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

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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.

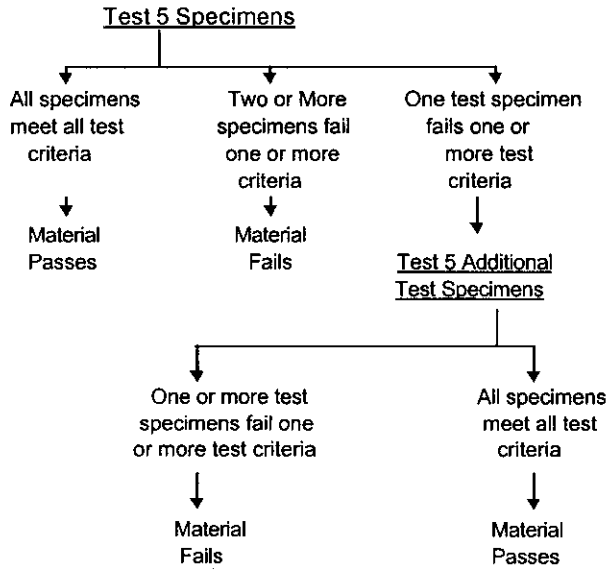
4. The maximum afterflame of any individual specimen, including afterflame of molten material or other fragments dropping from the specimen, shall not exceed 10 seconds.

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:

Test Flame	Yarns Vertical	Specimens
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:

Test Flame	Yarns Vertical	Specimens
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 scrims, 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

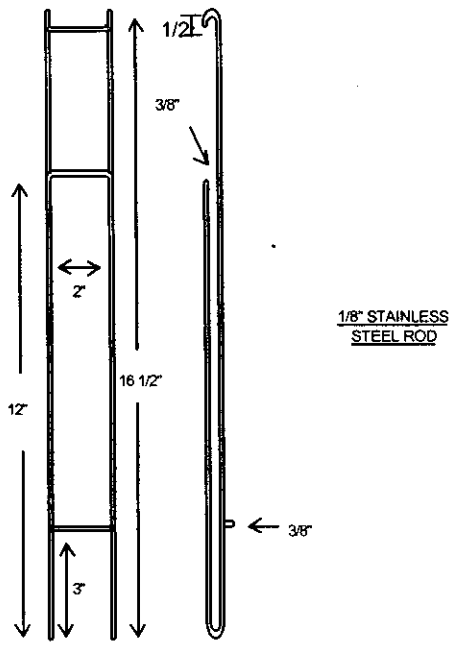


Figure A Figure B

Figure 117 - A

FLAMMABILITY TEST FRAME - MODIFIED CS 191-53

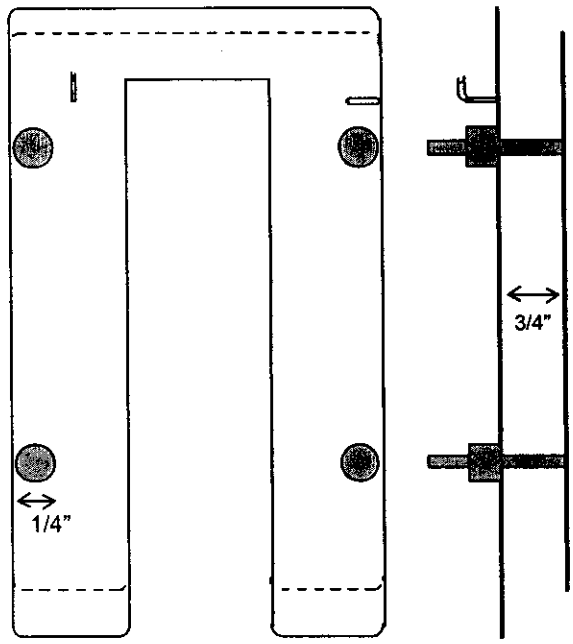


Figure 117 - B

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 ± 5°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/cm^3, 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/yd^2, 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

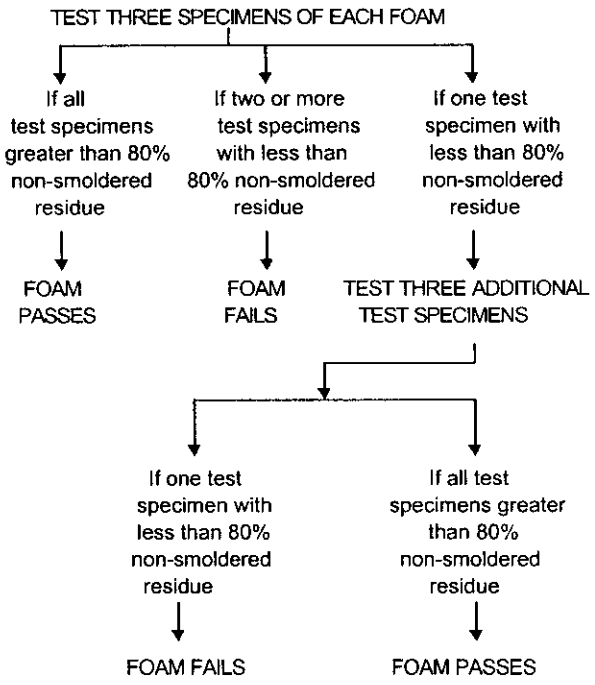
(b) Post test weight of non-smoldered foam = B

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



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. (54 inches)	:	14.5 oz.
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.

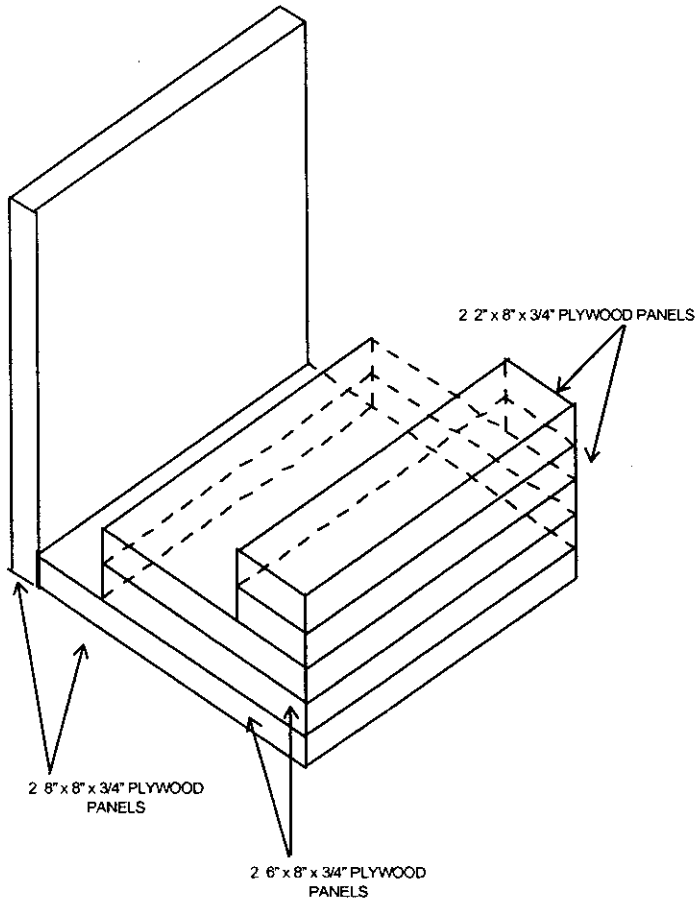


Figure 1

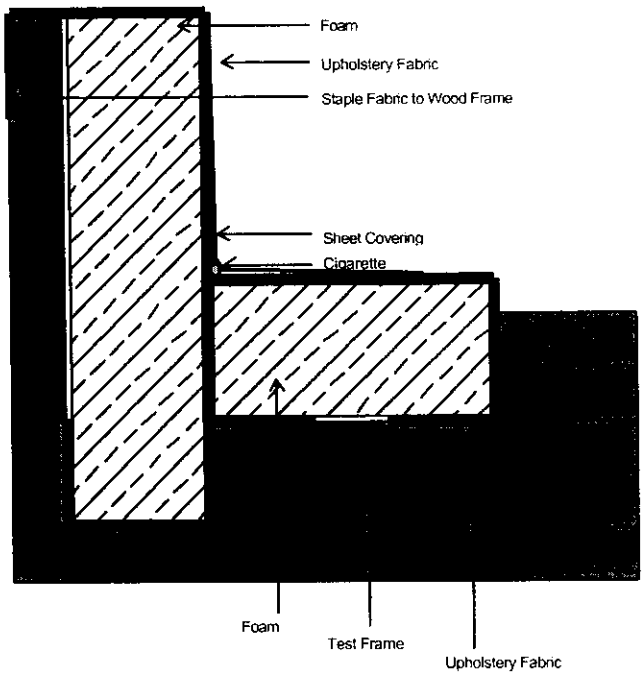

Foam
Upholstery Fabric
Staple Fabric to Wood Frame
Sheet Covering
Cigarette
Foam
Test Frame
Upholstery Fabric

Figure 2

Draft 2/2002

State of California
Department of Consumer Affairs

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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/ft^3
Indent Force Deflection (IFD) (25%) : 30 ± 5 lb.
Air Permeability: > 4.0 ft^3/min (>0.0019 m^3/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 ± 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:

% weight loss (WL) = (pre-test weight (A) – current weight (B))/ pre-test weight (A) x 100%. or

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

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 ± 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 ± 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.

