as polyurethane foam. This process interrupts or slows the process of synergistic action leading to rapid fire propagation of core fills, such as polyurethane foam.

CELLULAR FOAM PADS

Bureau data validates the significant role that polyurethane foam pads play in preventing or contributing to worst-case furniture fires. Polyurethane foam is typically the major filling component in furniture and one of the most flammable components, if not properly formulated to resist flame. Given the fact that fire-retardant polyurethane

foam meeting the current TB 117 may still burn when contacted by burning fabric or fiber paddings, some improvement in the performance of foam is needed. Section 3 of the draft TB 117 test provides for a test that raises the level of performance over that of the current 117 foam and decreases the rate of fire growth in cases where the fabric or filling has been compromised due to fraying, wear, accidental tearing, arson or other scenarios.

LOOSE FILLINGS

Loose filling materials such as shredded polyurethane foam, polystyrene foam beads, etc. are typically used in children's products and tend to be more flammable than their solid counterparts, due to the intimate mixture of air and fuel inherent in the product. Thus, they represent a unique fire hazard. This hazard can be mitigated by use of flame-resistant barrier fabrics or tickings around the loose fillings as described in the proposed 117 standard, Section 4, or as proposed in the CPSC Composite Test.

COMPOSITE TEST

Upholstered furniture products are composites of individual component materials. A test consisting of the actual product or a composite sub-assembly representing the full product is thus more predictive than a test based on the individual performance of single components. This was demonstrated by the comparative tests described above. The Bureau proposes that if an upholstery fabric does not pass the individual fabric test of the draft TB 117, Section 1, or the proposed CPSC fabric test, it can still be used but its performance must be confirmed by testing in a composite form, per Section 5 of the TB 117 draft standard or per the CPSC's proposed Composite Test. This test will confirm that the combination of the fabric, barrier (if used) and the underlying fillings, meets the minimum expected performance criteria.

DUST COVER TEST

The Bureau recommends that a dust cover test such as proposed by CPSC be included in the national standard.

BARRIER QUALIFICATION TEST

While there is no barrier qualification test in the Feb. 2002 draft of TB 117, the Bureau's experience is that use of effective barriers can provide significant improvements in fire safety for upholstered furniture. Thus, we support the concept of use of barriers along with maintaining minimal standards for filling materials as a redundant feature of furniture safety. The Bureau would also urge that research continue on an alternative to the BS 5852 Crib 5, barrier test. While this test offers value in selecting effective barriers, an alternative test method is needed that is more indicative of the actual flammability performance of real fabrics as they burn on the surface of articles of upholstered furniture.

SMOLDERING TESTS

While smoldering hazards have not been the recent, primary focus of a national furniture standard, a critical need still exists for a smoldering standard that minimizes fires initiated by cigarettes, cigars and other smoldering sources. Thus, the February 2002 draft of TB 117 includes the original smoldering standards in place in the current TB 117 document. Alternatives to the current TB 117 component smoldering standards include the Upholstered Furniture Action Council (UFAC) standards, which the CPSC acknowledges have demonstrated value through the years in reducing smoldering-caused fire losses nationwide or Technical Bulletin 116 (TB 116), which is now voluntary in California but widely referenced.

HARMONIZATION BETWEEN THE PROPOSED CPSC AND CALIFORNIA 117 FURNITURE TESTS













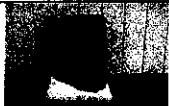











While the February, 2002 draft TB 117 test and the latest proposed CPSC Upholstered Furniture Flammability Protocol are not equivalent, they both employ a bench-scale furniture mockup system, using similar test equipment, equivalent sample sizes and geometry and similar ignition procedures for upholstery fabrics and furniture composites. These tests can also be conducted in a laboratory hood, which is less expensive than a full-scale fire test facility. Thus, the two standards each can employ the benefits of more realistic and predictable test conditions than small scale tests employed in the current TB 117 standard and have the ability to use weight loss numbers versus time as a surrogate for full-scale heat release values. Given this, opportunities exist for harmonization of the best elements of these draft standards into a national standard that is practical, effective, cost efficient and provides significant improvements in upholstered furniture fire safety.

Respectfully Submitted,



Lynn Morris
Bureau Chief

Large Scale Mockup Tests

Fabric A Test #3 Composite: Fabric A New Cal 117 Batting New Cal 117 Foam	 Pre	 1 min	 2 min	 3 min	 4 min
	 5 min	 6 min	 7 min	 8 min	 9 min
	 Post				
Fabric A Test #4 Composite: Fabric A FR Barrier Conventional Batting New Cal 117 Foam	 Pre	 Post			
Fabric B Test #7 Composite: Fabric B FR Barrier Conventional Batting New Cal 117 Foam	 Pre	 1 min	 2 min	 3 min	 4 min
	 5 min	 6 min	 7 min	 8 min	 10 min
	 Post				

**RESULTS - COMPARISON OF FOUR FURNITURE FABRIC OPEN-FLAME TESTS
(Dec. 2003)**

Fabric	Fiber ID	45 degree 1 sec ignition, average flame spread, s	45 degree 5 sec ignition, average flame spread, s	Proposed 117 Mockup Result			Large Scale Mockup Result	
				117 composite	4% Weight Loss Time, s	60g Weight Loss Time, s	Peak Heat Release Rate (Average of 3 runs), kW	Approx. Time to Peak Heat Release Rate (Average of 3 runs)
Fabric A API Test # 3	64% rayon/36% polyester	DNI	DNI (Class I)	Fabric A New Cal 117 Batting New Cal 117 Foam	165	275	199	6:55
Fabric A API Test # 4	64% rayon/36% polyester	DNI	DNI (Class I)	Fabric A FR Barrier Conv. Batting New Cal 117 Foam	245	512	Negligible	N/A
Fabric B API Test # 7	72% polyolefin/ 28% polyester	DNI	DNI, 1 case 73.5 (Class I)	Fabric B FR Barrier Conv. Batting New Cal 117 Foam	200	253	180	13:27
Fabric C	100% Nylon	DNI	30.9 (Class I)	Fabric C BS crib 5 Foam	140	EB**	N/A	N/A
Fabric D	100% polyester	DNI	51.0 (Class I)	Fabric D BS crib 5 Foam	125	EB**	N/A	N/A
Fabric E	100% wool	DNI	DNI (Class I)	Fabric E New Cal 117 foam	SE*	SE*	N/A	N/A

API = Alliance for the Polyurethane Industry - Interlaboratory Study on Proposed 117 test

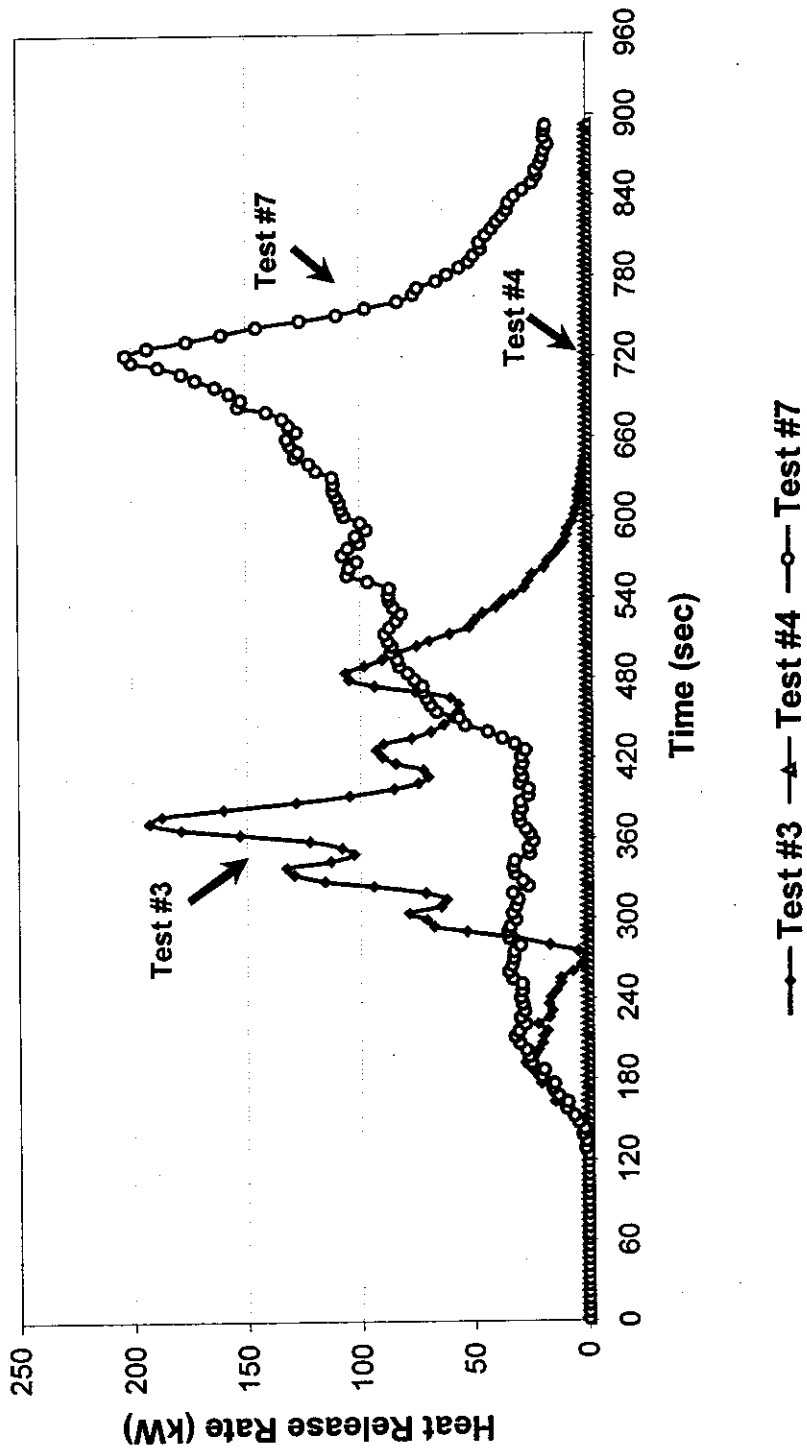
DNI = Did not ignite

BS = British Standard 5852

SE* - Self-extinguished.

EB** - Fire was extinguished before 60 gram weight loss reached due to intensive flame.

**Graph - Full Scale Test Results on Different Constructions
(Test #3, #4 and #7) - 12/03**



STATE OF CALIFORNIA
DEPARTMENT OF CONSUMER AFFAIRS
BUREAU OF HOME FURNISHINGS
AND THERMAL INSULATION
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TECHNICAL BULLETIN 117

Requirements, Test Procedure and Apparatus for
Testing the Flame Retardance of Resilient Filling Materials
Used in Upholstered Furniture

MARCH 2000

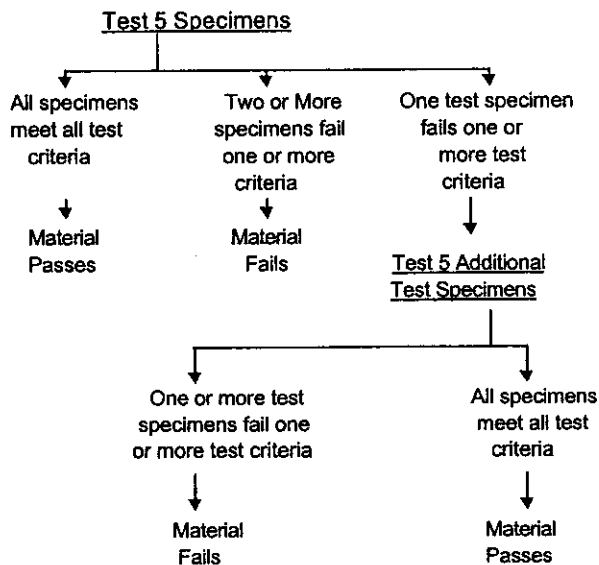
TECHNICAL BULLETIN 117

Requirements, Test Procedure and Apparatus for Testing the Flame Retardance of Resilient Filling Materials Used in Upholstered Furniture

SECTION A - Part I Resilient Cellular Materials

I. Requirement

1. The average char length of all specimens shall not exceed 6 inches.
2. The maximum char length of any individual specimen shall not exceed 8 inches.
3. The average afterflame, including afterflame of molten material or other fragments dropping from specimens, shall not exceed 5 seconds.
4. The maximum afterflame of any individual specimen, including afterflame of molten material or other fragments dropping from the specimen, shall not exceed 10 seconds.
5. The average afterglow, including afterglow of molten material or other fragments dropping from the specimen, shall not exceed 15 seconds.
6. Resilient cellular materials shall meet the above requirements both before and after aging for 24 hours in a forced air circulating oven at 220°F (104°C).
7. A minimum of 10 test specimens shall be tested; 5 specimens before aging and 5 specimens after aging.
8. Test requirements for resilient cellular materials shall be evaluated according to the following sampling procedure both before and after aging.



II. Test Procedure

1. Scope

This procedure is intended for use in determining the resistance of resilient cellular materials to flame and glow propagation and tendency to char.

2. Test specimen

Test specimens shall be rectangles of cellular materials 12 x 3 x 1/2 inches.

3. Apparatus

3.1. Cabinet - A test cabinet fabricated in accordance with the requirements of Federal Test Method Standard No. 191 Method 5903.2 or FF 3-71 shall be used.

3.2. Burner - The burner shall be in accordance with the requirements of Federal Test Method Standard No. 191 Method 5903.2 or FF 3-71.

3.3. Gas - The test gas shall be Matheson Gas B.

3.4. Specimen Holder - A stainless steel specimen holder fabricated in accordance with the requirements specified in Figure 117-A shall be used.

4. Procedure

4.1. All specimens shall be tested, and conditioned for a minimum of 24 hours, at 70 ± 5°F and less than 55% relative humidity.

4.2. The specimen in its holder shall be suspended vertically in the cabinet in such a manner that the lower end of the specimen is 0.75 inches above the top of the burner.

4.3. The burner flame shall be adjusted by means of a needle valve in the base of the burner to give a flame height of 1.5 inches with air supply to the burner permanently shut off.

4.4. After inserting the specimen, the burner flame shall be applied vertically at the middle of the lower edge of the specimens for 12 seconds.

4.5. The cabinet door shall remain shut during testing.

III. Definitions

1. Afterflame

The afterflame time shall be the time the specimen continues to flame after the burner flame is extinguished, and shall include afterflame of molten drops of material.

2. Afterglow

The afterglow time shall be the time the specimen continues to glow after it has ceased to flame, and shall include afterglow of molten drops of material.

3. Char length

The char length shall be the distance from the end of the specimen which was exposed to the flame, to

the upper edge of the void area. In the measurement of char length all readily removable portions of carbonaceous char shall be removed prior to measurement.

IV. Test Results

1. The char length of each specimen shall be recorded to the nearest 0.1 inches and the afterflame time and afterglow time to the nearest 0.1 seconds.
2. Maximum and average char length, afterglow and afterflame, shall be determined for each resilient cellular material.

SECTION A - PART II

Shredded Resilient Cellular Materials (e.g., shredded polyurethane foams)

Shredded resilient cellular materials shall meet the following requirements.

