UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
BETHESDA, MD 20814

Staff Cover Letter on Upholstered Furniture Validation Memoranda[1]

In 2008, the U.S. Consumer Product Safety Commission (CPSC) proposed a flammability standard for residential upholstered furniture under the Flammable Fabrics Act (FFA).[2] The proposed standard would establish performance requirements to reduce the likelihood of smoldering-induced ignition of upholstered furniture. Manufacturers and importers of upholstered furniture could choose one of two possible methods for compliance: (1) use cover materials that meet the specified cigarette-ignition performance test, *i.e.*, "Type I" furniture; or (2) incorporate fire barriers between the cover fabric and interior filling materials that meet both the smoldering and small open-flame resistance tests, *i.e.*, "Type II" furniture. The proposed standard would provide detailed labeling requirements for upholstered furniture. It also would require manufacturers and importers of upholstered furniture to certify compliance with the standard and comply with certain recordkeeping requirements.

The proposed standard would require: (1) resistance to smoldering ignition, and (2) limited fire growth by means of bench-scale performance tests for cover fabrics ("Type I" furniture) or, alternatively, for fire barriers ("Type II" furniture). In Type I furniture, cover fabrics must meet smoldering-ignition resistance requirements. If Type II fire barriers are chosen as the means of compliance, they must meet both small open-flame and smoldering-ignition resistance requirements. The proposal adapts elements and variations of existing standards, including California Technical Bulletin 117, ASTM E–1353 (tests from the Upholstered Furniture Action Council (UFAC) industry-consensus voluntary guidelines), and United Kingdom regulations (based on British Standard BS–5852).

At the time that the proposed standard was published in a notice of proposed rulemaking (NPR) in 2008, CPSC staff stated that real scale validation testing was needed to demonstrate that the bench-scale test approach in the NPR was adequate to address the fire performance of full-scale furniture. This point was also raised later in public comments received in response to the 2008 NPR.

Since the 2008 NPR, CPSC staff performed a series of tests to validate the methodology and to assess the potential effectiveness of the proposed standard. The tests were designed to demonstrate that materials (Type I cover fabrics and Type II fire barriers) that met the criteria of the proposed standard in bench-scale construction showed an increase in fire safety when used in a full-scale chair. Although the proposed standard does not require full-scale tests for compliance of any materials, full-scale testing was conducted to characterize the performance of the proposed bench-scale tests as a reliable predictor of full-scale

[1] This cover letter and the attached memoranda are the views, opinions, and comments of CPSC staff, and they have not been reviewed or approved by, and do not necessarily represent the views of, the Commission.
[2] 73 F.R. 11702. "16 CFR Part 1634, Standard for the Flammability of Residential Upholstered Furniture; Proposed Rule" March 4, 2008.

furniture fire performance. The series of CPSC staff's testing and data analysis reports, which are attached to this memorandum and listed below, detail the findings of this testing:

1. "Upholstered Furniture Full-Scale Chair Tests – Open-Flame Ignition Results and Analysis," Memorandum to Dale Ray, Project Manager, from Shivani Mehta, CPSC Directorate for Engineering Sciences, Division of Combustion and Fire Sciences. May 11, 2012.
2. "Analysis of Chair Open-Flame Data," Memorandum to Dale Ray, Project Manager, from David Miller, CPSC Directorate for Epidemiology, Division of Hazard Analysis. May 11, 2012.
3. "Mockup Test Program on Upholstery Fabrics and a Fire Barrier," Memorandum to Rohit Khanna, Project Manager, from Linda Fansler, CPSC Directorate for Laboratory Sciences, Division of Engineering. July 16, 2012.
4. "Summary of Data Collected During Smoldering Chair Tests," Memorandum to Rohit Khanna, Project Manager, from Linda Fansler, CPSC Directorate for Laboratory Sciences, Division of Engineering. July 16, 2012.
5. "Analysis of Chair Smoldering Data," Memorandum to Dale Ray, Project Manager, from David Miller, CPSC Directorate for Epidemiology, Division of Hazard Analysis. May 11, 2012.

At the start of the validation test program in 2008, CPSC contracted with a furniture manufacturer to procure specified materials and manufacture upholstered chairs. The materials used in this test plan were chosen based on previous extensive testing conducted at the CPSC. The cover fabrics represented a range of smoldering performance, observed in initial mockup tests with qualifying standard polyurethane foam (SPUF). The fire barrier used in the tests was selected based on preliminary mockup tests with a qualifying standard fabric and SPUF, as specified in the proposed rule. The manufacturer was asked to procure each specified material in one order so that the materials would be of the same production lots. Upon receipt of the materials, the furniture manufacturer sent a portion of the materials to the CPSC for bench-scale testing.

Smoldering- and open-flame ignition bench-scale testing described in the proposed standard was conducted to confirm that the materials received actually behaved comparably to previous tests. The bench-scale, open-flame tests of the fire barrier showed that the barrier was able to prevent ignition of the foam, as previously observed.

The smoldering-ignition tests showed that the specified materials did not behave consistently, as previously observed. Cover fabrics that were expected to result in a range of smolder insult to the underlying foam filling material did not show a practical difference. Similarly, the test of foam smolder performance with and without fire barriers was also not practically different. The SPUF foam was specified per the proposed standard, but it was purchased from a different manufacturer than in the previous tests and was determined to be the cause for the inconsistent results. This outcome made clear the need to develop better specifications for standard foam for use in the regulation to ensure repeatable and reproducible results. The CPSC contracted with the National Institute of Standards and

Technology (NIST) to develop specifications for a standard reference material (SRM) foam; the NIST report on that effort is forthcoming.

Full-scale testing of chairs was conducted with the same cover fabrics, foam, and fire barriers used in the bench-scale testing. Based on the bench-scale tests that are used to qualify a fire barrier per the proposed standard, staff expected that the chairs constructed with the fire barrier would not result in any smoldering ignitions and would limit combustion in an open-flame exposure scenario. However, when tested, the fire barrier did not consistently provide a clear result on protection against smoldering ignitions. The chairs constructed with fire barriers demonstrated a considerable amount of smoldering.

During testing, it was found that the construction of the chairs was not uniform. For example, in some cases, the plastic that wraps the foam prior to use was included in the final chair, and the seams may not have been at the exact edge of the cushions. Despite these irregularities, staff determined that they did not affect considerably the actual result of the tests. The performance of the fire barriers, when exposed to an open-flame ignition source, did indicate that the fire barrier was somewhat successful in reducing fire severity.

As described in the five attached CPSC staff technical reports on the testing and data analyses, materials from the same manufacturing batch were used in both bench- and full-scale tests. If the performance of a bench-scale mockup is to be used to predict full-scale furniture performance, behavior in both scales should be similar qualitatively. Because the bench-scale mockups are expected to predict the behavior of cover materials in full-scale furniture, any irregularities in chair construction should not affect their qualitative performance with the same ignition source. For this test series, the bench-scale performance did not demonstrate an adequate prediction of real furniture flammability performance, especially in the smoldering ignition tests. However, it does appear that the open-flame ignition bench-scale qualification tests for fire barriers results in improvement in full-scale fire performance.

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Memorandum

Date: May 9, 2012

TO : Dale R. Ray, Project Manager, Upholstered Furniture Project

THROUGH: George A. Borlase
Associate Executive Director, Directorate for Engineering Sciences

Patricia K. Adair
Director, Division of Combustion and Fire Sciences

FROM : Shivani Mehta
Fire Protection Engineer, Division of Combustion and Fire Sciences

SUBJECT : Upholstered Furniture Full Scale Chair Tests – Open Flame Ignition Results and Analysis.

1 BACKGROUND

The U.S. Consumer Product Safety Commission (CPSC) proposed a flammability standard for residential upholstered furniture under the Flammable Fabrics Act (FFA).[1] The proposed standard establishes performance requirements to reduce the likelihood of smoldering-induced ignition of upholstered furniture. Manufacturers of upholstered furniture could choose one of two possible methods for compliance: (1) use cover materials that are sufficiently smolder resistant to meet the specified cigarette ignition performance test, *i.e.*, "Type I" furniture; or (2) incorporate fire barriers between the cover fabric and interior filling materials that meet smoldering and small open-flame resistance tests, *i.e.*, "Type II" furniture. The proposed standard also details labeling requirements for upholstered furniture. The proposed rule would require manufacturers of upholstered furniture to certify compliance with the standard and to comply with certain record-keeping requirements.

In developing the proposed flammability standard to address smoldering ignition of residential upholstered furniture, CPSC staff considered the available hazard information and existing standards development research, together with the latest CPSC test results and technical information developed by other organizations. Economic, health, and environmental factors were also considered.

The proposed standard addresses resistance to smoldering ignition and limited fire growth by means of bench-scale performance tests for cover fabrics or, alternatively, for fire barriers. Cover fabrics must meet smoldering ignition-resistance requirements. If fire barriers are chosen as the means of compliance, they must meet both small open-flame and smoldering ignition-resistance requirements. The proposal adapts elements and variations

[1] 73 F.R. 11702. "16 CFR Part 1634, Standard for the Flammability of Residential Upholstered Furniture; Proposed Rule" March 4, 2008.

of existing standards, including California Technical Bulletin 117,[2] ASTM E–1353[3] (tests from the Upholstered Furniture Action Council (UFAC) industry-consensus voluntary guidelines), and United Kingdom regulations (based on British Standard BS–5852[4]).

CPSC staff is performing bench-scale and full-scale tests to assess the potential effectiveness and benefits of the proposed standard. Testing will include an evaluation of Type I (smolder-resistance of cover fabrics) and Type II (smolder- and small open-flame resistance of fire barriers) compliant upholstered furniture. This report presents staff's evaluation of open-flame ignition resistance of full-scale, Type II upholstered chairs.

The proposed standard does not require full-scale tests for compliance of any materials. The objective of conducting full-scale tests was to characterize the performance of proposed bench-scale tests as a reliable predictor of full-scale furniture fire performance. Specifically, the purpose of the testing is to evaluate the effectiveness of the fire barrier for chairs of different fabrics and foams, as measured by the peak heat release rate and the time to reach the peak heat release.

2 TEST DESCRIPTION

Flammability performance of full-scale furniture constructed with Type II barriers was compared with flammability performance of furniture constructed without fire barriers. Since there are no standard test procedures or pass/fail criteria for fire barriers in full-scale furniture, the CPSC tasked the National Institute of Standards and Technology (NIST) to aid in developing a test protocol and to perform the tests at the NIST Large Fire Laboratory (LFL).

2.1 Test Room

An ISO 9705-[5]compliant room, as shown in Figure 1, was constructed and instrumented. An ISO 9705-size room is typically used when evaluating the heat release rate (HRR) of upholstered furniture.

- The wood-stud constructed walls were covered with two layers of Type C gypsum wallboard on the interior surface. The wallboard paper covering was burned off before testing because the burning paper could generate a sharp HRR spike that would interfere with the test furniture heat release data.
- A piece of Durock®[6] was placed in a catch pan under the test specimen to collect any debris during testing.
- A heat flux gauge was placed in the middle of the room at floor level, pointing up toward the ceiling.

[2] CA TB 117, Test Procedures and Apparatus for Testing the Flame Retardance of Resilient Filling Materials Used in Upholstered Furniture. 2000.
[3] ASTM E1353, Standard Test Methods for Cigarette Ignition Resistance of Components of Upholstered Furniture.
[4] BS-5852, Methods of test for assessment of the ignitability of upholstered seating by smouldering and flaming ignition sources. 1990.
[5] ISO 9705:1993, Fire tests - Full-Scale Room Test for Surface Products.
[6] Durock® is a cement board.

- Two thermocouple (TC) trees were placed in the room to measure the vertical temperature gradients at two different locations. Each tree consisted of eight thermocouples positioned at eight heights, including one inch from the ceiling and at seven, 1-foot intervals from the ceiling. One tree was located near the chair and the other in the front of the room, near the doorway.
- Carbon monoxide (CO) and carbon dioxide (CO_2) sensors were located directly outside the room at door height and were used to measure CO and CO_2 levels in the upper gas layer in the room.
- Two paper signs were located at 48 and 72 inches above the floor, one at standing height and one at seated height, to note the rate of smoke layer growth in the room by observing loss of visibility of the paper signs when viewed from the doorway.
- Video cameras were placed at four locations: two cameras were focused on the chair seat, one on a side arm and one under the chair.

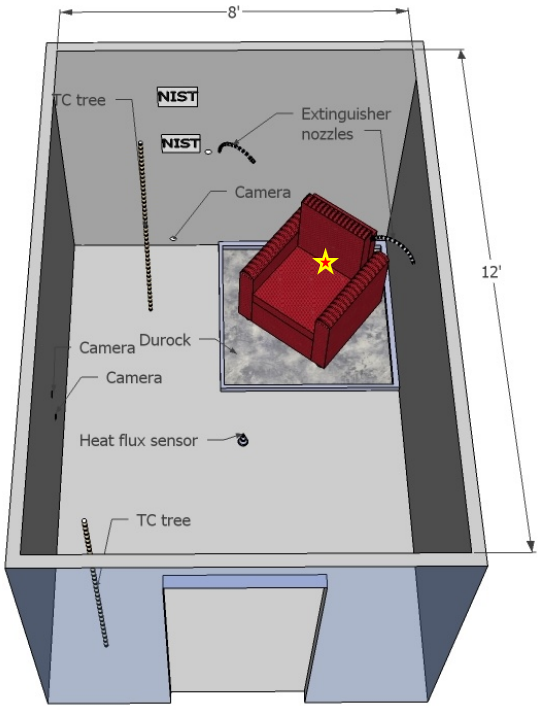


Figure 1. Schematic of ISO Room

2.2 Test Procedure

The sample chairs were conditioned at 21°± 3°C (70°± 5°F) and at a relative humidity of between 50 percent and 66 percent for at least 48 hours at the NIST LFL. After conditioning and within 10 minutes of ignition start time, a sample chair was placed on the Durock® board in the far right corner of the ISO 9705 room for the tests, as shown in Figure 1.

A 240 mm butane flame[7] was applied at in the center of the crevice of the seat and back cushion for 70 ± 1 seconds (see star on Figure 1). The heat release rate data were observed in real time on an overhead monitor. The test was allowed to continue until the peak heat release rate (PHRR) was observed. Time to melt dripping,[8] smoke obscuration, and full sample involvement in the fire were visually observed and annotated while tests were being conducted.

Sixty-four chairs were tested in this evaluation. The chairs were constructed with different combinations of a fire barrier, foams, and cover fabrics to characterize their flammability performance, in accordance with a statistical plan developed by the CPSC Directorate for Epidemiology staff. A description of the materials and combinations is detailed in the next section of this report.

[7] This is the same ignition source specified in the proposed standard to test mock-ups with barriers.
[8] In this report, melt dripping refers to the melted foam dripping as a liquid.

3 DESCRIPTION OF TEST SAMPLES

The chairs used in this evaluation were made to order based on CPSC staff specifications for fabrics, foams, and a fire-barrier installed on a basic wooden frame. The materials, chosen on the basis of previous bench-scale testing by CPSC Directorate for Laboratory Sciences (LS), were all commercially available and were purchased by the furniture manufacturer.

3.1 Test Samples

CPSC contracted with a residential furniture manufacturer to procure materials for and assemble 64 chairs in 16 combinations. The materials that make up the 16 combinations are listed in Table 1. A schematic of the chairs is shown in Figure 2, and a partially upholstered chair is shown in Figure 3. The chair manufacturer obtained the materials as specified above. The chairs were assembled with either nonfire-retardant (SPUF) or fire-retardant (FR) foam, covered with either a fire barrier or typical polyester batting, and the specified cover fabric.

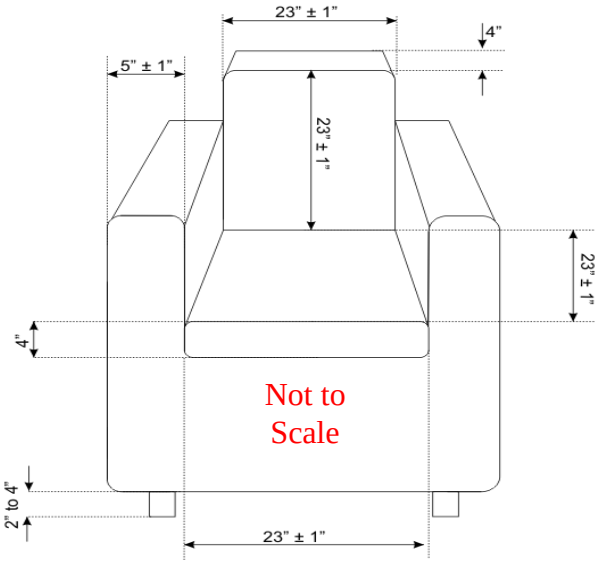


Figure 2. Schematic of Sample Chair

Figure 3. Prototype of Partially Upholstered Chair

Table 1. Chair Material Combinations for Full-Scale, Open-Flame Testing

Combination	Foam	Polyester batting	Barrier	Cover Fabric	Number of chairs
1	SPUF		✓	1a	4
2	SPUF	✓		1a	4
3	FR		✓	1a	4
4	FR	✓		1a	4
5	SPUF		✓	1b	4
6	SPUF	✓		1b	4
7	FR		✓	1b	4
8	FR	✓		1b	4
9	SPUF		✓	2a	4
10	SPUF	✓		2a	4
11	FR		✓	2a	4
12	FR	✓		2a	4
13	SPUF		✓	2b	4
14	SPUF	✓		2b	4
15	FR		✓	2b	4
16	FR	✓		2b	4

3.2 Cover fabrics

Four groups of 16 test chairs were constructed with four different cover fabrics as described in Table 2. Fabrics 1a and 1b were shown to be highly smolder prone, while Fabrics 2a and 2b were shown to exhibit inconsistent smolder resistance, as determined in prior testing conducted at the CPSC Laboratory.[9] The fabrics were selected because of these smoldering characteristics.

Table 2. Cover Fabrics for Full-Scale Tests

Fabric Code	Fiber	Weight (oz/yd^2)	Weave
1a	100% cotton	8	Twill
1b	100% cotton	20	twill (denim)
2a	100% cotton	7	Jacquard
2b	100% cotton	8	Matelasse

3.3 Foam

Full-scale chairs were constructed with commercially available foams, including SPUF and FR foam to observe any difference in flammability behavior when a barrier was used. The

[9] In the bench-scale tests, these fabrics were neither always smoldering nor never smoldering when exposed to a burning cigarette.

batch of foam used in this test series was not tested in mockups prior to the tests. The foams were specified from the foam manufacturer as follows:

Non-FR SPUF Foam:

- Density: 1.8 ± 0.1 lb/ft^3
- Indentation Load Deflection (ILD): 25 to 30%;
- Air Permeability: Greater than 4.0 ft^3/min; and
- No flame-retardant chemical treatment as determined by post production chemical analysis.

FR foam was specified as foam that meets California Technical Bulletin 117 (TB 117) requirements.

3.4 Fire-barrier System

The purpose of the open flame tests is to evaluate the performance of fire-barriers. A series of tests conducted by CPSC Directorate for Laboratory Sciences staff identified a fire-barrier system consisting of a combination of polyester batting over a commercially available fire-barrier, which met the requirements for the proposed Type II tests.[9] This fire-barrier system was used for the full-scale testing.

- The fire-barrier was a commercial product composed of a fiberglass base needle-punched with polyester and modacrylic fibers.
- The 100% polyester batting was nominally 4 oz/yd^2, 0.375" thick, nonwoven construction.

3.5 Polyester Batting

The chair design was intended to represent conventional residential furniture as found in the market. The CPSC staff has been advised by manufacturers that it is common practice to place a thin layer of polyester batting between the foam cushion and cover fabric. The polyester batting was nominally 7 oz/yd^2, 0.75 inch thick, nonwoven

4 DATA AND OBSERVATIONS

During the tests, specific events in each test were observed and noted. Heat flux was measured in the center of the room, and CO and CO_2 levels were recorded from the effluent gases in the exhaust hood. Additionally, flame spread across the cushions, melt dripping, pool fires, smoke layer, and full involvement of the chair were observed during the tests. Thermocouple trees located in the room measured temperature and HRR was also measured via oxygen consumption calorimetry in the hood.

4.1 Heat Release Rate Data

Heat release rate (HRR) is used to quantitatively describe the size of a fire. It is the rate at which the combustion process produces heat and is a driving force in the spread of fire. The peak HRR (PHRR) indicates the point at which the fire produces the most heat (*i.e.*, the instantaneous largest size of the fire). The time to the PHRR indicates how fast the fire has grown and is considered an important parameter of fire growth characterization.

The HRR was measured in the effluent from the room, using oxygen consumption calorimetry. Plots of all HRR data from all 64 tests are detailed in Appendix A. An example of an HRR progression is shown in Figure 4. As seen in the Figure 4 plot, the burn sequence featured two peaks in the heat release profile. The first peak occurred when the soft materials (cushions, fabric, and batting on arms) were burning intensely. The second peak was observed once the wood frame was fully involved in the fire and much of the upholstery materials were consumed. The proposed standard addresses the performance of the soft materials only; the contribution of upholstery materials has little effect on the second peak. Thus, the first PHHR value and time to this PHRR will be examined as the principal measures of effectiveness of the proposed standard and will be closely examined in this report

Figure 5 shows the value of the first PHRR for each of the fires involving the 64 chair samples. Figure 6 shows the time at which these PHHR occurred for each of the 64 chairs. In some cases, the first peak was not well defined; so an average was taken in the area of the peak in the data to account for uncertainty in the exact PHRR. The fires were suppressed with water after the second peak was reached, which caused the heat released to drop quickly within the test room.