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

% weight loss (WL) = (pre-test weight (A) – current weight (B))/ pre-test weight (A) x 100%, or
%WL = (A – B)/A x 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 ± 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, ungarnetted (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 ± 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 = (pre-weight (A) – (post-weight (B))/pre-weight (A)) x 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 ± 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 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 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 x 300 mm ± 5 mm (17.6 x 11.7 ± 0.2 in) x 75 ± 2 mm (3.0 ± 0.2 in) thick. The horizontal (seat) pieces shall have total dimensions of 450 x 83 ± 5 mm (17.6 x 3.25 in ± 0.2 in) x 75 ± 2 mm (3.0 ± 0.2 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:

% weight loss (WL) = (pre-test weight (A) – current weight (B))/ pre-test weight (A) x 100%. or

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

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 ± 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 ± ¼ in) by 178 ± 6 mm (7 ± ¼ 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 ± 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 = post-test weight (B)/pre-test weight (A) x 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 ± 0.004 in) outside diameter, 6.5 ± 0.1 mm (0.256 ± 0.004 in) internal diameter and 200 ± 5 mm (8 ± 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 ± 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)

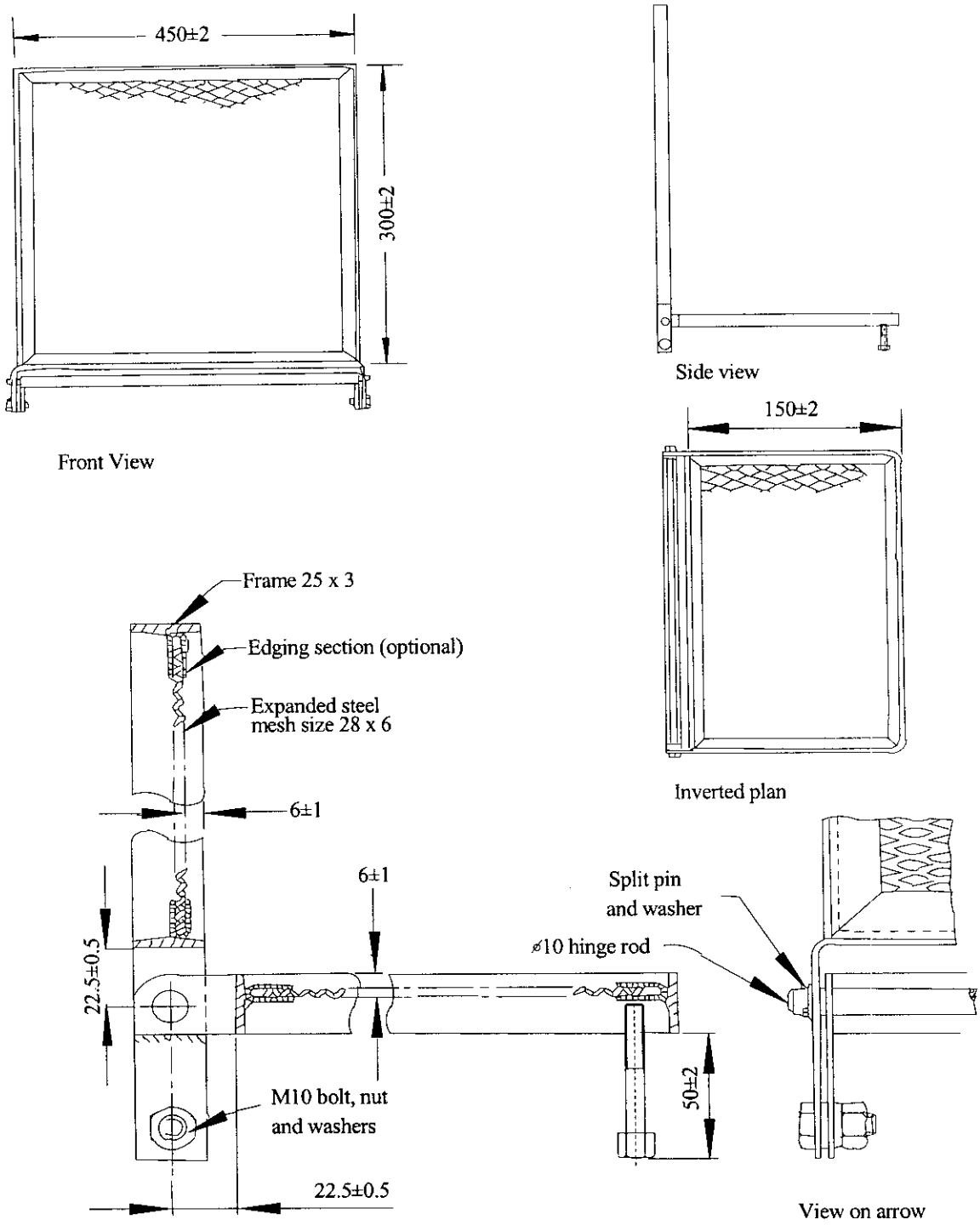
The metal test frame shall consist of two rectangular metal frames (either aluminum, for lower weight, or steel is permissible), hinged together and capable of being locked at right angles to each other (as illustrated in Fig. 5 in BS 5852:1990). The frames shall be made of 25 mm x 25 mm (1 in x 1 in) 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)

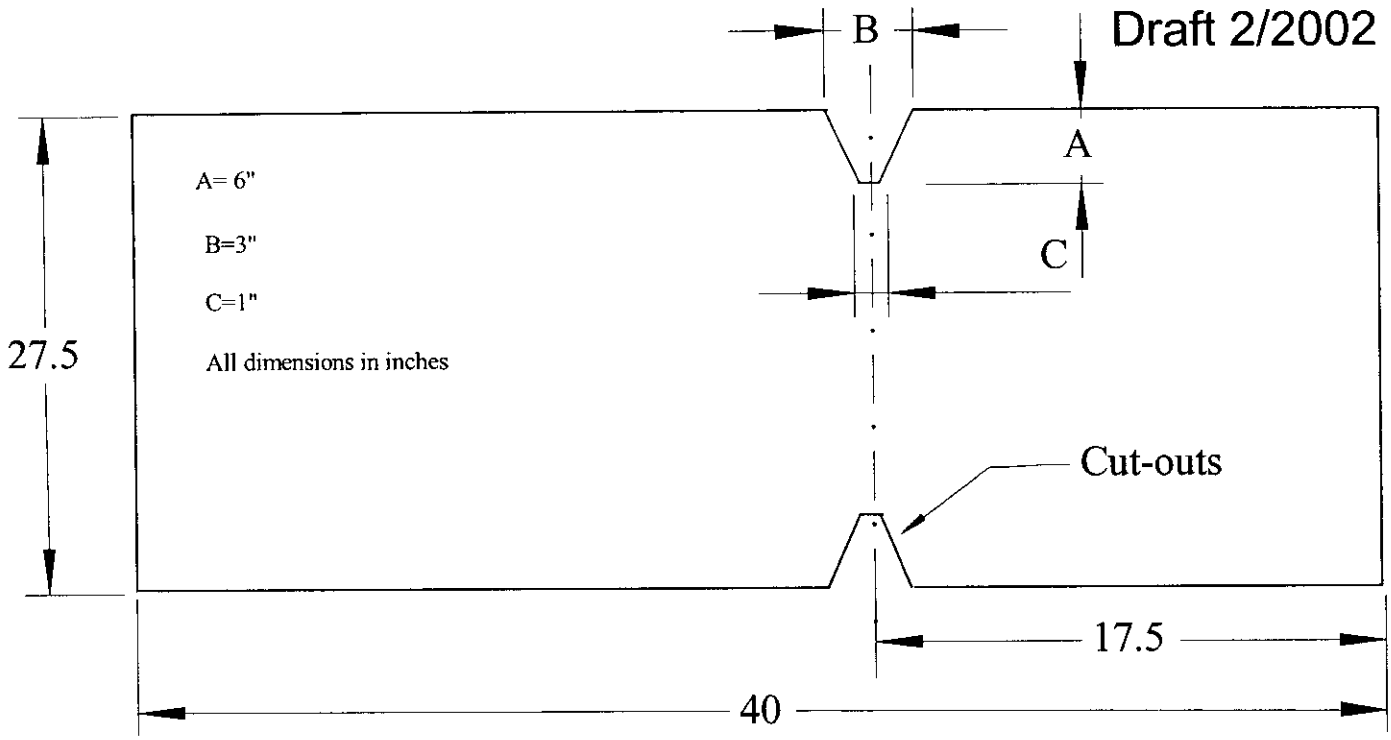


Figure A-2. Fabric cut-out for mock-up tests

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 m^3 (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.