1. The resilient cellular material used for shredding shall meet the requirements of Section A and D of this Technical Bulletin prior to shredding, or a post flame treated shredded foam may be used.
2. All resilient cellular material shall be encased in a fabric/ticking, and the requirements of the following test procedure shall be met.
3. A 13 x 13 inch (finished size) pillow/cushion fabricated from the fabric/ticking and filled with flame retardant foam, shall be used for testing.
4. The packing density of the shredded foam shall approximate that of intended use.
5. The pillow/cushion shall not lose more than 5% in weight when subjected to a 1.5 inch flame from a Bunsen Burner for 12 seconds.
6. The burner shall be positioned 0.75 inches below the center of the bottom lateral surface of the horizontally positioned pillow/cushion.
7. The pillow/cushion shall be supported in such a manner that a minimum 10 inch diameter circular portion of the lower fabric surface be directly exposed to the burner flame.
8. The pillow/cushion shall meet the test requirements both before and after aging for 24 hours at 220°F (104°C).
9. The test gas shall be Matheson Gas B, and all pillow/cushions shall be conditioned for a minimum of 24 hours at 70 ± 5°F and less than 55% relative humidity.
10. The burner flame shall be adjusted by means of a needle valve in the base of the burner to give a flame height of 1.5 inches with air supply to the burner permanently shut off.
11. The fabric/ticking used to encase the shredded resilient cellular material shall meet the requirements of Technical Bulletin No. 117, Section A, Requirements 1, 2, 3, 4 and 5, when tested in accordance with Federal Test Method Standard No. 191 Method 5903.2. The burner flame shall be applied vertically at the middle of the lower edge of the specimens for both 3 seconds and 12 seconds.

12. A total of 20 fabric specimens shall be tested as follows:

<u>Test Flame</u>	<u>Yarns Vertical</u>	<u>Specimens</u>
3 sec.	Warp	5
3 sec.	Fill	5
12 sec.	Warp	5
12 sec.	Fill	5

SECTION A - PART III

Expanded Polystyrene Beads

i. Requirements

1. Weight loss shall not exceed 5% in any of five consecutive tests.
2. Materials shall meet the above requirement after aging for 48 hours in an air circulating mechanical convection oven at 150 ± 5°F.

ii. Apparatus

1. Oven - A mechanical convection air circulating oven capable of maintaining 150 ± 5°F.
2. Laboratory Hood - The test shall be conducted in a laboratory fume hood.
3. Test Basket - 3-inch deep, 8-inch square, wire mesh basket. (U.S. mesh No. 12 or finer)
4. Aluminum Foil - To catch molten material.
5. Methenamine reagent tablets - Eli Lilly No. 1588.
6. Tongs.
7. Matches.
8. Balance - Capable of measuring to the nearest 0.1 gram.

iii. Test Procedure

1. All test material shall be aged for a minimum of 48 hours at 150 ± 5°F, and conditioned for a minimum of 24 hours at 70 ± 5°F and less than 55% relative humidity before testing.
2. A pre-weighed wire basket shall be filled to the 3-inch level with the aged material, and the weight of the test material determined.
3. Place the test basket on a sheet of aluminum foil in a fume hood. The hood fan should remain off during the test.
4. Hold a methenamine tablet with tongs and ignite with a match.
5. Place the burning tablet gently on the top center of the test material.
6. Continue the test until all flames are completely extinguished.
7. After cooling, re-weigh the basket and record percentage weight loss. Molten material which remains in the basket or on the aluminum foil is not considered as weight loss.

8. A total of five test samples of each material shall be evaluated.

SECTION B - PART I
Non-Man-Made Filling Materials

- I. Non-man-made filling materials shall meet all the requirements under Section A of this technical bulletin with the following modifications:
 1. Specimens shall not be mounted in a specimen holder, but shall be vertically suspended into the flame. The upper 1/2 inch of the specimen may be used for suspension.
 2. Specimens size shall be 12 x 3 inches and in the thickness in which the batting is to be used up to 1 inch. If the filler is to be used in thicknesses of greater than one inch, specimens shall be cut to one inch thickness prior to testing.
 3. Non-man-made products shall not be aged for 24 hours at 220°F (104°C).
 4. The afterglow test requirement as stated in Section A, Part I is not applicable for non-man-made filling materials.

SECTION B - PART II
Shredded and Loose Fill Materials/Feathers and Down

Feathers and down may be used in articles of upholstered furniture provided that the following requirements are met:

1. The feathers and down shall be encased in a flame retardant fabric/ticking.
2. The fabric/ticking shall meet the requirements of Technical Bulletin 117, Section A, Requirements 1, 2, 3, 4 and 5, when tested in accordance with Federal Test Method Standard No. 191 Method 5903.2.
3. The burner flame shall be applied vertically at the middle of the lower edge of the specimens for both 3 seconds and 12 seconds.
4. Specimen size shall be 12 x 2-3/4 inches.
5. Twenty specimens shall be tested as follows:

<u>Test Flame</u>	<u>Yarns Vertical</u>	<u>Specimens</u>
3 sec.	Warp	5
3 sec.	Fill	5
12 sec.	Warp	5
12 sec.	Fill	5

SECTION C
Man-Made Fiber Filling Materials

- I. **Requirements**
 1. The average flame spread of all specimens shall not be less than 10 seconds.
 2. The minimum flame spread of any individual specimens shall not be less than 7 seconds.
 3. Man-made fiber fillers shall meet these requirements when tested both with and without any attached woven or non-woven materials such as scrim, cheese cloth, etc.
 4. Man-made fiber fillers shall meet these requirements when tested in both machine (or linear) and transverse directions.
- II. **Test Procedure**
 1. **Scope**
 This procedure is intended for use in determining the resistance of resilient man-made fiber filling materials to flame spread, when tested using a modified version of Commercial Standard 191-53.
 2. **Test Specimen**
 Test specimens shall be rectangles of fillers 6 x 3 inches and in the thickness in which the fillers are to be used. A minimum of 5 specimens shall be tested.
 3. **Apparatus**
 - 3.1. **Cabinet** - A test cabinet fabricated in accordance with the requirements of Commercial Standard 191-53 shall be used.
 - 3.2. **Burner and Gas** - The burner and gas specified in Commercial Standard 191-53 shall be used.
 - 3.3. **Specimen Holder** - A modified stainless steel specimen holder fabricated in accordance with the requirements of Figure 117-B shall be used.
 4. **Summary of Method**
 - 4.1. All specimens shall be tested, and conditioned for a minimum of 24 hours, at 70 ± 5°F and less than 55% relative humidity.
 - 4.2. The specimen in its holder shall be supported at an angle of 45°.
 - 4.3. The burner flame, adjusted to a length of 5/8 inches, shall be applied to the specimen near the lower edge for 5 seconds.
 - 4.4. The time required for the flame to proceed up the batting a distance of 5 inches shall be recorded.
 - 4.5. The cabinet door shall remain shut during testing.

III. Definitions

1. Flame Spread - The time in seconds from application of the burner until the specified burn end point is reached.
2. Self-Extinguishing Time - The time in seconds from application of the burner until the specimen flame extinguishes, provided the flame front has not reached the specified burn end point.

IV. Test Results

1. The time of flame spread of individual specimens shall be noted. Average flame spread shall be determined.
2. If a specimen burn does not reach the specified end point, the self-extinguishing time shall be noted.

V. NOTE: Mixed Fiber Fillers

1. Fillers consisting of 60% or greater of non-man-made fibers (e.g., cottons, kapok, hair, etc.) must meet the requirements of Section B, Part I.
2. Fillers consisting of 60% or greater of man-made fibers must meet the requirements of Section C.
3. Fillers not classified in V.1. and V.2. above must meet the requirements of both Section B, Part I and Section C.

FLAMMABILITY TEST FRAME - FLEXIBLE FOAMS

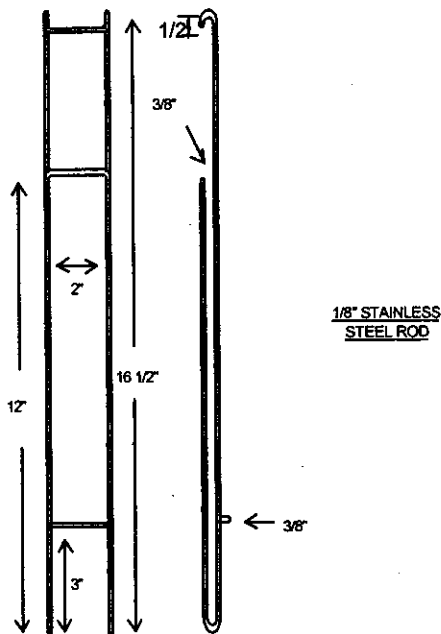


Figure 117 - A

FLAMMABILITY TEST FRAME - MODIFIED CS 191-53

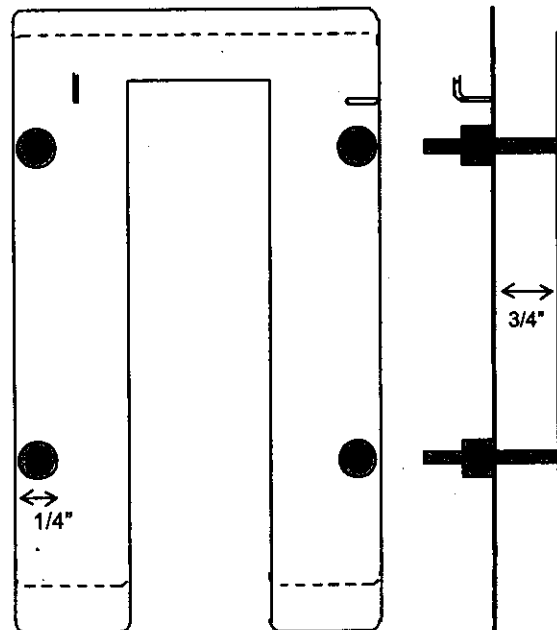


Figure 117 - B

SECTION D - PART I

Resilient Filling Materials - Cigarette Resistance

I. Requirements

1. All resilient filling materials other than cellular materials (such as foams), shall meet the requirements of this procedure.
2. The maximum char length of any specimen shall not exceed 2 inches in any direction from the cigarette.
3. Resilient cellular materials shall meet the requirements of Section D, Part II.

II. Test Procedure

1. Specimens no less than 12 x 12 inches and in the thickness of intended use shall be tested.
2. Cigarettes, meeting the cigarette specification of DOC FF 4-72, shall be burned on the surface, at the center of the specimen.
3. Specimens shall be tested with cigarettes both uncovered, and covered with one layer of sheeting material.
4. Sheeting materials shall meet the sheet specifications of Section D, Part II, 2.2.4.
5. A minimum of 3 specimens both covered and uncovered shall be tested.
6. All test materials shall be conditioned for at least 24 hours prior to testing at $70 \pm 5^\circ\text{F}$ and less than 55% relative humidity.

III. Test Results

1. The char dimensions of each specimen shall be measured to the nearest 0.1 inches.

SECTION D - PART II

Resilient Cellular Materials - Smoldering Screening Test

1. Apparatus

1.1. Test Stand - A test stand constructed as shown in Figure 1 shall be used in all tests. Construction material shall be 3/4 inch plywood.

1.2. Test Enclosure - To prevent extreme changes in surface ventilation rate, tests should be performed inside an enclosure measuring 48 inches long, 21 inches deep and 18 inches high, with an integral bottom, but without top. The enclosure is designed such that three individual test stands may be positioned simultaneously. Individual test stands should be at least six (6) inches apart. The enclosure construction material may be wood, transite, sheet metal, PMMA or other similar materials. It is desirable that the enclosure contain an observation window so that tests may be visually monitored.

1.3. Test Hood - The test enclosure shall be placed under a canopy type hood or in a conventional laboratory hood for all testing. Ventilation shall be controlled such

that air flow for the particular hood shall be just sufficient to remove products of combustion. Extreme or excessive air flow is not desirable and may affect test results.

- 1.4. Caution - Products of combustion can be irritating and dangerous to test personnel. Test personnel must avoid exposure to smoke and gases produced during testing as much as possible. Flaming combustion is a possibility in tests such as these, therefore, tests should not be left unattended. If flaming combustion should occur, the test should be immediately terminated. The availability of a functioning fire extinguisher is advisable.

2. Test Materials

2.1. Ignition Source - Shall be cigarettes without filter tips made from natural tobacco 85 ± 2 mm long with a packing density of 0.27 ± 0.02 gms/cm³, and a total weight of 1.1 ± 0.1 gms.

2.2. Test Foams - Shall be 7.25 x 8 x 2 inches for vertical panels, and 8 x 4 x 2 inches for horizontal panels.

2.3. Standard Test Fabric - (see Note 6.6.2) The standard test fabric shall be 15 x 8 inches for vertical panels, and 11 x 8 inches for horizontal panels.

2.4. Cover Sheeting Material - Cotton or cotton/polyester blend bed sheeting material 3.7 ± 0.8 oz/yd², white in color, and not treated with flame retardants shall be used to cover test cigarettes. The sheeting shall be laundered and dried at least once before use. 6 x 6 inch pieces of sheeting shall be used for test.

3. Procedure

3.1. Weigh foam test panels correct to the nearest 0.1 gms.

3.2. Assemble the foam test panels, standard fabric, cigarette and cover fabric as shown in Figure 2. Straight pins may be used to support the cover fabric. The cigarette shall be placed at the crevice created by the abutment of the vertical and horizontal panels, such that the cigarette contacts both horizontal and vertical panels, and shall be equal distance from the edges of the test panels.

3.3. Light the cigarette (but no more than 4 mm burn), attach cover sheeting material and cover cigarette. (Note: A finger shall be run along the length of the covered cigarette to ensure good cover fabric-to-cigarette contact.)

3.4. Continue test until all evidence of combustion has ceased for at least 5 minutes. If a test is inadvertently interrupted it must be repeated from the beginning.

3.5. After all combustion has ceased remove cover fabric and remains of standard test fabric. Carefully remove foam test panels, clean all carbonaceous char from panels by scraping with a spatula and weigh the non-burned portions of the test panels to the nearest 0.1 gms.

4. Test Measurements

4.1. The following weight measurements of the foam test panels shall be made:

(a) Pre-test weight = A

(b) Post test weight of non-smoldered foam = B

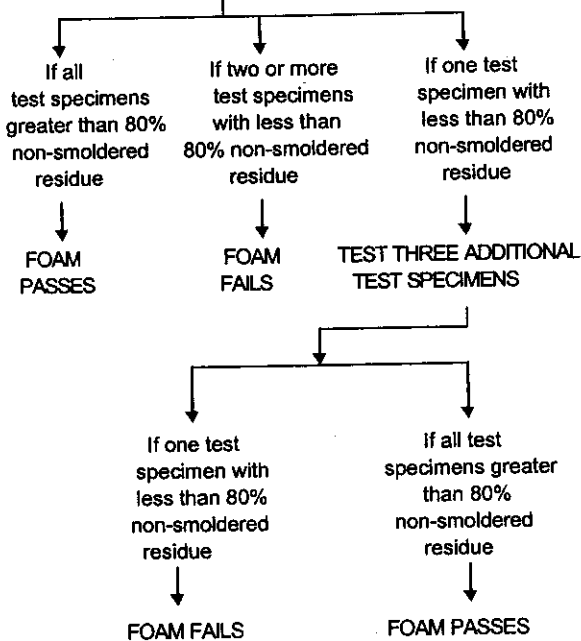
4.2. Calculate the percent non-smoldered foam.

$$\frac{100B}{A}$$

4.3. Tests on each foam formulation shall be conducted in triplicate.

5. Test Criteria

TEST THREE SPECIMENS OF EACH FOAM



6. Notes

6.1. Conditioning - All test foams, standard fabric, cover sheeting and cigarettes shall be maintained at 70°F ± 5°F (21.1°C ± 2.8°C) and less than 55% relative humidity for at least 24 hours prior to test.

6.2. Standard Fabric - The standard upholstery test fabric shall have the following specifications:

FABRIC	:	Pattern 8500
COLOR	:	Beige
FIBER CONTENT	:	100% Cotton Velvet
WEIGHT/LINEAL YD.	:	14.5 oz.
(54 inches)		
BACKCOATING	:	None
MANUFACTURER	:	J.B. Martin
AVAILABLE FROM	:	VAN WATERS & ROGERS
		16300 Shoemaker Avenue
		Cerritos, CA 90701
		(213) 926-0441

NOTE: This fabric was changed pursuant to a note to interested parties dated December 2, 1982. The change was caused by unavailability of previous fabric.