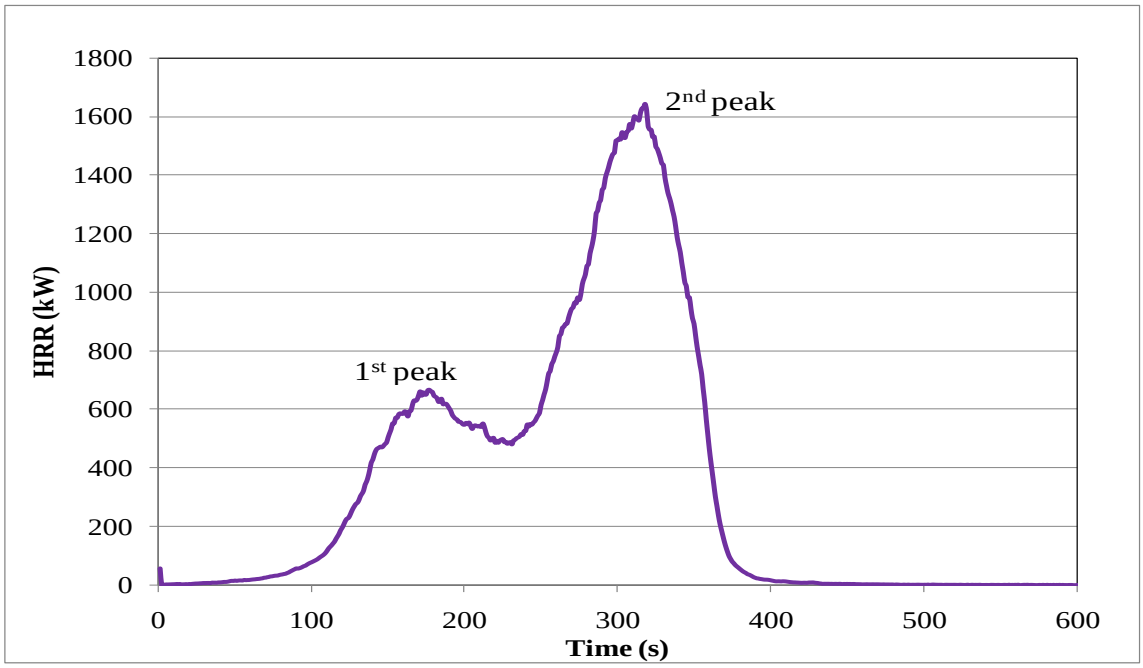


Figure 4. Heat Release Rate Curve Demonstrating Two "Peaks"

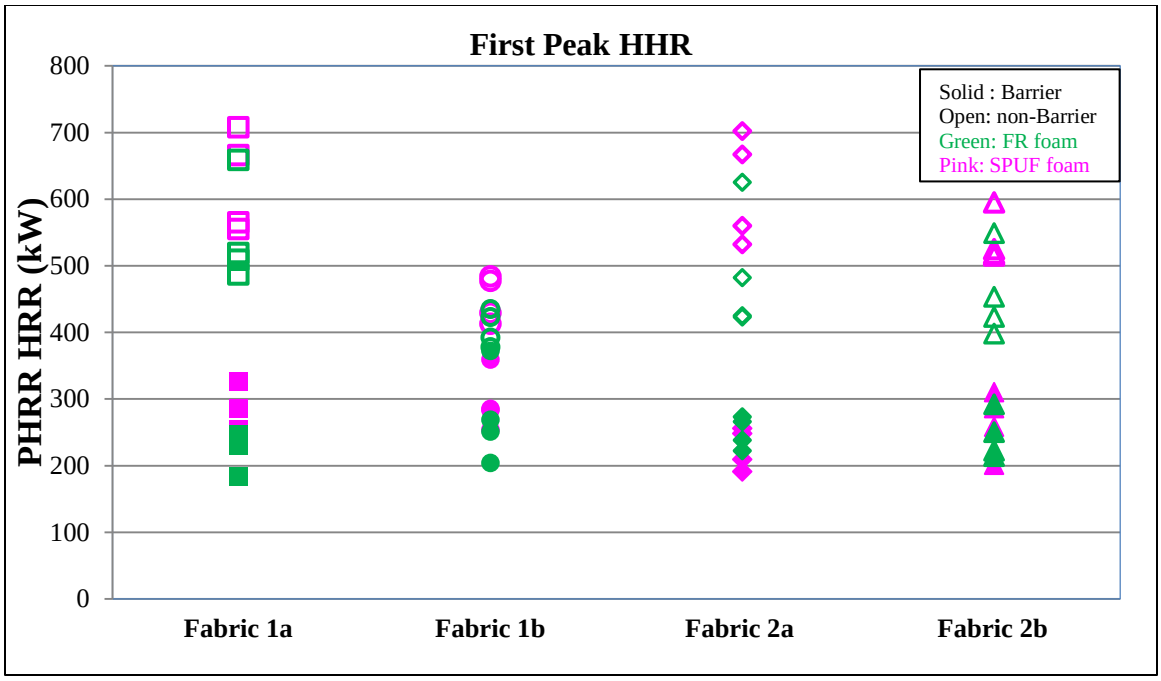


Figure 5. First Peak Heat Release Rates for All 64 Tests, by Fabric

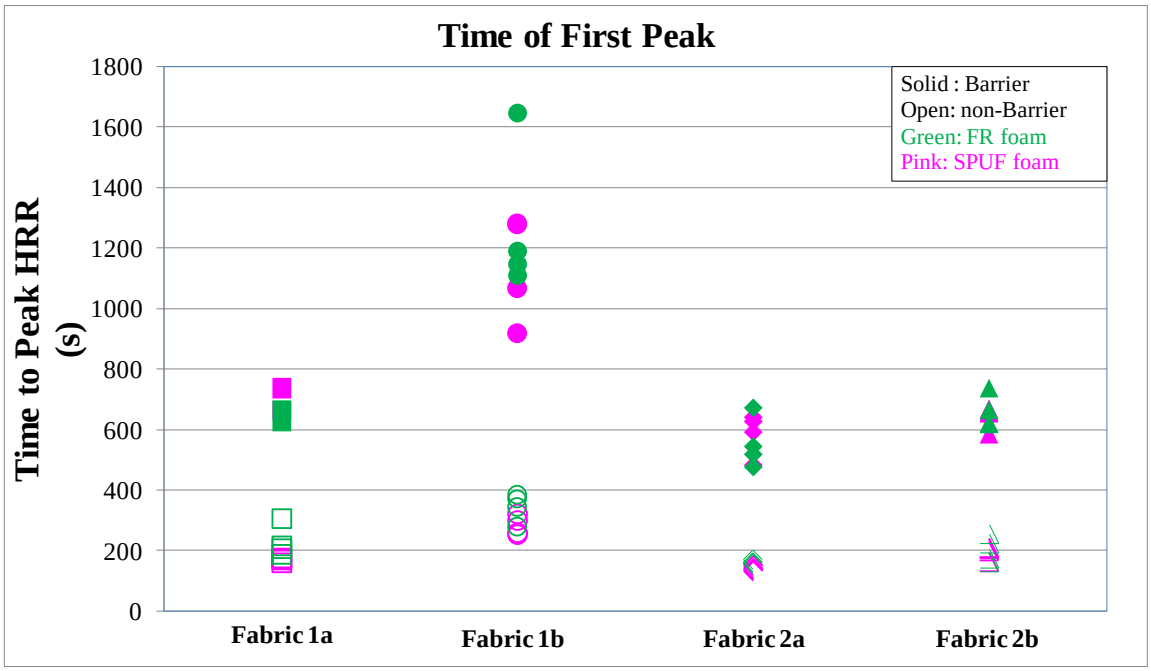


Figure 6. Time to First Peak Heat Release Rate for All 64 tests, by Fabric

4.2 Temperature Data

Temperatures were recorded at two locations to characterize the convective heat transfer from a burning chair to the test room. The temperature distributions along the thermocouple trees indicate the growth of the hot layer and provide insight into tenability for occupants, among other useful information.

In this test series, temperatures were recorded near the door and near the chair, at eight heights. As expected, the thermocouple tree data shows a vertical temperature gradient, as illustrated by the typical profiles depicted in Figures 7 and 8. High temperature smoke was produced, which rose to form a hot upper layer and a cool lower layer from which fresh air was entrained to feed the fire. The upper layer temperatures followed the same profile with respect to time as the HRR; there was a sharp rise, followed by a dip, and then another sharp rise.

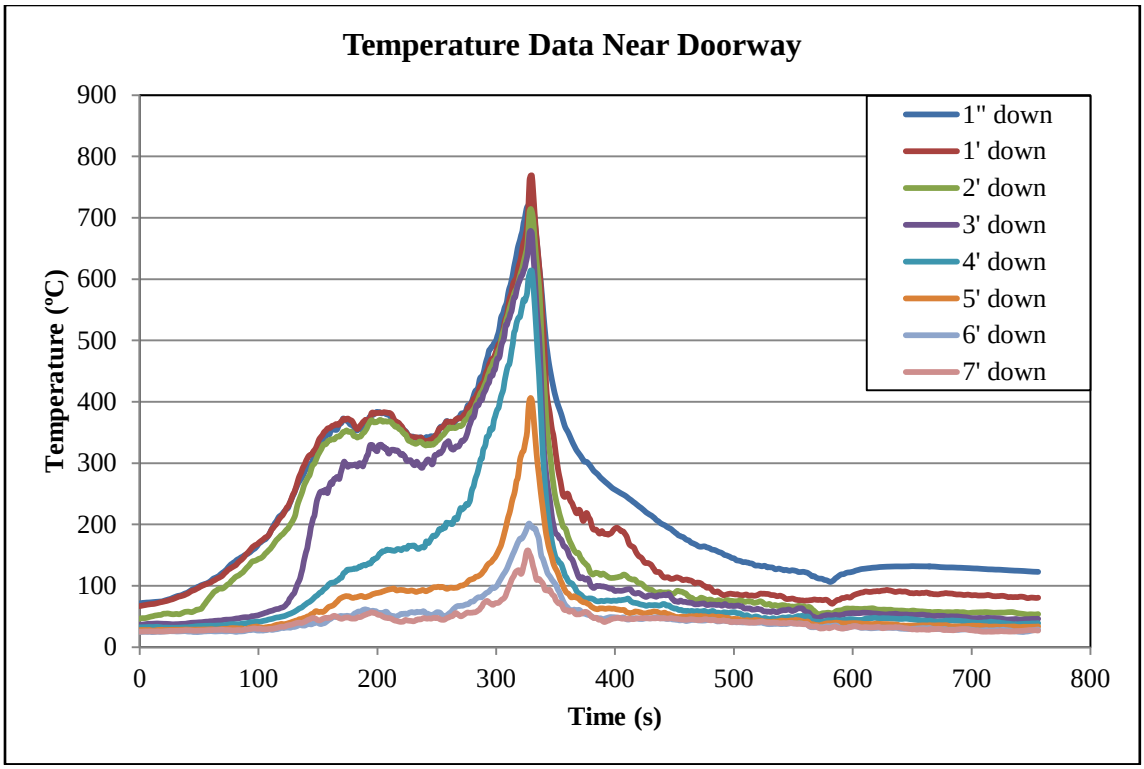


Figure 7. Typical temperature profile near doorway, measured down from the ceiling

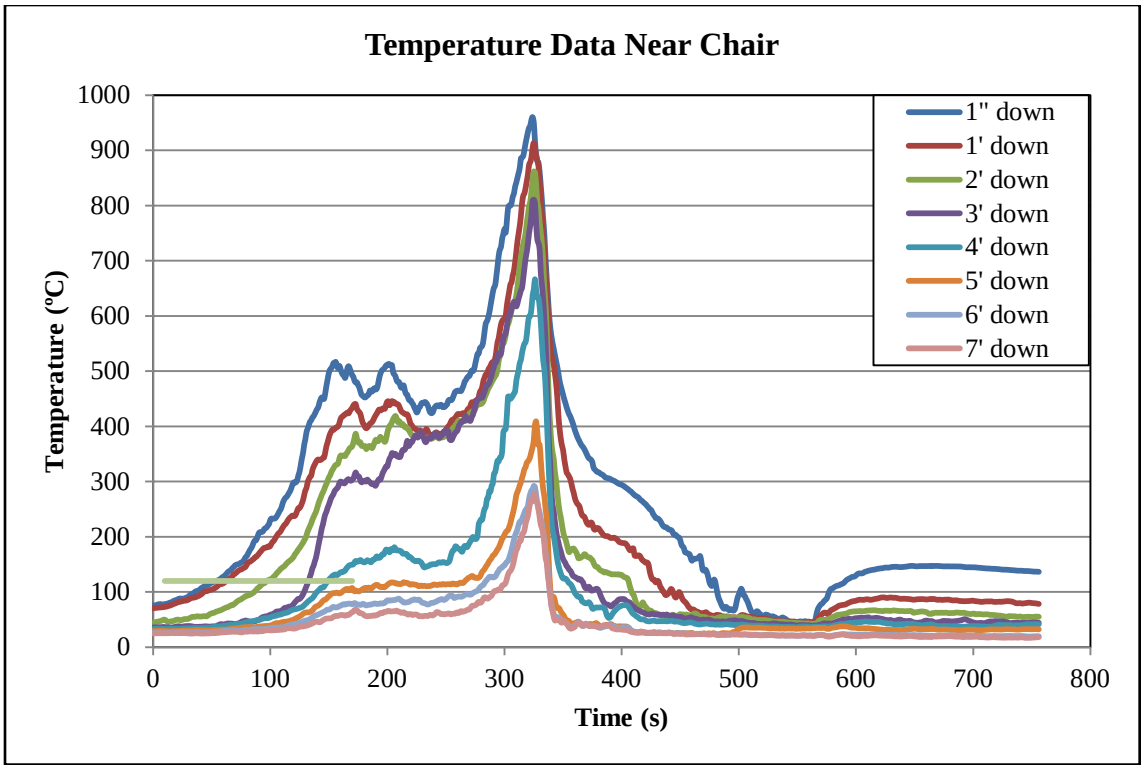


Figure 8. Typical temperature gradient near chair, measured down from ceiling

4.3 Observations

In addition to recording the HRR of the test samples, visual observations during all 64 tests provided qualitative differences in the burning behaviors of the chair samples.

4.3.1 Flame Spread

The propagation of flames on the chairs was observed to be similar in all the tests of this series. Photographs 3a through 3h included in Table 3 show an example using a chair with a fire barrier. As the ignition source flame was applied (flame application time = 70s), the cover fabrics formed a thin char layer (3a). The char then split open and allowed the heat from the flames to reach the layers of material below the cover fabric (3b). As the flames progressed along the back/seat cushion crevice, the flames also spread up and across the back cushion (3c). The seat cushion started to show some charring and flames as the materials in the back/seat cushion crevice burned more intensely (3d). Once the flames spread to the edges of the back/seat cushion crevice, the arms of the chair became involved (3e). When the flames spread to the edges of the back cushion, the flames traveled around the cushion (3f). This flame progression provided heat to the back frame of the chairs and eventually involved the fabric and wood from that part of the chair (3g). As flames moved around the back cushion, flames also progressed down the seat cushion toward the front of the chair (3h). The flame front on the seat cushion moved slower than on the back cushion, involving the chair arms as it progressed toward the front edge of the chair. In many of the chairs that contained a fire barrier, the back cushion fell forward onto the seat, presumably because the support provided by the seat cushion burned away, causing a faster rate of burning for the remainder of the chair.

The major difference between the fire-barrier and nonfire-barrier chairs was the rate of flame propagation, as evidenced by the times to peak HRR (shown earlier in Figure 6). The fire barrier slowed down the progression of flames on the faces of the cushions. However, once the flames started to wrap around the back cushion and came into contact with the chair back, the flames grew in magnitude; there was no fire-barrier material on the chair frame in any of the chairs. Another difference between the fire-barrier and nonfire-barrier chairs was that at the end of the test, the chairs with a fire barrier kept the general shape of the cushion with the interior foam burned, while the chairs without a fire barrier lost the entire cushion.

Table 3. Propagation of Burning on a Chair with a Fire Barrier

			
3a	3b	3c	3d
			
3e	3f	3g	3h

4.3.2 Melt Dripping

For most samples, melt dripping was observed during the tests. The melt drippings are created by liquefied foam that falls under and around a burning chair. As the flames get closer to the bottom of the chair, the melt drippings form a pool. The vapors from the pool are heated by the surrounding fire, causing a pool fire. The pool fire then also provides heat from below the chair and increases fire growth. An example of a pool fire observed in this test series is shown in Figure 9. Pool fires occurred in tests regardless of chair material combinations but occurred earlier in tests involving nonfire-barrier chairs than in tests with fire-barrier chairs. It is unclear whether this is because the foam took longer to melt or the barrier was able to contain the melted foam longer without dripping.

Figure 9. Example of a Pool Fire

4.3.3 Fire Growth

As mentioned earlier, the heat release data indicate that the chairs with fire barriers were associated with lower peak heat release rates and slower fire growth. Enhanced fire resistance of chairs with fire barriers was also evident during observations of the tests. Photographs taken during the tests demonstrated the differences in fire growth times between the chairs with and without fire barriers. A snapshot of the test chairs four minutes after ignition for the 16 fabric/foam/fire-barrier combinations tested are shown in Table 4. Additionally, the photographs illustrate the slower progression of flames in fabric 1b, which was more than twice the weight of the other three fabrics (1a, 2a, and 2b).

Table 4. Photographs of Chair Samples Four Minutes After Ignition. Each photograph shows a sample of one of 16 fabric/foam/fire-barrier combinations.

Fabric	Nonfire Barrier, SPUF	Nonfire Barrier, FR	Fire Barrier, SPUF	Fire Barrier, FR
1a	 Combination 2	 Combination 4	 Combination 1	 Combination 3
1b	 Combination 6	 Combination 8	 Combination 5	 Combination 7

Fabric	Nonfire Barrier, SPUF	Nonfire Barrier, FR	Fire Barrier, SPUF	Fire Barrier, FR
2a	 Combination 10	 Combination 12	 Combination 9	 Combination 11
2b	 Combination 14	 Combination 16	 Combination 13	 Combination 15

5 ANALYSIS AND DISCUSSION

The three components evaluated in this study were the fabrics, the foams, and the fire barrier. Determining the effect of the fire barrier on the flammability performance is the primary goal of this evaluation and is discussed below. Interactions among the components of the chairs can also have effects on the flaming behavior; they are also examined for the following combinations: cover fabric and foam, fire-barrier and foam, and fire-barrier and fabric. Each interaction contributed in varying levels to the heat release rates and temperatures. These interactions are further discussed below. It is important to note that results of this test series using selected combinations of components cannot be generalized over the entire market of materials that may be incorporated into furniture

5.1 Fire-Barrier Effect

Since the proposed standard only requires open-flame tests to evaluate the fire barrier, this test series was designed primarily to assess the behavior of the fire barriers. Examining the PHRR data for all 64 tests using the fire barrier as the discriminating factor demonstrates the effect of the fire barrier. There is a clear difference in the PHRR and the time to PHRR, as shown in Figures 10 and 11. The fire barriers work to increase the time to PHRR while decreasing the actual size of the fire. The Directorate for Epidemiology (EPI) estimates that a fire barrier in the chair results in a time to PHRR that is 3.323 times longer than for the chairs without fire barriers.[10] The effect of the fire barrier as an interaction with the other components is detailed below.

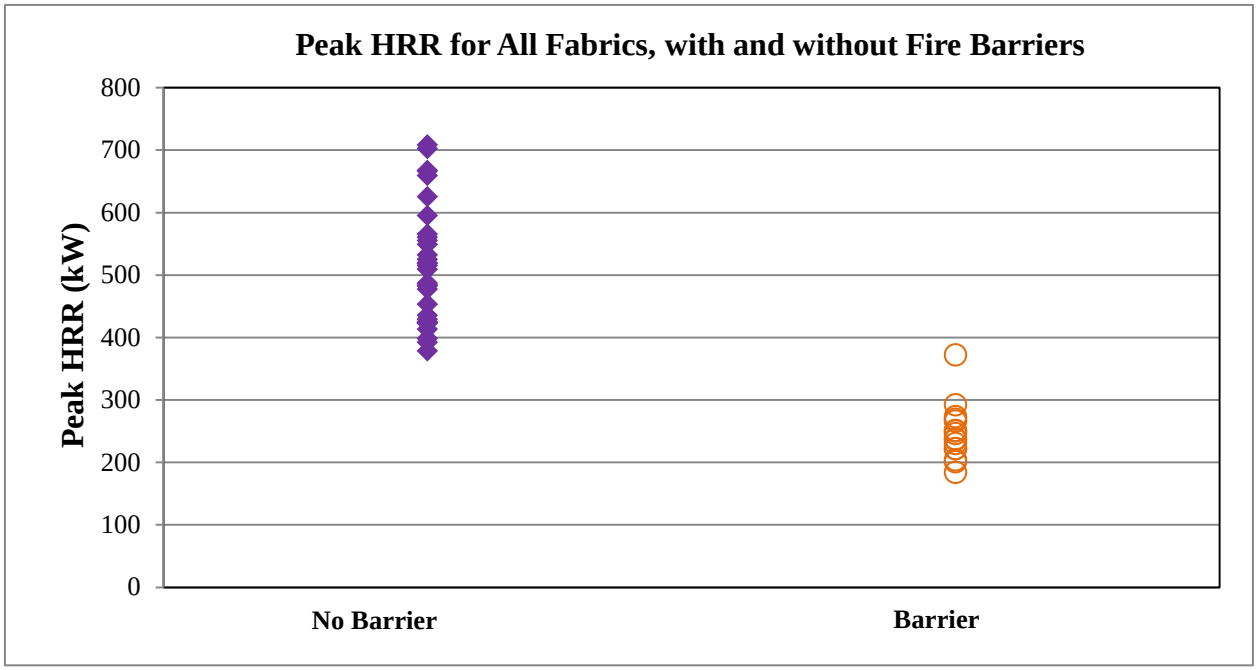


Figure 10. PHRRs for All 64 Tests, Separated by Fire Barrier Use

[10] "Analysis of Chair Open- Flame Data" Memo to Dale Ray, Project Manager, from David Miller, Directorate for Epidemiology, Division of Hazard Analysis. September 16, 2010.