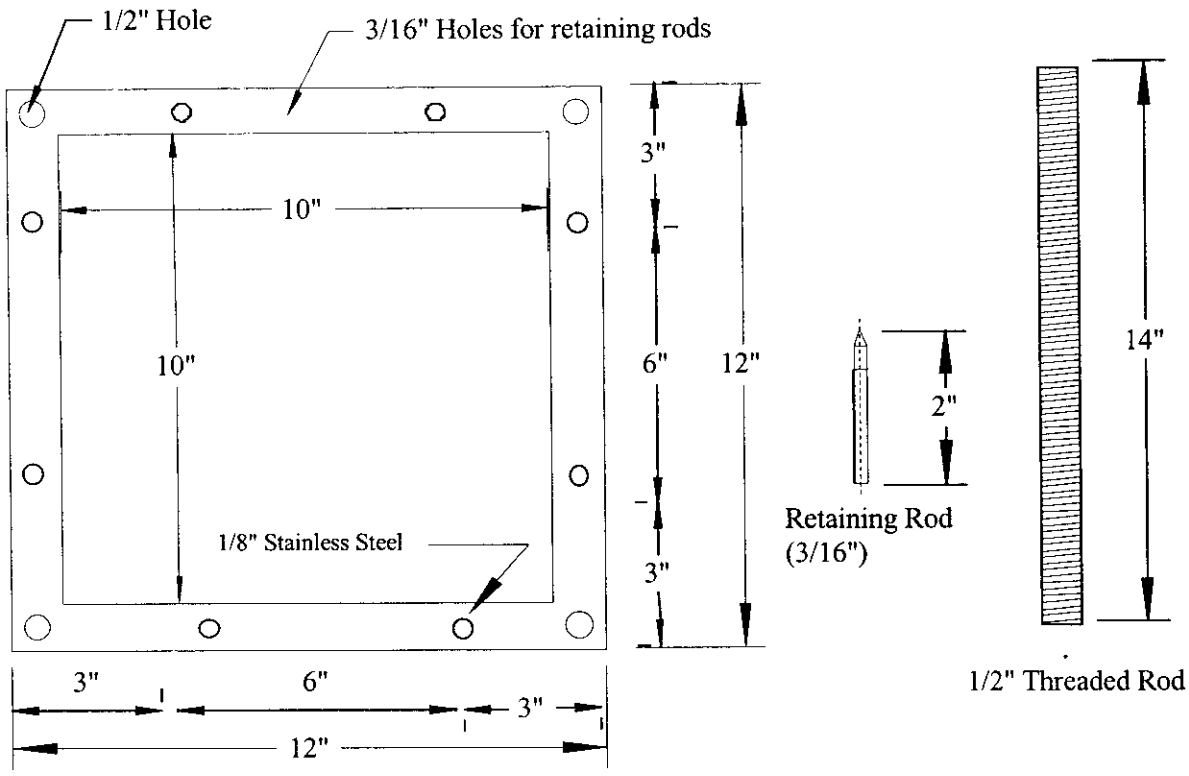
ANNEX C

Horizontal Test Apparatus for Fiber Battings and Loose-Fill Materials

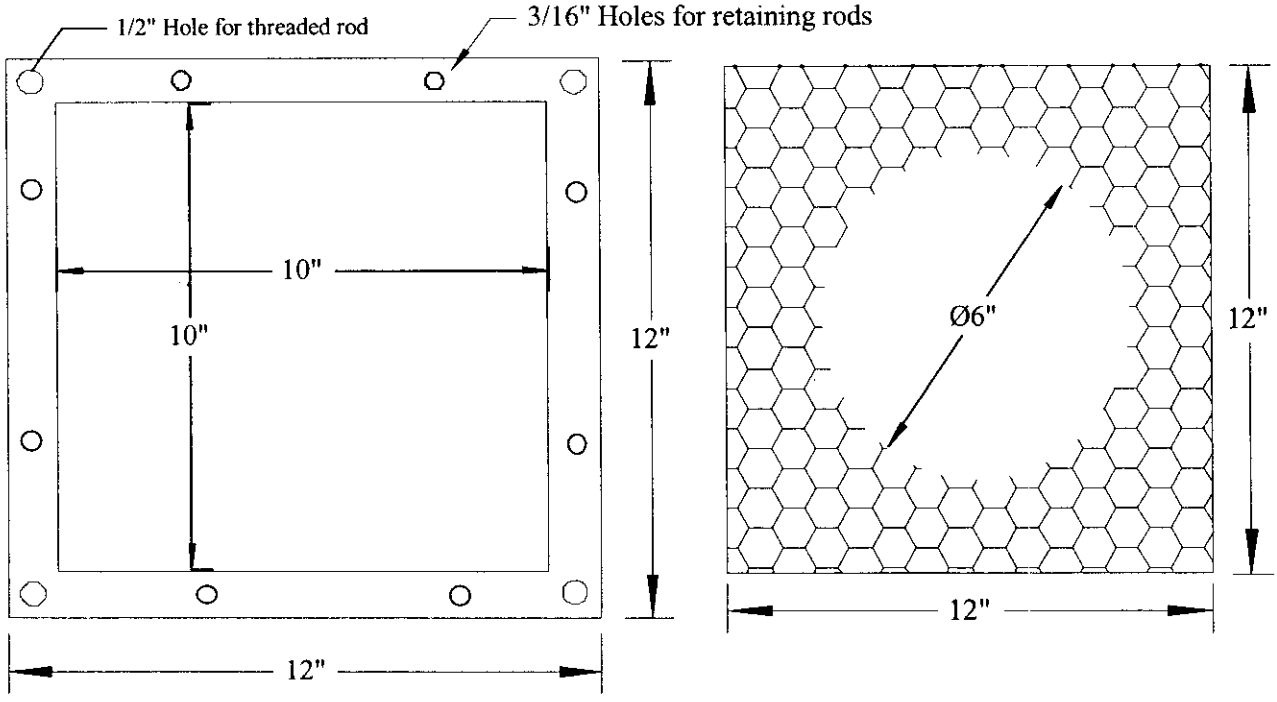
A test rack constructed, as in Figures C-1 to C-4, shall be used to support the sample for testing. This rack shall be used for both the fiber (batting or pad) component flame test (Section 2) and the loose filling cushion test (Section 4). The rack shall be constructed with a 356 x 356 mm (14 x 14 in) 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.



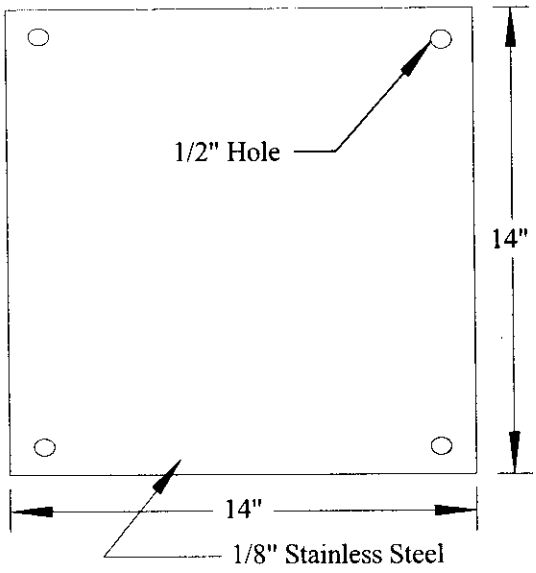
Lower Plate



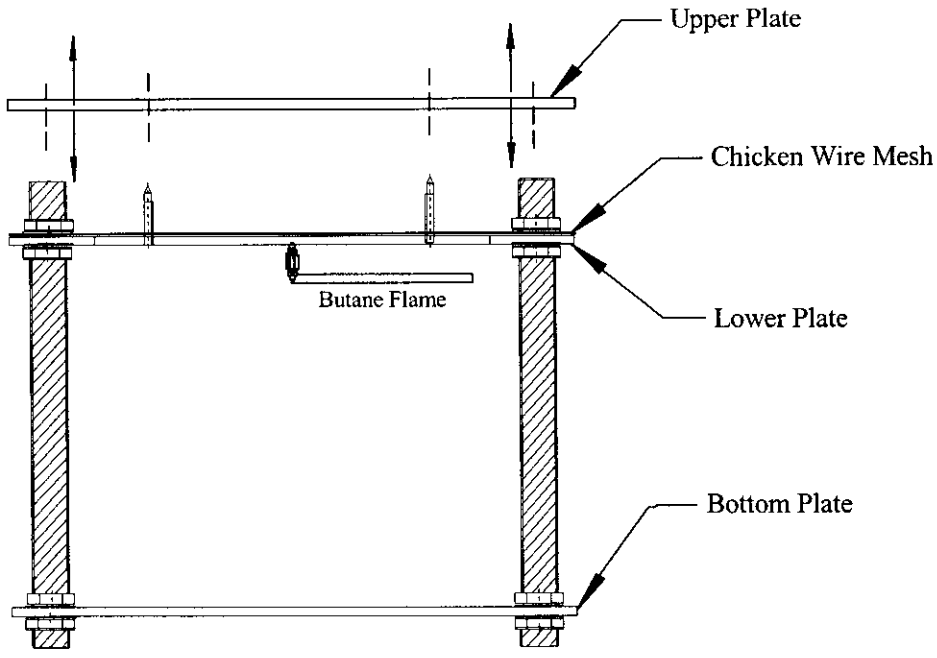
Upper Retaining Plate

Chicken wire mesh with a 6" hole in the middle

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

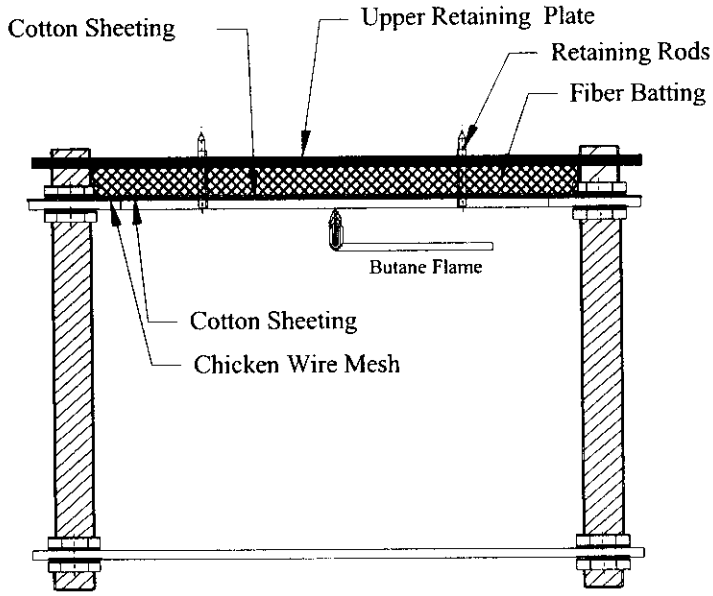


Figure C-3. Side view of horizontal fiber batting test apparatus assembly with cotton sheeting and fiber batting in place