SECTION E - PART I
Upholstery Fabrics

1. Fabrics which do not meet the Class 1 requirements of U.S. Department of Commerce Commercial Standard 191-53 shall not be used on articles of upholstered furniture.
2. Both surfaces of the fabric shall be tested to determine conformance with C.S. 191-53.
3. Specimens shall not be laundered or dry cleaned prior to testing.
4. Test a minimum of 5 specimens with the warp yarns in the long direction of test and 5 specimens with the fill yarns in the long direction of test.

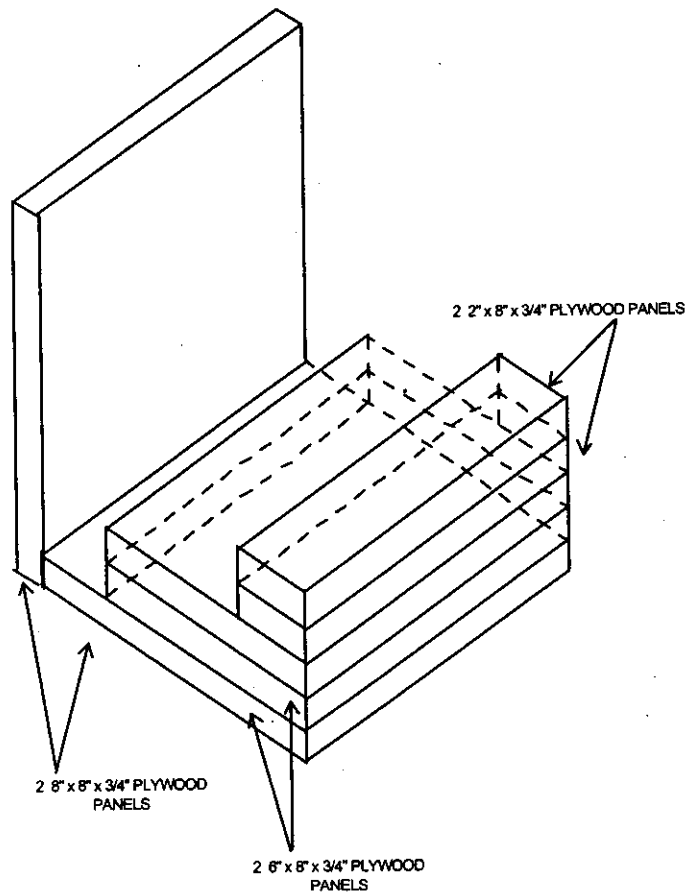


Figure 1

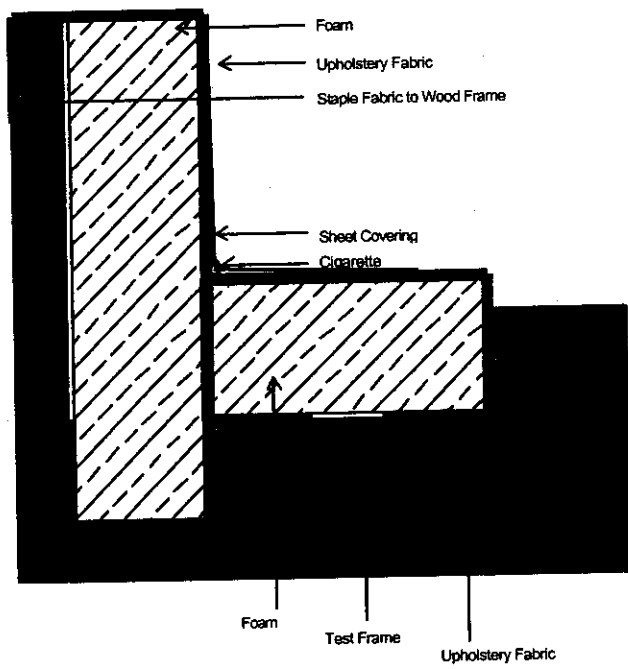


Figure 2

Draft 2/2002



State of California
Department of Consumer Affairs

BUREAU OF HOME FURNISHINGS
AND THERMAL INSULATION
3485 ORANGE GROVE AVENUE
NORTH HIGHLANDS, CALIFORNIA 95660-5595

TECHNICAL BULLETIN 117

*Requirements, Test Procedure and Apparatus
for testing the
Flame and Smolder Resistance of Upholstered Furniture*

February 2002

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PART I. UPHOLSTERED FURNITURE OPEN-FLAME RESISTANCE TESTS

Section 1 - Fabric Component Tests - Open-flame Resistance

Part A: Upholstery Fabric Open-Flame Test

1.A.1 Scope - This test procedure is intended for use in determining the resistance of upholstery cover fabrics to flame propagation, when tested with a small open-flame ignition source. The test applies to all upholstery fabrics used to cover filling materials in furniture as well as exposed decking fabrics used below detachable cushions. The test does not apply to structural fabrics located inside articles of furniture.

1.A.2 Summary of Test Method - This test method is based on the application of a small, open-flame ignition source to the crevice of a seat/back mock-up assembly of an upholstery fabric over a standard flame-retardant polyurethane foam pad. The burning behavior of the specimen is observed. The weight loss and burn time is recorded.

1.A.3 Significance and Use - This test method is designed to measure the response of an upholstery fabric to a small open-flame ignition source, representing that of a match, candle or cigarette lighter or similar size ignition source, when placed over specified standard flame-retardant polyurethane foam. The method attempts to simulate the burning behavior of the fabric over a standard filling substrate and acts as a comparison of relative fabric burning behaviors.

1.A.4 Test Apparatus and Materials - The test apparatus, including the furniture mock-up assembly frame, the gas train and accessories are described in Annex A.

Standard Flame-Retardant Polyurethane Foam (SFRPUF):

The upholstery fabrics are tested in a mock-up assembly metal test frame using standard flame-retardant polyurethane foam (SFRPUF). The flammability performance and material specifications of the SFRPUF are as follows:

When subjected to the open-flame mock-up foam test as described in Section 3, Option A, the SFRPUF will pass using a 20-second flame impingement time, but will fail using a 30-second flame impingement time.

Note: All SFRPUF foams submitted by industry for use as standard substrates in this test must be certified by the Bureau of Home Furnishings and Thermal Insulation.

In addition to its flammability performance, the SFRPUF shall have the following physical specifications:

Density: 1.4 ± 0.1 lb/ft³
Indent Force Deflection (IFD) (25%) : 30 ± 5 lb.
Air Permeability: > 4.0 ft³/min (>0.0019 m³/s)

1.A.5 Test Facility/Hazards - The test facility, exhaust system and hazards are described in Annex B.

1.A.6 Conditioning - Condition specimens prior to the test for a minimum of 24 hours at 23 ± 5 °C (73 ± 9 °F) and $50 \pm 10\%$ relative humidity (RH). If the sample is taken from a finished article of furniture, conditioning does not begin until the component is removed from the furniture.

If conditions in the test area are not the same as in the conditioning area, tests should begin within 10 minutes of removal from conditioning area.

1.A.7 Test Specimens - The cover fabric size needed for each test is 1020 x 700 ± 10 mm (40 x 27.5 ± 0.4 in). The cover fabric specimens shall have triangular cut-outs 575 mm (22.5 in) from one end on both sides. The size of these cut-outs shall be approximately 55 x 135 ± 5 mm (2.1 x 5.25 ± 0.2 in) high. See Annex A, Figure A-2.

If a flame-retardant fabric (interliner) is used below the upholstery fabric, cut it to the same dimensions and in the same orientation as the cover, for fitting to the metal test frame under the cover.

If the furniture product contains more than one upholstery fabric type, each fabric should be tested separately. The same fabric should be used on both the seat and back mockup surfaces for any one test.

Mock-Up Assembly:

- Position the seat frame in the upright position (see Annex A, Figure A-1).
- Lay the cover fabric flat and face up on the table.
- Fold the two sides of the larger section of fabric (from the 6 in cutout upwards) over the face of the fabric.
- Hold the two sides of the folded fabric and insert it under the horizontal rod. Pull the inserted fabric out from behind the seat mock-up frame until the cutout line is lined up with the horizontal rod.
- Re-insert the folded fabric over the rod and pull it out from the front of the frame.
- Line up and pull both the top and bottom sections of the fabric so that the cutout line is lined up with the metal rod and the fabric is flat and free of folds and wrinkles.
- Place the larger foam block flush against the back metal frame on the fabric.
- Wrap the larger portion of the fabric around the foam and secure it to the backside of the frame using metal clips.
- When the back section is completed, place the frame down so that the back of the frame is on the table.
- Lift up the smaller portion of the fabric up and lay it on the back cushion.
- Place the smaller piece of foam with the 3 1/4 in side flush with the seat section of the metal frame and press against the back block.
- Wrap the smaller section of the fabric all around the foam and secure it to the frame using metal clips. Re-position the assembly in the upright position.
- Ensure that the fabric is tight and under uniform tension at all locations to eliminate air gaps between the fabric and the foam. Do not allow a gap exceeding 3 mm (1/8 in) along the seat/back crevice.

1.A.8 Test Procedure

Have a means for extinguishing the specimen close at hand. A hand-held carbon dioxide extinguisher is adequate for most specimens; however, a water spray system should be available as a backup, in case the carbon dioxide fails to completely extinguish the fire.

Pretest:

1. Tare the balance with the empty metal test frame and metal clips or, if the balance does not have tare capability, weigh the metal test frame and metal clips together and record the weight.
2. Assemble the specimen on the metal test frame using the pre-weighed clips.
3. Record the weight of the assembly in order to determine the initial weight of the specimen either directly (if tared) or by subtraction (if not tared).
4. Calculate and record weight corresponding to 96% of the initial weight of the test specimen.

Lighting the igniter flame:

Open the butane tank slowly and light the end of the burner tube. Adjust the gas flow to the appropriate rate (see Annex A) and allow the flame to stabilize for at least 2 minutes.

Starting and performing the test:

1. For manual time-keeping of each individual ignition, start the clock at the same time the burner tube is moved into starting position. For automatic time-keeping, start the data collection at least 30 seconds before the igniter is moved into position on the specimen in order to collect baseline data. In the case of automatic recording (e.g., chart recorder or computer), provide for a signal to the recorder to mark the actual start of the test.
2. For manual data collection, record the weight of the specimen every at least 15 seconds. For automatic data collection, record data at a constant interval between 3 and 6 seconds.
3. Position the lit burner tube from the side of the test specimen, parallel to the crevice between the vertical and horizontal parts and in contact with both parts, so that the end of the igniter is at the center of the test specimen equidistant from either edge.
4. For each ignition, apply the flame for 20 ± 1 seconds, then immediately remove ignition source.

Note: The weight of the specimen will appear to increase due to pressure when burner tube is in contact with the mock-up. Ignore this temporary weight increase in assessing weight loss of sample.

5. Observe the specimen for evidence of ignition on the cover material or in the interior of the mock-up cushions for 10 minutes.
6. If the first specimen self extinguishes and it is re-useable, apply the second ignition equidistant between the center of the seat/back crevice and the left edge of the specimen.
7. If the second specimen self extinguishes and it is re-useable, apply the third ignition equidistant between the center of the seat/back crevice and the right edge of the specimen.
8. Conduct a maximum of three ignition runs on a single seat/back, mock-up specimen of each upholstery fabric. If three ignition runs cannot be obtained with one test specimen, a second or third specimen may be required.
9. Terminate a test run if any of the following conditions occur:
 - The specimen self extinguishes.
 - Weight loss exceeds four percent of the initial specimen weight (Weight reaches 96% of initial weight).
 - Time of test exceeds ten minutes.
 - Fire intensity and/or smoke evolution exceeds the capacity of the ventilation system and test must be aborted due to safety factors. Note: This is not an acceptable "end point" for the test, if one of the other criteria has not been exceeded. If an excessive smoke or fire condition occurs, test should be repeated in a hood exhaust system with adequate ventilation capacity to observe all failure criteria without compromising operator safety.
 - Any type of rapid increase in rate of combustion such that worker safety is compromised.

Note: When terminating a test, be certain that final weight readings are taken before extinguishing the specimen. Also, care should be taken that the weighing device and other instrumentation are not adversely affected by the process of extinguishing the specimen.

1.A.9 Pass/Fail Criteria

The sample must pass a minimum of three ignition runs.

The sample fails if any of the following criteria are exceeded during any ignition run:

- Weight loss exceeds four percent of the total initial weight of the specimen in the first 10 minutes of the test.
- The specimen burns progressively and it must be extinguished before 10 minutes.

1.A.10 Test Report

The test report shall contain, at a minimum, the following information:

- Name and address of the test laboratory.
- Date of the test(s).
- Operator conducting the test.
- Complete description of the test materials.
- Complete description of any procedures different from those described in this test method.
- Recorded results of the test as detailed below:
 - Initial weight (pre-test weight)
 - Weight corresponding to 96% of initial weight
 - Time to reach a weight equal to 96 % of the initial weight.

The weight loss at any given time is calculated as follows:

$$\% \text{ weight loss (WL)} = (\text{pre-test weight (A)} - \text{current weight (B)}) / \text{pre-test weight (A)} \times 100\% \quad \text{or}$$

$$\% \text{WL} = (A - B) / A \times 100\%$$

Note: If direct observation of the time to reach four percent weight loss was not taken during the test, use a linear interpolation of the nearest test data points (preferably at five or six-second intervals, but no more than 15 second intervals) to calculate the time to four percent weight loss.

- Statement of overall Pass/Fail results.

Part B: Dust Cover Open-Flame Test

1.B.1 Scope - This standard applies to all woven or non-woven fabric materials that are used as a dust cover in upholstered furniture.

1.B.2 Summary of Test Method - The test method consists of the application of a small open-flame ignition source to a dust cover fabric specimen, suspended horizontally on a test rack containing an opening in a wire mesh screen. Observations of the burning behavior and patterns are used to assess the performance of the specimen under these test conditions.

1.B.3 Significance and Use - This test method is designed to measure the response of a dust cover sample to a small open-flame ignition source, representing a match, candle or cigarette lighter or similar size ignition source. When contacted by a small open-flame source, dust covers may contribute to fire propagation in upholstered furniture, causing sustained burning and spread of the fire to other parts of the furniture.

1.B.4 Test Apparatus and Materials - The test apparatus, including the horizontal mock-up test frame apparatus, is described in Annex C (See Figures C1-C4).

Gas Burner Tube and Regulators - The gas train is the same as in Annex A.

1.B.5 Test Facility and Hazards - The test facility, exhaust system and hazards are described in Annex B.

1.B.6 Conditioning - Condition test specimens prior to the test for a minimum of 24 hours at 23 ± 5 °C (73 ± 9 °F) and 50 ± 10 % RH. If the sample is taken from a finished article of furniture, conditioning does not begin until the component is removed from the furniture.

If conditions in the test area are not the same as in the conditioning area, tests should begin within 10 minutes of removal from conditioning area.

1.B.7 Test Specimens - The specimen shall consist of a piece of dust cover material cut to 305 x 305 mm (12 x 12 in). Prepare specimens in triplicate.

1.B.8 Test Procedure:

1. Place the horizontal test rack in a test hood (See Annex B) containing adequate ventilation to exhaust harmful smoke and gases.
2. Secure the dust cover test specimen on the top of the horizontal wire mesh by mounting firmly on retaining rods. Ensure fabric is tight with no sagging or wrinkling.
3. Place the top metal square over the test specimen.
4. Subject dust cover specimen to a gas flame 35 mm (1 3/8 in) high, positioned 19 mm (3/4 in) below the center of the lower surface for 20 seconds, then immediately remove flame.
5. Continue test until all traces of flaming and smoldering have ceased. Make and record observations regarding penetration of the dust cover specimen by the flame.

1.B.9 Pass/Fail Criteria

The specimen fails to meet the requirements of this test procedure if the following criterion is exceeded:

- Any flaming or charring of the dust cover test sample that extends beyond the 6 inch opening in the wire mesh.

