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**Requirements, Test Procedure and Apparatus for Testing the
Smolder Resistance of Materials Used in Upholstered Furniture**

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REQUIREMENTS, TEST PROCEDURE AND APPARATUS FOR TESTING THE SMOLDER RESISTANCE OF MATERIALS USED IN UPHOLSTERED FURNITURE

INTRODUCTION

The intent of this standard is to produce upholstered furniture which is safer from the hazards associated with smoldering ignition. This standard provides methods for smolder resistance of cover fabrics, barrier materials and resilient filling materials for use in upholstered furniture.

1. SCOPE

- 1.1 This is a fire-test-response standard.
- 1.2 These test methods are designed for the assessment of the resistance of upholstered furniture component assemblies to combustion after exposure to smoldering cigarettes under specified conditions.
- 1.3 The tests apply to upholstered furniture components - cover fabrics, barrier materials and resilient filling materials.
- 1.4 The individual test methods and the materials to which they apply are as follows:
 - 1.4.1 *Cover Fabric Test* - Applies to outer cover fabrics.
 - 1.4.2 *Barrier Materials Test* - Applies to materials that are intended to serve as a barrier (interliner) between cover fabric and the resilient filling materials.
 - 1.4.3 *Resilient Filling Material Test* – Applies to resilient filling materials used in upholstered seating furniture.

2. REFERENCED DOCUMENTS

- 2.1 ASTM E1353-08a: Standard Test Method for Cigarette Ignition Resistance of Components of Upholstered Furniture (Addendum 1)
- 2.2 Federal Specification CCC-C-436-E, Cloth, Ticking Twill, Cotton; Type I.

3. TERMINOLOGY

- 3.1 *Obvious ignition* - pronounced continuous and self-sustaining combustion of the test system accompanied by rapid generation of heat and smoke. It is a matter of operator judgment based upon experience in this type of operation.
- 3.2 *Upholstery cover material* - the outermost layer of fabric or related material used to enclose the main support system or upholstery materials, or both, used in the furniture item.
- 3.3 *Barrier (interliner) material* - a layer of material (film, fabric, batting or pad) that lies under the cover fabric in order to reduce smoldering propensity of the seating furniture.
- 3.4 *Resilient filling material* - the resilient filling material in the form of batting, pads or loose fills used or intended to be used in an article of upholstered furniture.

4. SUMMARY OF TEST METHOD

These test methods consist of three tests used to evaluate the cigarette ignition resistance of upholstery cover fabrics, barrier (interliner) materials and resilient filling materials used in the manufacture of upholstered furniture. Each test involves a miniature assembly consisting of the component to be tested along with other specified materials, mounted on a plywood mock-up that resembles a small chair seat and back. The assembly is exposed to a lighted cigarette as an ignition source.

5. SIGNIFICANCE AND USE

- 5.1 These test methods are intended to estimate the performance of upholstered furniture under conditions of exposure to a smoldering cigarette. This is accomplished by testing furniture component assemblies. However, interactions between components in production furniture are not necessarily predicted by component assembly testing.
- 5.2 These test methods are not intended to measure the performance of upholstered furniture under conditions of open flame exposure and do not indicate whether the furniture will resist the propagation of flame under severe fire exposure or when tested in a manner that differs substantially from the test standard.
- 5.3 The results obtained with a material component tested in mock-up, in accordance with these test methods, do not necessarily indicate the performance of the same material component in other geometrical configurations, such as in full size furniture.

6. TEST FACILITY AND HAZARDS

The exhaust system and hazards are described in Annex A.

7. APPARATUS AND STANDARD TEST MATERIALS

The apparatus and standard test materials are specified in Annex B and C.

8. CONDITIONING

Condition test specimens and cigarettes prior to the test for a minimum of 24 hours at $21^{\circ} \pm 3^{\circ} \text{C}$ ($70^{\circ} \pm 5^{\circ} \text{F}$) and less than 55% relative humidity. 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.

SECTION 1: COVER FABRIC TEST

1.1 SCOPE

This test method measures the tendency of upholstery cover fabrics to smolder and contribute to fire propagation, when subjected to a smoldering ignition source.