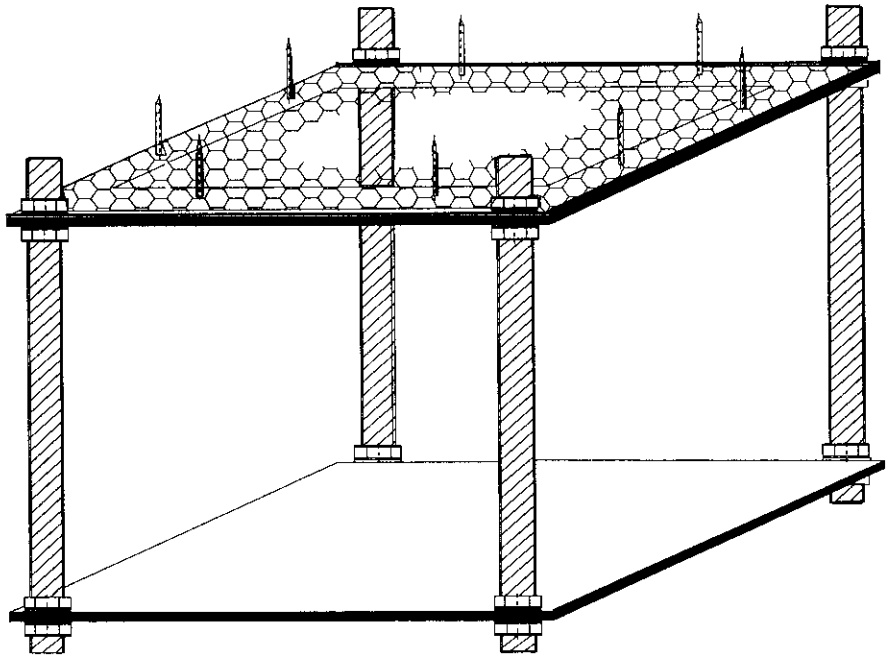


Figure C4. 3-D View of Horizontal fiber batting test apparatus (Upper retainig plate not shown)

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.

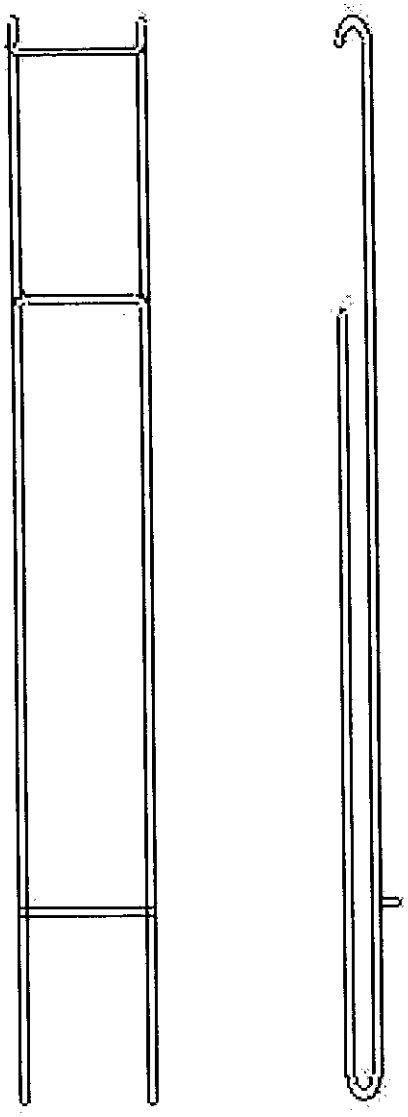


Figure D-1. Specimen holder for the vertical flame test of cellular foam

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/cm^3 (0.75 ± 0.06 lb/in^3) 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/m^2 (3.7 ± 0.8 oz/yd^2). 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.

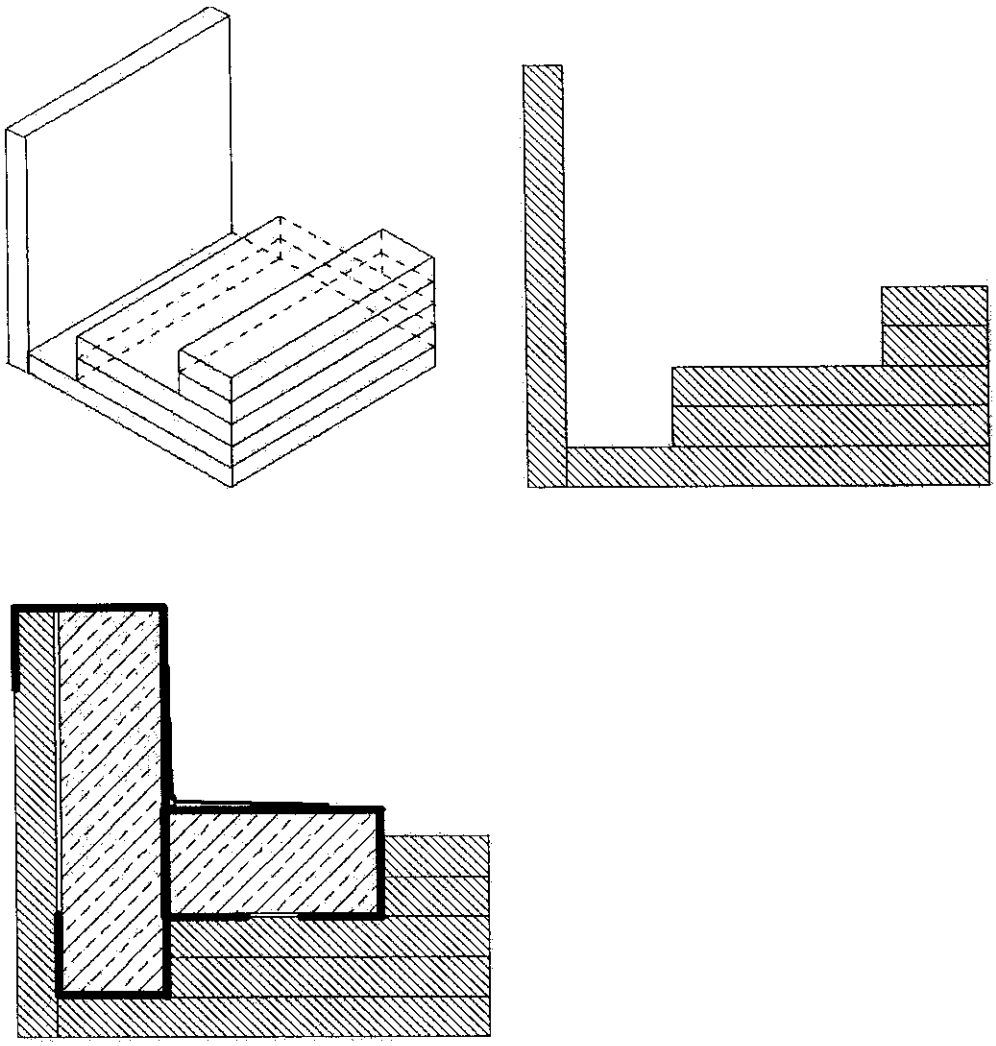


Figure E-1. Three views of the wooden stand for Smolder Resistance test of Resilient Cellular (Foam)

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.

Stevenson, Todd A.

Upholstered Furniture Comment 14

From: Ray, Dale R.
Sent: Monday, January 26, 2004 9:45 AM
To: Stevenson, Todd A.
Cc: Elder, Jacqueline
Subject: FW: API Input on ANPR

API ILS Abstract & Summary.pdf...

Todd - Please log this e-mail submission from the Alliance for the Polyurethanes Industry (API) as a comment in response to the upholstered furniture ANPR.
--Dale Ray

-----Original Message-----
From: Richard_Mericle@plastics.org [mailto:Richard_Mericle@plastics.org]
Sent: Friday, January 23, 2004 10:10 AM
To: Ray, Dale R.
Cc: athompson@foamex.com; agrand@grandcreative.com; beat.niederoest@eddy.foamex.com; christopher_cleet@plastics.org; Donna_L_klaich@huntsman.com; Doug.Kubalak@bayerpolymers.com; bredese@basf.com; Herman.H.Forsten@usa.dupont.com; jerry.cummings@carpenter.com; reimank@basf.com; lknudtson@futurefoam.com; mmehrafza@opl.com; john_mccormack@dca.ca.gov; mwallace@cottoninc.com; neil@ullman.net; claude-randall.ramey-sr@usa.dupont.com; Robert_J_Lockwood@huntsman.com; said_nurbakhsh@dca.ca.gov; salromo@opl.com; richard.skorpenske@bayerpolymers.com; steve.sanderson@ncfi.net; dsullivan@hickorysprings.com; terry.thiem@carpenter.com; vmartin@cottoninc.com; batsonr@afma4u.org; loupeters@pfa.org; psparber@aol.com; Mary_Bernhard@americanchemistry.com; Peter_McHugh@americanchemistry.com
Subject: API Input on ANPR

Dale:

Thank you for allowing API to provide the attached Review and Analysis of the Inter-Laboratory Study (ILS) we conducted over the past many months as comment on the CPSC ANPR on upholstered furniture flammability. We recognize that this input is somewhat tardy but is intended as a confirmation of the PowerPoint presentation made to your Commission at the public meeting in Bethsda on December 12, 2003.

We are in the process of completing a detailed full report on this mass loss test protocol for determining the combustibility characteristics of upholstered furniture composite constructions. The full report will require stringent internal legal review before publication and, thus, not be available before the end of February. If you are interested, we will certainly be happy to forward the full report to you at a later date - please advise.

Richard E Mericle II, Executive Director
Alliance for the Polyurethanes Industry
703-741-5652
703-741-5655 (FAX)

Please plan to attend Polyurethanes Conference 2004
October 18-20, Paris Las Vegas Hotel, Las Vegas, NV

(See attached file: API ILS Abstract & Summary.pdf)

Review and Analysis of the Inter-Laboratory Study (ILS) on Upholstered Furniture Composite Mock-Ups

Report Prepared For
Alliance for the Polyurethanes Industry (API)
1300 Wilson Boulevard
Arlington, VA 22209
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January 2004

ACC Contract Nos. 53/2224 and 37/1908

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ABSTRACT

An Inter-laboratory Study (ILS) was conducted on a small open flame furniture test method, using seven different material combinations and twelve laboratories. The objective of conducting the ILS was to develop a statistical assessment of the test protocol, including repeatability and reproducibility. In addition, comparisons were made of the laboratory-scale results to those from large- and full-scale testing on four of the composites.