1.B.10 Test Report

The test report shall contain, at a minimum, the following information:

- Name and address of the test laboratory.
- Date of the test(s).
- Operator conducting the test.
- Complete description of the test materials.
- Complete description of any procedures different from those described in this test method.
- Observations shall be made, and included in the report, of the behavior of the specimen in response to the application of the burner, specifically noting the following:
 - Any flaming or charring of the dust cover test sample.
 - Any dripping of the dust cover material
 - Whether the dust cover specimen self-extinguished.
 - Statement of overall Pass/Fail results.

Section 2 - Fiber Filling Materials (Natural and Synthetic) Component Test - Open-flame Resistance:

2.1 Scope - This standard applies to all synthetic (manufactured) and natural textile filling materials that can be carded, garnetted, air-layered or otherwise formed into a continuous fiber web consisting of battings, pads, etc. For the purposes of this standard, synthetic fiber includes acetate, acrylic, azlon, fiberglass, metallic, modacrylic, nylon, nitrile, polyolefin (polyethylene and polypropylene), polyester, rayon (viscose), polyvinylidene chloride, polyvinyl chloride, vinyon, spandex, manufactured

rubber fibers and all other forms of synthetic fibers, and any copolymer fiber consisting of two or more monomeric polymers. This standard also applies to natural fiber filling materials such as battings and pads consisting of vegetable fiber (cotton, cellulose, coco, excelsior, flax, jute, kapok, milkweed, moss, palma, sisal, tula, hemp, etc.) or animal fiber (horse, hog or cattle hair, silk, wool, etc.). In addition, all materials covered by this section must also meet the smoldering requirements of Part II, Sec. 1.

2.2 Summary of Test Method - The test method consists of the application of a small open-flame ignition source, representing that of a match, candle or cigarette lighter, to the midpoint of a cotton sheet placed under the batting specimen. The cotton sheet simulates a cellulosic material adjacent to or near the fiber. The specimen is situated over a hole in a wire mesh supported by a metal rack. Observations of the burning behavior and patterns are used to assess the performance of the specimen under these test conditions.

2.3 Significance and Use - This test method is designed to measure the response of a fiber test sample in a component furniture mock-up configuration, to a small open-flame ignition source, representing a match, candle or cigarette lighter. When contacted by a small open-flame source, fiber filling materials may contribute to fire propagation (flaming and/or charring) in upholstered furniture, especially if in contact with cellulosic fabric or fiber or other materials which may act as a wicking agent, possibly causing sustained burning. The test provides an indication of the interaction between the fiber filling material and adjacent materials within the furniture, such as cover fabric (simulated by the cotton sheeting).

2.4 Test Apparatus and Materials - The test apparatus, including the horizontal mock-up test frame apparatus, is described in Annex C, Figures C1-C4.

Gas Burner Tube and Regulators - The gas train is the same as in Annex A.

Sheets or Sheeting Material - Shall be the same as in Annex E.

2.5 Test Facility and Hazards - The test facility, exhaust system and hazards are described in Annex B.

2.6 Conditioning - Condition test specimens prior to the test for a minimum of 24 hours at 23 ± 5 °C (73 ± 9 °F) and $50 \pm 10\%$ RH if the sample is taken from a finished article of furniture, conditioning does not begin until the component is removed from the furniture.

If conditions in the test area are not the same as in the conditioning area, tests should begin within 10 minutes of removal from conditioning area.

2.7 Test Specimens - The specimen shall consist of a swatch of the fiber batting or pad. Cut each specimen to 305 x 305 mm (12 x 12 in) in the thickness of use up to a maximum of 38 mm (1½ in). Prepare specimens in triplicate.

2.8 Procedure:

1. Place the horizontal test rack in a test hood (See Annex B) containing adequate ventilation to exhaust smoke and gases.
2. Secure cotton sheeting on the top of the horizontal wire mesh by mounting firmly on retaining rods. Ensure sheeting is tight with no sagging or wrinkling. Place the fiber specimen over the cotton sheeting, so that the fiber contacts the sheeting at all points and the edges of the sheeting and fiber sample are aligned.
3. Place the top metal square over the fiber sample.
4. Subject fiber sample to a gas flame 35 mm (1 3/8 in) high, positioned 19 mm (3/4 in) below the center of the lower surface of the cotton sheeting for 20 seconds, then remove flame.

5. Continue test until all traces of flaming and smoldering have ceased. Make and record observations regarding penetration of the fiber specimen by the flame.

2.9 Pass/Fail Criteria

The sample fails to meet the requirements of this test procedure if the following criterion is exceeded:

Any penetration of the flame, which creates a void through the thickness of the fiber test specimen.

2.10 Test Report

The test report shall contain, at a minimum, the following information:

- Name and address of the test laboratory.
- Date of the test(s).
- Operator conducting the test.
- Complete description of the test materials.
- Complete description of any procedures different from those described in this test method.
- Observations shall be made, and included in the report, of the behavior of the specimen in response to the application of the burner, specifically noting the following:
 - Whether the fiber specimen allowed flame penetration to create an air void.
 - Extended smoldering (non-flaming) combustion.
- Statement of overall Pass/Fail results.

Section 3 - Resilient Cellular (Foam) Materials Component Test – Open-Flame Resistance

3.1 Scope - This test procedure is intended for use in determining the resistance of resilient cellular (foam) materials to flame propagation and tendency to melt, drip and char, when tested with a small open-flame ignition source.

The test applies to all resilient, cellular materials used as furniture fillings, including but not limited to, polyurethane, polychloroprene (synthetic latex), polyamide, polyvinyl, latex (styrene-butadiene) rubber, etc. and other types of resilient cellular polymers and copolymers of the above or other materials. Rigid cellular plastics that provide no resiliency are considered to be structural material and thus are not subject to a component test. In addition, all materials covered by this section must also meet the smoldering requirements of Part II, Sec. 2.

Option A: Mock-up Test of Cellular Foam

3.A.1 Scope - This test procedure is intended for use in determining the resistance of resilient cellular (foam) materials to flame propagation and tendency to melt, drip and char, when tested with a small open-flame ignition source in a small furniture mock-up configuration. The test applies to all resilient, cellular materials listed above in 3.1-Scope.

3.A.2 - Summary of Test Method - This test method is based on application of a small, open-flame to the crevice of a seat/back mock-up assembly of a resilient cellular (foam) material with no cover fabric. The burning behavior of the assembly is observed and the weight loss and time of burning of the assembly are recorded.

3.A.3 Significance and Use - This test method is designed to measure the response of a resilient cellular (foam) material to a small open-flame ignition source, representing that of a match, candle or cigarette lighter or similar size ignition source.

3.A.4 Test Apparatus and Materials - The test apparatus, including the furniture mock-up assembly frame, the gas train and accessories are described in Annex A. No standard materials are needed for this test.

3.A.5 - Test Facility/Hazards - The test facility, exhaust system and hazards are described in Annex B.

3.A.6 Conditioning - Condition the test specimens prior to the test for a minimum of 24 hours at $23 \pm 5^\circ\text{C}$ ($73 \pm 9^\circ\text{F}$) and $50 \pm 10\%$ RH. If the sample is taken from a finished article of furniture, conditioning does not begin until the component is removed from the furniture.

If conditions in the test area are not the same as in the conditioning area, tests should begin within 10 minutes of removal from conditioning area.

3.A.7 Test Specimens - Two pieces of foam filling shall be used. The vertical (back) piece shall be $450 \times 300 \pm 5$ mm ($17.6 \times 11.7 \pm 0.2$ in) $\times 75 \pm 2$ mm (3.0 ± 0.2 in) thick. The horizontal (seat) piece shall be $450 \times 83 \pm 5$ mm ($17.6 \times 3.25 \pm 0.2$ in) $\times 75 \pm 2$ mm (3.0 ± 0.2 in thick).

Mock-Up Assembly:

Position metal seat frame in the upright position (See Annex A, Figure A-1). Place the vertical (back) foam piece on the frame and against the back frame. Place the horizontal (seat) foam piece on the seat frame against the back piece in full contact with back piece.

3.A.8 Test Procedure:

Have a means for extinguishing the specimen close at hand. A hand-held carbon dioxide extinguisher is adequate for most specimens; however, a water spray system should be available as a back-up, in case the carbon dioxide fails to completely extinguish the fire.

Pretest:

1. Tare the balance with the empty metal test frame or, if the balance does not have tare capability, weigh the metal test frame.
2. Assemble the specimen on the test frame.
3. Record the weight of the assembly in order to determine the initial weight of the specimen either directly (if tared) or by subtraction (if not tared).
4. Calculate and record weight corresponding to 96% of initial weight of test specimen.

Lighting the igniter flame:

Open the butane tank slowly and light the end of the burner tube. Adjust the gas flow to the appropriate rate (see Annex A) and allow the flame to stabilize for at least 2 minutes.

Starting and performing the test:

1. For manual time keeping of each individual ignition, start the clock at the same time the burner tube is moved into starting position. For automatic time-keeping, start the data collection at least 30 seconds before the igniter is moved into position on the specimen in order to collect baseline data. In the case of automatic recording (e.g., chart recorder or computer), provide for a signal to the recorder to mark the actual start of the test.
2. For manual data collection, record the weight at least every 15 seconds. For automatic data collection, record data at a constant interval between 3 and 6 seconds.
3. Position the lit burner tube from the side of the test specimen, parallel to the crevice between the vertical and horizontal parts and in contact with both parts, so that the end of the igniter is at the center of the test specimen equidistant from either edge.
4. For each ignition, apply the flame for 20 ± 1 seconds, then immediately remove ignition source.

Note: The weight of the specimen will appear to increase due to pressure when burner tube is in contact with the mock-up. Ignore this temporary weight increase in assessing weight loss of sample.

5. Observe the specimen for evidence of ignition of the mock-up cushions for 10 minutes.
6. If the first specimen self extinguishes and the specimen is re-useable, apply the second ignition equidistant between the center of the seat/back crevice and the left edge of the specimen.
7. If the specimen self extinguishes and the specimen is re-useable, apply the third ignition equidistant between the center of the seat/back crevice and the right edge of the specimen.
8. Conduct a maximum of three ignition runs on a single seat/back, mock-up specimen of each upholstery fabric. If three ignition runs cannot be obtained with one test specimen, a second or third specimen may be required.
9. Terminate a test run if any of the following conditions occur:
 - The specimen self extinguishes.
 - Weight loss exceeds four percent of the initial specimen weight (Weight reaches 96% of initial weight).
 - Time of test exceeds ten minutes.
 - Fire intensity and/or smoke evolution exceeds the capacity of the ventilation system and test must be aborted due to safety factors. Note: This is not an acceptable "end point" for the test, if one of the other criteria has not been exceeded. If an excessive smoke or fire condition occurs, test should be repeated in a hood exhaust system with adequate ventilation capacity to observe all failure criteria without compromising operator safety.
 - Any type of rapid increase in rate of combustion such that worker safety is compromised.

Note: When terminating a test, be certain that final weight readings are taken before extinguishing the specimen. Also, care should be taken that the weighing device and other instrumentation are not adversely affected by the process of extinguishing the specimen.

3.A.9 Pass/Fail Criteria

The sample must pass a minimum of three ignition runs.

The sample fails if any of the following criteria are exceeded during any ignition run:

- Weight loss exceeds four percent of the total initial weight of the specimen in the first 10 minutes of the test.
- The specimen burns progressively and it must be extinguished before 10 minutes.

A.3.10 Test Report

The test report shall contain, at a minimum, the following information:

- Name and address of the test laboratory.
- Date of the test(s).
- Operator conducting the test.
- Complete description of the test materials.
- Complete description of any procedures different from those described in this test method.
- Recorded results of the test as detailed below:
 - Initial weight (pre-test weight)
 - Weight corresponding to 96% of initial weight
 - Time to reach a weight equal to 96 % of the initial weight.

The weight loss at any given time is calculated as follows:

$$\% \text{ weight loss (WL)} = (\text{pre-test weight (A)} - \text{current weight (B)}) / \text{pre-test weight (A)} \times 100\%, \text{ or}$$

$$\% \text{WL} = (A - B) / A \times 100\%$$

Note: If direct observation of the time to reach four percent weight loss was not taken during the test, use a linear interpolation of the nearest test data points (preferably at five- or six-second intervals, but no more than 15 second intervals) to calculate the time to four percent weight loss.

- Statement of overall Pass/Fail results.

Option B: Vertical Flame Test of Cellular Foam:

3.B.1 Scope - This test procedure is intended for use in determining the resistance of resilient cellular (foam) materials to flame propagation, when a thin sample of the foam is tested with a small open-flame ignition source. The test applies to all resilient, cellular materials used as furniture fillings, including but not limited to, polyurethane, polychloroprene (synthetic latex), polyamide, polyvinyl, polyvinylchloride, latex (styrene-butadiene rubber) and other types of resilient cellular polymers and copolymers of above or other materials. Rigid cellular plastics provide no resiliency and are considered to be structural material, thus are not subject to a component test.

3.B.2 Summary of Test Method - This test method is based on application of a small, open-flame to a thin specimen of a resilient cellular (foam) material in a vertical configuration. The specimens of foams are aged at an elevated temperature for 24 hours, reconditioned to room temperature and suspended vertically in the test cabinet. A small open-flame is applied to the lower edge of the specimen. The burning of the test specimen is observed and the char length and afterflame times are recorded and averaged, along with any flaming melts or drips.

3.B.3 Significance and Use - This test method is designed to measure the response of a resilient cellular (foam) material to a small open-flame ignition source, representing that of a match, candle or cigarette lighter or similar size ignition source.

3.B.4. Test Apparatus and Materials - The test cabinet, burner and foam specimen holder and measuring tools are the same as in Annex D.

The test gas is the same as in Annex A.

3.B.5 Test Facility/Hazards - The test facility, exhaust system and hazards are described in Annex B.

3.B.6 Conditioning - Condition test specimens prior to the test for a minimum of 24 hrs at 23 ± 5 °C (73 ± 9 °F) and $50 \pm 10\%$ RH. If the sample is taken from a finished article of furniture, conditioning does not begin until the component is removed from the furniture.

If conditions in the test area are not the same as in the conditioning area, tests should begin within 10 minutes of removal from conditioning area.

3.B.7 Test Specimens - Cut each test specimen to the size 305 x 75 x 12 mm (12 x 3 x ½ in). Specimens less than 12 mm (½ in) may be used if this thickness is not available. Specimens less than 12 mm (½ in) can only be substituted for 12 mm (½ in) thick specimens in upholstered furniture if they pass the required standard.

3.B.8 Test Procedure

1. Age each test specimen in a forced air circulating oven for 24 hours at 104 °C (220 °F), suspending specimens so that they do not contact each other.
2. Remove all samples from oven and suspend on conditioning rack for 24 additional hours before testing at the conditions specified in 3.B.6.
3. Suspend each test specimen vertically in the test cabinet in such a manner that the lower end of the specimen is 19 mm (3/4 in) above the top of the burner.
4. Adjust burner flame with needle valve in the base of the burner to a flame height of 38 mm (1 1/2 in). Obtain 38 mm (1 1/2 in) flame height by adjusting the valve so that the uppermost portion (tip) of the flame is level with the tip of the metal prong.
5. After inserting the specimen, apply burner flame vertically at the middle of the lower edge of the specimen for 12 seconds then remove burner.
6. Keep cabinet door closed during testing.
7. Record the char length of each foam specimen to the nearest 2 mm (0.1 in) and calculate and record an average char length.
8. Record the afterflame time of each foam specimen to the nearest 0.1 seconds and calculate and record the average afterflame time.
9. Determine maximum and average char length and afterflame for each resilient cellular specimen tested and apply against pass/fail criteria detailed in the Vertical Flame Test – Decision Tree. If additional tests are required, repeat appropriate steps above.
10. Test a minimum of 5 foam specimens of each formulation. See 3.B.9. Pass/Fail criteria and Vertical Flame Test – Decision Tree to determine additional testing required.