For cover fabrics that pass this section, the first layer of filling materials located below the cover fabric shall also meet the test requirements of section 3 of this test method.

1.2 TEST SPECIMEN

Prepare the test specimens as specified in ASTM E1353-08a (Section 10).

1.3 TEST PROCEDURE

Follow the test procedures of ASTM E1353-08a (Section 11 – Steps 11.1 through 11.9) and the additional test procedures specified below:

- 1.3.1 Use of the draft enclosure (Fig. 3) is optional.
- 1.3.2 Place the specimen assembly directly on the fiberglass board. If testing multiple specimens simultaneously, place the individual test specimens at least 125 mm (6 inches) apart to avoid heat transfers between specimens.
- 1.3.3 After completing test procedure step 11.6, the test operators shall start timers to record testing time.
- 1.3.4 When measuring the char length in test procedure step 11. 9, the maximum char length on the cover fabric shall be measured in all directions from the cigarette to the nearest 0.1 in. (2.5 mm).

1.4 PASS/FAIL CRITERIA

A material is considered to pass or fail based on the following criteria:

1. A single mock-up test specimen fails to meet the requirements of this test procedure if any of the following criteria occurs:
 - a) The mock-up test specimen continues to smolder after the 45 minute test duration;
 - b) A char develops more than 1.8 inches (45 mm) in any direction from the cigarette on the cover fabric measured from its nearest point.
 - c) The mock-up test specimen transitions to open flaming.
2. The cover fabric passes the test if three initial mock-up specimens pass the test, i.e., the cigarettes burn their full length and the mock-ups are no longer smoldering.
3. If more than one initial specimen fails, the cover fabric fails the test.
4. If any one of the three initial specimens fails, repeat the test on additional three specimens.
5. If all three additional specimens pass the test, the cover fabric passes the test. If any one of the additional three specimens fails, the cover fabric fails the test.

SECTION 2. BARRIER MATERIALS TEST

2.1 SCOPE

This test method measures the tendency of the barrier material to smolder after exposure to smoldering cigarettes under specified conditions.

Upholstery cover fabrics that fail the cover fabric test described in Section 1 can be used in upholstered furniture if a barrier (interliner) material that passes this test method is used. When a barrier is required, the barrier material must cover all sides and top of the seating cushion(s). Exceptions: Non-reversible and non-detachable seating cushions do not require the use of the barrier material on the underside of the seating cushion.

2.2 TEST SPECIMENS

Prepare the test specimens specified in ASTM E1353-08a (Section 20).

2.2.1: Use the Standard Type II cover fabric as described in Annex B.

2.3 TEST PROCEDURE

Follow the test procedures of ASTM E1353-08a (Section 21 - Steps 21.1 through 21.9) and the additional test procedures specified below:

2.3.1: Use of the draft enclosure (Fig. 3) is optional.

2.3.2: Place the specimen directly on the fiberglass board. If testing multiple specimens simultaneously, place the individual test specimens at least 125 mm (6 inches) apart to avoid heat transfers between specimens.

2.3.3: After completing test procedure step 21.6, the test operators shall start timers to record testing time.

2.3.4: When measuring the char length in test procedure step 21.9, the maximum char length on the Standard Test Fabric II shall be measured in all directions from the cigarette to the nearest 0.1 in. (2.5 mm).

2.4 PASS/FAIL CRITERIA

A material is considered to pass or fail based on the following criteria:

1. A single mock-up test specimen fails to meet the requirements of this test procedure if any of the following criteria occurs:
 - a) The mock-up test specimen continues to smolder after the 45 minute test duration;
 - b) A char develops more than two inches (50 mm) in any direction from the cigarette on the Standard Type II cover fabric measured from its nearest point.
 - c) The mock-up test specimen transitions to open flaming.
2. A barrier material passes the test if three initial mock-up specimens pass the test, i.e., the cigarettes burn their full length and the mock-ups are no longer smoldering.
3. If more than one initial specimen fails, the barrier material fails the test.
4. If any one of the three initial specimens fails, repeat the test on additional three specimens. If all three additional specimens pass the test, the barrier material passes the test. If any one of the additional three specimens fails, the barrier material sample fails the test.