The test protocol, based on the British Standard BS 5852 with the "source 1" igniter, involved the testing of laboratory mock-ups that included actual upholstery fabrics and foams, with batting and/or interliner as appropriate. The igniter flame, about the size of a match, candle or butane lighter, was applied for 20 seconds. The progress of the resultant ignition, if any, and continued fire involvement of the specimen was monitored by the mass of the test rig. Mass loss over time was the primary measurement, with mass loss rate and time to a particular mass loss designated as the "test results." Mass loss rate (MLR) of any given material is proportional to heat release rate (HRR), as described in the full report, in accordance with the relationship MLR*Hc = HRR, where Hc is effective heat of combustion. Heat release rate is often used for estimations of potential fire hazard (e.g., see references in the report to the books by Krasny, et al., and Babrauskas and Grayson, the CBUF study and the CFAST and HAZARD 1 computer models).

The U. S. Consumer Product Safety Commission (CPSC) and the California Bureau of Home Furnishings and Thermal Insulation (CBHFTI) have both expressed interest in a small open flame (SOF) test method for upholstered furniture composites. This ILS was designed, in part, to provide a statistical assessment of the laboratory protocol for use by these regulatory entities.

The seven composite specimens included three types of polyurethane foams, three fabrics (including a fire-retardant treated fabric), two polyester battings, and an interliner, in various combinations. Statistical analyses were developed for the average mass loss rate over the increment from 20 to 40 g mass loss (designated $MLR_{20/40}$), and the time to a mass loss of 10 g (designated t_{10}).

Some of the conclusions developed from the results of this study are as follows:

1) All labs successfully completed the evaluation of the composite specimens in accordance with the test protocol, and submitted results in the manner requested.
2) The within-laboratory "repeatability" of the results and the inter-laboratory "reproducibility" were computed.
3) The coefficients of variation (CV) for repeatability for the $MLR_{20/40}$ values ranged from six percent to 22 percent of the average mass loss rates. The CVs for the t_{10} values ranged from four percent to ten percent.

4) The CV's for reproducibility ranged from eight percent to 44 percent.
5) One composition neither ignited nor lost any mass in any of the tests conducted. Although this could not be dealt with in the statistical treatment (because there was "no result"), this clearly represented a composition that would not ignite under these test conditions. The other end of the range of compositions was represented by specimens that ignited and burned readily.
6) Large scale results (full-size cushion mock-ups) on four of the compositions were quantitatively comparable to the laboratory scale results using the calculation of $MLR_{20/40}$.
7) Full scale results (upholstered chairs), on the same four compositions, were qualitatively similar to the laboratory scale (i.e., producing the same rank order) by comparison of HRR-time patterns to MLR results.
8) The quantitative measurement of mass loss and subsequent calculation of mass loss rate, which were accomplished without substantial problems and within reasonable levels of consistency, have the potential for use in a regulatory specification.

A series of recommendations are proposed by the authors to address future improvements in the test protocol. Based on the seven composite constructions evaluated in this study, suggestions are also made for possible future testing in the event this protocol is pursued as a regulatory specification.

PROJECT SUMMARY

This report includes the results of an Inter-laboratory Study (ILS) on a small open flame furniture test method and comparison of the "small scale" test results to large- and full-scale testing of identical composite specimens. All of these experiments were conducted independently by the laboratories, but were organized and facilitated by the Alliance for the Polyurethane Industry (API). The test protocol, based on the British Standard BS 5852 with the "source 1" igniter, involved the testing of laboratory furniture composite mock-ups that included actual upholstery fabrics and foams, with batting and interliner as appropriate. The igniter flame, about the size of a match, candle or butane lighter, was applied for 20 seconds. The progress of the resultant ignition, if any, and continued fire involvement of the specimen was monitored by the weight (mass) of the test rig.

Mass loss of the specimen was the primary measurement, with mass loss rate and time to a particular mass loss designated as the "test results." Mass loss rate (MLR) is proportional to heat release rate (HRR), as described in the full report, in accordance with the relationship MLR*Hc = HRR, where Hc is effective heat of combustion (although Hc would not be expected to be constant over the entire duration of the burning of a composite product, it does not change the fact that MLR and HRR are related). Heat release rate is often used for estimations of potential fire hazard (e.g., see references in the report to the books by Krasny, et al., and Babrauskas and Grayson; the CBUF study and the CFAST and HAZARD 1 computer models).

The U. S. Consumer Product Safety Commission (CPSC) and the California Bureau of Home Furnishings and Thermal Insulation (CBHFTI) have both expressed interest in a small open flame (SOF) test method for upholstered furniture composites. No such method currently exists in any North American standard; whereas standards exist for open flame exposure of certain furniture components, for smoldering cigarette ignition of mock-up composites and for larger open flame exposure of full-size furniture items. The intent of exposing a laboratory furniture mock-up to a small open flame is to evaluate the resistance of the composite to ignition and spread of flame, rather than to estimate the performance of the composite based on the testing of one or more components. The development of such a test method recognizes the complex nature of the burning of composite specimens, whether on a laboratory- or larger-scale test specimen.

The ILS was conducted with twelve laboratories on seven composite specimens. Each specimen contained an upholstery fabric and a flexible polyurethane foam; four composites included polyester batting, two of those contained an interliner (FR barrier) as well. The fire performance of the specimens ranged from one that did not ignite in any of the tests to ones that ignited and spread flame rapidly. An attempt was made to include composites that would "test" the ability of the protocol to differentiate among fire performance characteristics of various types of furniture composites.

The primary objectives of the complete study (ILS and larger scale testing) included the development of a statistical assessment (repeatability and reproducibility) of the laboratory protocol and assessment of the potential of such a test method to be suitable for regulatory use. The comparison of the laboratory results to those produced by the "large scale" (Cal. TB 133 cushion mock-up) and "full scale" (actual furniture item) experiments should be important to those evaluating the regulatory potential.

Brief descriptions of the components of the composite specimens are presented in Table S-1 (Table 2 from the report).

Table S-1. Combinations of Components for ILS Tests

Series	Fabric[1]	Foam[2]	Batting[3]	Interliner[4]
1	"Selected" fabric	New Cal. 117	None	None
2	"Selected" fabric	New Cal. 117	Conventional	None
3	"Selected" fabric	New Cal. 117	New Cal 117	None
4	"Selected" fabric	New Cal. 117	Conventional	Commercial FR
5	"Selected" fabric	BS 5852, crib 5	None	None
6	FR back-coated	Non FR	None	None
7	Heavy polyolefin	New Cal. 117	Conventional	Commercial FR

Notes (more detailed descriptions are in the body of the report):

1) "Selected fabric" was a 64/36 blend of rayon/polyester with no back coating, 13.8 oz./linear yd.; the "heavy polyolefin" was a 72 percent polyolefin/28 percent polyester, with a latex back coating, 20.1 oz./linear yard; the "FR back-coated" was the "selected fabric" treated to comply with BS 5852, source 1.
2) The "New Cal. 117" polyurethane foam was compliant with the Feb. 2002 draft revision of the Cal. 117 standard; the "BS 5852, crib 5" polyurethane foam was compliant with the specifications in the crib 5 procedure in BS 5852. All foams were 1.7-1.8 pcf density with 25 % ILD between 27 and 29 lbs.
3) "Conventional" batting was a common, commercial polyester batting; while "New Cal 117" was compliant with the Feb. 2002 draft revision of the Cal. 117 standard. These battings were 1 in. thick and 1 oz./sq. ft.
4) The "commercial FR" interliner (or barrier fabric) was "Furn 85," from Freudenberg Nonwovens.

In the laboratories, the mass of the specimen was recorded as a function of time for the duration of the test. Subsequently the "mass loss" and the "mass loss rate" were calculated for various increments. The "test results" selected for the statistical analyses reported herein were as follows: 1) the average mass loss rate (in g/s) over the increment from 20 to 40 g mass loss, designated $MLR_{20/40}$; and 2) the time (seconds) to a mass loss of 10 g, designated t_{10}.

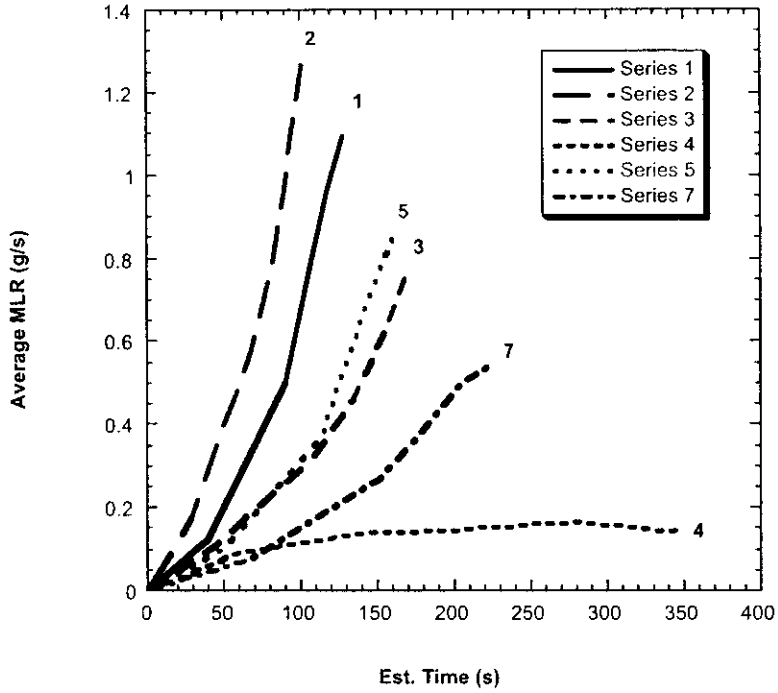

Figure S-1. Overall average small scale MLRs for all ILS labs

Figure S-1 (Fig. 4 from the report) is an illustration of the curves of mass loss rate (MLR) vs. time for the six specimens that had some mass loss during the course of the test (i.e., all except "Series 6" which did not sustain ignition and lost no mass in any of the tests conducted). The times used to develop these plots were back-calculated from the average MLR values, as described in the report.