3.B.9 Pass/Fail Criteria

The specimen fails to meet the requirements of this test procedure if any of the following criteria are exceeded:

- The maximum char length of any individual specimen exceeds 100 mm (4.0 in).
- The average char length of all specimens exceeds 75 mm (3.0 in).
- The maximum afterflame of any individual specimen, including afterflame of molten material or other fragments dropping from the specimen, exceeds 8.0 seconds.
- The average afterflame, including afterflame of molten material or other fragments dropping from the specimen, exceeds 4.0 seconds.

Vertical Flame Test – Decision Tree

- The sample passes the standard if the results of each of the five test specimens and the average values of all five specimens meet the test criteria.
- If one specimen fails one or more criteria, age and test five additional specimens. If the second set of five passes all criteria, the sample passes, unless the average of 10 specimens exceeds any of the average criteria.
- If two or more test specimens fail one or more criteria, the sample fails.

3.B.10 Test Report

The test report shall contain, at a minimum, the following information:

- Name and address of the test laboratory.
- Date of the test(s).
- Operator conducting the test.
- Complete description of the test material including color.
- Complete description of the presence of any additional material contamination on Sample, such as adhesive.
- Complete description of size and shape of sample if different from specimen size described in the test method.
- Complete description of any procedures different from those described in this test method.
- Calculated results of the test as detailed below:

- Record the char length (inches) and the afterflame time (seconds) for each individual test specimen.
- Calculate and record the average char length (inches) and average afterflame time (seconds) of all specimens.
- Statement of overall Pass/Fail results.

Section 4: Loose filling Materials (Natural and Synthetic) Component Test - Open-Flame Resistance

4.1 Scope - This test procedure is intended for use in determining the open-flame resistance of loose-fill component materials of any type used in upholstered furniture. The test measures weight loss when loose fillings are encased in flame-resistant ticking to form a cushion and tested with a small, open-flame ignition source. The test applies to all shredded polyurethane and other (latex, etc.) cellular foams, feathers and down, ungarmented (loose) synthetic, natural and natural/synthetic-blend fibers, polystyrene beads, buckwheat hulls, and any other types of resilient loose-fills used in furniture construction. In addition, all materials covered by this section must also meet the smoldering requirements of Part II, Sec. 1.

4.2 Summary of Test Method - This method applies to all loose filling materials, regardless of type. The materials are encased in a flame-resistant ticking/fabric and tested against a small open-flame ignition source for 20 seconds. This flame-resistant ticking/fabric must be the same type as is used in the actual furniture to encase the loose filling. The cushion shall not break open during testing and expose the loose filling to burning.

4.3 Significance and Use - Loose filling materials are frequently used in the backs, headrests and arms of upholstered furniture to impart comfort (resiliency) and may sometimes be used as seat padding. Also, entire pieces of furniture (such as "bean bag chairs", etc.) may be constructed solely from fabrics surrounding loose filling materials. Due to the presence of significant mixtures of air with these fillings, they may ignite easily and propagate flame rapidly if the cover fabric is breached and compromised by an open-flame source such as a match, candle or cigarette lighter or similar size ignition source.

4.4 Test Apparatus and Materials

The horizontal metal test frame is described in Annex C, Figures C-1 to C-4.
The gas train and accessories are described in Annex A.

4.5 Test Facility and Hazards - The test facility, exhaust system and hazards are described in Annex B.

4.6 Conditioning - Condition test specimens prior to the test for a minimum of 24 hours at 23 ± 5 °C (73 ± 9 °F) and $50 \pm 10\%$ RH. If the sample is taken from a finished article of furniture, conditioning does not begin until the component is removed from the furniture.

If conditions in the test area are not the same as in the conditioning area, tests should begin within 10 minutes of removal from conditioning area.

4.7 Test Specimens

1. Use the ticking or fabric and loose filling materials to construct a 330 × 330 mm (13 × 13 in) (finished size) test cushion. Sew the cushion first on three sides then, insert the filling material and sew the fourth edge to completely encase the filling. If flame-resistant ticking is not used to encase the loose filling materials, the actual upholstery fabric shall be used for this test.

2. Approximate the packing density of the loose filling material as closely as possible to the density of the filling material in the actual furniture product intended for use.
3. If the existing cushion from the finished product is approximately the size of the test cushion, it can be tested in lieu of constructing a standard-sized test cushion.

Note: Fabrics which melt and break open, when subjected to small, open-flame component test, are not suitable for this test, since they do not serve as an effective flame-resistant barrier to protect the internal fill materials from flame contact.

4.8 Test Procedure

1. Pre-weigh cushion on a balance with a tolerance of at least 0.1 grams and record cushion weight to the nearest 0.1 grams. Support cushion on horizontal test apparatus (see Annex C, Figure C-4) in such a manner that the bottom of the cushion is in the center of the open area of the screen.
2. Adjust burner flame to a flame height of 35 mm (1 3/8 in).
3. Position the burner horizontally such that the tip of the burner is 19 mm (3/4 in) below the bottom of the cushion sample. Expose the bottom of the cushion to the flame for 20 seconds, then remove and observe extent of burning.
4. After all flaming and smoldering has ceased, reweigh test specimen to the nearest 0.1 grams and calculate percentage weight loss.
5. Observe and note any unusual or prolonged burning patterns or behavior.

4.9 Pass/Fail Criteria

The specimen fails to meet the requirements of this test procedure if any of the following criteria are exceeded:

- Cushion loses more than 5 % of its original weight after self-extinguishing.
- The cushion fabric breaks open at any time during the test and exposes the filling contents to open-flame, resulting in melting, dripping and/or flaming combustion.

Note: In addition to complying with this loose-fill cushion test, individual loose-fill component materials shall be flame and smolder resistant and shall meet their respective, applicable component test prior to being encased in an flame-resistant ticking/fabric and subjected to this cushion test. Compliance with the applicable component tests and encasement in a flame-resistant ticking/fabric provides a higher level of open-flame resistance than provided by the fabric alone.

4.10 Test Report

The test report shall contain at a minimum, the following information:

- Name and address of the test laboratory.
- Date of the test.
- Operator(s) conducting test.
- Complete description of test materials.
- Complete description of any changes in the described standard test method.
- Recorded results of the test as detailed below:
 - The following weight measurements of each cushion test specimen shall be made:
 - Pre-test weight of cushion
 - Post-test weight of cushion
- Calculated results of the test as detailed below:
 - Calculate percentage weight loss = $(\text{pre-weight (A)} - (\text{post-weight (B)})/\text{pre-weight (A)}) \times 100\%$.
- Statement of overall Pass/Fail results.

Section 5 - Upholstered Furniture Composite Mock-up Test- Open-flame Resistance

5.1 Scope – If an upholstery fabric that does not meet the requirements of Part I, Section 1.A is intended for use in furniture, a composite mock-up assembly containing the actual filling materials shall pass this test to qualify the fabric for use in actual furniture. This composite test is designed to assess the tendency of a bench-scale mockup system to burn with a small open-flame. The mock-up consists of a seat and back piece constructed of the actual cover fabric (and any interliner (fire barrier) material, if present) and the filling materials in the first three inches of layering of the actual furniture item. The intent of this standard is to produce upholstered furniture which is generally safer from the hazards associated with small open-flame, by slowing the ignition and propagation rate of a fire and allowing additional time for occupant recognition and escape.

5.2 Summary of Test method - This test method is based on application of a small open-flame to the crevice of a seat/back mock-up specimen of a furniture composite assembly. The burning behavior of the specimen is observed. The continuous weight loss and time of burning of the specimen are recorded.

5.3 Significance and Use - This test method is designed to measure the response of a furniture composite mock-up assembly to a small open-flame ignition source representing a match, candle or cigarette lighter or similar size ignition source.

5.4 Test Apparatus and Materials - The test apparatus, including the furniture mock-up assembly frame, the gas train and accessories are described in Annex A.

5.5 Test Facility/Hazards - The test facility, exhaust system and hazards are described in Annex B.

5.6 Conditioning - Condition test specimens prior to the test for a minimum of 24 hours at 23 ± 5 °C (73 ± 9 °F) and $50 \pm 10\%$ RH. If the sample is taken from a finished article of furniture, conditioning does not begin until the component is removed from the furniture.

If conditions in the test area are not the same as in the conditioning area, tests should begin within 10 minutes of removal from conditioning area.

5.7 Test Specimens

Cover Material and Flame-Resistant Interliner (if used)

The cover fabric size needed for each test is $1020 \times 700 \pm 10$ mm ($40 \times 27.5 \pm 0.4$ in). The cover fabric specimens shall have triangular cut-outs 575 mm (22.5 in) from one end on both sides. The size of these cut-outs shall be approximately $55 \times 135 \pm 5$ mm ($2.1 \times 5.25 \pm 0.2$ in) high. See Annex A, Figure A-2.

If an interliner (fire barrier) is used, cut it to the same dimensions and in the same orientation as the cover fabric, for fitting to the metal test frame under the cover.

If a furniture product contains more than one type of upholstery fabric, each type of fabric must be tested to the fabric open-flame component test (Part I, Section 1.A).

Composite Upholstery Filling Assemblies

Some cushioning assemblies consist of several layers, typically a fiber batting, wadding or pad over various foams. The upholstery fillings shall consist of the actual filling materials present in the first three inches of layering of the seat of the furniture item and the first three inches of layering of the

back. Filling types should be placed in the same order in the composite mock-up as they are located in the actual furniture.

Use two separate assemblies of filling pieces, one for the vertical back and one for the horizontal seat. The vertical (back) pieces shall have total dimensions of $450 \times 300 \text{ mm} \pm 5 \text{ mm}$ ($17.6 \times 11.7 \pm 0.2 \text{ in}$) $\times 75 \pm 2 \text{ mm}$ ($3.0 \pm 0.2 \text{ in}$) thick. The horizontal (seat) pieces shall have total dimensions of $450 \times 83 \pm 5 \text{ mm}$ ($17.6 \times 3.25 \text{ in} \pm 0.2 \text{ in}$) $\times 75 \pm 2 \text{ mm}$ ($3.0 \pm 0.2 \text{ in}$) thick.

Note: Filling materials for use in this test are not subject to the dimension tolerances of fabrics and flame-resistant barrier fabrics since they are more difficult to cut to accurate sizes.

Where the total thickness exceeds 75 mm (3 in), reproduce only the upper 75 mm (3 in) of the cushioning assembly, except that the upper layer, typically fiber batting, is continued over and around the front edges of the seat assembly and the top edges of the back assembly. If the filling in either the seat or back of the actual furniture is less than 75 mm (3 in) thick, do not build up the test piece to a thickness of 3 inches but test at the thickness found in the actual product. Pull the fabric tight so that no air gap exists between the fabric and fill at any point.

Filling layers which are more than 3 inches below the upholstery fabric are not included in the construction of the composite assembly.

Conduct the composite test with loose filling components only if they are encased in a flame-resistant ticking/fabric and the cushion insert constructed with this fabric and filling has previously complied with Part I, Section 4. If the loose filling material in the actual furniture exceeds three inches in thickness, construct a three-inch thick cushion insert with the overall dimensions given above, at the filling density of actual use and place in appropriate location in the mockup (back or seat).

Composite Mock-Up Assembly

- Position the seat frame in the upright position (see Figure A-1 of Annex A).
- Lay down the cover fabric (and any fire barrier material) flat and face up on the table.
- Fold the two sides of the larger section fabric (from the 6 in cutout upwards) over the face of the fabric.
- Hold the two sides of the folded fabric and insert it under the horizontal rod. Pull the inserted fabric out from behind the seat mock-up frame until the cutout line is lined up with the horizontal rod.
- Re-insert the folded fabric over the rod and pull it out from the front of the frame.
- Line up and pull both the top and bottom sections of the fabric such that the cutout line is lined up with the metal rod and the fabric is flat and free of folds and wrinkles.
- Place the larger foam block flush against the back metal frame on the fabric.
- Wrap the larger portion of the fabric around the foam and secure it to the backside of the frame using metal clips.
- When the back section is completed, place the frame down such that the back of the frame is on the table.
- Lift the smaller portion of the fabric up and lay it on the back cushion.
- Place the smaller piece of foam with the 3 1/4 in side flush with the seat section of the metal frame and press against the back block.
- Wrap the smaller section of the fabric all around the foam and secure it to the frame using metal clips. Re-position the assembly in the upright position.
- Ensure that the fabric is tight and under uniform tension at all locations to eliminate air gaps between the fabric and the foam. Do not allow a gap exceeding 3 mm (1/8 in) along the seat/back crevice.

5.8 Test Procedure

Have a means for extinguishing the specimen close at hand. A hand-held carbon dioxide extinguisher is adequate for most specimens; however, a water spray system should be available as a backup, in case the carbon dioxide fails to completely extinguish the fire.

Pretest:

1. Tare the balance with the empty metal test frame and metal clips or, if the balance does not have tare capability, weigh the metal test frame and metal clips together, and record the weight.
2. Assemble the specimen on the metal test frame using the pre-weighed clips.
3. Record the weight of the total assembly in order to determine the initial weight of the specimen either directly (if tared) or by subtraction (if not tared).
4. Calculate and record weight corresponding to 96% of initial weight of test specimen.

Lighting the igniter flame:

Open the butane tank slowly and light the end of the burner tube. Adjust the gas flow to the appropriate rate (see Annex A) and allow the flame to stabilize for at least 2 minutes.

Starting and performing the test:

1. For manual timekeeping of each individual ignition, start the clock at the same time the burner tube is moved into starting position. For automatic timekeeping, start the data collection at least 30 seconds before the igniter is moved into position on the specimen in order to collect baseline data. In the case of automatic recording (e.g., chart recorder or computer), provide for a signal to the recorder to mark the actual start of the test.
2. For manual data collection, record the weight of the specimen at least every 15 seconds. For automatic data collection, record data at a constant interval between 3 and 6 seconds.
3. Position the lit burner tube from the side of the test specimen, parallel to the crevice between the vertical and horizontal parts and in contact with both parts, so that the end of the igniter is at the center of the test specimen equidistant from either edge.
4. For each ignition, apply the flame for 20 ± 1 seconds, then immediately remove ignition source.

Note: The weight of the specimen will appear to increase due to pressure when burner tube is in contact with the mock-up. Ignore this temporary weight increase in assessing weight loss of sample.

5. Observe the specimen for evidence of ignition on the cover material or in the interior of the mock-up cushions for 10 minutes.
6. If the first specimen self extinguishes and the specimen is re-useable, apply the second ignition equidistant between the center of the seat/back crevice and the left edge of the specimen.
7. If the specimen self extinguishes and the specimen is re-useable, apply the third ignition equidistant between the center of the seat/back crevice and the right edge of the specimen.
8. Conduct a maximum of three ignition runs on a single seat/back, mock-up specimen of each upholstery fabric. If three ignition runs cannot be obtained with one test specimen, a second or third specimen may be required.
9. Terminate a test run if any of the following conditions occur:
 - The specimen self extinguishes.
 - Weight loss exceeds four percent of the initial specimen weight (Weight reaches 96% of initial weight).
 - Time of test exceeds ten minutes.

- Fire intensity and/or smoke evolution exceeds the capacity of the ventilation system and test must be aborted due to safety factors. Note: This is not an acceptable "end point" for the test, if one of the other criteria has not been exceeded. If an excessive smoke or fire condition occurs, test should be repeated in a hood exhaust system with adequate ventilation capacity to observe all failure criteria without compromising operator safety.
- Any type of rapid increase in rate of combustion such that worker safety is compromised.

Note: When terminating a test, be certain that final weight readings are taken before extinguishing the specimen. Also, care should be taken that the weighing device and other instrumentation are not adversely affected by the process of extinguishing the specimen.

5.9 Pass/Fail Criteria

The sample must pass a minimum of three ignition runs.