SECTION 3. RESILIENT FILLING MATERIAL TEST

3.1 SCOPE

This test method measures the tendency of resilient filling materials to smolder and contribute to fire propagation, when covered with smolder resistant fabric and subjected to a smoldering ignition source. The materials covered by this test method include, but not limited to:

1. Resilient foams or other filling materials,
2. Batting of natural and man-made fibers,

3. Resilient pads of natural or man-made fibers.

Resilient filling materials that fail the test described in this section can be used in upholstered furniture if a barrier (interliner) material that passes Section 2 of this test method is used between the cover fabric and the filling materials.

3.2 WEIGHING DEVICE

A means of weighing the test specimen and providing a display or electronic output of the weight is necessary. The device must be capable reading 0.1 grams.

3.3 TEST SPECIMEN

Prepare the test specimen as specified in ASTM E1353-08a (Section 16 - Steps 16.1 and 16.2) and as follows:

- 3.3.1: Cut three specimens, each 8 by 8 in. (203 by 203 mm), from the Standard Type I cover fabric for horizontal panels, and three specimens, 8 by 15 in. (203 by 381 mm), for vertical panels. Note: The fabric measurements are different than ASTM (Section 16 – step 16.3).
- 3.3.2: If the test sample material is less than 2 in. (51 mm) thick, stack multiple layers to make up the required thickness.
- 3.3.3: If the inside filling material is less than ½ in (1.27 mm) thick use multiple layers to make up a 1 in. (25.4 mm) thick specimen and combine with a 1 in. (25.4 mm) thick removable plywood panel to construct the 2 in. (51 mm) thick test specimen horizontal and vertical panels. The removable plywood panels shall rest on horizontal and vertical surfaces of the mock-up specimen holder.
- 3.3.4: Weigh and record each test specimen panel to the nearest 0.1 grams.

3.4 TEST PROCEDURE

Follow the test procedures of ASTM E1353-08a (Section 17 – Steps 17.1 through 17.9) and the additional test procedures specified below:

- 3.4.1: Use of the draft enclosure (Fig. 3) is optional.
- 3.4.2: Place the specimen assembly directly on the fiberglass board. If testing multiple specimens simultaneously, place the individual test specimens at least 125 mm (6 inches) apart to avoid heat transfers between specimens.
- 3.4.3: The fabric shall overlap the top and bottom of the substrate and be stapled to the top backside as shown in Fig. C4. NOTE: This test specimen assembly is different than those specified in ASTM E1353-08a (Section 17 – step 17.2).
- 3.4.4: After completing test procedure 17.6, the test operators shall start timers to record testing time.

- 3.4.5: Continue test until all evidence of combustion has ceased for at least 5 minutes.
- 3.4.6: After all combustion has ceased carefully remove the remains of the sheeting material and the Standard Type I cover fabric. Carefully remove the resilient material test specimen panels, clean all carbonaceous char from panels by scraping with a spatula and weigh the combined non-burned portions of the horizontal and vertical test specimen panels/bags to the nearest 0.1 grams.
- 3.4.7: For loose filling materials remove the remains of the sheeting material weigh the horizontal and vertical panels to the nearest 0.1 grams.

3.4 PASS/FAIL CRITERIA

A material is considered to pass or fail based on the following criteria:

1. A single mock-up test specimen fails the requirements of this test procedure if any of the following criteria occurs:
 - a) The mock-up specimen continues to smolder and the test must be terminated due to intensifying smoldering.
 - b) The mock-up specimen transitions to open flaming;
 - c) The resilient filling material substrate (i.e., sum of both horizontal and vertical pieces) of the mock-up test specimen has more than 20% mass loss.
 - Calculate the percentage of mass loss for each test specimen substrate piece from each mock-up as: $\text{Percentage mass loss} = ((\text{pre-weight (A)} - \text{post-weight (B)}) / \text{pre-weight (A)}) \times 100\%$.
2. The resilient filling material passes the test if three mock-up specimens pass the test.
3. If more than one specimen fails, the resilient filling material fails the test.
4. If any one of the three initial specimens fails, repeat the test on additional three specimens. If all three additional specimens pass the test, the resilient filling material passes the test. If any one of the additional three specimens fails, the resilient filling material fails the test.