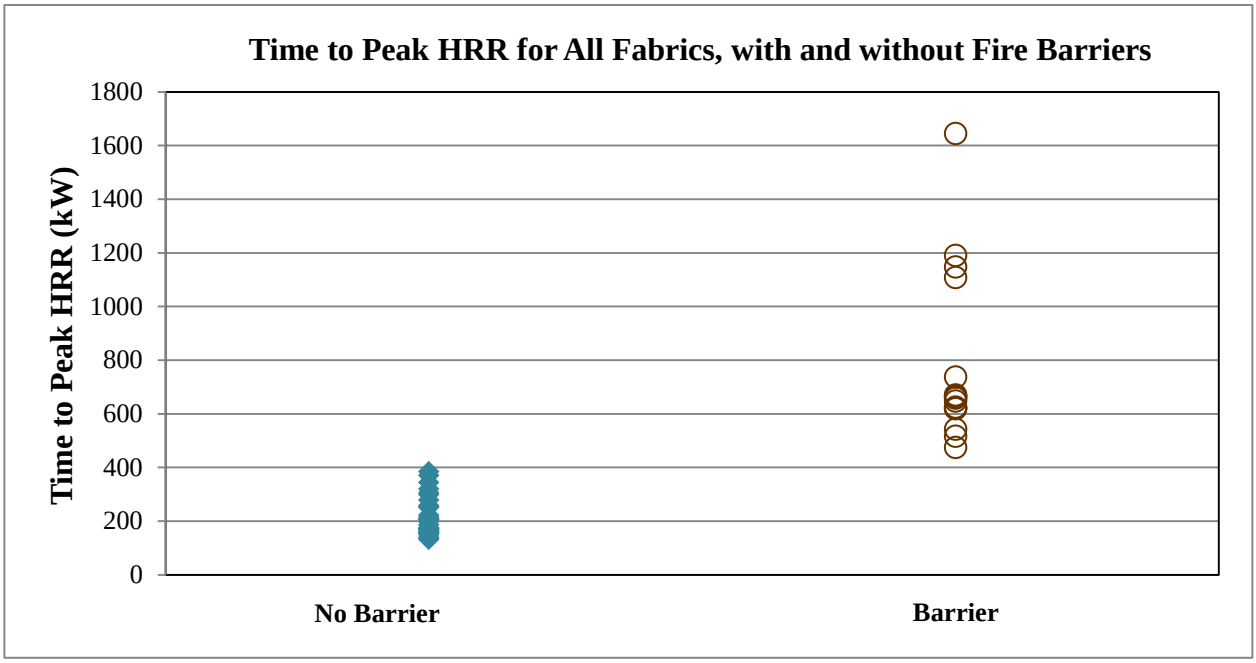


Figure 11. Time to PHRR for All 64 Tests, Separated by Fire Barrier Use

5.2 Foam and Fire Barrier Interaction

To determine whether there is an interaction between the fire barrier and the type of foam used, the data for all the tests without the fabric identifier were examined. All of the PHRR data are shown in Figure 12 to demonstrate the relationship between barriers and foam type. In both cases (*i.e.*, chairs constructed with fire barriers and chairs constructed without fire barriers), there is no clear distinction between the PHRR values for the two types of foam. Additionally, statistical testing of the data shows a 7 percent mathematical difference. The graphs and statistical testing indicate that for open-flame ignitions, the type of foam does not have a practically significant effect on barrier performance as measured by PHRR.

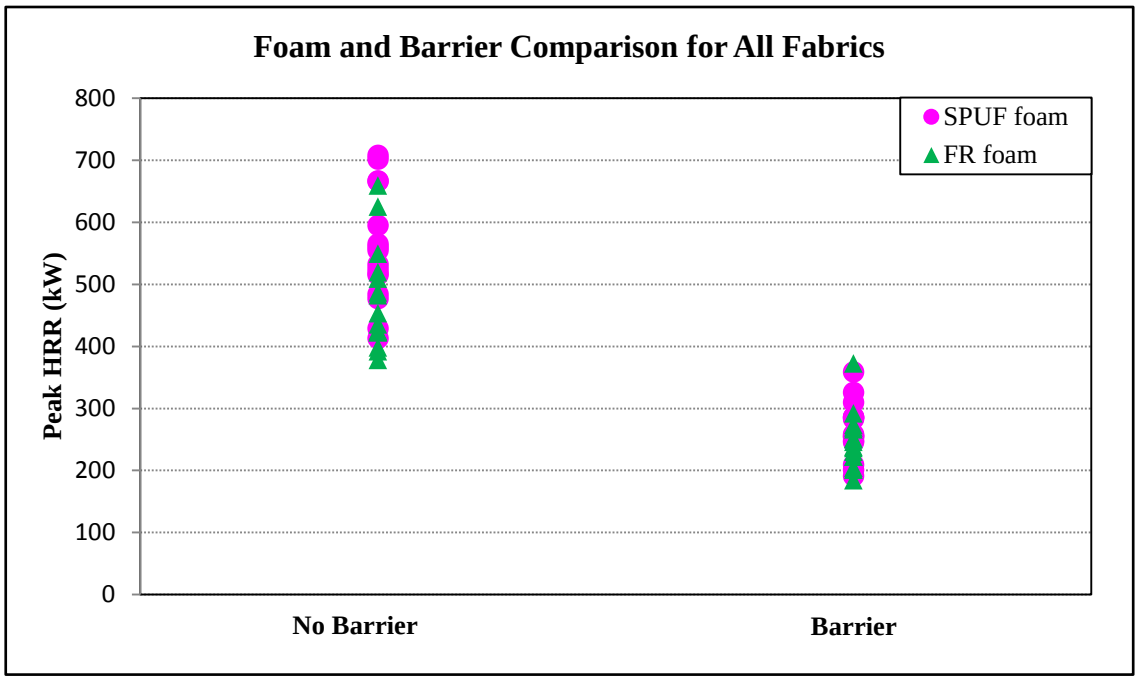


Figure 12. Peak HRR for All Tests

5.3 Fabric and Foam Interaction

As detailed earlier, four fabrics (1a, 1b, 2a, and 2b) that previously demonstrated a range of smolder propensity were included in this study. Two commercially available foams were used in this study—one FR and one non-FR (SPUF)—as found in the marketplace.

The test data for chairs with the fire barrier were reviewed to observe the interaction between fabrics and foams, with the fire barrier as a parameter in the behavior. The HRRs for chairs constructed with fabric 1a and with either SPUF or FR foam are shown in Figure 13. The first peaks in the heat release rate for the chairs with SPUF and with the FR occur in the same region. The values of the peaks are not significantly different and overlap in some cases.

The same observations were made for the chairs with the fire barriers in place, as shown in Figure 14. Figures 5 and 6 are compilations of the values and times of the first peaks for all the fabrics. There are no distinct separations for the data between the types of foams, indicating a similar performance for all the fabrics. This observation is further confirmed by the analysis provided by EPI,[10] in which a statistically significant interaction was not found between the fabrics and foams and their effect on the PHRR of the chairs.

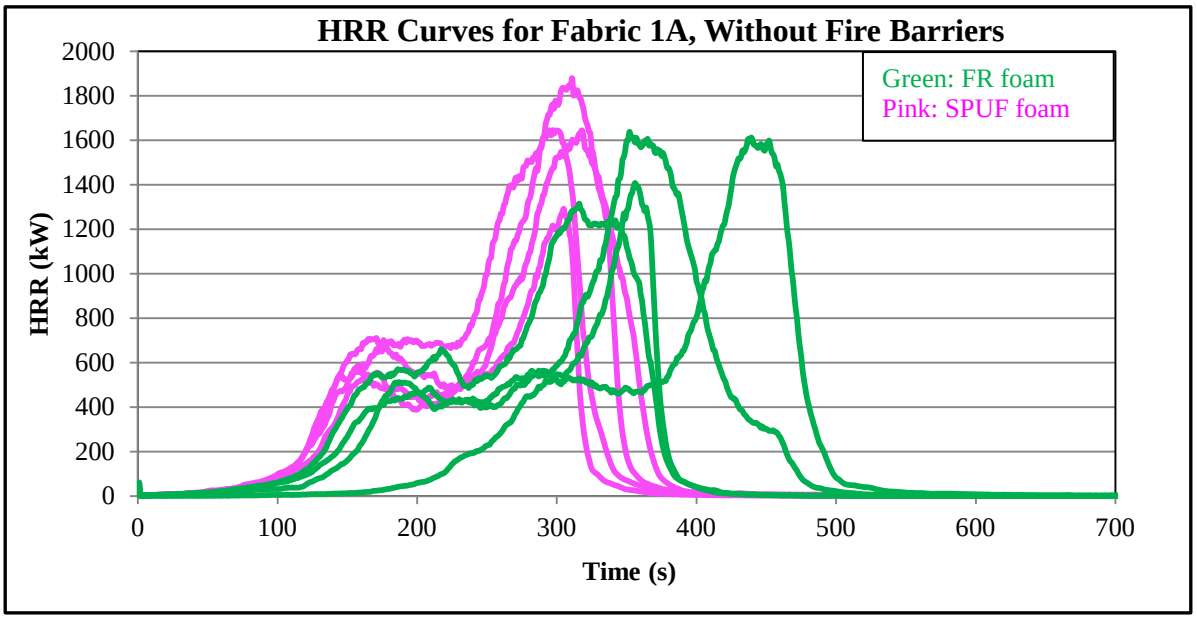


Figure 13. Heat Release Rate Curves for Fabric 1a Without Fire Barriers for SPUF and FR Foam

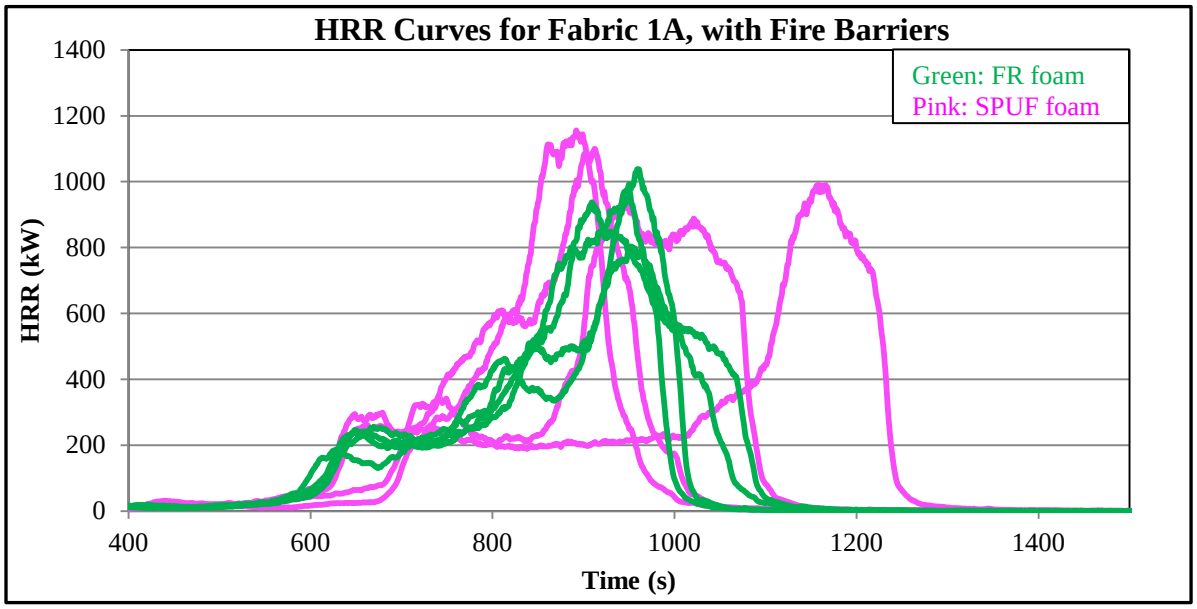


Figure 14. Heat Release Rate Curves for Fabric 1a with Fire Barriers for SPUF and FR foam

5.4 Fabric and Fire Barrier Interaction

The fabrics used in the test chair samples were fabrics that either have a high propensity to smolder, (fabrics 1a and 1b, consistent smolder behavior), or have a moderate propensity to smolder, fabrics 2a and 2b (inconsistent smolder behavior). Staff expects that under the proposed standard these fabrics would require a fire barrier.

Between the highly smolder-prone fabrics (1a and 1b), fabric 1b was the better performing fabric when no fire barrier was present; the tests resulted in the lowest PHRRs and the highest times to PHRR (as shown in Figures 5 and 6). However, adding a fire barrier did not significantly change the results for fabric 1b as it did for fabric 1a. The PHRR values for fabric 1b are very close for the chairs with and without fire barriers, as shown in Figure 13. Fabric 1a showed a considerable decrease in PHRR and increase in time to PHRR when a fire barrier was present.

The moderately smolder-prone fabrics (2a and 2b) demonstrated similar flammability behavior in the open-flame ignition tests. Chairs with both cover fabrics and the fire barrier showed a lower value of PHRR and substantial increase in time to PHRR—indicating a slower growing, smaller fire—than chairs without fire-barriers.
While the addition of a fire barrier affected the fire behavior of the chairs, the magnitude of the difference varied. Three of the four fabrics—1a, 2a and 2b—demonstrated a sizeable change in the value of PHRR and the time to PHRR. These three fabrics had similar area densities, while fabric 1b was more than twice the weight. The results suggest that the area density of the cover fabric has a beneficial influence on the effect that the fire barrier has on the flammability behavior of the chairs.

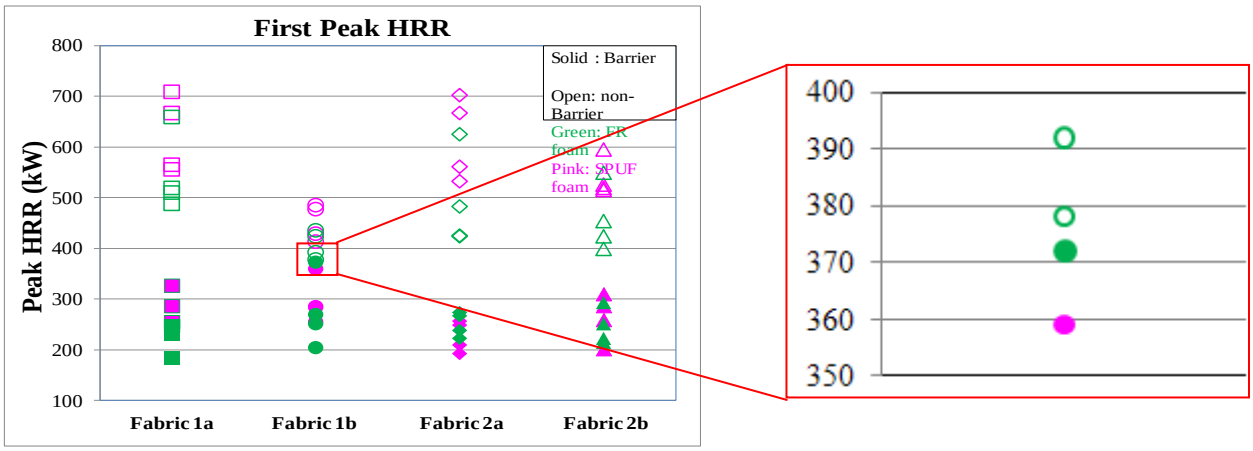


Figure 15. Close-Up of Fabric 1b Data

5.5 Effect on Life Safety

The life safety hazards associated with a fire may include: heat (heat flux and temperature), toxic gases, and smoked obscuration (loss of visibility for quick egress). In these experiments, quantitative measures of heat release rates and temperature were made; and qualitative measures of visibility were made by test operators.

5.5.1 Temperature and Heat Flux

Heat is transferred from the source to surrounding objects by conduction, convection, and radiation, either singularly, or in combination. Frequently, the hazard from the fire to a person is simplified as an exposure temperature for a prescribed duration. In the room of origin, an occupant will be exposed to heat primarily through convection and radiation, quantified by temperature and heat flux.[11] It is generally estimated that the tenability limit

[11] Heat flux is defined by heat release rate over an area (kW/m^2).

due to convected heat near the occupant is 120ºC (248ºF) or to radiant heat fluxes above 2.5kW/m^2.[12] Above this limit, the onset of pain is rapid, and burns can develop within a few minutes or less, as temperatures increase above this threshold. These limits are affected by factors that influence the rate at which the skin temperature itself is elevated, such as clothing, fit of clothing, humidity, air flow, and skin thickness, which can mitigate or exacerbate the impact of the heat transfer to the victim's skin for a given heat level and exposure time. Therefore, the numerical values of temperature (120ºC) and heat flux (2.5kW/m^2) are used as a basis for discussion rather than as absolute limits.

Comparisons of the effects of the various chair constructions on tenability are made by examining the temperatures at approximately five feet above the floor, two feet above the floor, and the heat flux at the floor, in the center of the room. The 5-foot elevation can be considered the face height of a typical, standing person, the lower elevations depicting a crawling person. Figures 16 and 17 show the time at which the tenability limit of 120ºC occurs near the chair and near the door, respectively, at two different heights. Figure 18 shows the time at which the tenability limit of 2.5 kW/m^2 occurs at the center of the room, at floor level.

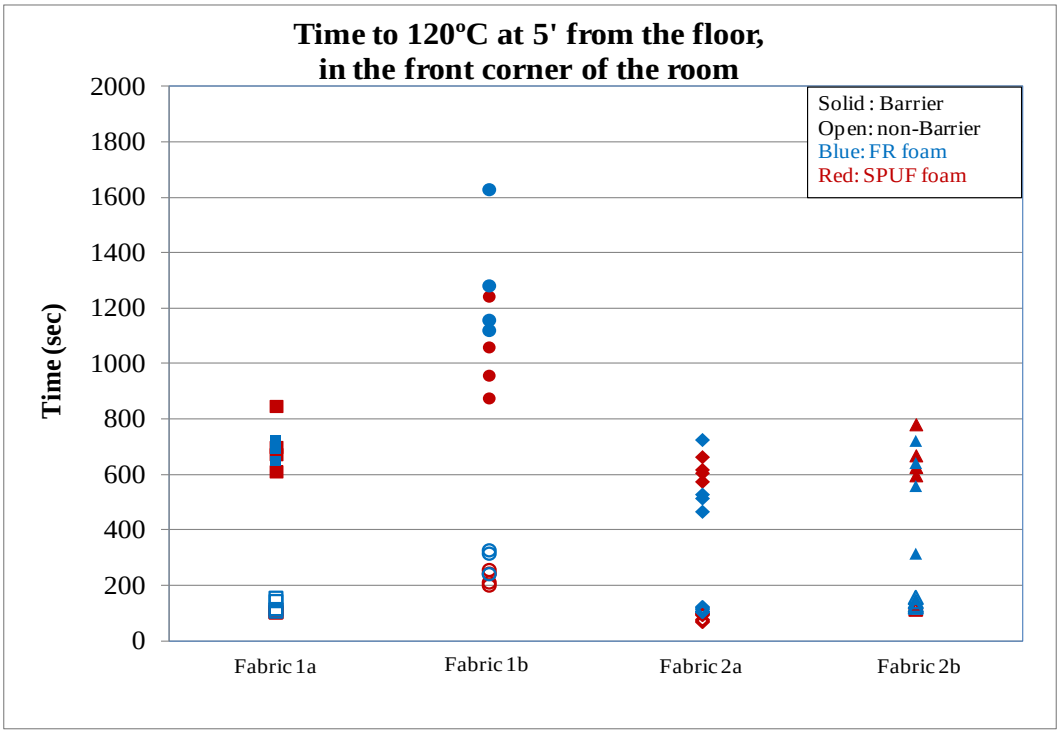


Figure 16 a. Time to 120ºC for All 64 tests, Taken at Five Feet from Floor, Near Door

[12] Purser, D.A., "Assessment of Hazards to Occupants from Smoke, Toxic Gases, and Heat" The SFPE Handbook of Fire Protection Engineering. 4th Ed, 2008. Pp 2-141-142.