The sample fails if any of the following criteria are exceeded during any ignition run:

- Weight loss exceeds four percent of the total initial weight of the specimen in the first 10 minutes of the test.
- The specimen burns progressively and it must be extinguished before 10 minutes.

5.10 Test Report

The test report shall contain, at a minimum, the following information:

- Name and address of the test laboratory.
- Date of the test(s).
- Operator conducting the test.
- Complete description of the test materials.
- Complete description of any procedures different from those described in this test method.
- Recorded results of the test as detailed below:
 - Initial weight (pre-test weight)
 - Weight corresponding to 96% of initial weight
 - Time to reach a weight equal to 96 % of the initial weight.

The weight loss at any given time is calculated as follows:

$$\% \text{ weight loss (WL)} = (\text{pre-test weight (A)} - \text{current weight (B)}) / \text{pre-test weight (A)} \times 100\%. \text{ or}$$
$$\% \text{WL} = (A - B) / A \times 100\%$$

Note: If direct observation of the time to reach four percent weight loss was not taken during the test, use a linear interpolation of the nearest test data points (preferably at five or six-second intervals, but no more than 15 second intervals) to calculate the time to four percent weight loss.

- Statement of overall Pass/Fail results.

PART II- UPHOLSTERED FURNITURE COMPONENTS- SMOLDER RESISTANCE TESTS**Section 1: Fibrous and Loose Filling Materials (Natural and Synthetic) Component ("Sandwich")
Test- Smolder Resistance.**

1.1 Scope - This test method measures the tendency of fiber battings and pads and loose filling materials to smolder and contribute to fire propagation, when subjected to a smoldering ignition source. Filling components not in compliance with this standard are not suitable for use in constructing upholstered furniture. The method is based on ASTM D 5238-98, "Standard Test Method for Smoldering Combustion Potential of Cotton-Based Batting", a voluntary consensus standard adopted by the National Cotton Batting Institute (NCBI) and the Upholstered Furniture Action Council (UFAC) as a joint industry quality assurance program for screening of fire-retardant cotton batting supplies. This method is applicable to all fibers and loose filling materials, natural or synthetic.

1.2 Summary of Test Method - Samples are subjected to ignition from a standard smoldering test cigarette by placing the sample completely around the cigarette to form a sandwich. Continued and sustained smoldering in any direction indicates the sample is a smoldering hazard.

1.3 Significance and Use - Fiber and loose filling materials may constitute a smoldering hazard in furniture unless properly smolder retarded or inherently smolder-resistant. If smoldering is allowed to continue indefinitely, it may progress to open-flaming, causing a more immediate fire hazard. This test assesses the tendency of these materials to initiate and sustain smoldering, leading to a fully-propagated fire.

1.4 Test Apparatus and Materials

Draft Barrier - a) Box constructed of wood, with dimensions 305 mm (width), 305 mm (height) and 381 mm (length) (12 in x 12 in x 15 in) with no top or bottom, or b) the test enclosure described in Annex E.

Wooden Sheet - 203 mm x 203 mm x 12 mm (8 in x 8 in x 0.5 in) thick.

Ignition Source - The cigarette ignition source is the same as in Annex E.

Ruler - standard, 152 mm (6 in) long (for char length measurement).

1.5 Test Facility and Hazards - The exhaust system and hazards are described in Annex B.

1.6 Conditioning - Condition test specimens and cigarettes prior to the test for a minimum of 24 hours at 23 ± 5 °C (73 ± 9 °F) and $50 \pm 10\%$ RH. If the sample is taken from a finished article of furniture, conditioning does not begin until the component is removed from the furniture. If conditions in the test area are not the same as in the conditioning area, tests should begin within 10 minutes of removal of samples from conditioning area.

1.7 Test Specimens - Representative specimens of fibers or loose filling material shall be sampled for testing from various points in the batting, pad or loose filling, consistent with sound statistical sampling protocols. Three sets of specimens should be prepared from different areas of the material. Each set shall consist of two specimens. Cut and prepare each specimen from adjacent material to dimensions of 178 ± 6 mm ($7 \pm \frac{1}{4}$ in) by 178 ± 6 mm ($7 \pm \frac{1}{4}$ in) in the thickness of use.

1.8 Test Procedure

1. Place one specimen on the wooden sheet, located on a horizontal test surface.
2. Light one test cigarette so that no more than 4 mm (0.16 in) is burned away, place it on the center of the surface of the positioned specimen, parallel to the side of the specimen and record the time.

3. Cover the lower specimen and lit cigarette immediately, with the second specimen, placed so as to form a "sandwich" of fiber batting. Both specimens should be aligned evenly with no overhang of the top specimen. If a test is inadvertently interrupted or cigarette self-extinguishes on lighting, it must be repeated from the beginning with a new cigarette until the cigarette does not self-extinguish or until three cigarettes self-extinguish without burning their full length. Repeat for other two sets of specimens.
4. If using draft barrier a) place the draft barrier box around the set of test specimens, centering the specimens in the lower opening of the box. If using draft barrier b), the larger test enclosure (see Annex E), place a maximum of six sets of specimens in the enclosure with a minimum spacing between sets of 3 inches in the width dimension and 8.5 inches in the length dimension.
5. Observe smoldering combustion of undisturbed specimens until the cigarette has burned completely and emits no visible smoke (approximately 25-30 minutes), smoldering continues to consume the entire sample or open flaming is observed.
6. If open flaming occurs, the sample should be extinguished immediately.
7. After 30 minutes of burning by the cigarette or 5 minutes after the last visible smoke is observed (whichever time is longer), remove the top specimen, exposing the charred area. Lay both specimens flat with the charred areas up and ensure smoking has ceased.
8. Measure maximum char lengths for each specimen, in all directions, from the edge of the cigarette ashes, to the point where black charring ends and brown discoloration begins.

1.9 Pass/Fail Criteria

The sample fails to meet the requirements of this test procedure if any of the following criteria are exceeded:

- A maximum char length measurement for any specimen exceeding 25 millimeters (1 in) in any direction.
- Smoldering combustion leading to open flaming is observed.

1.10 Test Report

The test report shall contain, at a minimum, the following information:

- Name and address of the test laboratory.
- Date of the test(s).
- Operator conducting the test.
- Complete description of the test material including color.
- Complete description of the presence any additional materials such as adhesives.
- Complete description of any procedures different from those described in this test method.
- Recorded results of the test as detailed below:
 - The maximum char length for each specimen shall be recorded to the nearest 1 mm (1/16 in).
 - Evidence and documentation of smoldering combustion leading to open flaming.
- Statement of overall Pass/Fail results.

Section 2 - Resilient Cellular (Foam) Filling Materials Component Test-Smolder Resistance

2.1 Scope – This test measures the tendency of resilient cellular (slabstock) foam materials to smolder and contribute to fire propagation, when subjected to a smoldering ignition source. In addition to complying with this test, these materials must also comply with the requirements of Part I, Section 3.

2.2 Summary of Test Method - The cellular foam specimen is tested with a standard cigarette in a small mockup configuration covered by a standard substrate 100% cotton napped fabric. The sample must not exhibit excessive smoldering and weight loss and must not progress to open flaming.

2.3 Significance and Use - Resilient cellular foam materials must meet an open-flame resistance test (Part I, Section 3). Although slabstock cellular foams are generally smolder-resistant, formulation of flame-retardant foams sometimes causes them to be more prone to smolder. To preserve good smolder-resistance and open-flame resistance for each formulation, compliance with this test as well as the open-flame performance test, is required on all resilient cellular slabstock foams.

2.4 Test Apparatus and Materials

Test Apparatus: The test stand and test enclosure are the same as in Annex E.

Test Materials: The cigarette ignition source, standard test fabric and cotton sheeting are the same as in Annex E.

2.5 Test Facility and Hazards -The exhaust system and hazards are described in Annex B.

2.6 Conditioning - Condition foam test specimens, standard cotton sheeting and standard cigarettes prior to the test for a minimum of 24 hours at 23 ± 5 °C (73 ± 9 °F) and $50 \pm 10\%$ RH. If the sample is taken from a finished article of furniture, conditioning does not begin until the component is removed from the furniture.

If conditions in the testing area are not the same as in the conditioning area, tests should begin within 10 minutes of removal of samples from conditioning area.

2.7 Test Specimens - Three foam sample specimen sets should be cut from a representative piece of slabstock foam with no physical defects or surface skin present. Each specimen set shall be 184 x 203 x 50 mm (7.25 x 8 x 2 in) for vertical (back) panels, and 203 x 100 x 50 mm (8 x 4 x 2 in) for horizontal (seat) panels (See Annex E, Figure E-1).

2.8 Test Procedure

1. Weigh each set of foam (seat/back) test panels as one assembly correct to the nearest 0.1 grams and record weight on test sheet. Assemble the foam test panels by placing standard fabric over test foam as shown in Annex E, Figure E-1. Straight pins or staples may be used to support the cover fabric, and fabric should be pulled tight so that no air gaps exist between the fabric and foam samples.
2. Place entire mockup in test enclosure with crevice facing forward.
3. Repeat assembly step for remaining two mockup sets and place side by side in test enclosure. No more than three mockups should be placed in test enclosure and each should be equidistant from the other and from enclosure end walls to avoid heat transfer between samples.
4. Light cigarette so that no more than 4 mm (0.16 in) is burned away and place cigarette on each mockup crevice created by the intersection of the vertical and horizontal panels, such that the cigarette contacts both surfaces and is equidistant from the side edges of the test panels. Run one finger over the sheet along the length of the covered cigarette to ensure good cover sheeting-to-cigarette contact. If a test is inadvertently interrupted or cigarette self-extinguishes on lighting, it must be repeated from the beginning with a new cigarette until the cigarette does not self-extinguish or until three cigarettes self-extinguish without burning their full length.
5. Continue testing until all evidence of combustion has ceased for at least 5 minutes. After all combustion has ceased, remove cover sheeting fabric and remains of standard test fabric.
6. Carefully remove foam test panels, clean all carbonaceous char from panels by scraping with a spatula and brush and weigh the non-burned portions of the foam test panels to the nearest 0.1 grams.
7. If one test specimen of the original three tested has less than 80% non-smoldered residue, test three additional specimens, repeating steps 2 through 8. If there is insufficient sample to test an additional three specimens, test as many specimens as the sample will allow.

2.9 Pass-Fail Criteria

The sample fails to meet the requirements of this test procedure if the following criteria are exceeded:

- Two or more test specimens have less than 80% non-smoldered residue.

2.10 Test Report

The test report shall contain, at a minimum, the following information:

- Name and address of the test laboratory.
- Date of the test(s).
- Operator conducting the test.
- Complete description of the test material including color.
- Complete description of the presence any additional materials such as adhesives or molded skin on the foam surface.
- Complete description of any procedures different from those described in this test method.
- Recorded results of the test as detailed below:
 - The following weight measurements of each foam test specimen panel shall be made:
 - Pre-test weight of foam pieces
 - Post-test weight of non-smoldered foam residue
- Calculated results of the test as detailed below:
 - Calculate percentage non-smoldered foam residue for each specimen
 - % Non-smoldered Foam Residue = $\text{post-test weight (B)}/\text{pre-test weight (A)} \times 100\%$.
- Statement of overall Pass/Fail results.

ANNEX A**Mock-up Test Apparatus****Butane Gas Flame Ignition Source**

- The burner tube shall consist of a length of stainless steel tube, 8.0 ± 0.1 mm ($5/16 \pm 0.004$ in) outside diameter, 6.5 ± 0.1 mm (0.256 ± 0.004 in) internal diameter and 200 ± 5 mm ($8 \pm 1/4$ in) in length, connected to a cylinder containing butane.
- C.P. Grade butane, 99.0% purity with 2-stage regulator shall be provided.
- The following items are required to connect the butane cylinder to the burner tube: clear, flexible tubing (2.5 to 3.0 m (8 to 10 ft) in length, 7.0 ± 1.0 mm ($1/4 \pm 0.04$ in) I.D.), a mass flow meter (optional), a fine adjustment needle valve, an on-off valve (optional) and a cylinder regulator capable of providing a nominal outlet pressure of 2.8 kPa (28 mbar).
- The flow rate of butane shall be 45 ± 2 ml/min (354 ± 16 cfm) at 23 °C (73 °F), which produces a flame height of approximately 35 mm (1 3/8 in) (measured from the center end of the burner tube when held horizontally and the flame allowed to burn freely in air).

NOTE: The following specific items have been found to be satisfactory for the butane gas train: Air Products CP grade, 99.0% purity butane, 20 lb. cylinder; Matheson 2-stage regulator, Model 8-2-510; Matheson 9.0 kPa pressure gauge, P/N 63-3103; Matheson fine control valve, brass, Model 4170 series; Matheson mass flow meter, Model 8112-0422, 200 standard cubic centimeter (sccm) range (a mass flow meter has been found to be particularly useful for resetting the butane flow from day to day).

Furniture Metal Test Frame (Mock-up Frame)

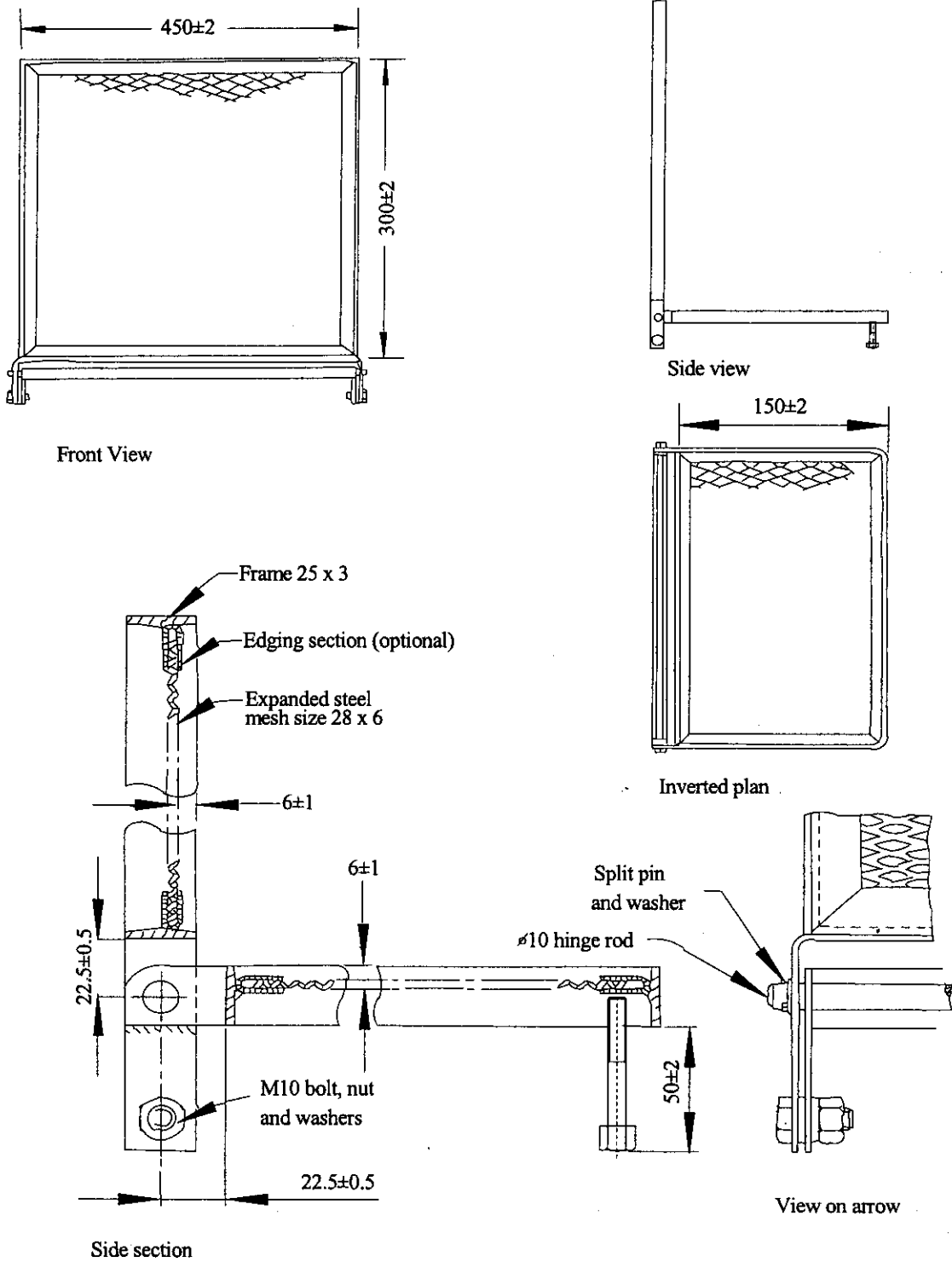
The metal test frame shall consist of two rectangular metal frames (either aluminum, for lower weight, or steel is permissible), hinged together and capable of being locked at right angles to each other (as illustrated in Fig. 5 in BS 5852:1990). The frames shall be made of 25 mm x 25 mm (1 in x 1 in) steel or aluminum angle 3 mm (1/8 in) thick, and shall securely hold platforms of steel mesh set 6 ± 1 mm (0.25 ± 0.05 in) below the front face of each test frame. An optional standard edging section around the expanded metal will provide protection and greater rigidity. The hinge rod shall be continuous across the back of the rig. The frames shall be lockable at right angles.