Annex A

Test Facility, Exhaust System and Hazards

Test Facility/Exhaust System

The test area shall be a room with a volume greater than 20 m³ (in order to contain sufficient oxygen for testing) or a smaller area equipped with inlet and extraction systems permitting the necessary flow of air. All smoldering tests shall be conducted under appropriate test hoods and/or test cabinets equipped with variable speed exhaust fans or other means of controlling the exhaust flow rates, such as dampers. Airflow rates shall be between 0.02 m/s and 0.2 m/s (4 and 40 ft/min), measured in the locality of the test specimen. Position specimen to provide adequate air around the test specimen without disturbing the burning behavior.

Note 1: These rates of airflow have been shown to provide adequate oxygen without physically disturbing the burning behavior of the ignition source or the specimen.

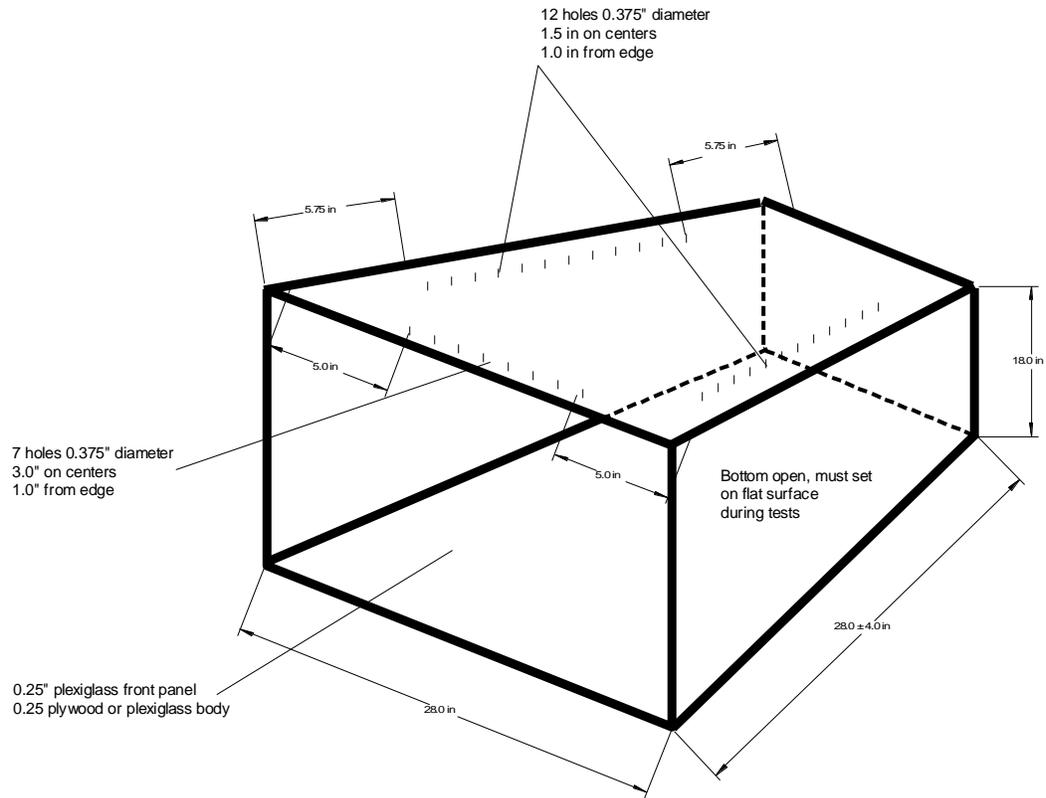
Note 2: An open draft preventive enclosure, as shown in Figure A.1, is also an acceptable test enclosure.

Note 3: A fume hood with air curtains across the face and zero air velocity at the test locations is recommended. Zero air velocity is indicated by an undisturbed vertical smoke plume of 6 in.