Each specimen was tested three times in each laboratory, producing a total of 252 sets of data from the ILS. A complete statistical assessment of the results ($MLR_{20/40}$ and t_{10}) of these laboratory tests is included in the report. While it is difficult to summarize the statistical results, the following can be said about the ILS:

1) All labs successfully completed the testing of the composite specimens in accordance with the test protocol, and submitted results as requested.
2) The within-laboratory "repeatability" of the results and the inter-laboratory "reproducibility" were dependant both on the nature of the various specimens and the ability of each of the laboratories to conduct the tests.

3) The repeatability of the results of testing certain specimens was excellent, with coefficients of variation (CV) for the $MLR_{20/40}$ value on the order of 10 percent or less of the average value. Other specimens were not as good, ranging as high as 22 percent. The CV values were not proportional to the average MLRs.
4) The CV's for reproducibility of the $MLR_{20/40}$ values ranged from about 10 percent to over 40 percent. Again, the CV values were not proportional to the average MLRs.

Summaries of the average test results and of the precision statistics for $MLR_{20/40}$ and t_{10} are shown below as Tables S-2 and S-3, respectively (Tables 6 and 8 from the report). The small "r" refers to repeatability (within lab) and the capital "R" to reproducibility (between labs).

Table S-2. Summaries of precision statistics for $MLR_{20/40}$ (all values in g/s, except CV which is percent)

Series	Avg. MLR	s_r	s_R	r	R	CV_r	CV_R
1	0.86	0.07	0.09	0.18	0.25	7.7	10.2
2	0.90	0.11	0.19	0.32	0.53	12.6	21.1
3	0.52	0.10	0.23	0.28	0.65	19.4	44.7
4	0.16	0.01	0.03	0.03	0.09	6.3	19.6
5	0.64	0.14	0.20	0.40	0.56	22.3	30.8
7	0.44	0.05	0.08	0.13	0.22	10.4	18.2

Table S-3. Summaries of precision statistics for t_{10} (all values in s, except CV which is percent)

Series	Avg. t_{10}	s_r	s_R	r	R	CV_r	CV_R
1	83.4	5.7	9.0	15.9	25.2	6.8	10.8
2	63.0	6.3	13.6	17.8	38.1	10.1	21.6
3	96.1	5.8	13.1	16.1	36.7	6.0	13.6
4	114.9	5.6	8.9	15.8	25.1	4.9	7.8
5	105.3	8.1	16.3	22.6	45.6	7.6	15.5
7	135.1	5.8	12.1	16.1	34.0	4.3	9.0

Abbreviations used in these tables are as follows:

s_r and s_R – standard deviation for repeatability and for reproducibility, respectively;
r and R – repeatablility and reproducibility "intervals," respectively; and
CV_r and CV_R – coefficients of variation (expressed as a percentage) for repeatability and for reproducibility, respectively.

Graphical representation of the more important of these statistics (s_r and s_R) for $MLR_{20/40}$ and for t_{10}, respectively, are shown in Figures S-2 and S-3 (Figures 5 and 6 from the text).

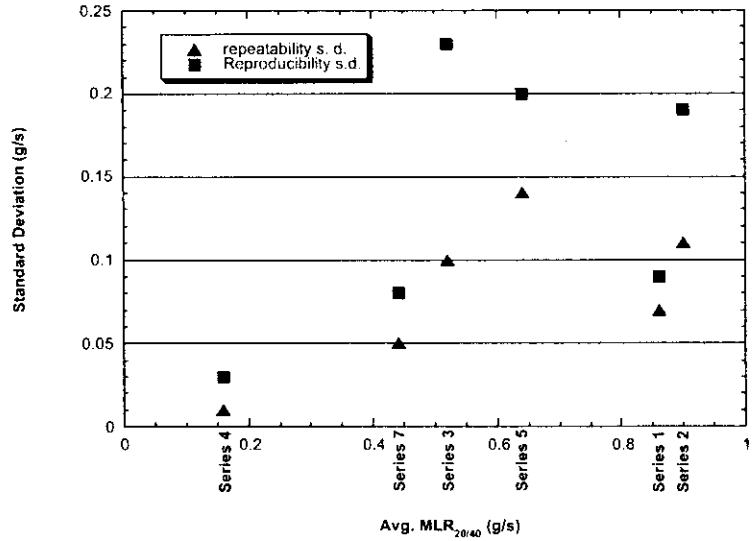

Figure S-2. Repeatability and reproducibility standard deviations as a function of average $MLR_{20/40}$.

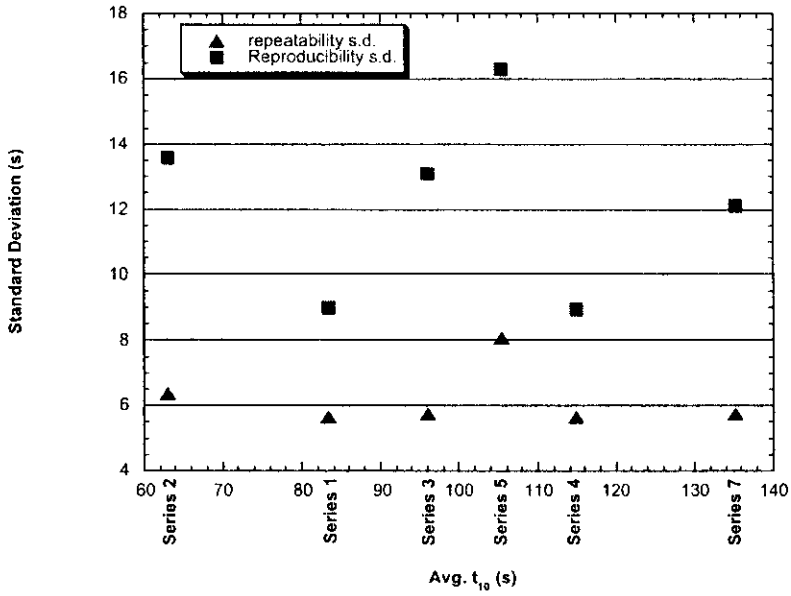

Figure S-3. Repeatability and reproducibility standard deviations as a function of average level of t_{10}.

The statistical treatments performed on other fire tests (e.g., ASTM E1354, the "cone calorimeter"; ASTM E1537, same as CA TB 133; and ASTM E1352, a smoldering cigarette test) were each performed "differently" from the way in which the statistical analysis was performed for this ILS (which involved more laboratories, generally more specimens, with a more detailed analysis of the results). Also, the "results" of one fire test are generally not directly comparable to the results of another fire test because of the complex character of ignition and flame spread. On the other hand, when fire scientists discuss the results of fire experiments, a difference of ±10 percent between two specimens is generally considered to be not out of the ordinary. Much higher variations than this have been reported for accepted fire tests. Thus, the variability of the measurements in this ILS are within the general range anticipated for a fire test method.

Seven composite specimens were evaluated in accordance with this test method. One of the compositions ("Series 6," with the FR treatment of the fabric) did not ignite or burn and therefore lost no mass. Although all laboratories, in triplicate experiments, obtained the same "result" (i.e., zero mass loss), there was no result from a statistical point of view. Therefore, the data from this specimen have not been included in any calculations.

The composition with the lowest measured average mass loss rate was Series 4, which included an interliner (FR barrier) between the fabric and the batting/foam. As shown in Table S-2, this composition produced an average $MLR_{20/40}$ of 0.16 g/s. This measurement may be expressed as a "95 percent confidence interval" (±2 standard deviations) as follows: 0.16±0.02 g/s. This is excellent repeatability for a fire test method. For this composite, even the reproducibility was reasonably good ($2*s_R = 0.06$ g/s).

The other specimens, other than Series 6 and Series 4, all ignited and burned. Some of them burned rapidly and others more slowly. These ILS MLR results, within the 95 percent confidence interval, do not permit statistically-significant differentiation of the five composites from one another (see Figure S-4, Figure 15 from the report). While the apparent "rank order" of the average $MLR_{20/40}$ values is complemented by the results of the large- and full-scale results to be discussed, any regulatory requirement should take into account the variability in results that could be achieved by different laboratories.