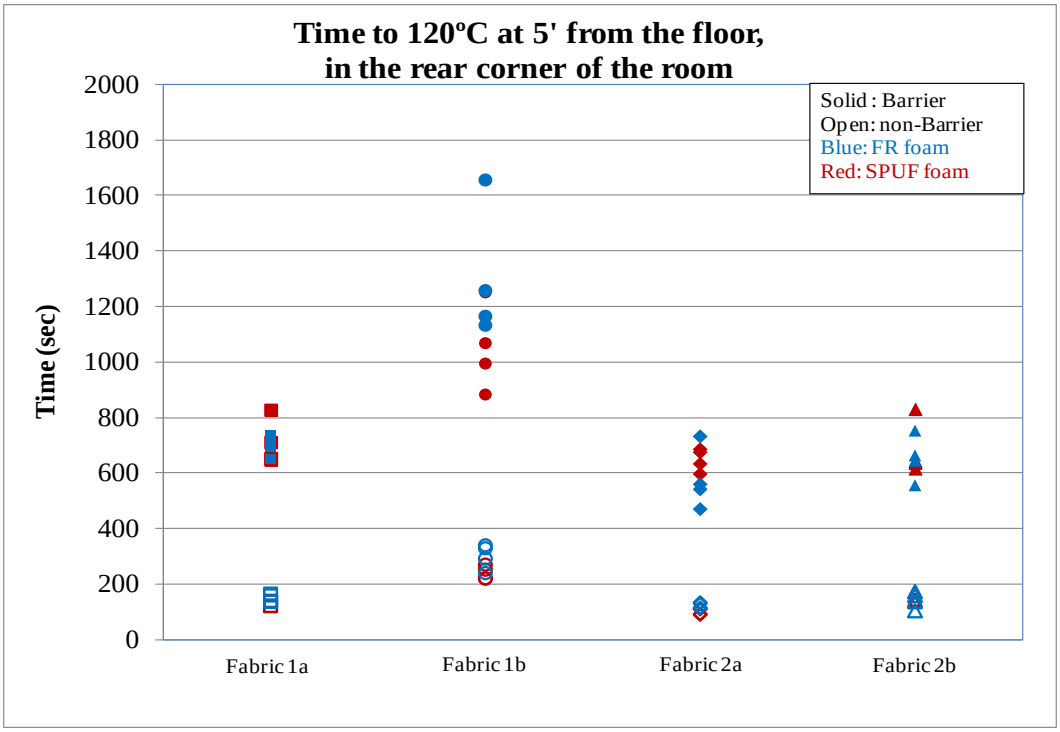


Figure 16 b. Time to 120ºC for All 64 Tests, Taken Five Feet from the Floor, Near Chair

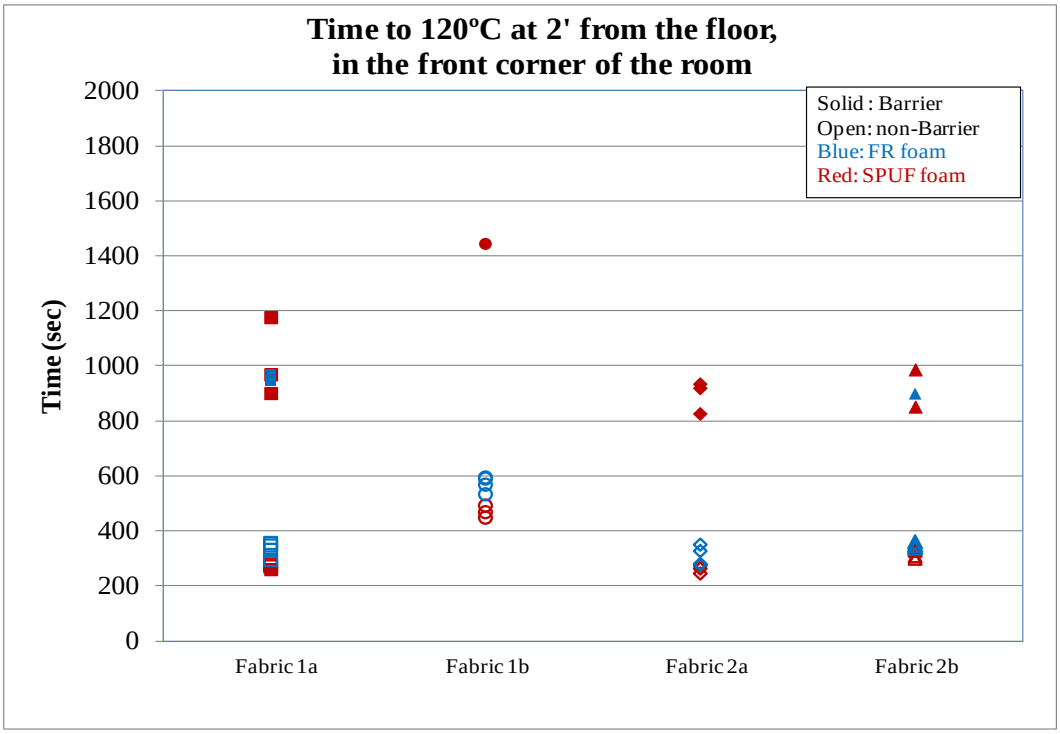


Figure 17 a. Time to 120ºC for All 64 Tests, Taken at Two Feet from the Floor, Near Door

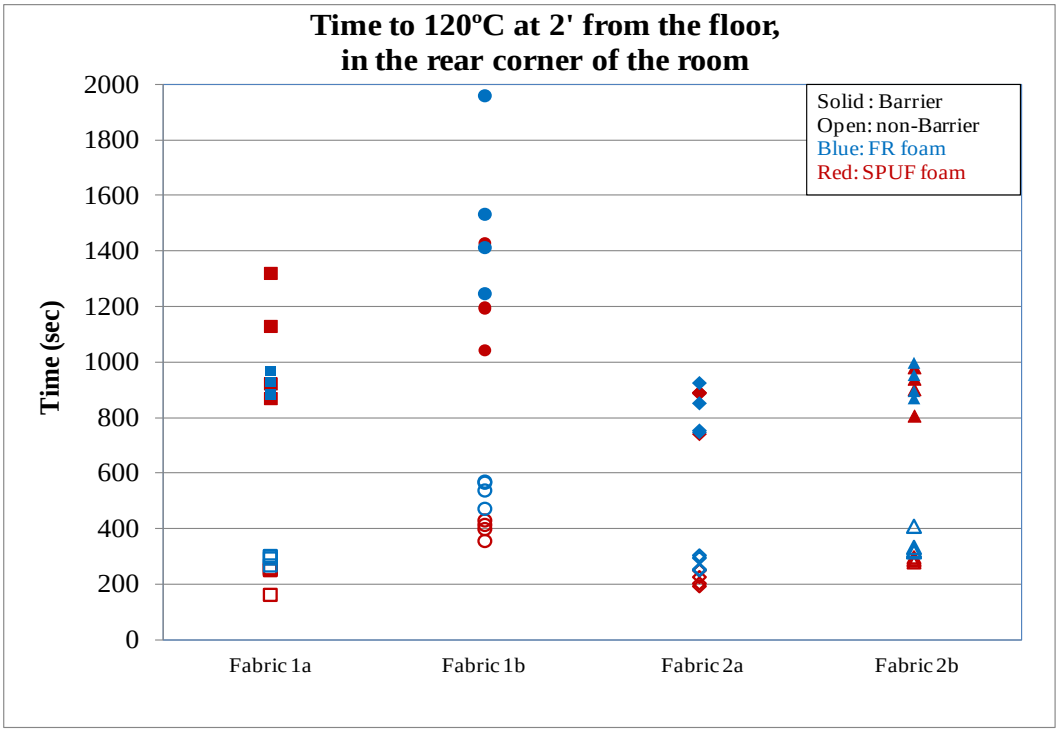


Figure 17 b. Time to 120ºC for All 65 Tests, Taken at Two Feet from the Floor, Near Chair

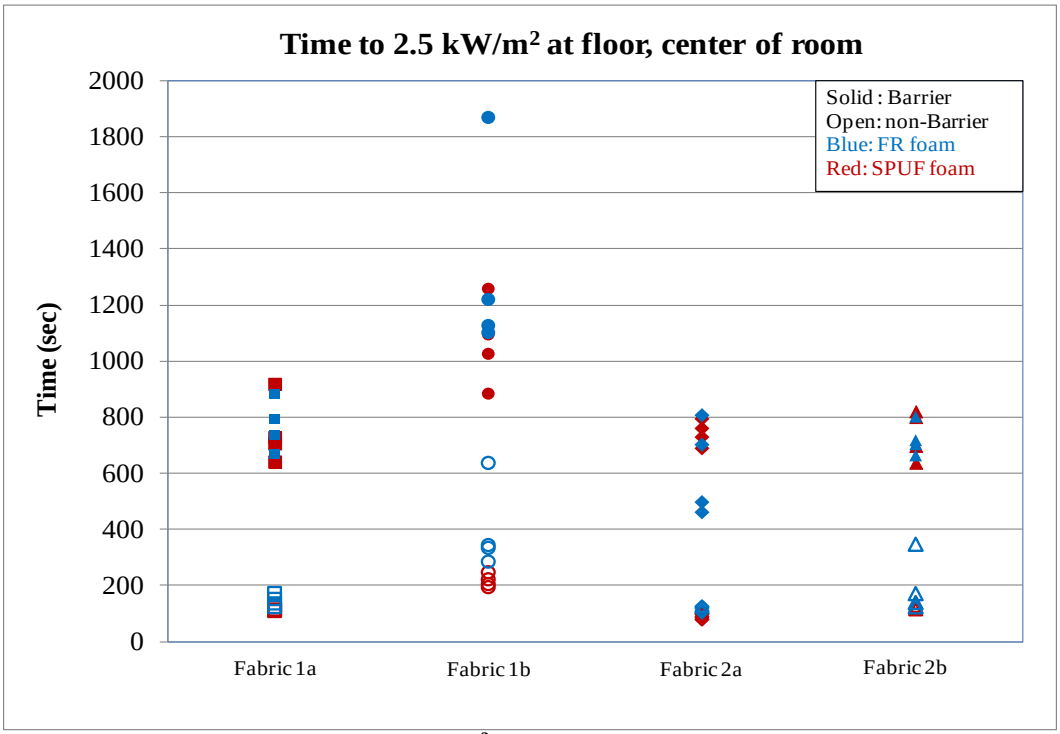


Figure 18. Time to 2.5kW/m^2 for All 64 Tests, Taken at the Floor

Although the absolute times for which the limits occur differ, the distribution of the data is similar to the time to PHRR, indicating that the chairs with fire barriers markedly improve tenability time, regardless of metric used.

5.5.2 Visibility Measurements

Qualitative visibility measurements were taken during each test. A paper sign with "NIST" printed on it was placed on the far wall of the room at four feet from the floor. Since only one of the test operators noted when he could no longer see "NIST," the observation was made from the same height each time. In this test series, obscuration of the sign was not consistently indicative of the tenability conditions in the room. Either thick white or black smoke obscured the sign. When the fire was growing quickly and the smoke was full of thick black soot, the sign could often be seen until the time of flashover, whereas in slow growing fires, the sign was obscured early in the fire. These measurements do not aid in examining the effect of the fire barriers in the chairs on egress time improvement.

5.5.3 Carbon Monoxide Measurements

Often, carbon monoxide (CO) measurements are also used in determining tenability of a space during a fire. In this test series, the data were taken outside the room, under the hood. The data were extremely noisy and did not provide any insight into the behavior of CO generation from the chairs.

6 CONCLUSIONS

This test series examined the results of open-flame ignition tests conducted with upholstered furniture chairs. Specifically, the aim of the study was to determine the effect that the selected fire barrier had on the flammability characteristics of the chairs. Sixteen combinations of materials were chosen from materials previously tested by CPSC staff. The cover fabrics used in this series would likely require the use of a fire barrier under the proposed rule. The foams were chosen to represent both an FR and non-FR-treated (SPUF) foam. The data presented in this report are valid only for the materials used in this series; other fabrics, foams, and fire barriers may behave differently. The fabrics chosen for this series, however, represent differing levels of smolder propensity, and thus, they can be expected to illustrate different levels of fire performance with the fire barriers.

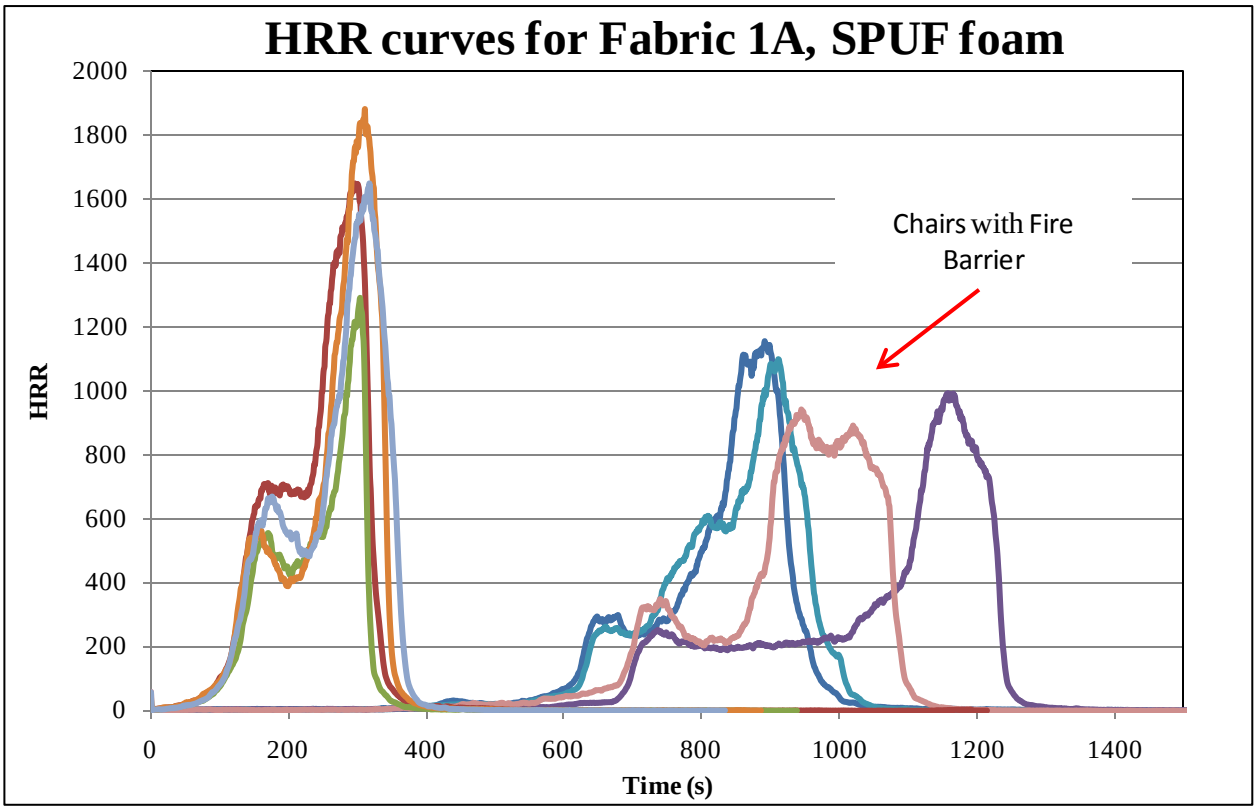
The four fabrics were categorized into two types: very smolder prone and moderately smolder prone. The very smolder-prone fabrics exhibited different burning behaviors from each other with respect to fire size and growth time. Conversely, the moderately smolder-prone fabrics performed similarly to each other and to one of the very smolder-prone fabrics (fabric 1a). This tends to support the widely held view that fabric smolder propensity is not necessarily a good indication of open-flame ignition performance.

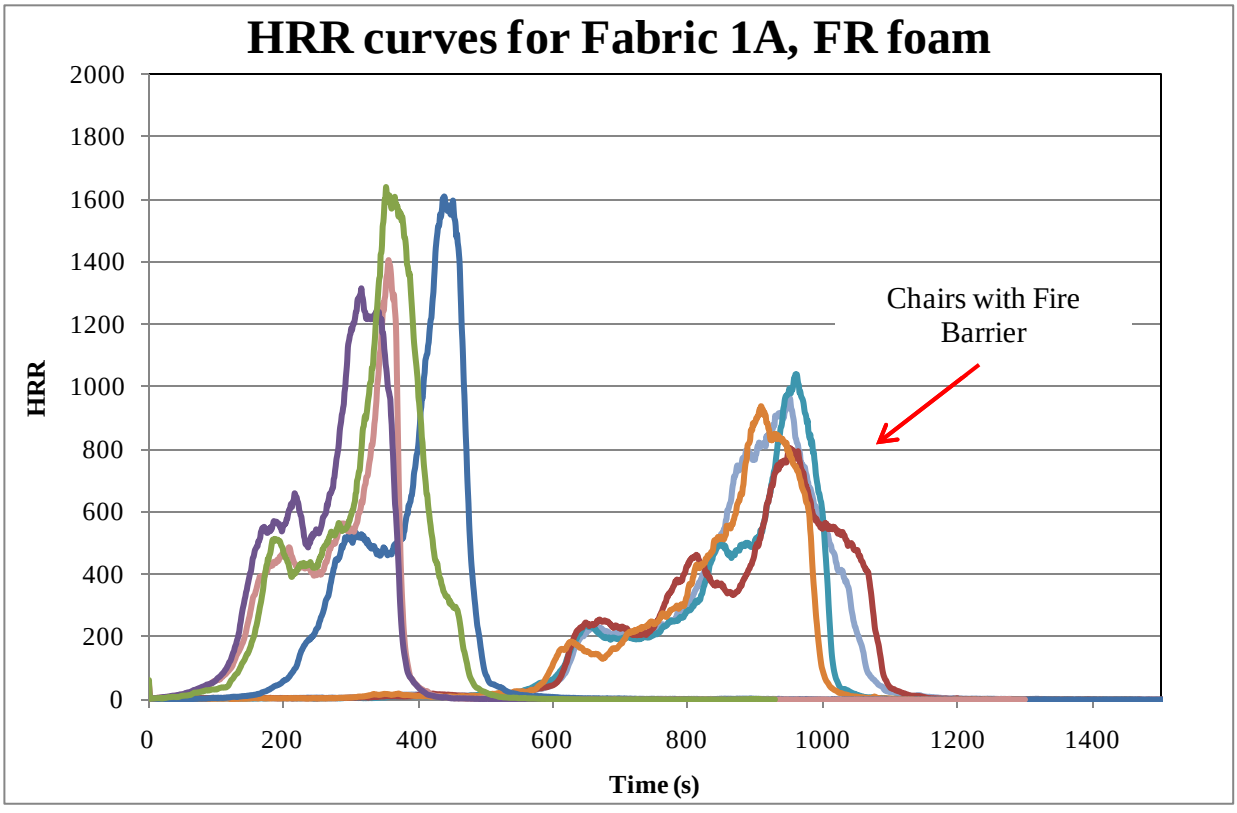
Overall, the results demonstrated that the addition of a fire barrier markedly increased the fire safety of the furniture. The data indicated that the fire sizes were smaller and the time to reach the peak fire size was slower with fire barriers, regardless of the fabric or foams used. Among the other effects examined, a relative difference was noticed in the foams, but the fire-retardant foams did not offer a practically significantly greater level of open-flame safety than did the untreated foams.