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 proper safety equipment.
- 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 is recommended. It may be difficult to judge when all combustion in a test specimen has ceased due to potential smoldering or burning deep inside the specimen even after extinguishment. Care should be taken that specimens are disposed of only when completely inert.
- Warning - Even under the most carefully observed conditions, smoldering combustion can progress to a point where it cannot be readily extinguished. It is imperative that a test be discontinued as soon as continuing combustion has definitely occurred. Immediately wet the exposed area with a water spray from the water bottle, remove the charred or burned material, and immerse the material in a bucket of water. Ventilate the test area.

Figure A-1. Draft Enclosure (Drawing Not to Scale)



Annex B

Standard Test Materials for Smolder Resistance of Cover Fabrics and Barrier Materials Used as Components in Upholstered Furniture.

Ignition Source: The standard ignition source shall be a non-filtered cigarette and be either the SRM 1196 (Standard Reference Material) or meet the following specifications:

Table 1. Cigarette Specifications.

Property	Value
Filter	None
Length	83 mm ± 2 mm
Mass	1.1 g ± 0.1 g
Packing Density	0.270 g/cm ³ ± 0.020 g/cm ³
Circumference – for guidance only	Nominally 24.8 mm
Ignition Strength	70 PFLB to 95 PFLB

PFLB = Percentage of Full Length Burn

The cigarettes shall be conditioned for at least 24 hours at 70 ± 5 °F and less than 55% relative humidity prior to use.

Standard Polyurethane Substrate: The Standard Polyurethane Substrate shall have the following specifications based on physical test methods described in the most current version of ASTM-D3574: Density: 1.8 ± 0.1lb/ft³, Indentation Force Deflection (IFD): 25 to 30, Air permeability: Greater than 3.5 ft³/min, with no flame-retardant chemical added in either the manufacturing or post manufacturing processes.

Standard Type I Cover Fabric: The Standard Type I cover fabric shall be 100 % cotton mattress ticking conforming to Fed. Spec. CCC-C-436-E. It shall be laundered and tumble-dried once before using.

Standard Type II Cover Fabric: The Standard Type II cover fabric shall have the following specifications:

FABRIC : Pattern 8500, COLOR : Beige, FIBER CONTENT : 100% Cotton Velvet,
WEIGHT/LINEAL YD.: 14.5 oz., (54 inches), BACKCOATING: None

Sheeting Material: The sheeting material to cover the test cigarettes shall be 50% cotton/50% polyester or 100% cotton bed sheeting material weighing 3.7± 0.8 oz/yd² (125± 28g/m²). The material shall be laundered in an automatic home clothes washing machine and dried in a tumble drier at least once before use. For testing, the sheeting material shall be cut into pieces approximately 5 by 5 in. (12.5 by 12.5 cm).

Annex C

Specimen Holder (Mini Mockup Tester):

Figure C-1. Specimen Holder (Mini-Mock-up Tester) for Mock-up Smoldering Ignition Resistance Tests
(Drawings Not to Scale)