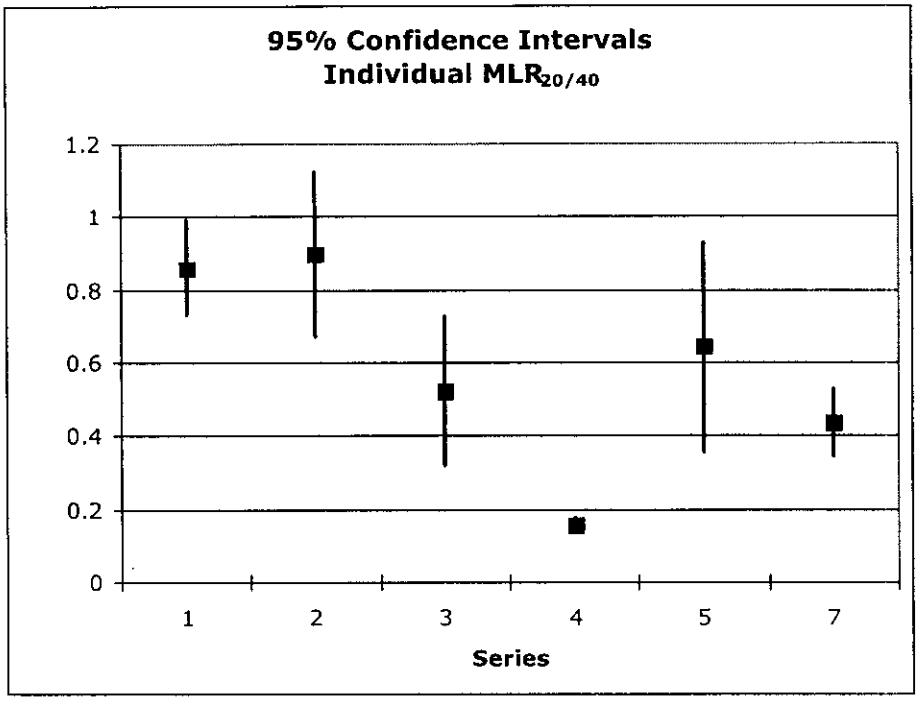

Figure S-4. Average $MLR_{20/40}$ values for each Series, with ± 2 s_r

Large scale (LS) and full scale (FS) fire tests were also conducted during the course of this program, for comparison to the ILS small scale (SS) tests. The LS specimen configuration consisted of Cal TB 133-size cushions positioned in that test's mock-up frame. The FS configuration consisted of full size upholstered lounge-style chairs (photographs of each of these are in the report). In both cases, the components used were the same as for the same "series" in the ILS and the ignition burner and application time were the same as for the ILS. The four compositions selected for the comparison testing were as follows:

Series 2 – Fabric, conventional batting, foam
Series 3 – Fabric, new Cal 117 batting, foam
Series 4 – Fabric, interliner, conventional batting, foam
Series 7 – Heavy polyolefin fabric, interliner, conventional batting, foam

Comparisons of the results among the SS, LS and FS tests were accomplished in two ways. Mass measurements were obtained from the LS tests for comparison to the SS results, and are shown in Figure S-5 (Fig. 12 from the report). In addition, heat release rate (HRR) results from both the LS and FS tests were obtained for comparison to one another and to aid in an estimation of "rank order" of these specimens with respect to fire performance and potential fire hazard. These HRR plots are shown in Figures S-6 and S-7 (Figs. 13 and 14, respectively, from the report).

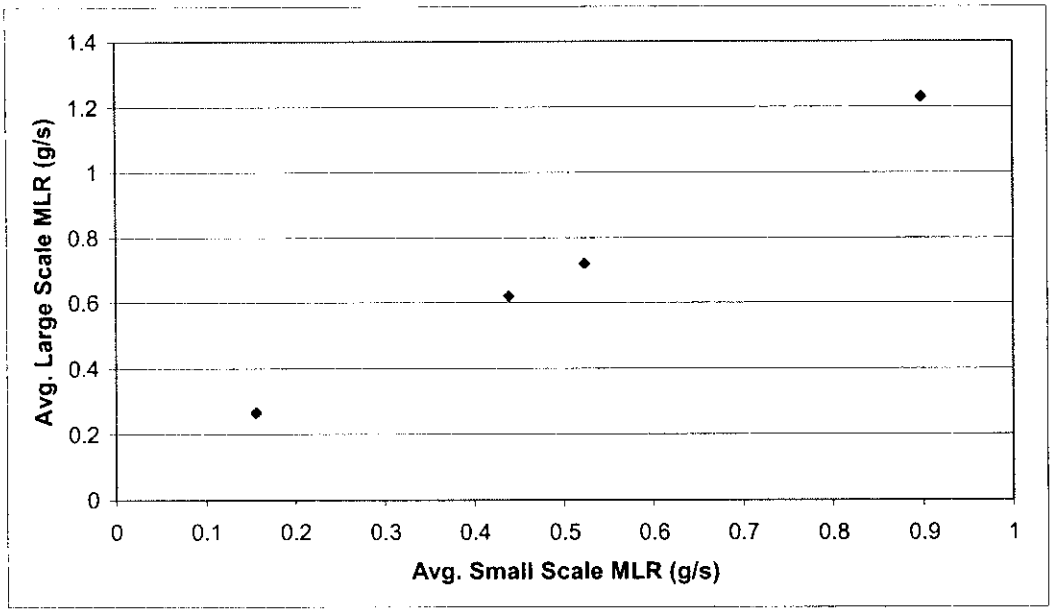

Figure S-5. Average large scale $MLR_{20/40}$ results vs. average small scale $MLR_{20/40}$ results

The results shown in Fig. S-5 represent a correlation of these particular MLR results between the average SS and the average LS tests. Although this should not be interpreted as a general correlation of the results of different size specimens, the relationship is encouraging with respect to the development of a legitimate comparison of the small scale protocol with larger scale fire behavior.

The HRR-time plots (Figs. S-6 and S-7) contain results of certain large scale (LS) and full scale (FS) experiments. The plots were selected to be typical of those available in an effort to represent the results of the study (HRR plots for all LS and FS test runs are contained in Appendix C).

Interpretation of the HRR results relies on the following presumptions regarding HRR-time relationships: lower HRR (especially at the peak) and longer time to reach any given HRR (or the peak HRR) generally correspond to better fire performance and a lower fire hazard. When both time and HRR are relatively higher or lower for a given composition, the case is even stronger, within the limits of repeatability of the test. HRR and time to reach some given HRR are analogous to the laboratory scale calculations of $MLR_{20/40}$ and t_{10}.

It is apparent from the large scale HRR results in Fig. S-6 (which are supported by a non-statistical estimation of variability of these results as discussed in the report) that the "ranking" of the four materials evaluated in large scale tests is as follows: from poorer fire performance to better, Series 2, Series 3, Series 7 and Series 4 (which clearly had the best results of these four compositions).

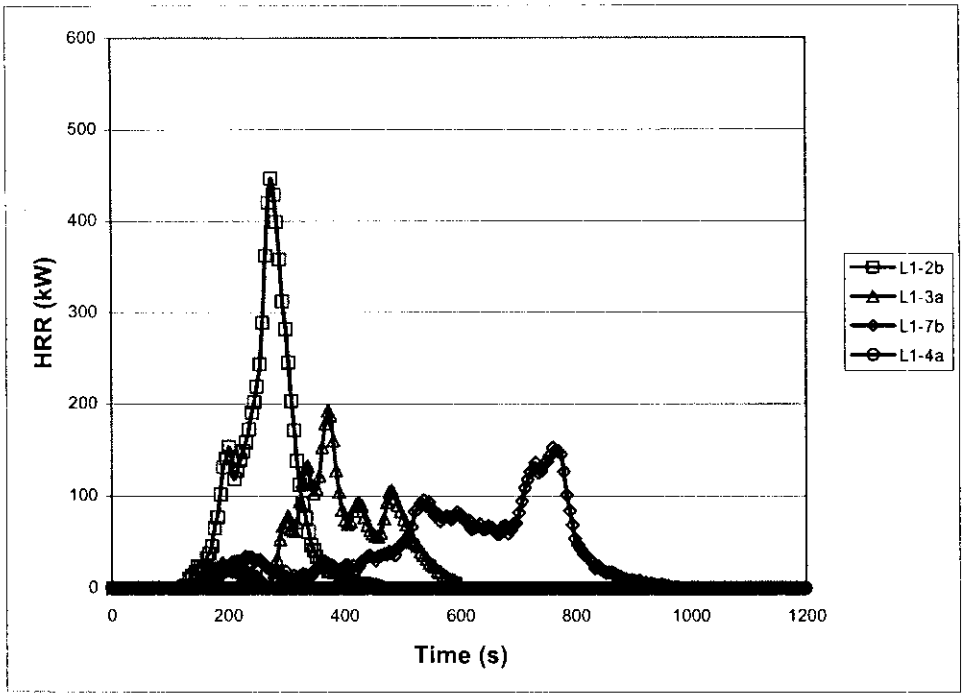

Figure S-6. Selected plots of large scale test HRR results on different constructions (Series 2, 3, 4 and 7)

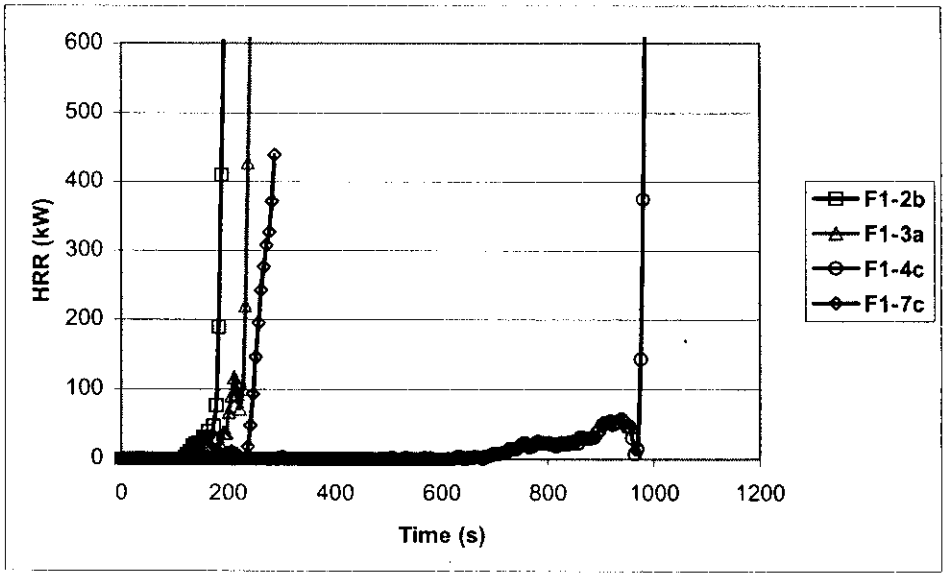

Figure S-7. Selected plots of full scale test HRR results on different constructions (Series 2, 3, 4 and 7)

The mass loss readings in the early part of the full scale (FS) tests were considered to be less reliable than those for the SS or LS experiments, due to differences in the load cells for the heavier furniture specimens. Therefore, only the HRR curves were used for comparison of the FS tests to the LS tests.