Weighing Device

- A means of weighing the specimen and providing a display or electronic output of the weight is necessary. The device must be capable of accommodating the entire metal test frame with the specimen in place (typically, the total weight will be in the range of 13 to 15 kg) and must be capable of reading 1 ± 0.5 g.
- A means for recording the weight of the specimen at intervals equal to or less than every 15 s during the test shall be provided. Typically, a load (balance) cell with computer or chart recorder readout is used, with readings taken every 5 or 6 seconds. A test operator manually reading a clearly visible readout of the weighing device is adequate for this test procedure.

Instrumentation

A stopwatch, accurate to 1 s and capable of measuring for at least one hour, shall be provided.



All parts are of steel. All dimensions are in millimeters and have a tolerance of 2.5 %, unless otherwise shown.

Figure A-1. Mock-up Test Apparatus Assembly (Metal Test Frame)

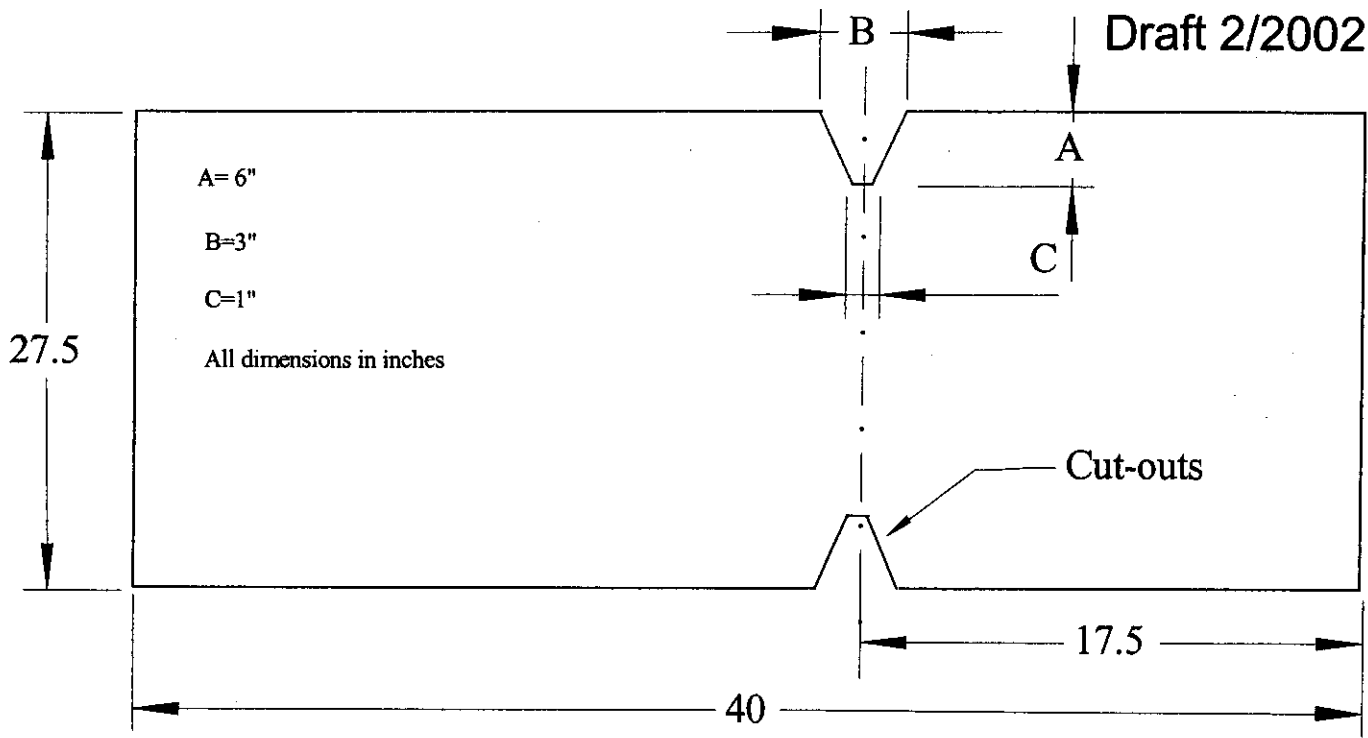


Figure A-2. Fabric cut-out for mock-up tests

ANNEX B

Test Facility, Exhaust System and Hazards

Test Facility/Exhaust System

- The test area shall be a room with a volume greater than 20 m³ (in order to contain sufficient oxygen for testing) or a smaller area equipped with inlet and extraction systems permitting the necessary flow of air. Airflow rates shall be between 0.02 m/s and 0.2 m/s, measured in the locality of the test specimen position specimen to provide adequate air without disturbing the burning behavior.

Note: These rates of airflow have been shown to provide adequate oxygen without physically disturbing the burning behavior of the ignition source or the specimen.

- A means of extracting smoke and combustion gases from the test area shall be provided.

Hazards

- There are potential risks associated with running any fire test. It is essential that suitable precautions be taken, which include the provision of breathing apparatus and protective clothing.
- Products of combustion can be irritating and dangerous to test personnel. Test personnel must avoid exposure to smoke and gases produced during testing.
- Suitable means of fire extinguishment shall be at hand. When the termination point of the experiment has been reached, the fire is extinguished, if necessary, with carbon dioxide or water. Presence of a back-up fire extinguisher (water hose) is recommended.
- It may be difficult to judge when all combustion in a test specimen has ceased, even after extinguishment, due to potential burning deep inside the specimen. Care should be taken that specimens are disposed of only when completely inert.

ANNEX C**Horizontal Test Apparatus for Fiber Battings and Loose-Fill Materials**

A test rack constructed, as in Figures C-1 to C-4, shall be used to support the sample for testing. This rack shall be used for both the fiber (batting or pad) component flame test (Section 2) and the loose filling cushion test (Section 4). The rack shall be constructed with a 356 x 356 mm (14 x 14 in) stainless steel metal (2.4 mm (3/32 in) thick) base. At each corner, a 356 mm (14 in) long, 12 mm (1/2 in) O.D. threaded rod shall be mounted vertically to allow adjustment of a horizontal test support to various heights using threaded nuts. The test support shall consist of two square metal plates, a lower fixed plate and an upper removable retaining plate, with inside openings of 254 x 254 mm (10 x 10 in). Both plates shall have holes to act as guides for positioning. Eight vertical specimen retaining holder/guide rods, 75 mm (3 in) high by 5 mm (3/16 in) O.D shall be mounted on the lower plate as illustrated in Figure C-4.

A 300 x 300 mm (12 x 12 in) sheet of a 20-gauge hexagon wire mesh with 25 mm (1 in) openings shall be tightly secured on the top of the bottom square plate using threaded nuts to support and to prevent sagging of the test specimen. The top square plate (the retaining plate) shall fit over the bottom square and shall hold the fiber component sample horizontally in place by its own weight. A 150 mm (6 in) diameter hole shall be cut in the center of the wire mesh to allow the flame to contact the sample directly.

For tests of cushions with loose fillings, no upper retaining plate shall be used. The sample is placed directly on the wire mesh screen.

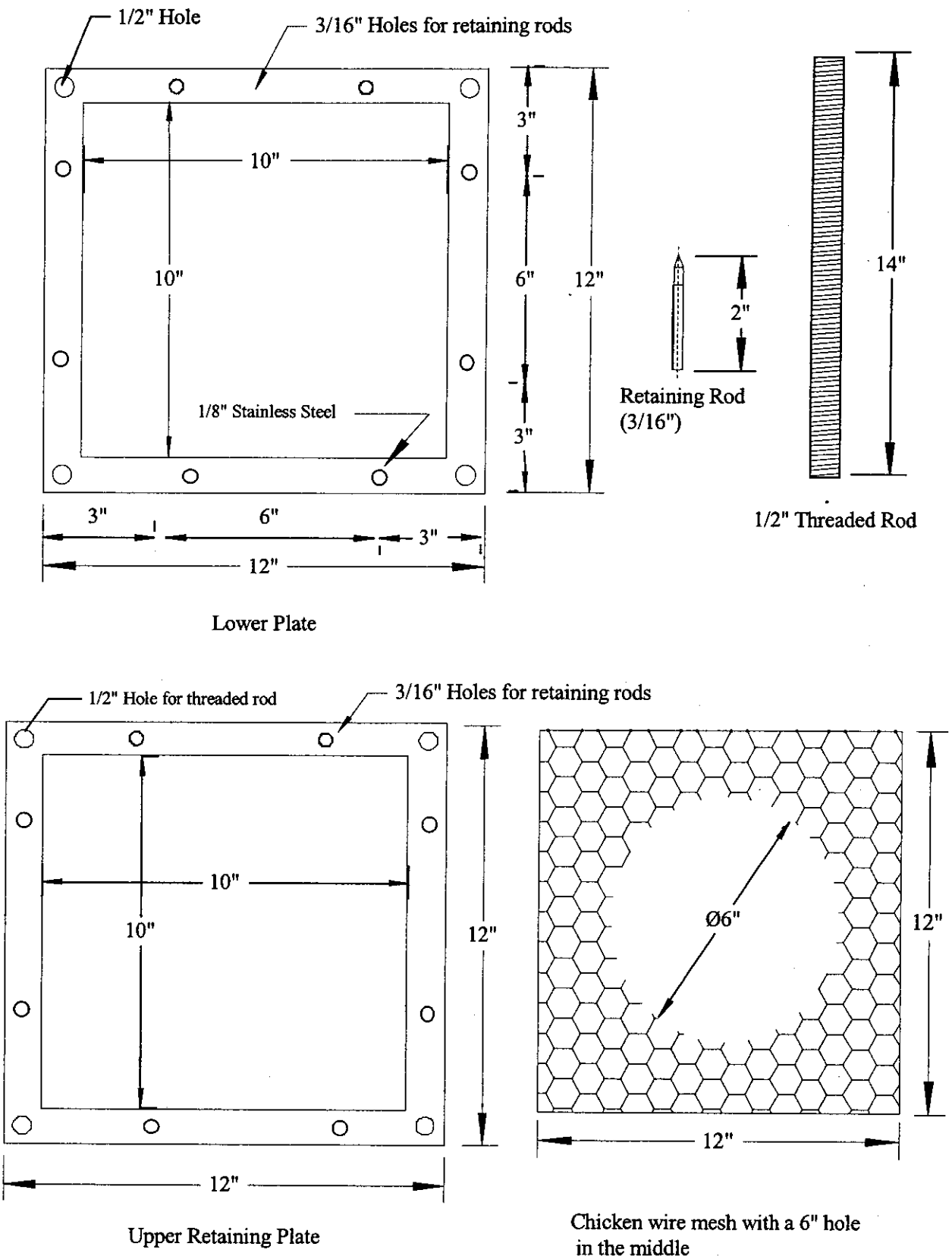
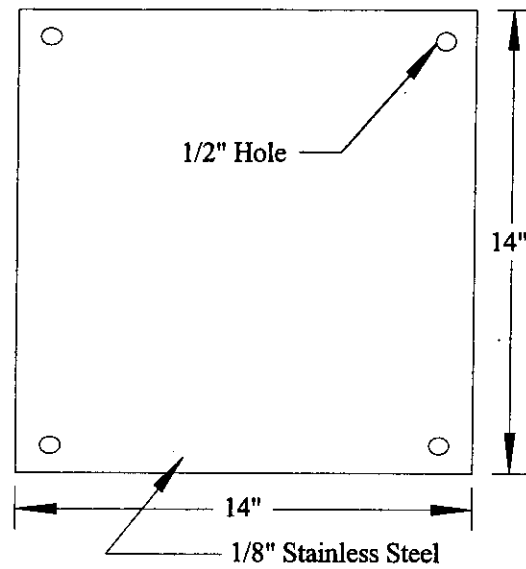
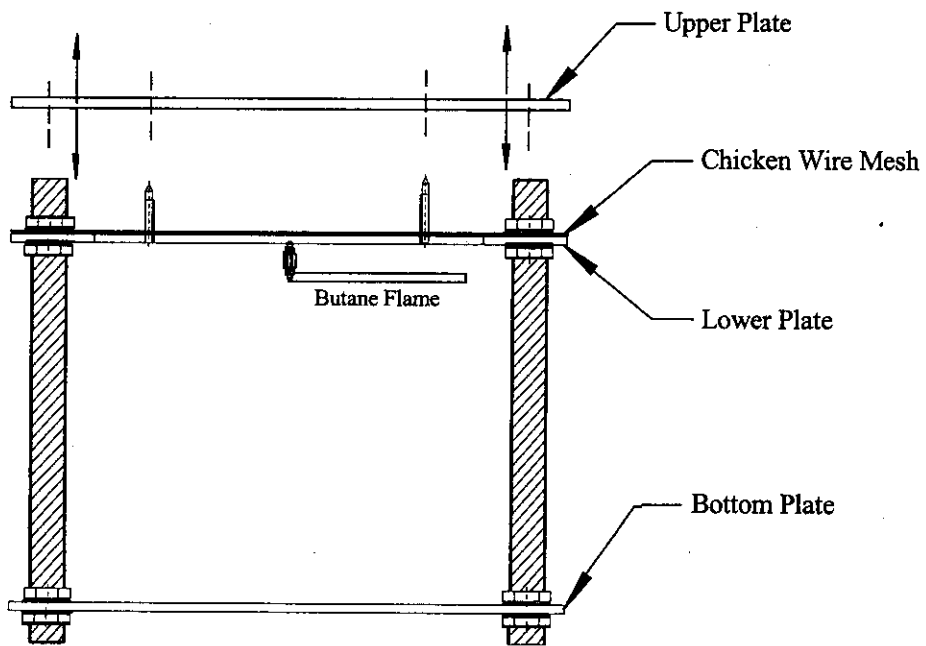