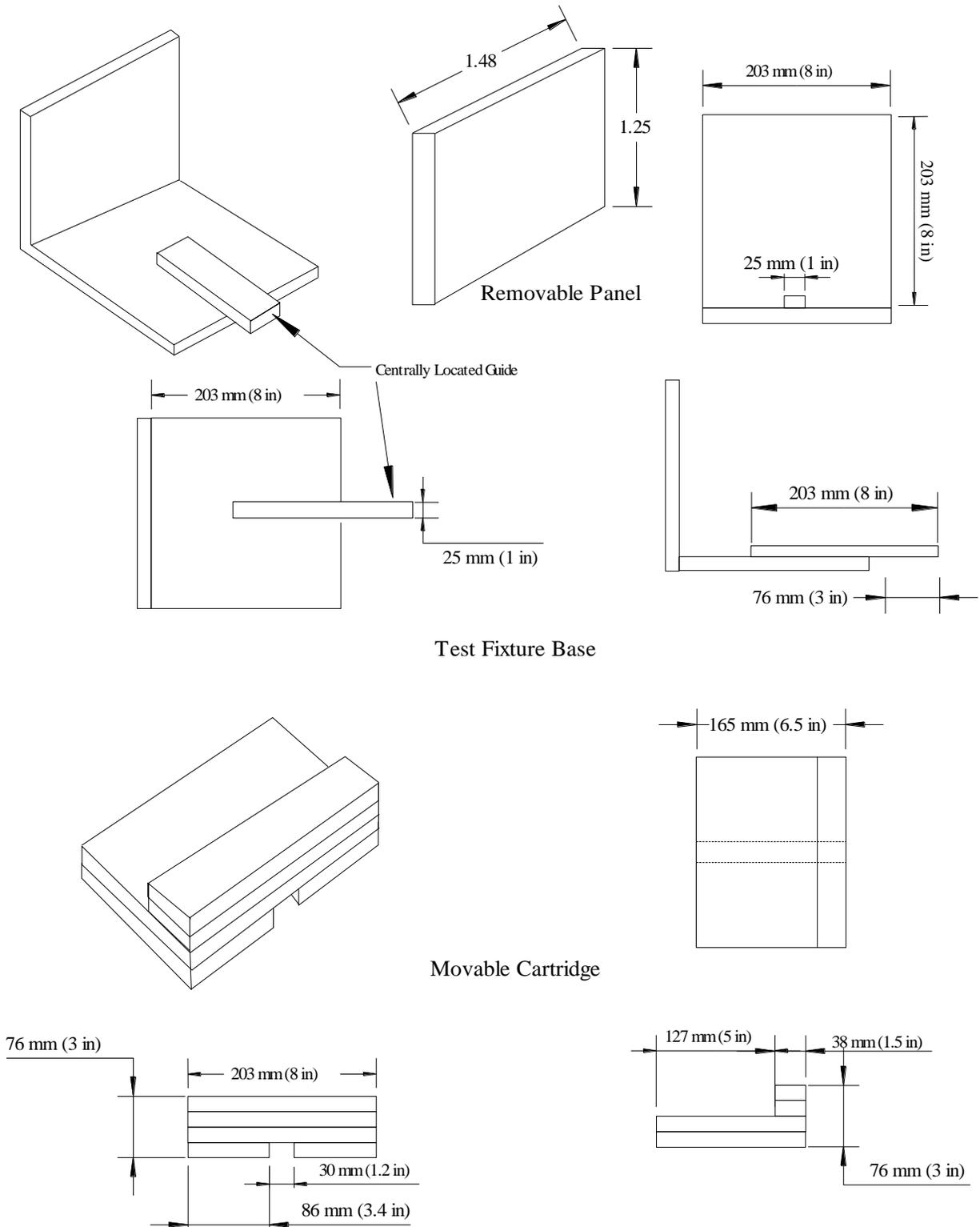


Figure C-2. Mock-up Assembly for Smoldering Ignition Resistance Test of Upholstery Cover Fabrics