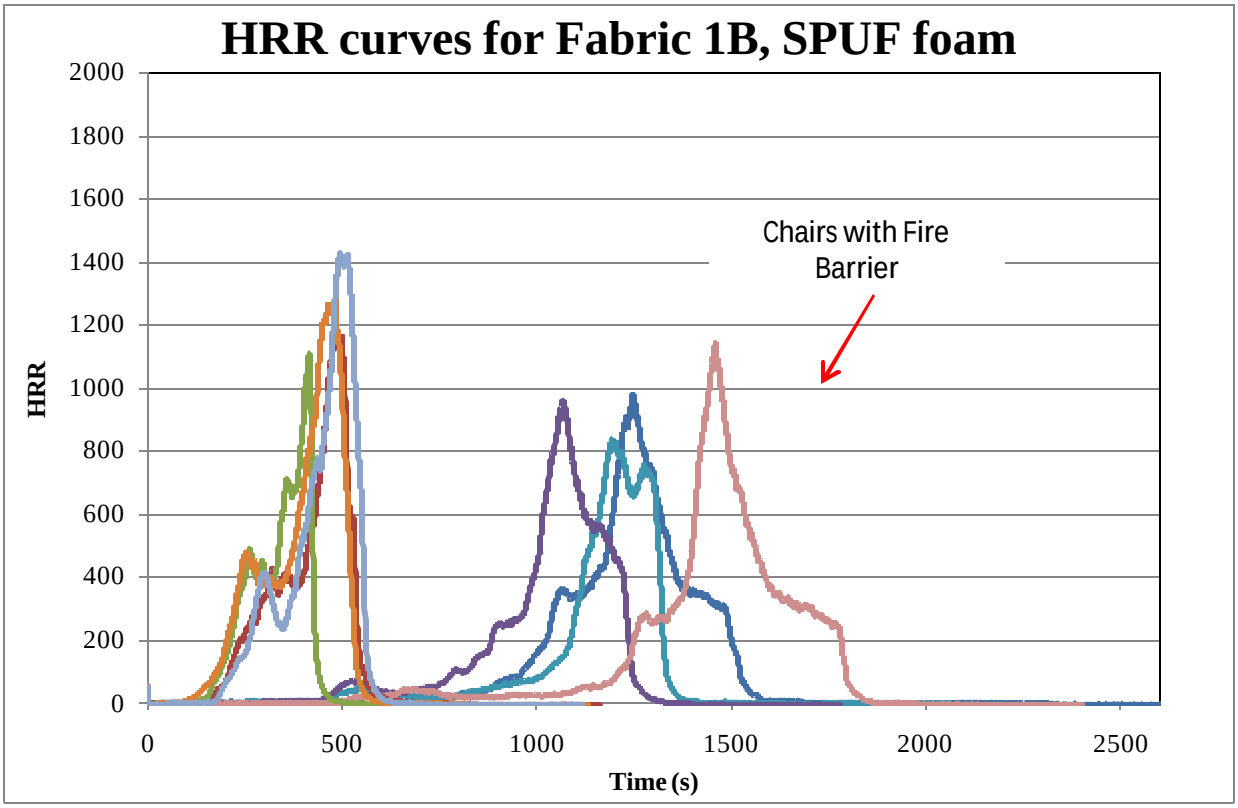
7 APPENDICES

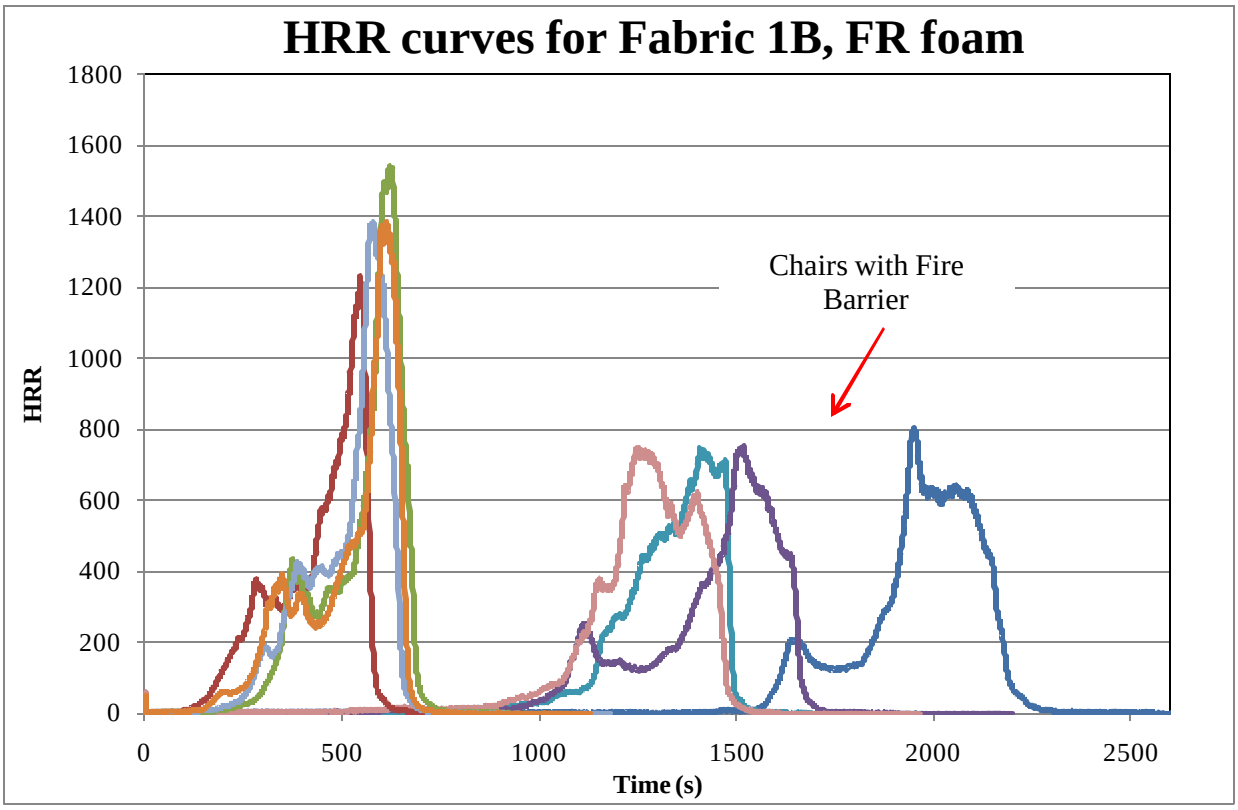
Appendix A. HRR Curves for Tests, by Fabric and Foam Combinations
Appendix B. Temperature Curves for Tests by Fabric and Foam Combinations.
Appendix C. Heat flux curves for the Tests by Fabric and Foam Combinations.
Appendix D. Test Plan

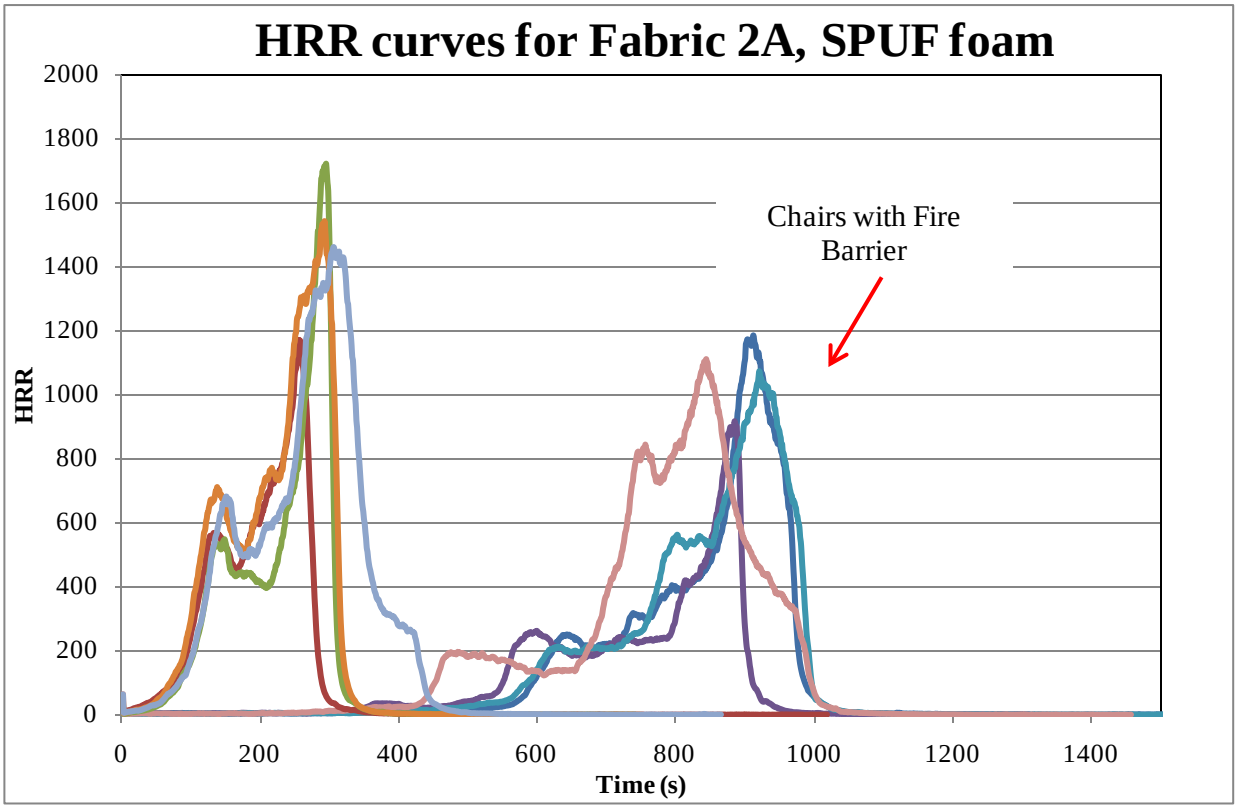
Appendix A. HRR Curves for Tests, by Fabric and Foam Combination

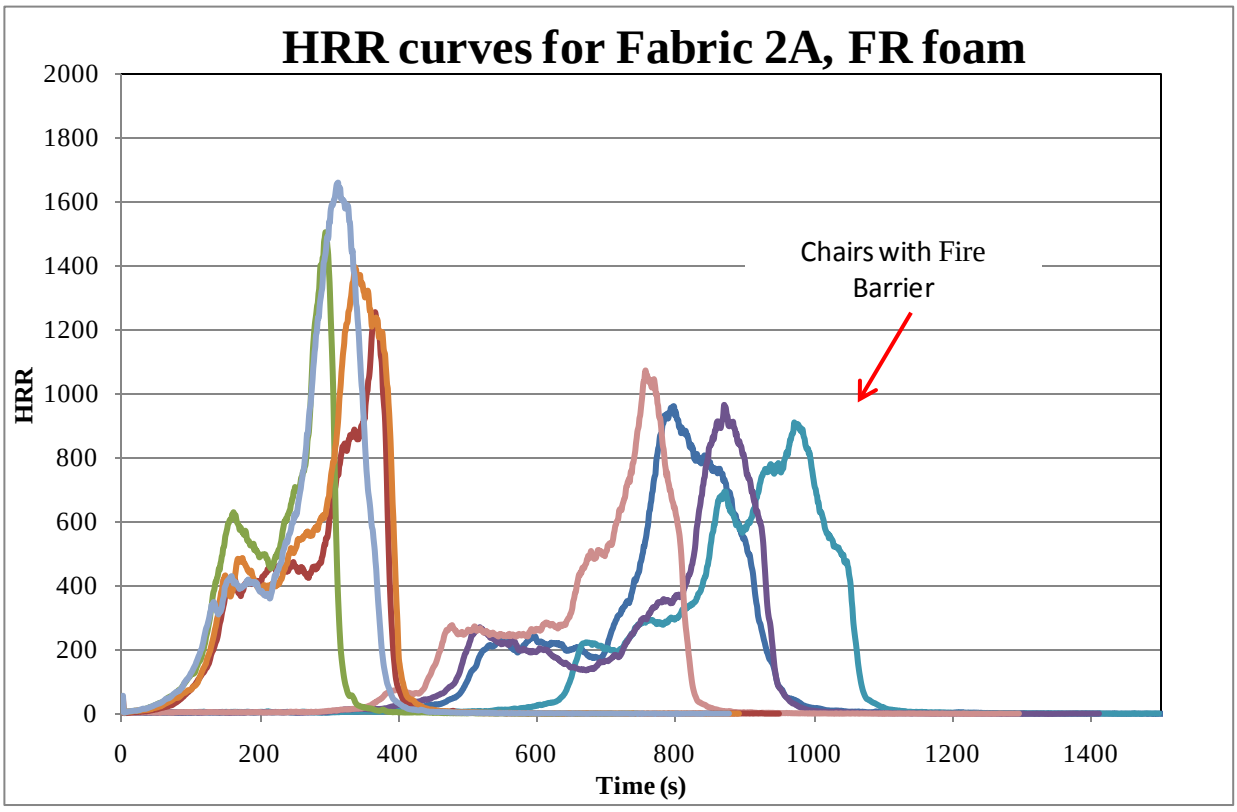





HRR curves for Fabric 1B, SPUF foam
HRR
Time (s)
Chairs with Fire Barrier
0
200
400
600
800
1000
1200
1400
1600
1800
2000
0
500
1000
1500
2000
2500


HRR curves for Fabric 1B, FR foam
HRR
Time (s)
Chairs with Fire Barrier
0
200
400
600
800
1000
1200
1400
1600
1800
0
500
1000
1500
2000
2500


HRR curves for Fabric 2A, SPUF foam
HRR
2000
1800
1600
1400
1200
1000
800
600
400
200
0
0
200
400
600
800
1000
1200
1400
Time (s)
Chairs with Fire Barrier


HRR curves for Fabric 2A, FR foam
HRR
2000
1800
1600
1400
1200
1000
800
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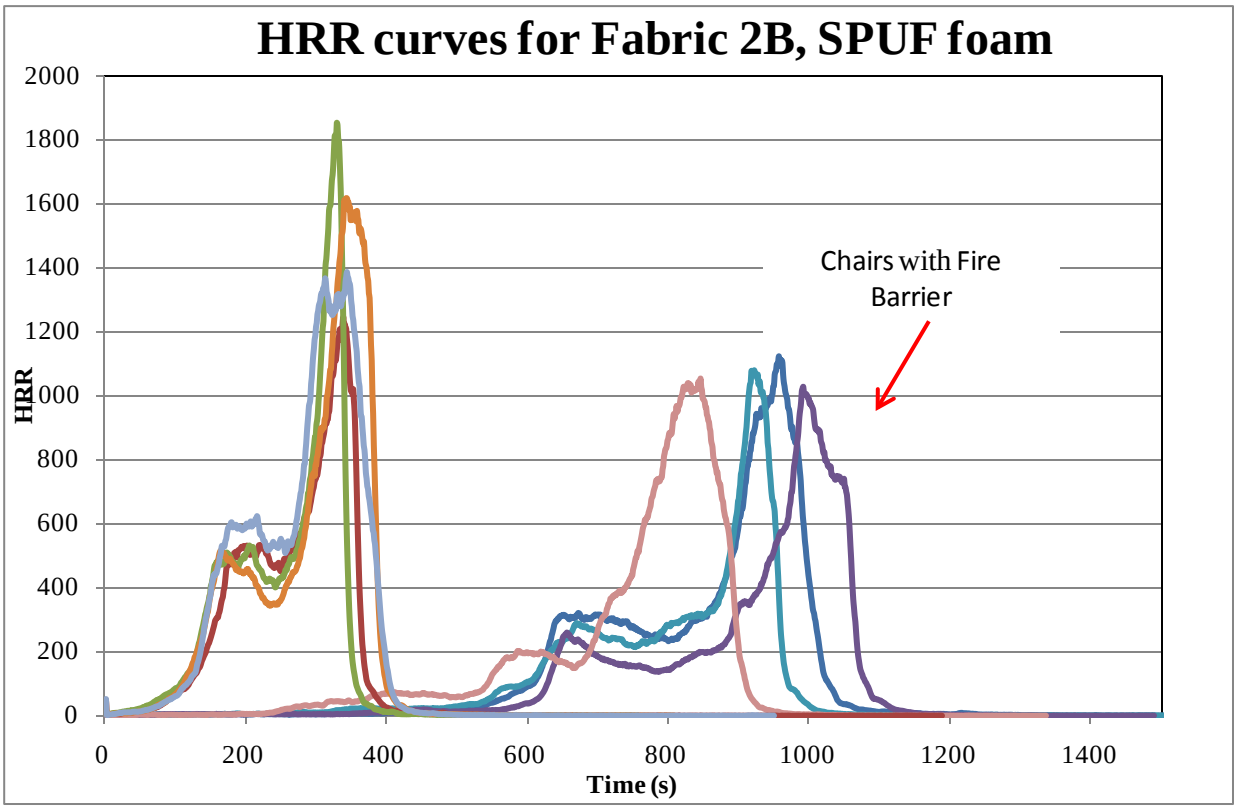
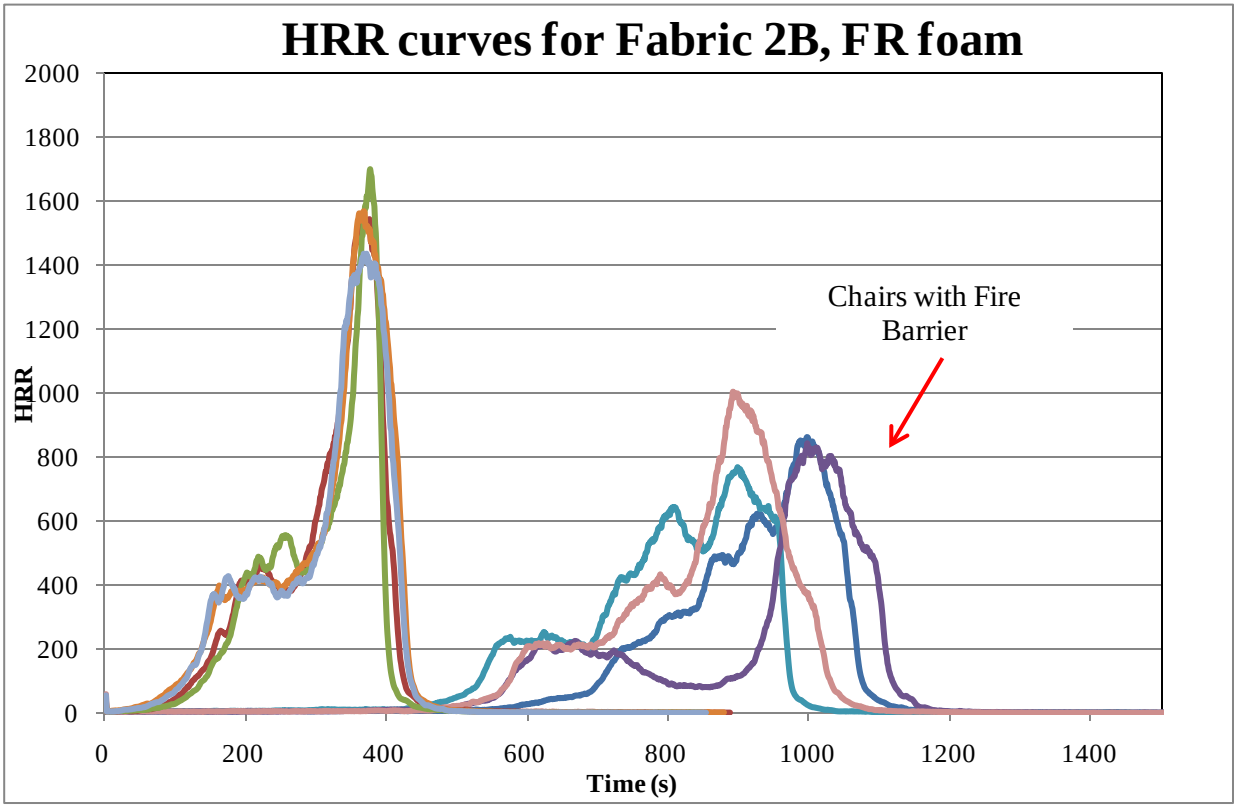
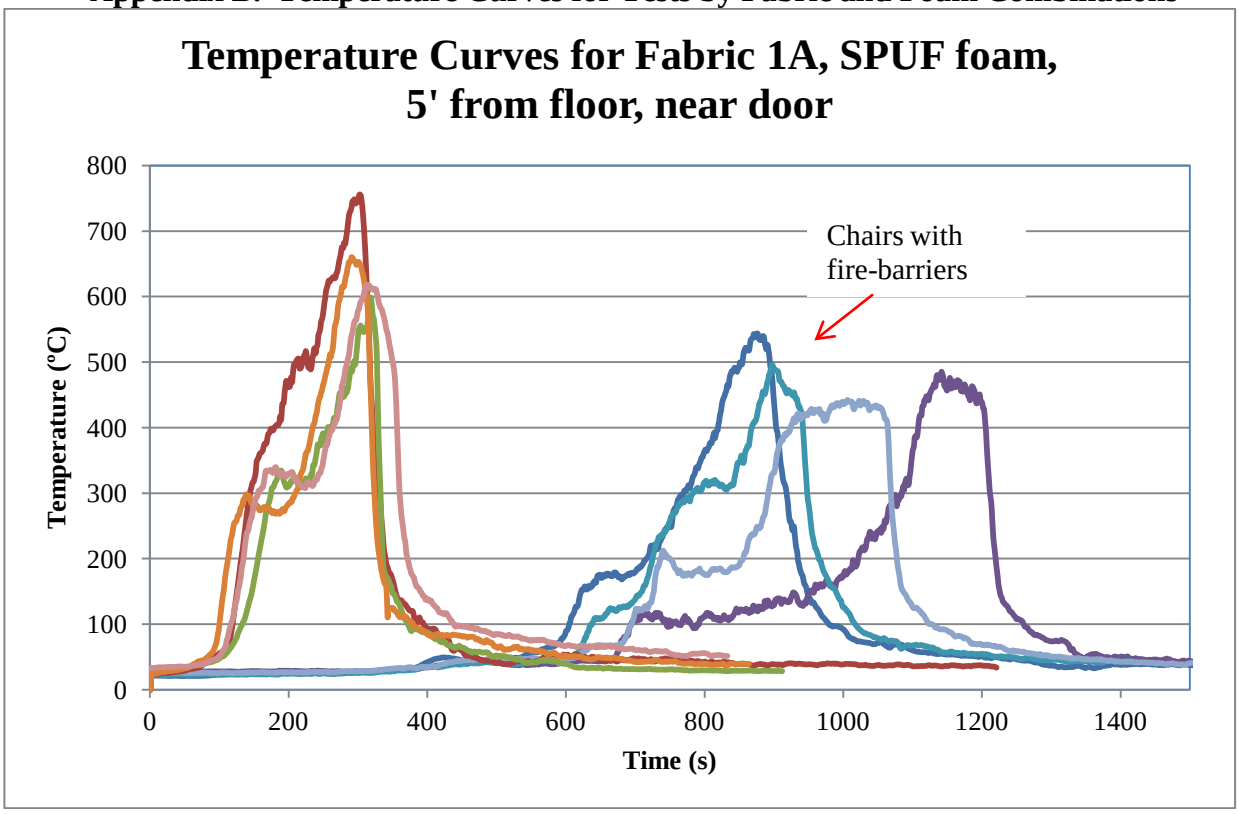
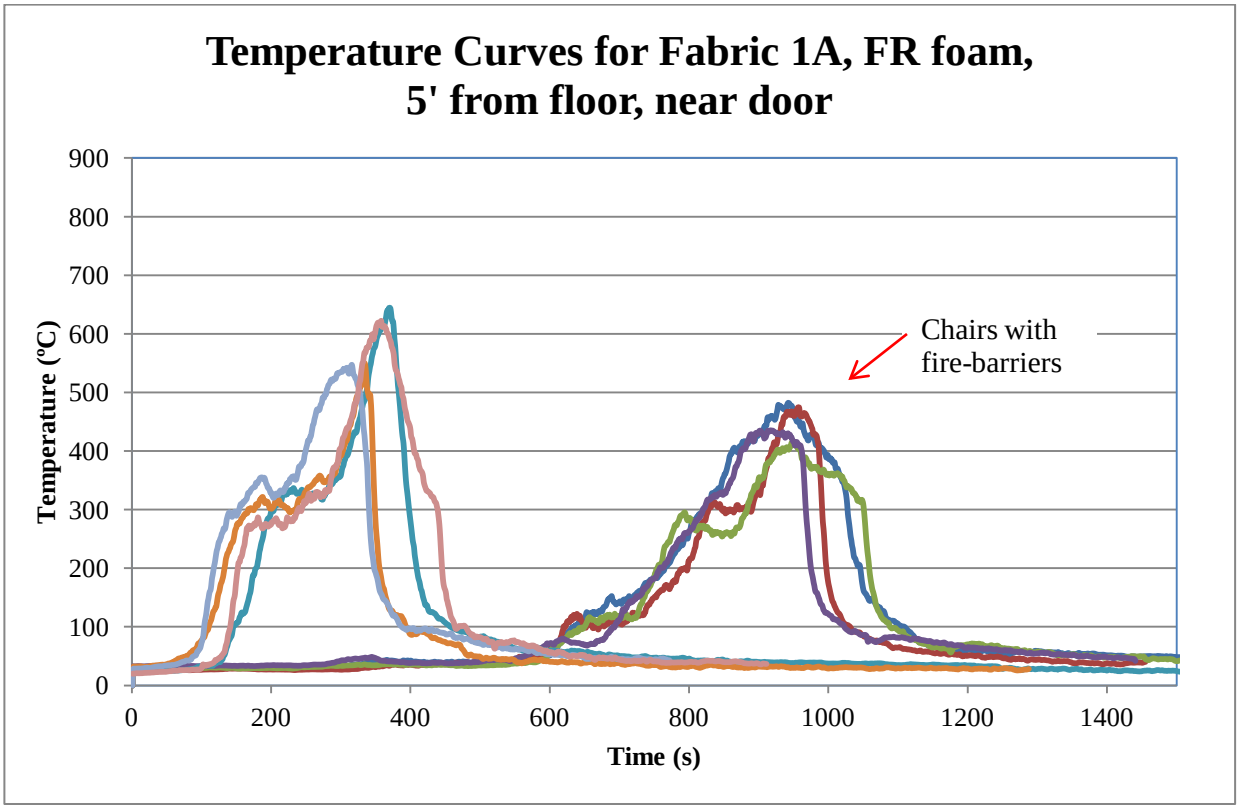
200
400
600
800
1000
1200
1400
Time (s)
Chairs with Fire Barrier