As illustrated in Figure S-7, all four of the specimens tested in the full scale (upholstered chair) tests eventually burned and approached or reached the equivalent of flashover in a "standard" fire test room (i.e., 1000 kW in a room 10 ft. x 12 ft. x 8 ft. high). While this result was not a surprise for three of the compositions, the results of the "Series 4" specimens were not anticipated. As discussed in the report, possible differences in the final integrity of the interliner (barrier fabric) may have caused the Series 4 specimens to eventually progress to full burning. In any event, the difference between the range of times to a major increase in HRR for Series 2, 3 and 7 (Figure S-7) and that for the Series 4 tests is substantial. The three compositions began to burn vigorously at approximately 150 to 250 s (around 4 minutes or less); while the Series 4 specimens did not start burning rapidly until about 900 to over 1000 s (15 minutes or more). This substantial increase in potential "time to escape" for the Series 4 compositions reinforces the results of the laboratory and large scale tests – that this composition was substantially different from the others.

CONCLUSIONS AND RECOMMENDATIONS

The conclusions derived from this study may be summarized as follows:

1. The ILS on a small open flame (SOF) exposure of upholstered furniture mock-ups was completed successfully. Thus, twelve, very different laboratories were able to conduct the test procedure and to derive comparable results from the testing.
2. The statistical evaluation of the ILS results was more detailed and more in keeping with the precepts of ASTM E691 than probably any other fire test previously examined. The results of the statistical assessment ran the range from excellent "repeatability" (within laboratory) for some of the compositions to a lower order of repeatability for some of the other compositions (e.g., they ranged from a coefficient of variation of less than 10 percent of the average value to greater than 20 percent).
3. The reproducibility (between laboratories) encompassed a wide range (from less than 10 percent of the average value to more than 40 percent for one composition). Assessments of these variations and some rationale for the poorer reproducibility results were presented.
4. A major finding from the statistical assessment was that the Series 4 composite (with the "selected" fabric, an interliner, batting and foam), which ignited and burned at a slow rate, had a lower average mass loss rate ($MLR_{20/40}$) than the five other compositions that ignited, even taking into account the range in the average MLR values at the 95 percent confidence level.
5. One composition ("Series 6," which contained an FR-treated fabric) neither ignited nor lost any mass under this test protocol in any of the labs in triplicate tests. Although not dealt with in the statistical assessment (because there was "no result"),

this composition represented an obviously good outcome for this test protocol. Thus, nearly the full range of possible results was demonstrated by these ILS tests, from a specimen that would not ignite to specimens that ignited and burned rapidly.

6. Based on the results presented in this report, component testing alone may not be suitable for predicting the fire performance of composite products. This statement is supported by the following observations: a) the use of a BS 5852 crib 5-compliant foam (Series 5) in place of a California T. B. 117 foam (Series 1) did not substantially improve the fire performance of the composite specimen; b) ignition of a heavy fabric was sufficient to cause an interliner to eventually break through (Series 7 in the LS and FS tests); and c) the fire performance characteristics of the fabrics were of critical importance to the fire performance of the composite specimens in this test protocol (based on observations of all specimens).
7. The recording of mass loss and subsequent calculation of mass loss rate, which were accomplished without major problems and with some level of consistency, have the potential for use in a regulatory specification.
8. Large scale (California T. B. 133-size cushions in a mock-up) and full scale (actual upholstered furniture) specimens were tested, using the same ignition source as for the ILS. The large scale results were quantitatively comparable to the laboratory scale measurements, using the calculation of $MLR_{20/40}$; and the full scale results were qualitatively similar, using comparison of HRR, to the rank order of lab- and large-scale results. It is recommended that additional tests be performed to supplement those conducted in this program.
9. Mass loss rate is an accurately measured parameter that is relevant to fire hazard assessment of burning furniture items. The relative errors in the results, both in the laboratory scale and in larger scale experiments, must be taken into account if this method is considered for regulatory action.

Recommendations were developed by the authors for changes in the test protocol, based on the results obtained during the ILS; and for additional tests that could be conducted to supplement those described in this report. These recommendations are offered to help improve the scientific validity of the test and, possibly, to also improve the repeatability and reproducibility of the method. A brief list of these recommendations is shown below:

Recommendations for improvements in the test protocol include the following areas:

1. Installation of batting
2. Identification of components
3. Limitation on airflow near the specimen
4. Specifications for the end of a test
5. Decision on rounding of values
6. Establishment of the "initial mass"
7. Clarification of the start time

More consistent attention to these operational points should reduce the level of variation among future test results.

Recommendations for additional laboratory experiments include the following:

1. Additional specimens with moderate to low mass loss rates
2. Differentiation among specimens with moderate to high mass loss rates
3. Tests including batting
4. Calibration techniques or use of a "standard" specimen
5. Evaluation of a variety of different fabrics
6. Further large scale or full scale tests

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March 8, 2004

The Honorable Hal Stratton, Chairman
U. S. Consumer Product Safety Commission
4330 East-West Highway
Bethesda, MD 20814-4408

Re.: **Upholstered Furniture Flammability Proceeding**

Dear Chairman Stratton:

The Alliance for the Polyurethanes Industry (API) represents the membership listed on the left margin of this letter. These companies are the leading manufacturers of polyurethane chemicals, processing equipment, additives, formulated polyurethane systems and others with a stake in the polyurethane industry. Although our members do not manufacturer upholstered furniture, as a major supplier of the raw materials that are used to produce the majority of the cushioning they are vitally interested in the sustainability of this industry. The furniture and bedding producers consumed approximately 1.1 billion pounds of polyurethane raw materials in 2002 (21% of the total market for polyurethanes). In addition, the polyurethane industry annually supports a total of about 57,000 jobs directly in the United States and another 206,000 jobs indirectly.

API issued a position statement on "Residential Upholstered Furniture and Mattress Fire Performance" in February 2001. Our stated objective has been and continues to be to reduce the incidence of fire deaths and injuries associated with residential upholstered furniture and mattresses. The API is concerned about deaths and injuries from fires involving residential furniture and mattresses and supports a combination of approaches to further the objective stated above. Approaches should address development of a technically sound, effective national standard for residential furniture and mattresses as well as fire safety education and product labeling.

We believe the final standard for upholstered furniture should address the following concepts:

- Test selection and design should address the actual hazard.
- The final test should be a performance-based test representative of upholstered furniture constructions in residential use.
- All residential upholstered furniture must meet the same test regardless of the materials used in construction.
- The test criteria and procedures should be practical.
- Appropriate labeling provisions should be included.

To address the concept of a practical test (i.e. performed on a small-scale mock-up in a standard laboratory fume hood) that demonstrates full-scale fire behavior, API undertook a test development and verification program. In Phase I of this undertaking we developed the mass loss test that is now followed by the verification process in Phase II reported in the attached. This undertaking has been shared with your staff over the last three years with interim reports provided to them as they considered their rule making on this topic. We now have completed this extensive work and have issued the enclosed final report on the "Inter-Laboratory Study (ILS) on Upholstered Furniture Composite Mock-Ups". The Summary of this report was presented to your staff on December 12, 2003.

We believe the conclusions and recommendations presented in the attached report can be of value to CPSC in the current rule making procedure. Summarizing some of the conclusions:

- The ILS on a small open flame (SOF) exposure of upholstered furniture mock-ups was completed successfully. Thus, twelve, very different laboratories were able to conduct the test procedure and to derive comparable results from the testing.
- The statistical evaluation of the ILS results was more detailed and in keeping with the precepts of ASTM E691. The results of the statistical assessment ran the range from excellent "repeatability" (within laboratory) for some of the compositions to a lower order of repeatability for some of the other compositions (e.g., they ranged from a coefficient of variation of less than 10 percent of the average value to greater than 20 percent).
- The reproducibility (between laboratories) encompassed a wide range (from less than 10 percent of the average value to more than 40 percent for one composition). Assessments of these variations and some rationale for the poorer reproducibility results were presented.
- Based on the results presented in this report, component testing alone may not be suitable for predicting the fire performance of composite products.
- The recording of mass loss and subsequent calculation of mass loss rate, which were accomplished without major problems and with some level of consistency, have the potential for use in a regulatory specification.
- Large scale (California T. B. 133-size cushions in a mock-up) and full-scale (actual upholstered furniture) specimens were tested, using the same ignition source as for the ILS. The large-scale results were quantitatively comparable to the laboratory scale measurements, using the calculation of Mass Loss Rate; and the full-scale results were qualitatively similar, using comparison of Heat Release Rate, to the rank order of lab- and large-scale results. It is recommended that additional tests be performed to supplement those conducted in this program.
- Mass loss rate is an accurately measured parameter that is relevant to fire hazard assessment of burning furniture items. The relative errors in the results, both in the laboratory scale and in larger scale experiments, must be taken into account if this method is considered for regulatory action.

Although API does not plan additional work at this time in the development of this mass loss test protocol, we have offered recommendations to help improve the scientific validity of the test and, possibly, the repeatability and reproducibility of the method. We will be delighted to work with the appropriate entities if called upon to further develop this protocol or to provide input on the development of other testing protocols.

We extend our thanks to you and your staff for your commitment to reaching the same objective that we have stated above and been aggressively pursuing with other stakeholders. Hopefully, the technically sound, effective national standard we all strive to achieve will be accomplished during the current calendar year.

Sincerely,

Richard E. Merickle II
Executive Director

Enclosure: Review and Analysis of the Inter-Laboratory Study (ILS) on Upholstered Furniture Composite Mock-Ups

Copies: K. A. Reimann, Chair, API Combustibility Issue Management Group
Dale R. Ray, Project Manager, Directorate for Economic Analysis, CPSC