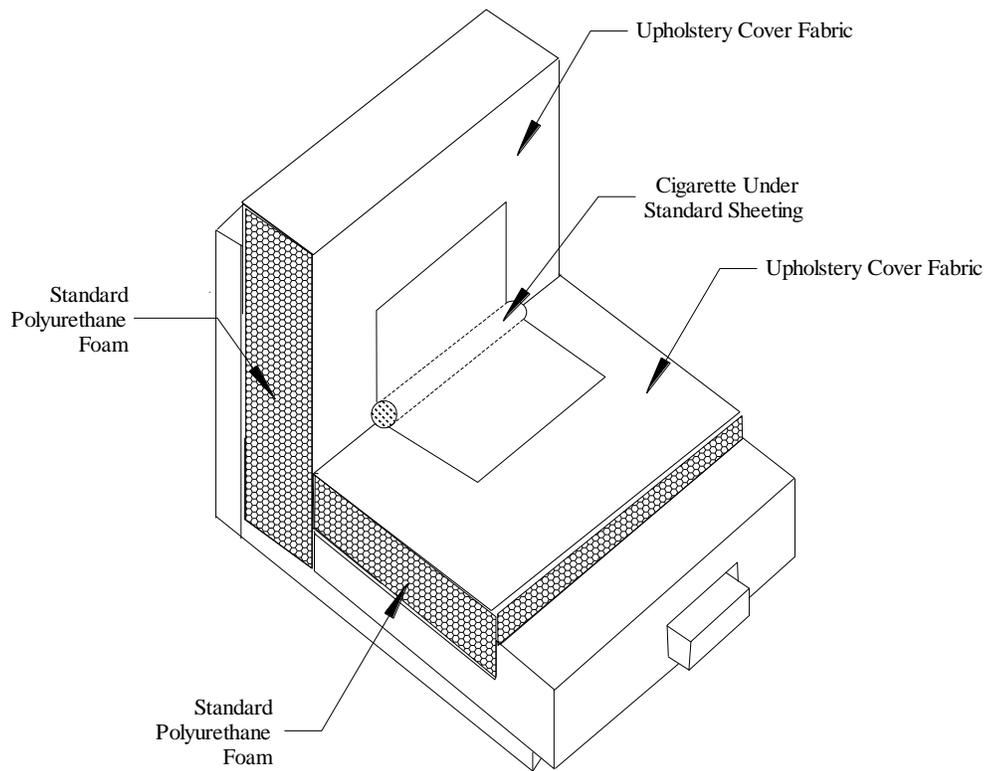


Figure C-3. Mock-up Assembly for Smoldering Ignition Resistance Test of Barrier Materials

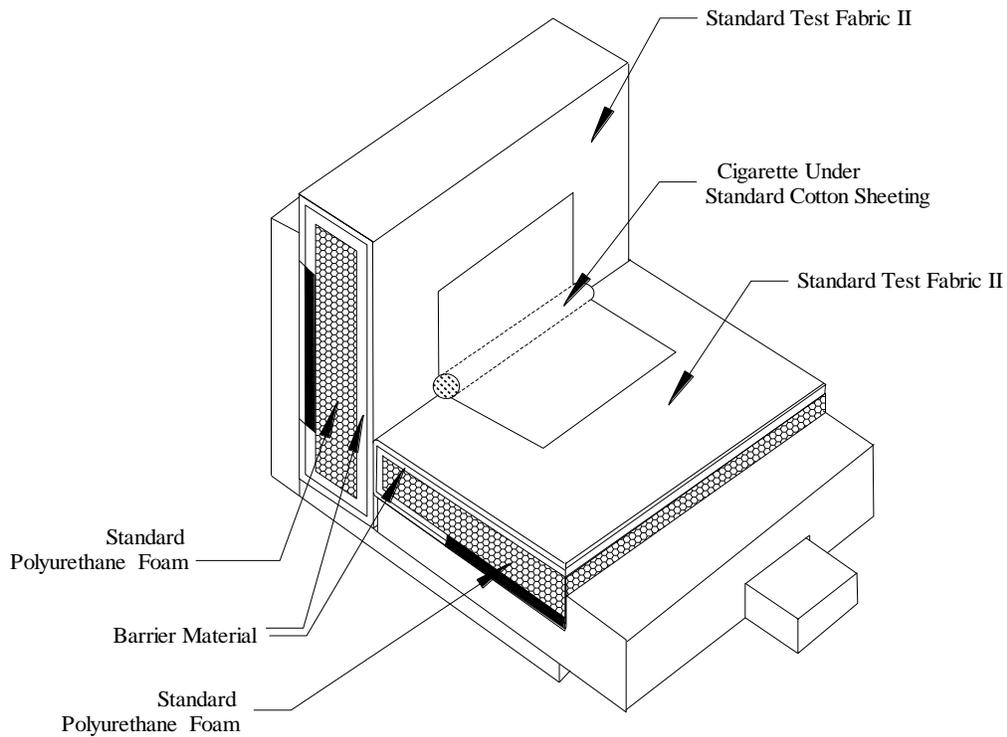


Figure C-4. Mock-up Assembly for Smoldering Ignition Resistance Test of Resilient Filling Component Materials