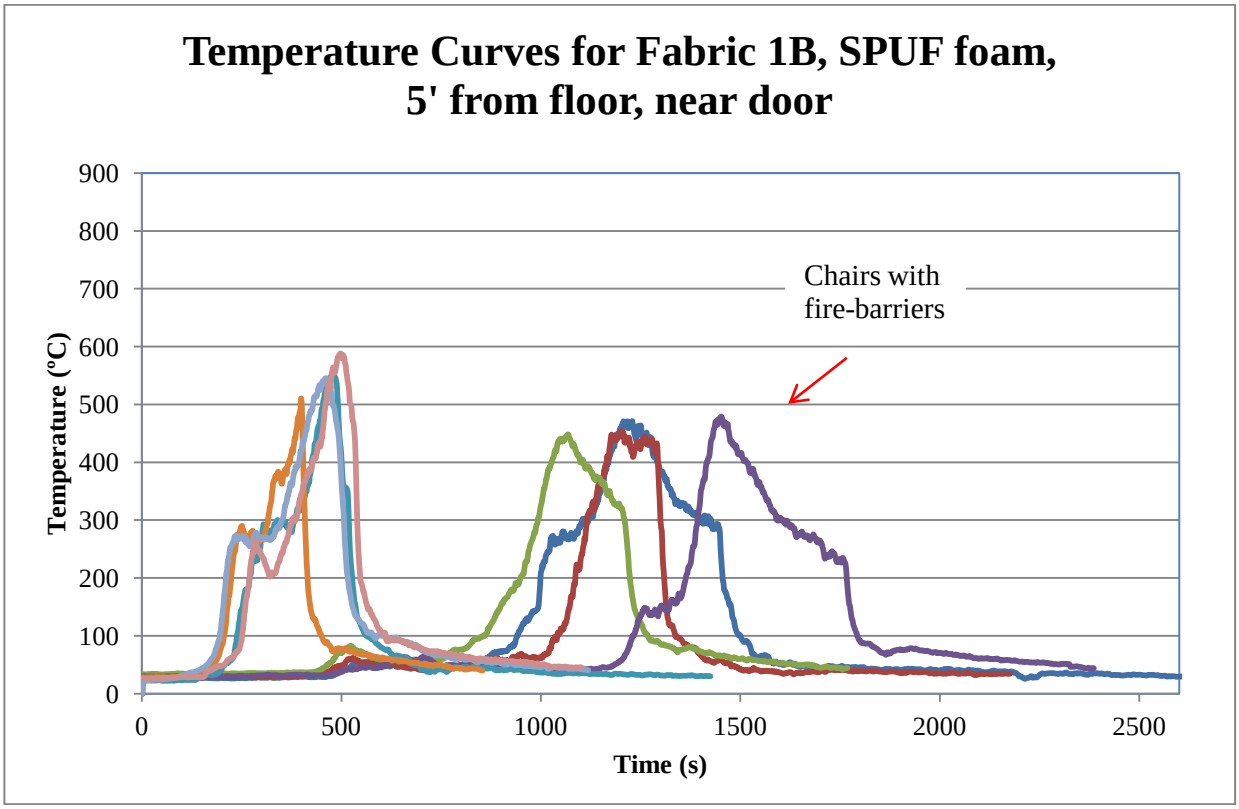

HRR curves for Fabric 2B, SPUF foam
HRR
Time (s)
Chairs with Fire Barrier
0
200
400
600
800
1000
1200
1400
1600
1800
2000

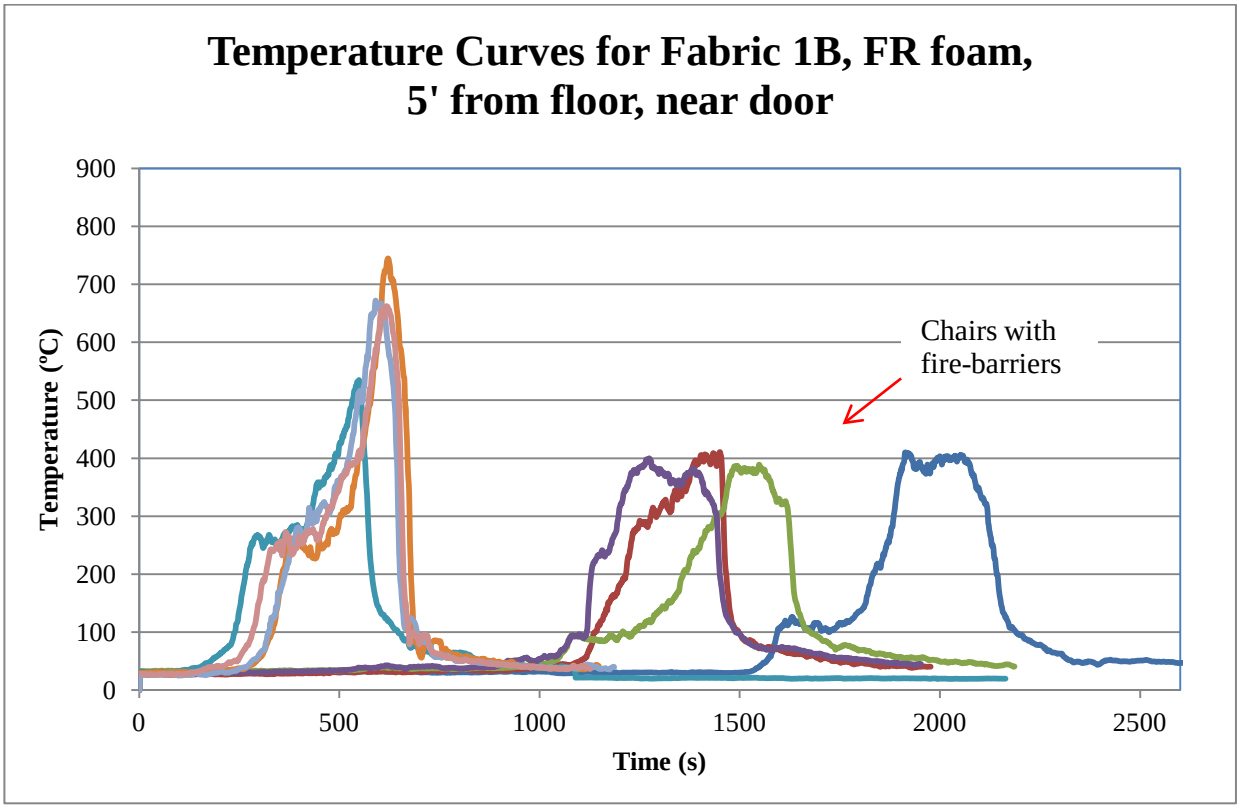

HRR curves for Fabric 2B, FR foam
HRR
Time (s)
Chairs with Fire Barrier
0
200
400
600
800
1000
1200
1400
1600
1800
2000

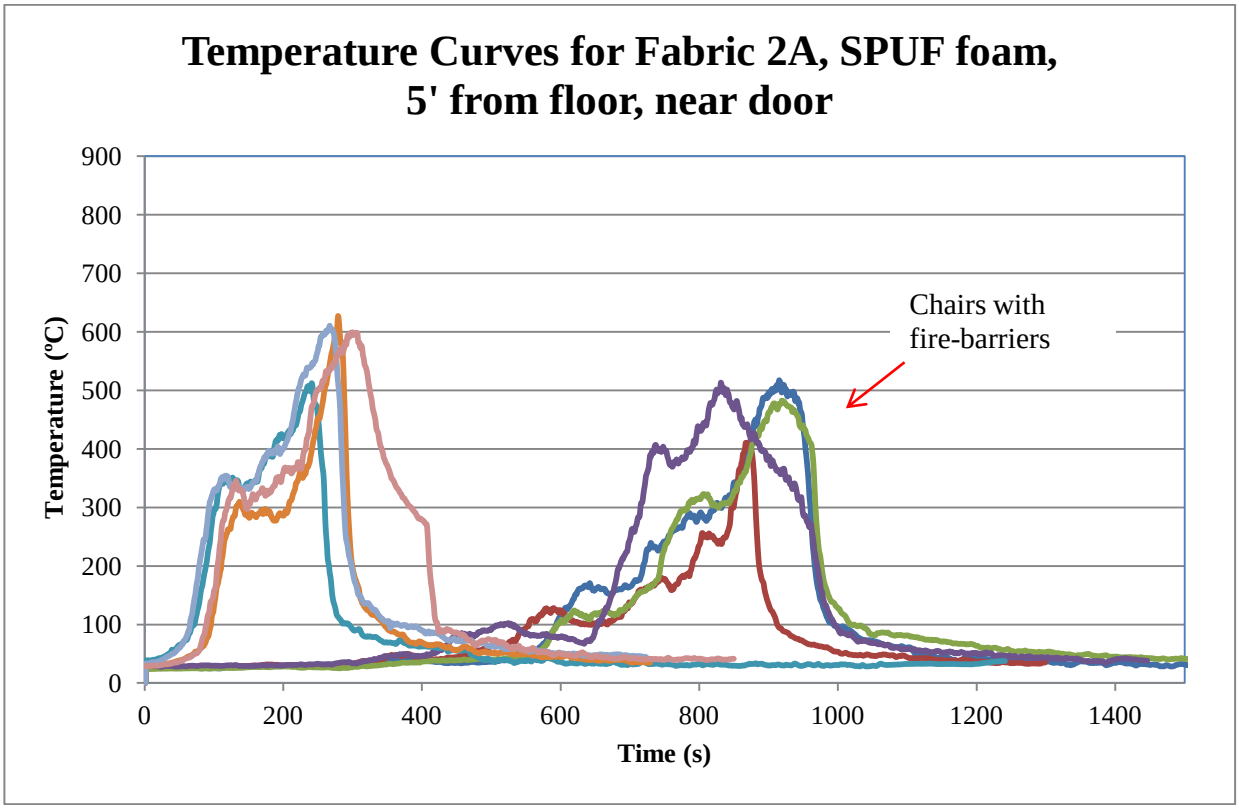
Appendix B. Temperature Curves for Tests by Fabric and Foam Combinations

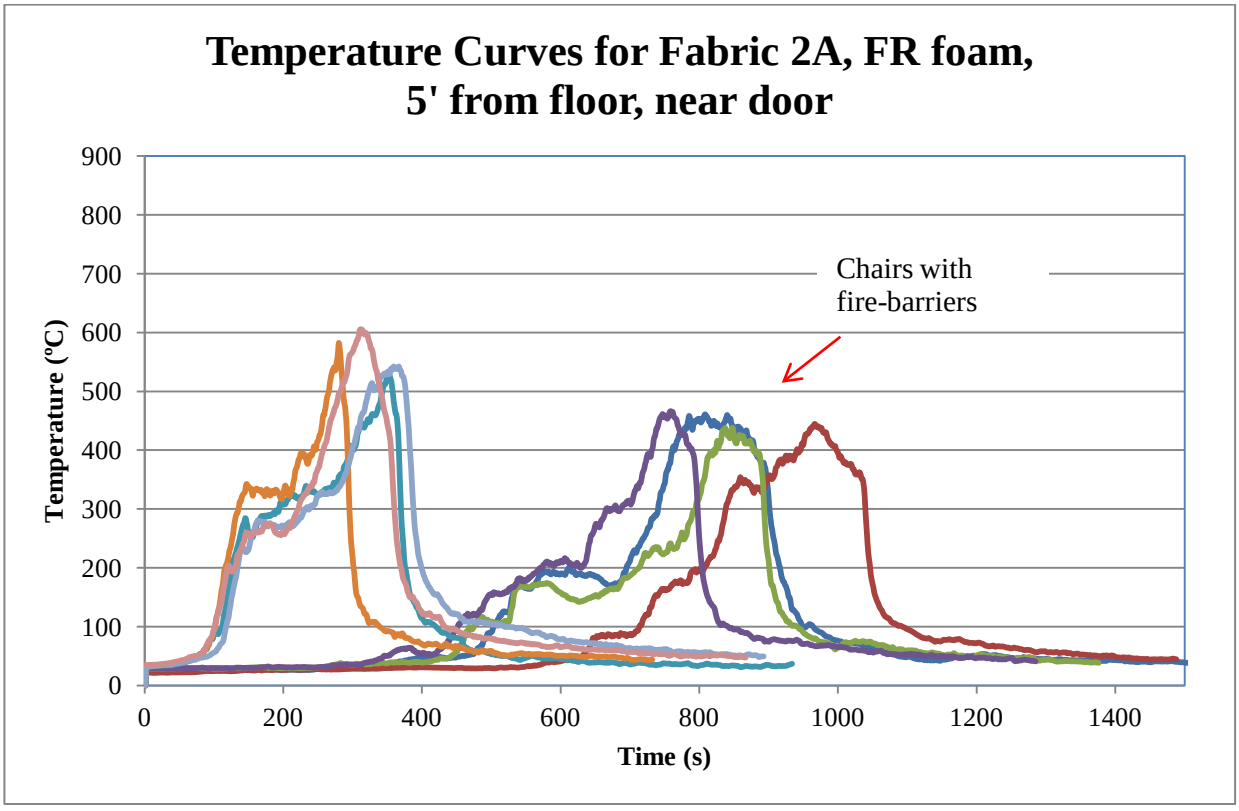





Temperature Curves for Fabric 1B, SPUF foam,
5' from floor, near door
Chairs with
fire-barriers
Temperature (ºC)
Time (s)
0
100
200
300
400
500
600
700
800
900
0
500
1000
1500
2000
2500


Temperature Curves for Fabric 1B, FR foam,
5' from floor, near door
Chairs with
fire-barriers
Temperature (ºC)
Time (s)
0
100
200
300
400
500
600
700
800
900
0
500
1000
1500
2000
2500


Temperature Curves for Fabric 2A, SPUF foam,
5' from floor, near door
Temperature (ºC)
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
1400
Time (s)
Chairs with
fire-barriers


Temperature Curves for Fabric 2A, FR foam,
5' from floor, near door
Temperature (ºC)
900
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100
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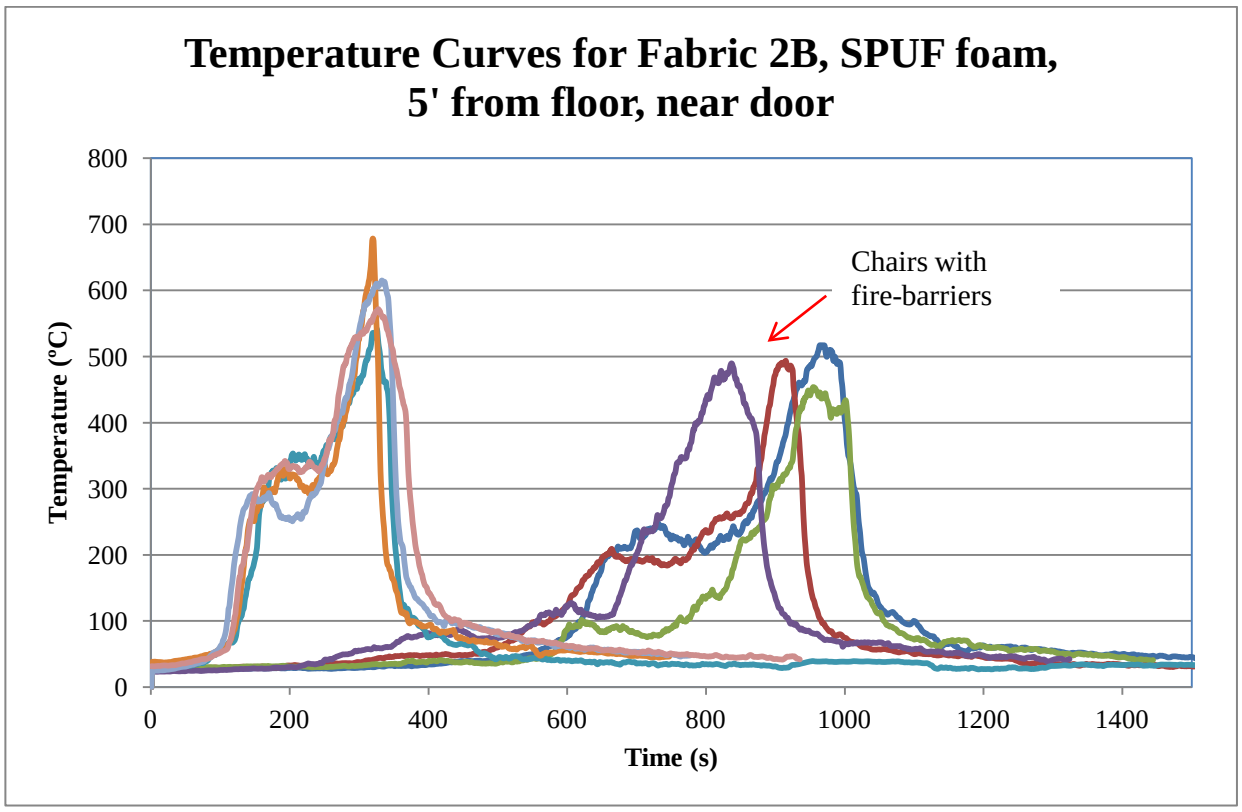
200
400
600
800
1000
1200
1400
Time (s)
Chairs with
fire-barriers