Figure C-1. Details of the horizontal fiber batting test apparatus



Bottom Plate



Side view of the horizontal test apparatus

Figure C-2. Details of the horizontal fiber batting test apparatus

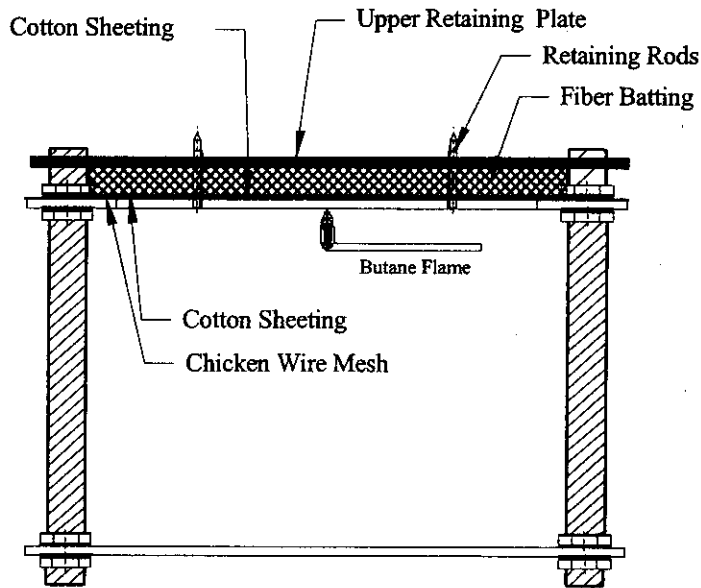


Figure C-3. Side view of horizontal fiber batting test apparatus assembly with cotton sheeting and fiber batting in place

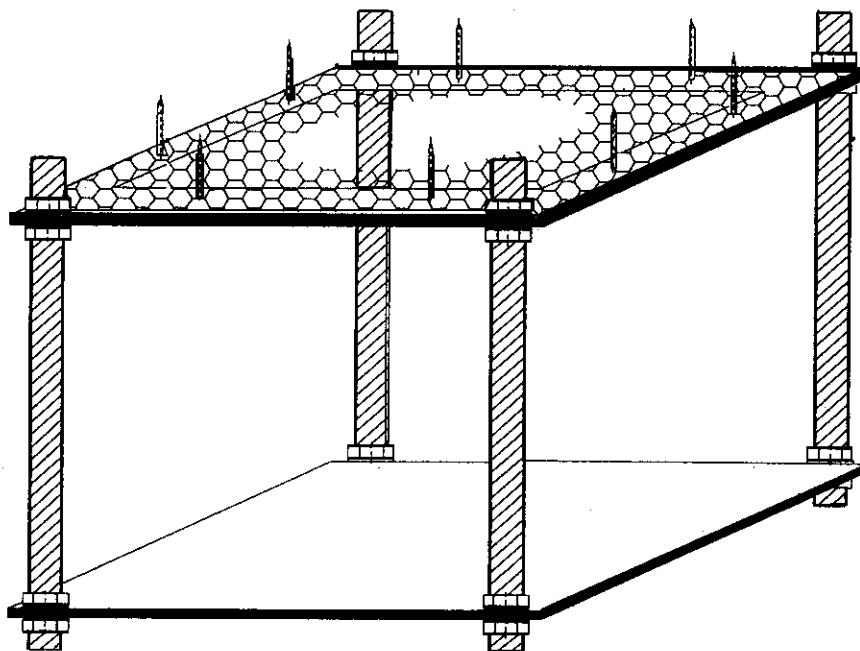


Figure C4. 3-D View of Horizontal fiber batting test apparatus (Upper retaining plate not shown)

Annex D**Test Apparatus Vertical Flame Test of Cellular Foam****Test Cabinet**

The test cabinet shall be a metal container fabricated in accordance with Federal Test Method Standard No. 191, Method 5903.2 or Federal Flammable Fabrics Act regulation 16 CFR 1615, "Standard for the Flammability of Children's Sleepwear, Sizes 0 through 6X (formerly DOC FF 3-71) or 16 CFR 1616, "Standard for the Flammability of Children's Sleepwear, Sizes 7 through 14" (formerly DOC FF5-74).

Burner

The burner shall be the same as that used in Federal Test Method Standard No. 191, Method 5903.2 or Federal Flammable Fabrics Act regulation 16 CFR 1615, "Standard for the Flammability of Children's Sleepwear, Sizes 0 through 6X (formerly DOC FF 3-71) or 16 CFR 1616, "Standard for the Flammability of Children's Sleepwear, Sizes 7 through 14" (formerly DOC FF 5-74).

Test Gas

The test gas used will be the same as in Annex A.

Foam Specimen Holder

A stainless steel specimen holder fabricated in accordance with the requirements specified in Figure D-1 shall be used. This holder is designed for testing cellular foam specimens 12 mm (1/2 in) thick and substitutes for the standard fabric specimen holder specified in Federal Test Method Standard 191, Method 5903.2 or 16 CFR 1615 and 1616.

Measurement Tools

Steel measure, (ruler or tape), graduated to 0.01 in or 1 mm intervals and at least 12 inches (300 mm) in length.

A stopwatch, accurate to 0.01 s and capable of measuring for at least one hour, shall be provided.

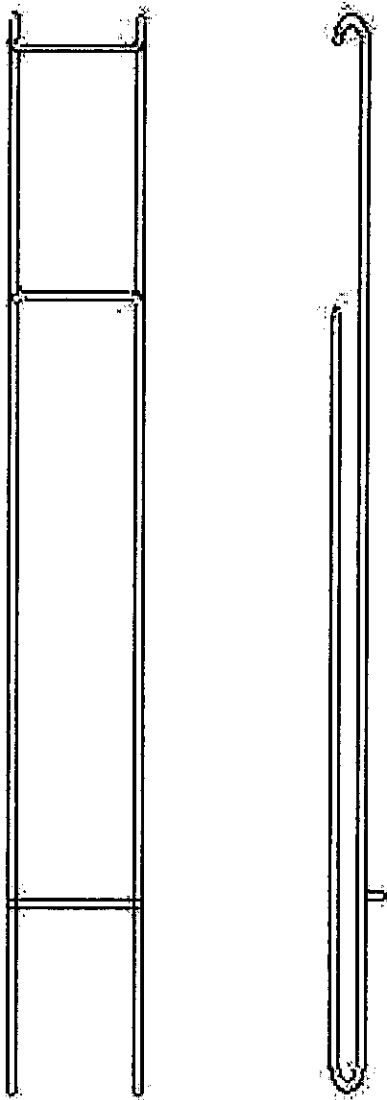


Figure D-1. Specimen holder for the vertical flame test of cellular foam

Annex E**Test Apparatus and Materials for Smolder Resistance of Resilient Cellular (Foam) Filling Materials Used as Components in Upholstered Furniture.**

Test Stand - A test stand constructed as shown in Figure E-1 shall be used in all tests. Construction material shall be 19 mm (3/4 in) plywood.

Test Enclosure - To prevent extreme changes in surface ventilation rate, tests should be performed inside an enclosure measuring 1219 mm (48 in) long, 533 mm (21 in) deep and 457 mm (18 in) high, with an integral bottom, but without top. The enclosure is designed such that three individual foam mockup test stands may be positioned simultaneously. Individual test stands should be at least 152 mm (6 in) apart. The enclosure construction material may be wood, transite, sheet metal, PMMA (polymethylmethacrylate) or other similar materials. It is desirable that the enclosure, if opaque, contain an observation window so that tests may be visually monitored. Fiberglass batts (1 in thick) may be placed on the bottom surface of the enclosure to avoid heat sink effects (melting) of the enclosure during failures. This enclosure may also be used as an alternative to the draft barrier box (option a) in Part II, Section 1 for smolder testing of fiber components.

Ignition Source - Shall be standard cigarettes without filter tips made from natural tobacco 85 ± 2 mm (3.35 ± 0.1 in) long with a packing density of 0.27 ± 0.02 g/cm³ (0.75 ± 0.06 lb/in³) and a total weight of 1.1 ± 0.1 g (0.04 ± 0.004 oz).

Standard Test Fabric - The standard test fabric shall be 381 x 203 mm (15 x 8 in) for vertical (back) panels, and 279 x 203 mm (11 x 8 in) for horizontal (seat) panels.

The standard upholstery test fabric, designed to simulate a worst case smoldering substrate, shall have the following specifications:

Fabric: Pattern 8500
Color: Beige
Fiber Content: 100% Cotton Velvet (napped)
Weight/lineal yard: 14.5 oz (411 g) (54 in bolt)
Backcoating/Fire Retardant: None
Manufacturer: J.B. Martin

Sheets or Sheeting Material - Use white, 100 percent cotton sheets or sheeting material, not treated with a chemical finish which imparts a characteristic such as permanent press or flame resistance, 19 - 33 threads per square centimeter (120-210 threads per square inch), fabric weight - 125 ± 28 g/m² (3.7 ± 0.8 oz/yd²). The sheeting shall be laundered once before use in an automatic home washer using the hot water setting and longest normal cycle with the washer manufacturer's recommended quantity of a commercial detergent and dried in an automatic home tumble dryer. Cut the sheet or sheeting material to 152 x 152 mm (6 x 6 in) to be used for the test.

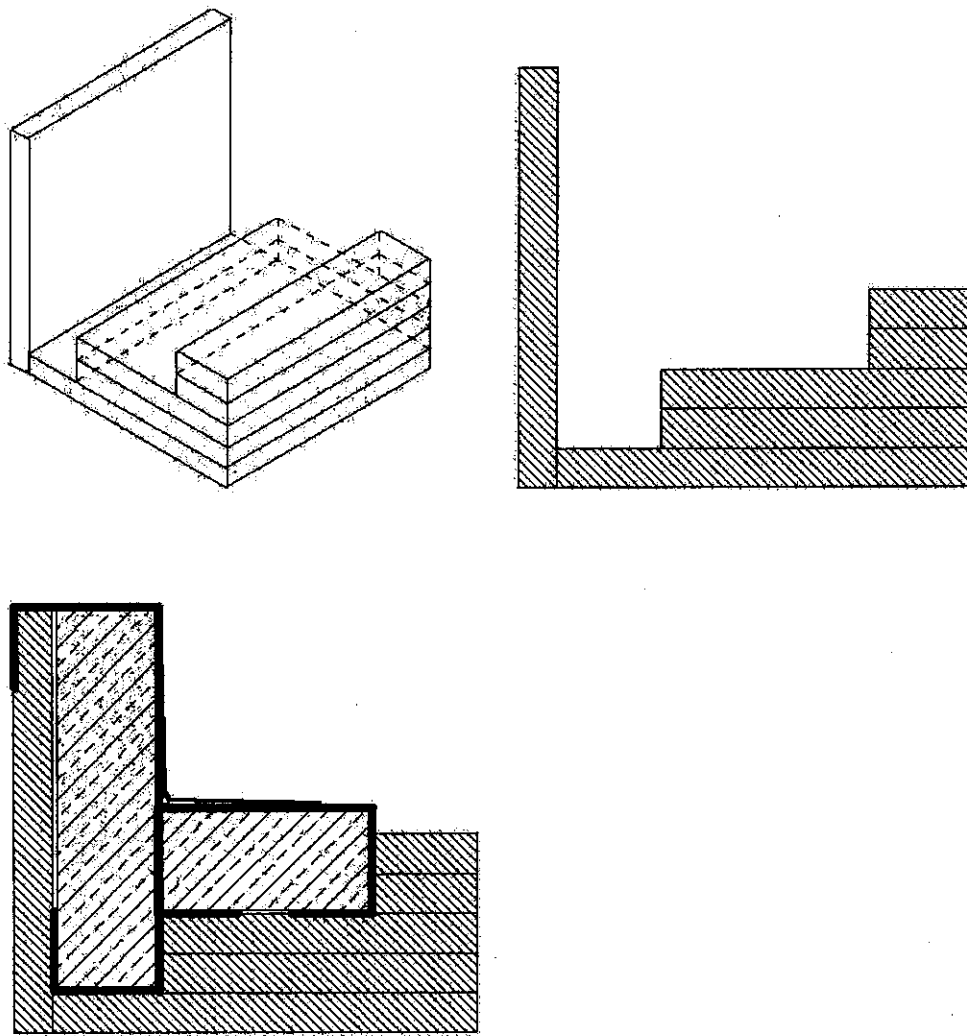


Figure E-1. Three views of the wooden stand for Smolder Resistance test of Resilient Cellular (Foam)

APPENDIX A – Glossary

Afterglow - Combustion characterized by incandescence, without visible flame, after removal of the ignition source from the sample.

Afterflame - Combustion characterized by the presence of a visible flame after removal of the ignition source.

Barrier - A material that is intended to reduce the flame spread of upholstery

* **Char Length** - The distance on a test sample from the point of contact of the ignition source to the outermost char zone.

Combustion - An exothermic, self-sustaining reaction involving a solid or liquid, and or gas phase fuel. It can occur through flaming, glowing or smoldering.

Component Test - Any test measuring the fire response of an individual element or part of an article of upholstered furniture. The test may involve use of standard substrate materials other than the tested component.

Composite Test- Any test measuring the fire response of a combination of two or more component materials used to construct a finished article of upholstered furniture.

Cover Fabric - The outermost layer of fabric or related material used to enclose the main support system and upholstery filling used in the furniture item.

Dust Cover - The outermost layer of non-structural material on the underside of the finished item of upholstered furniture.

Flame - Combustion characterized by the presence of a visible flame after removal of the ignition source.

Flame-Resistant - An adjective term referring to the ability of a component of upholstered furniture to withstand flame impingement or give protection from flame.

Flame-Retardant- An adjective term referring to an upholstered furniture component which has had a flame-retardant chemical, coating or treatment added to it to impart greater flame-resistance.

Ignition - Initiation of combustion. It is perceived by the presence of any visible flaming, glowing, or smoldering after removal of the ignition source.

Interliner (Fire Barrier) - A layer of material which, when secured to a combustible material or otherwise interposed between the material and the potential fire source, delays ignition and combustion of the material when the barrier is exposed to fire.

Seating Area - The intersection of the vertical and horizontal surfaces of upholstered furniture that is intended for seating purposes.

Self-Extinguishment - The termination of any visible combustion within a defined time period (i.e,10 minutes) of the test flame removal before the specimen is consumed.

Slabstock- Refers to a physical type of resilient, cellular foam (i.e., polyurethane, etc.) material which is still in pad form and not shredded.

Small Open-Flame - A flaming ignition source that simulates the heat output of a match, candle, or cigarette lighter.

Smolder - Combustion characterized by smoke production, without visible flame or glowing.

Upholstered Furniture - A unit of interior furnishing with a resilient surface, covered in whole or in part with fabric or related material, that is intended for use or may be expected to be used in homes, and is intended or promoted to support the human body in a seating position.

Appendix B - Additional Observations

Part I

Section 1

Observations of the tests as detailed below may be valuable in assessing test results:

- Observations shall be made, and included in the report, of the behavior of the specimen in response to the application of the burner, specifically noting the following:
 - Time to apparent ignition of the specimen.
 - Unusual burning characteristics, such as burning in an irregular pattern across the surface of either the seat or the back or burn through the thickness of the specimen at any point.
 - Extended smoldering (non-flaming) combustion.

Section 3, Option A

Observations of the test as detailed below may be valuable in assessing test results:

Observations shall be made, and included in the report, of the behavior of the specimen in response to the application of the burner, specifically noting the following:

- Time to apparent ignition of the specimen.
- Unusual burning characteristics, such as burn through the thickness of the specimen at any point.
- Extended smoldering (non-flaming) combustion.

Section 3, Option B

Observations of the test as detailed below may be valuable in assessing test results:

Observations shall be made, and included in the report, of the behavior of the specimen in response to the application of the burner, specifically noting the following:

- Unusual melting, dripping or burning onto the cabinet base.
- Other unusual melting, dripping or burning on the specimen holder.

Section 4

Observations of the test as described below may be valuable in assessing test results:

Observations shall be made, and included in the report, of the behavior of the specimen in response to the application of the burner, specifically noting the following:

- Specimen's response to burner application, including whether the fabric broke open and exposed filling contents to flame.
- Unusual or irregular burning patterns.
- Extended smoldering combustion.

Section 5

Observations of the test as detailed below may be valuable in assessing test results:

Observations shall be made, and included in the report, of the behavior of the specimen in response to the application of the burner, specifically noting the following:

- Time to apparent ignition of the specimen.
- Unusual burning characteristics, such as burning in an irregular pattern across the surface of either the seat or the back or burn through the specimen at any point.
- Extended smoldering (non-flaming) combustion.