Temperature Curves for Fabric 2B, SPUF foam,
5' from floor, near door
Temperature (°C)
800
700
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100
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200
400
600
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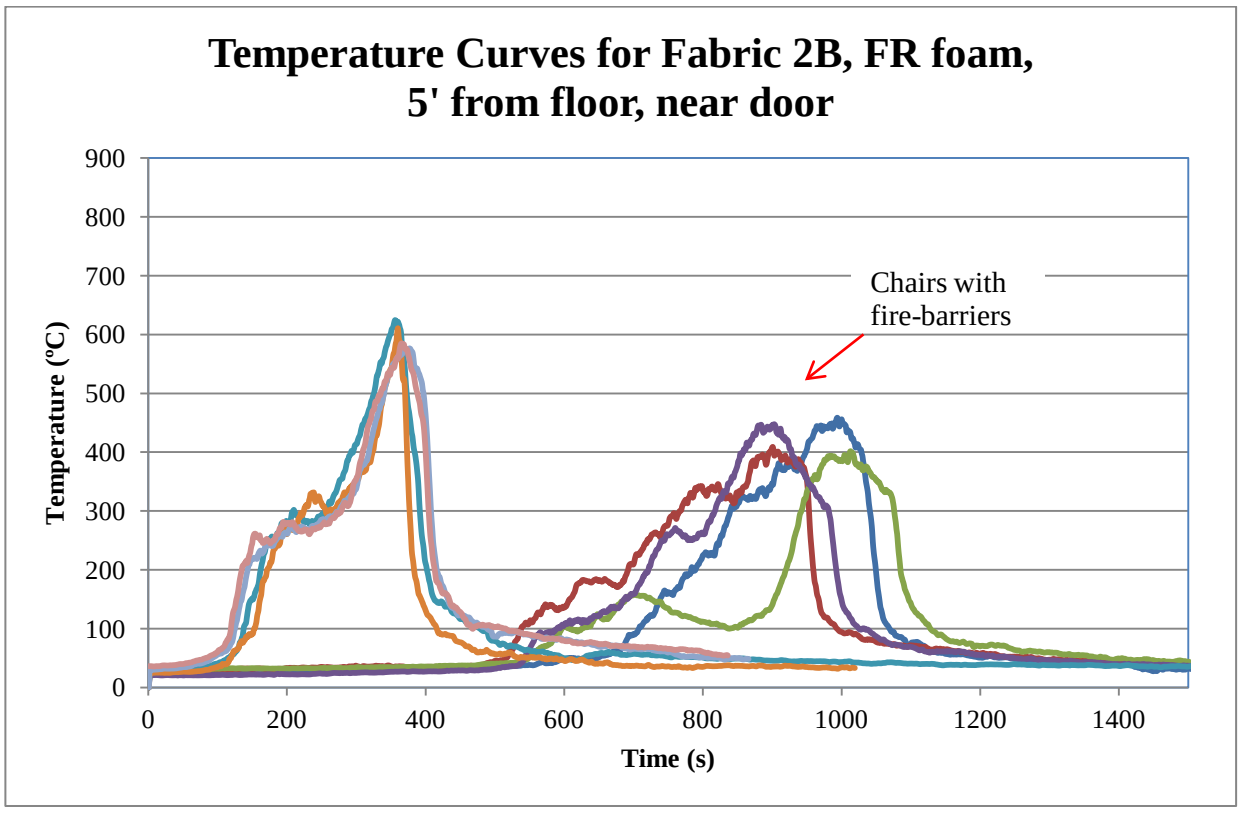
1000
1200
1400
Time (s)
Chairs with
fire-barriers


Temperature Curves for Fabric 2B, FR foam,
5' from floor, near door
Temperature (°C)
900
800
700
600
500
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200
400
600
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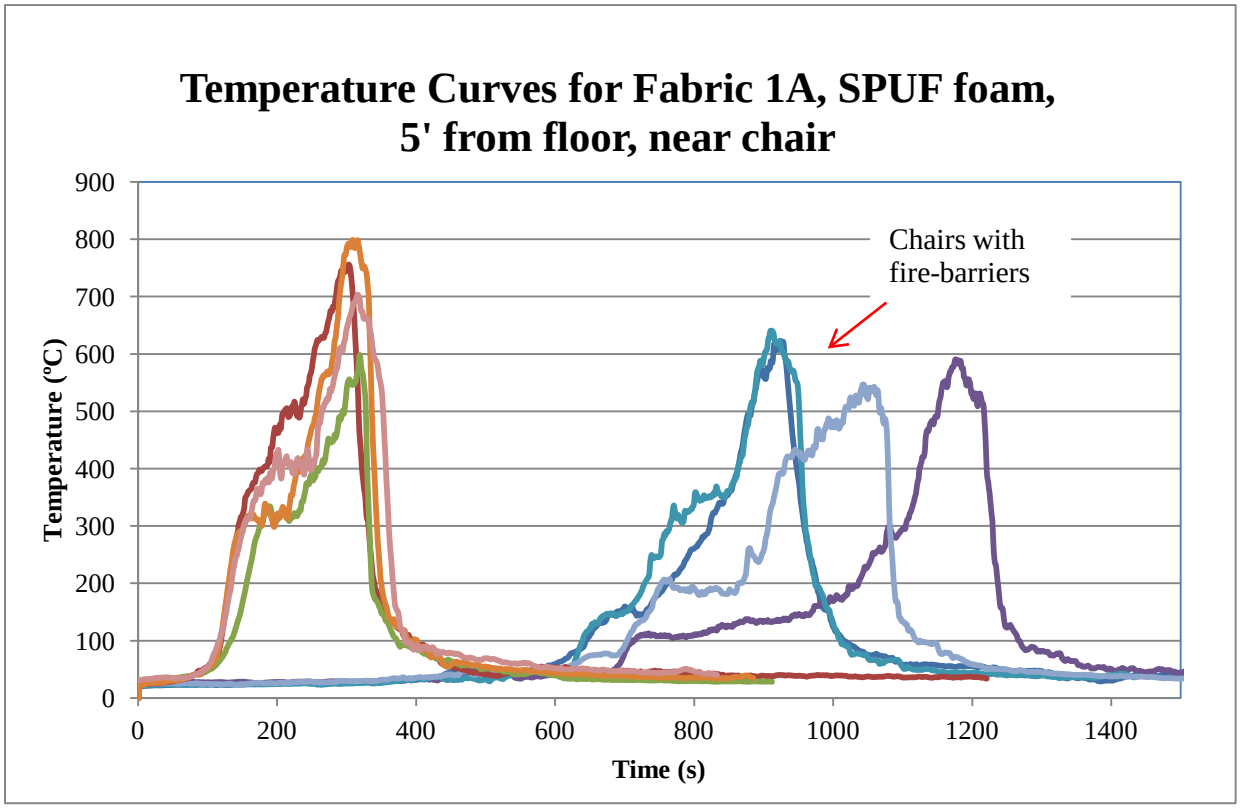
1200
1400
Time (s)
Chairs with
fire-barriers


Temperature Curves for Fabric 1A, SPUF foam,
5' from floor, near chair
Chairs with
fire-barriers
Temperature (ºC)
Time (s)
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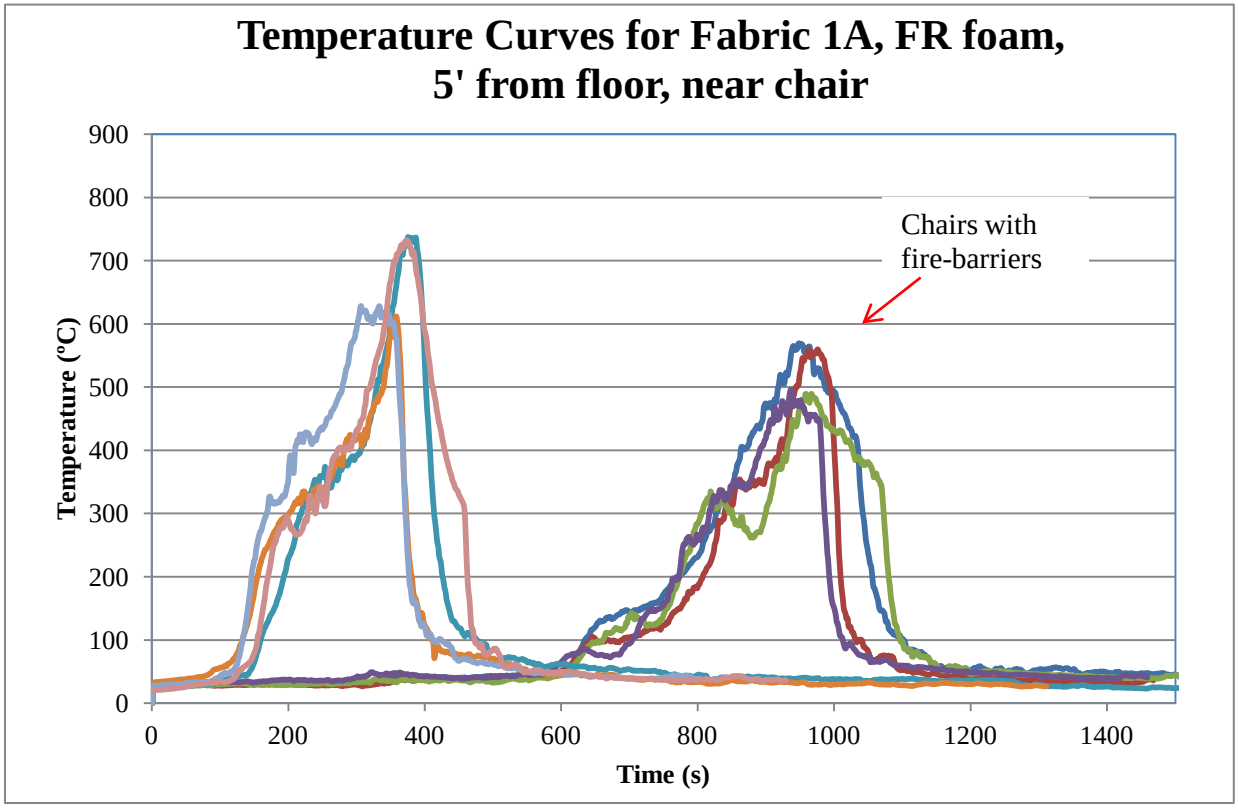
Temperature Curves for Fabric 1A, FR foam,
5' from floor, near chair
Chairs with
fire-barriers
Temperature (ºC)
Time (s)
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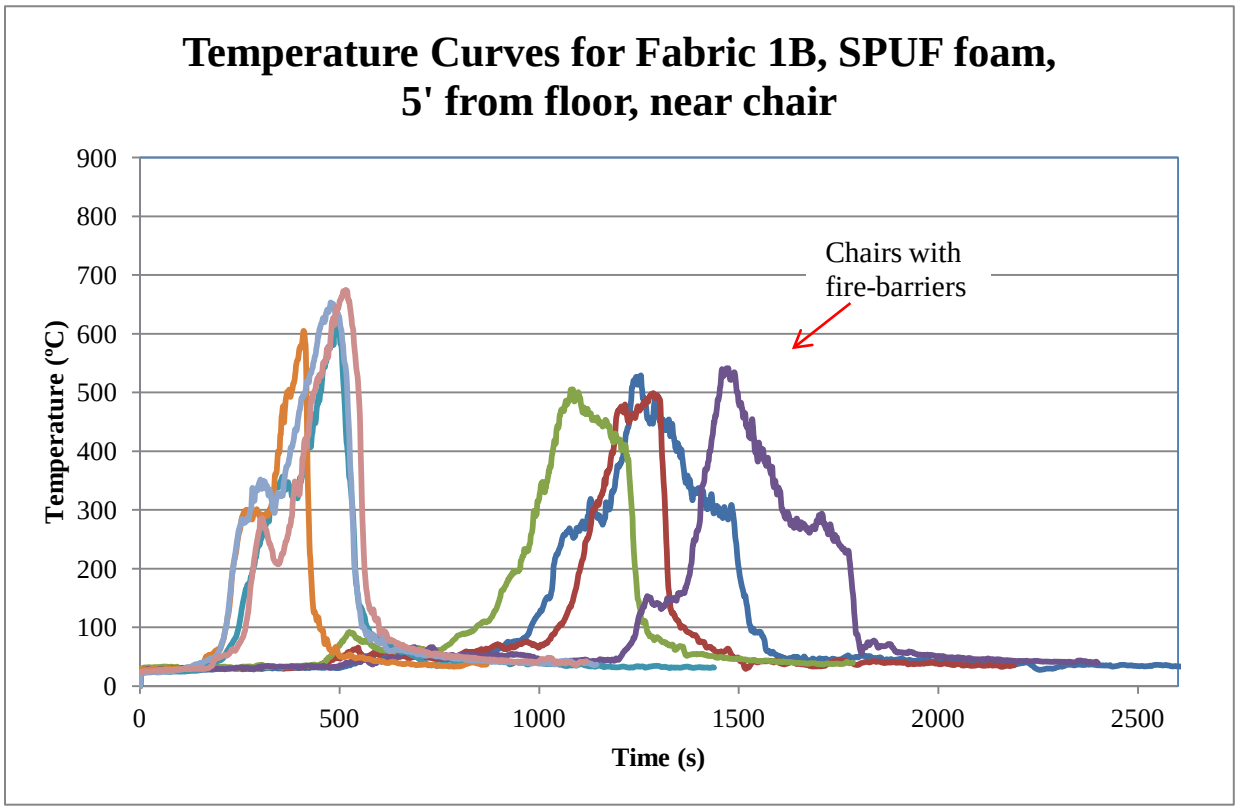
Temperature Curves for Fabric 1B, SPUF foam,
5' from floor, near chair
Temperature (ºC)
900
800
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200
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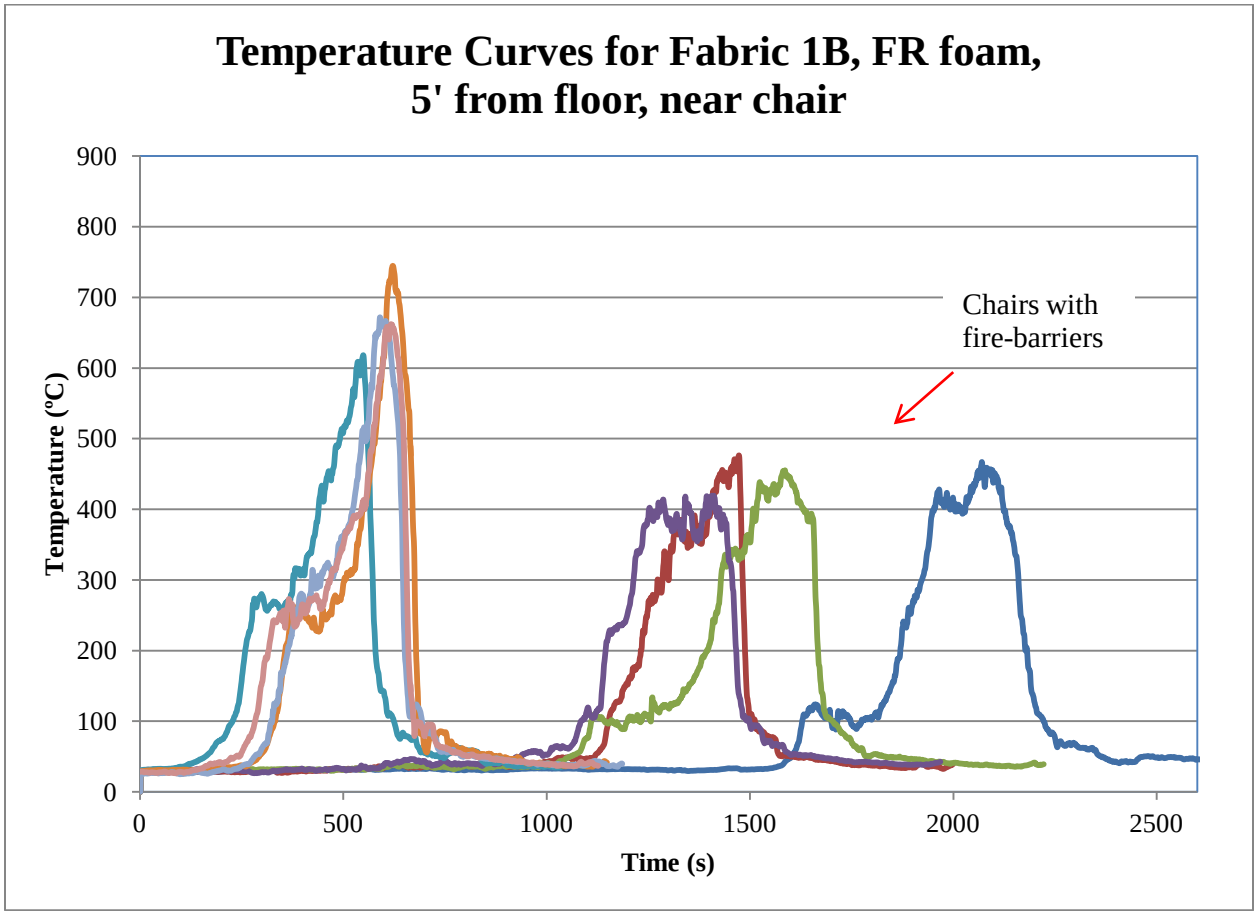
500
1000
1500
2000
2500
Time (s)
Chairs with
fire-barriers


Temperature Curves for Fabric 1B, FR foam,
5' from floor, near chair
Temperature (ºC)
900
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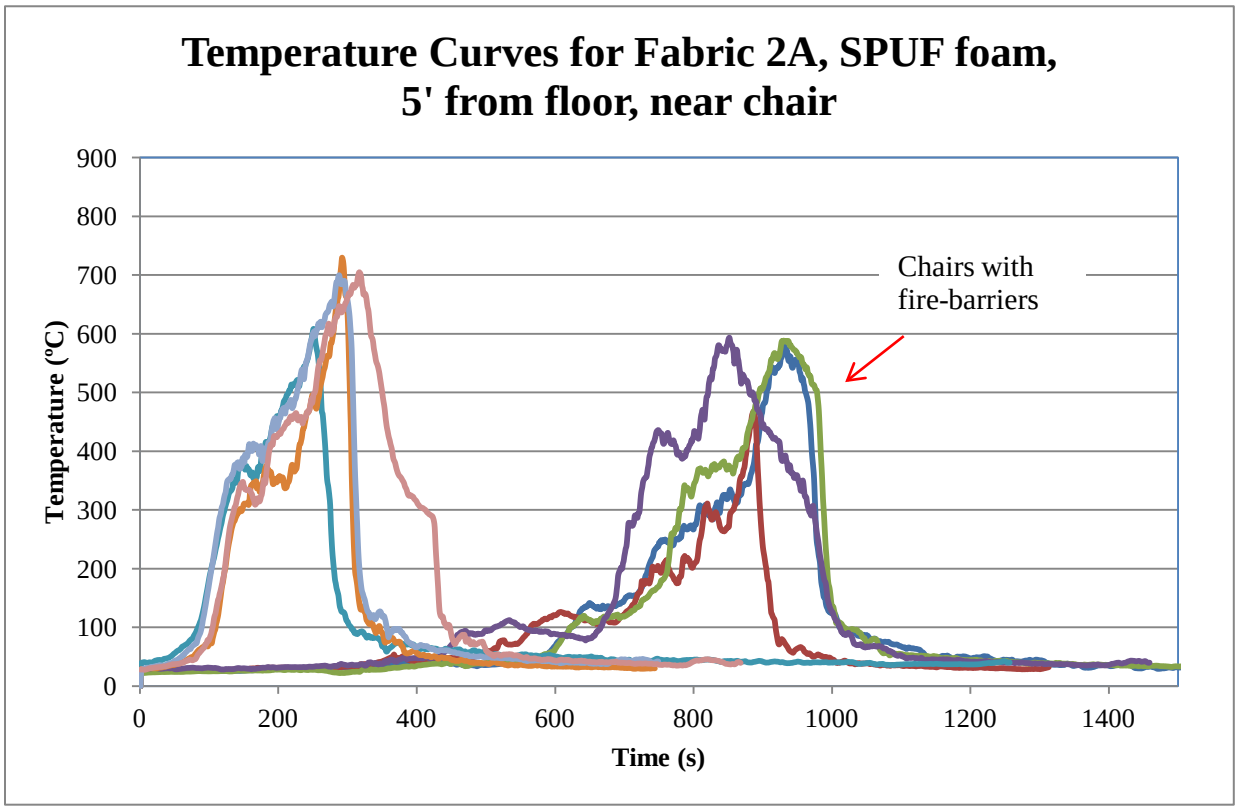
500
1000
1500
2000
2500
Time (s)
Chairs with
fire-barriers


Temperature Curves for Fabric 2A, SPUF foam,
5' from floor, near chair
Temperature (ºC)
900
800
700
600
500
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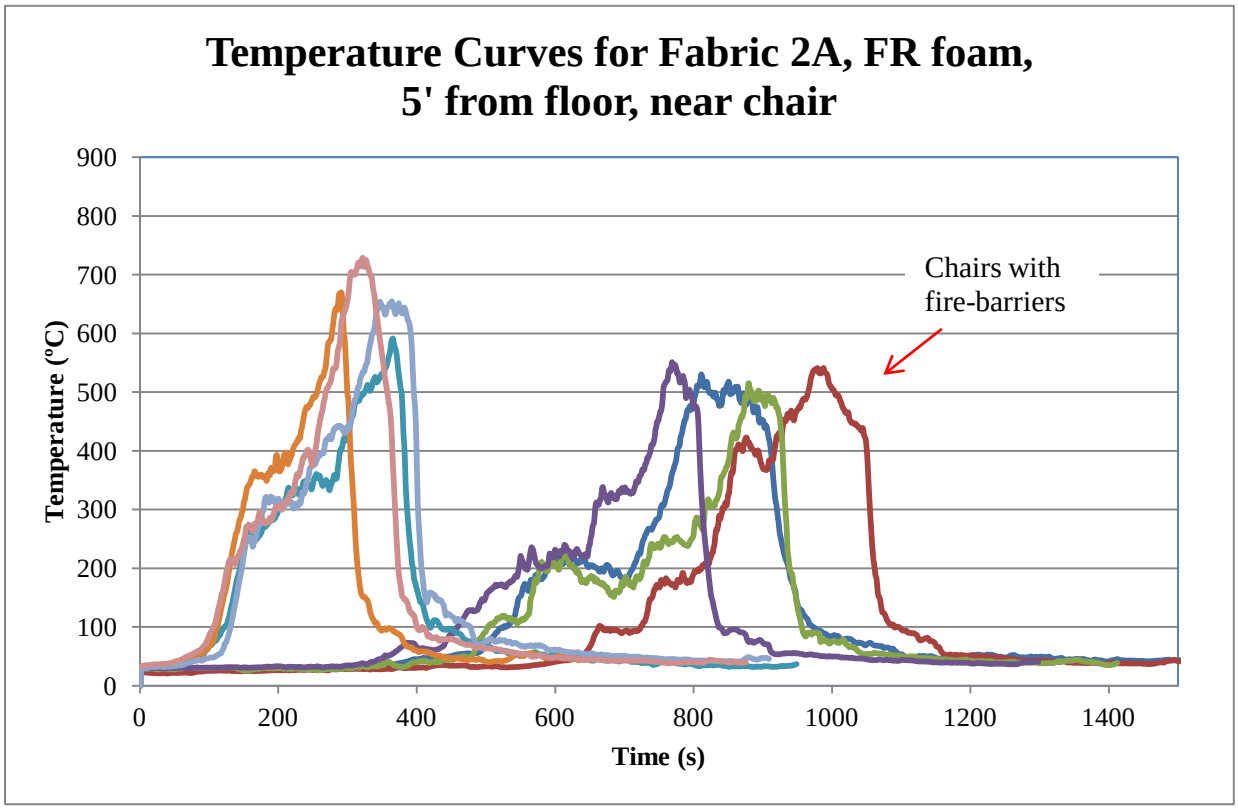
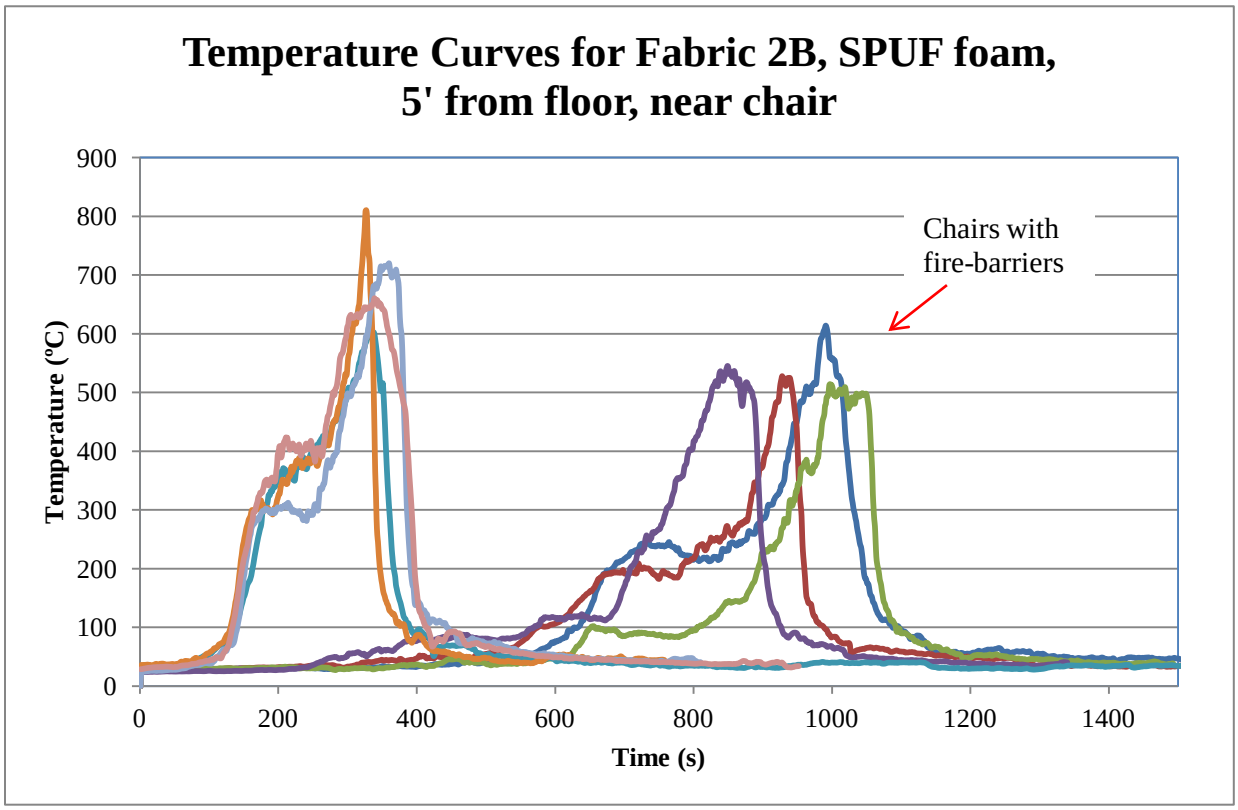
200
400
600
800
1000
1200
1400
Time (s)
Chairs with
fire-barriers


Temperature Curves for Fabric 2A, FR foam,
5' from floor, near chair
Temperature (ºC)
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
1400
Time (s)
Chairs with
fire-barriers


Temperature Curves for Fabric 2B, SPUF foam,
5' from floor, near chair
Chairs with
fire-barriers
Temperature (ºC)
Time (s)
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100
200
300
400
500
600
700
800
900
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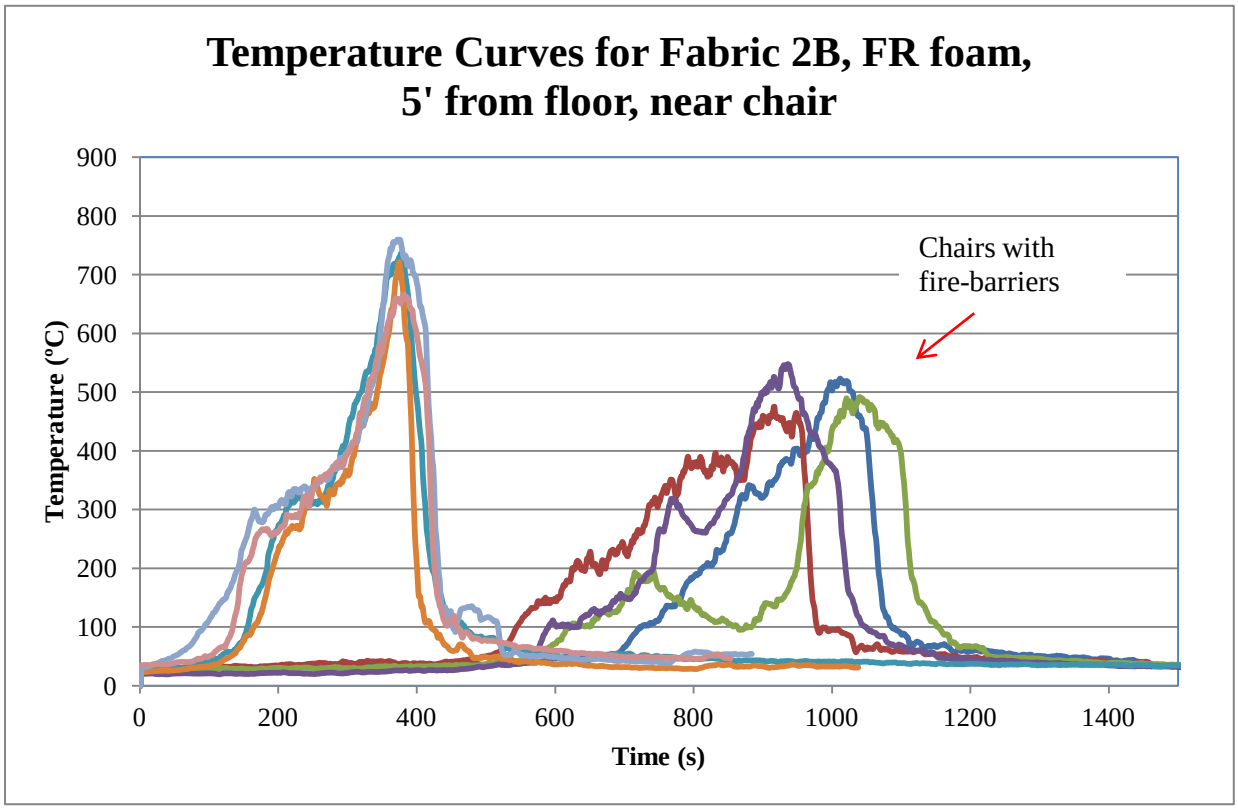
1200
1400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5' from floor, near chair
Chairs with
fire-barriers
Temperature (ºC)
Time (s)
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100
200
300
400
500
600
700
800
900
0
200
400
600
800
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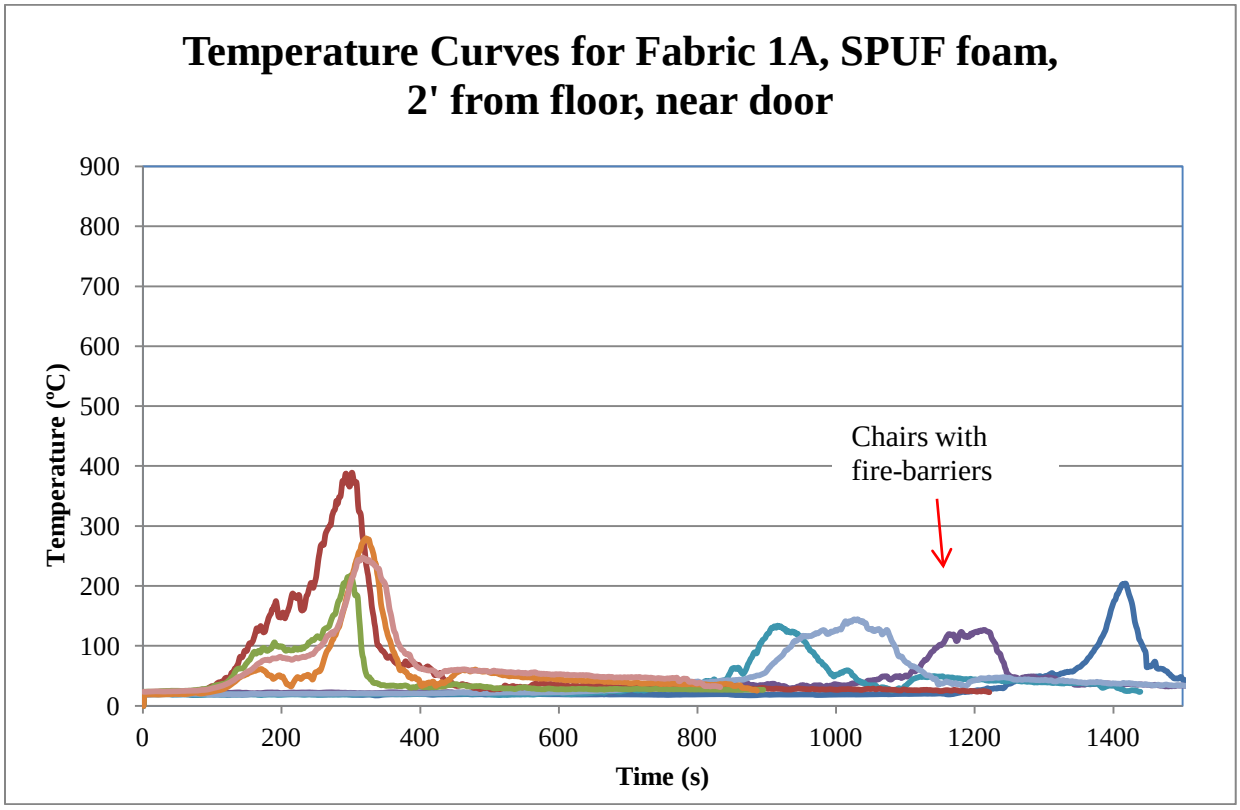
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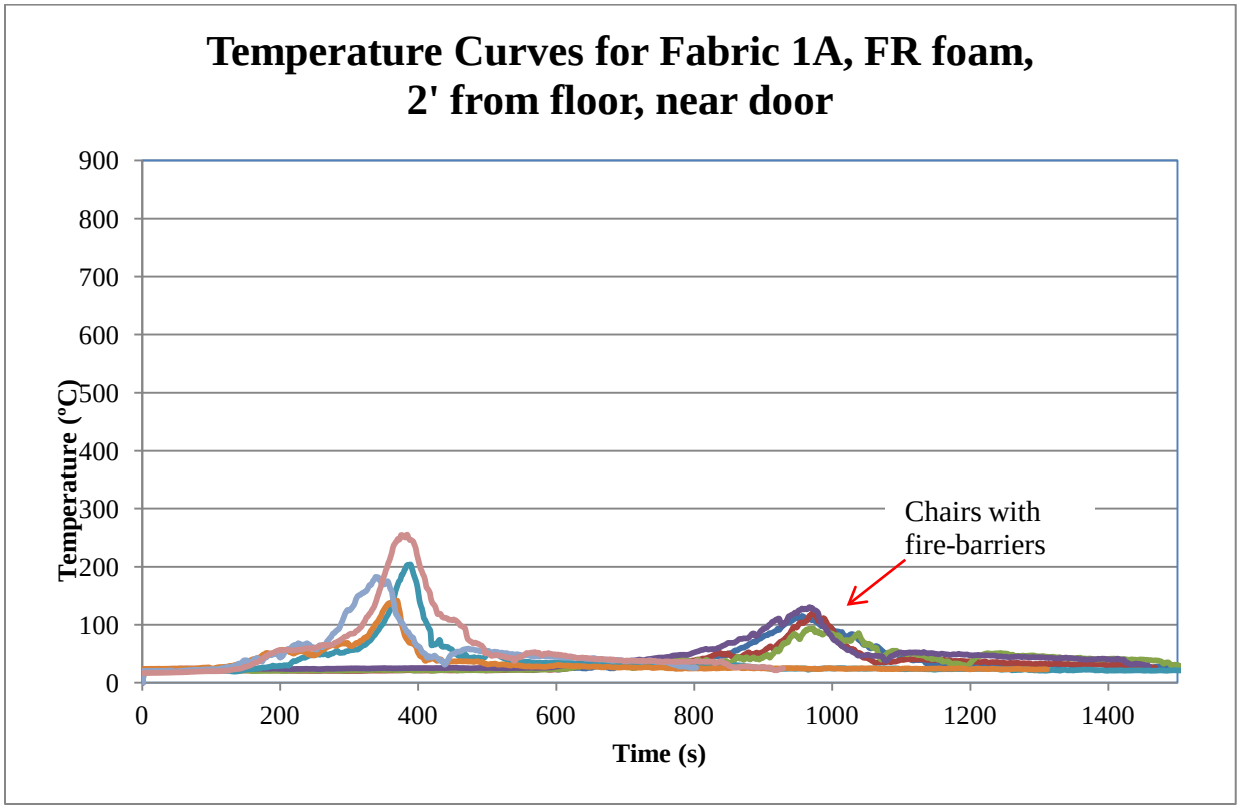
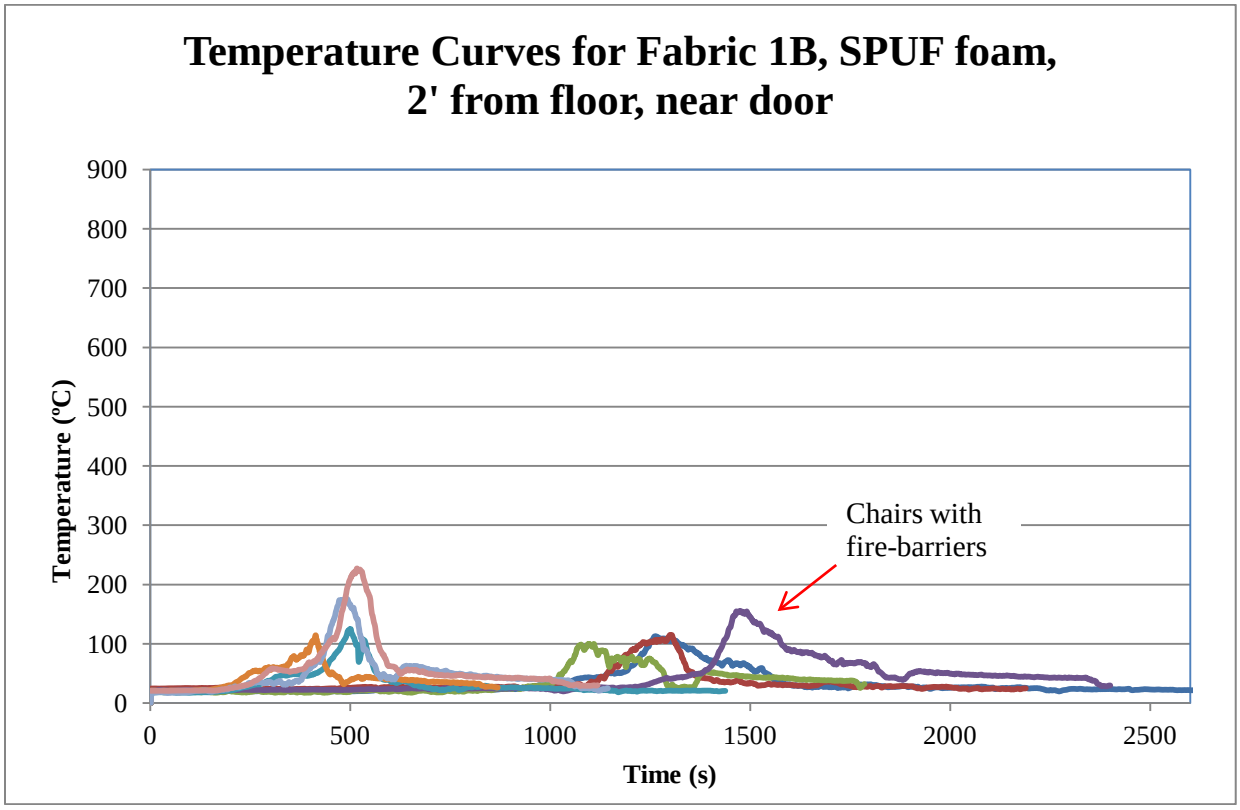
2' from floor, near door
Temperature (ºC)
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
1400
Time (s)
Chairs with
fire-barriers


Temperature Curves for Fabric 1A, FR foam,
2' from floor, near door
Temperature (ºC)
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
1400
Time (s)
Chairs with
fire-barriers


Temperature Curves for Fabric 1B, SPUF foam,
2' from floor, near door
900
800
700
600
500
400
300
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100
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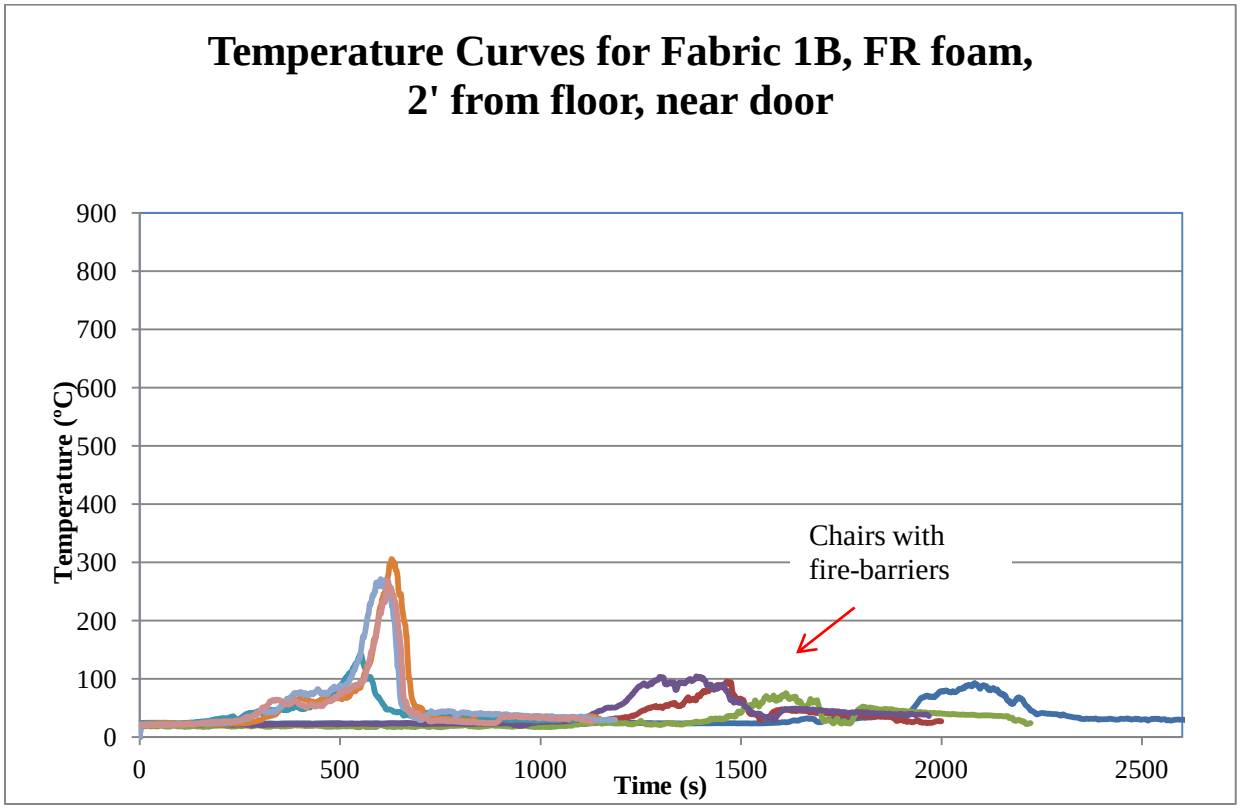
Temperature (ºC)
0
500
1000
1500
2000
2500
Time (s)
Chairs with
fire-barriers


Temperature Curves for Fabric 1B, FR foam,
2' from floor, near door
900
800
700
600
500
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Temperature (ºC)
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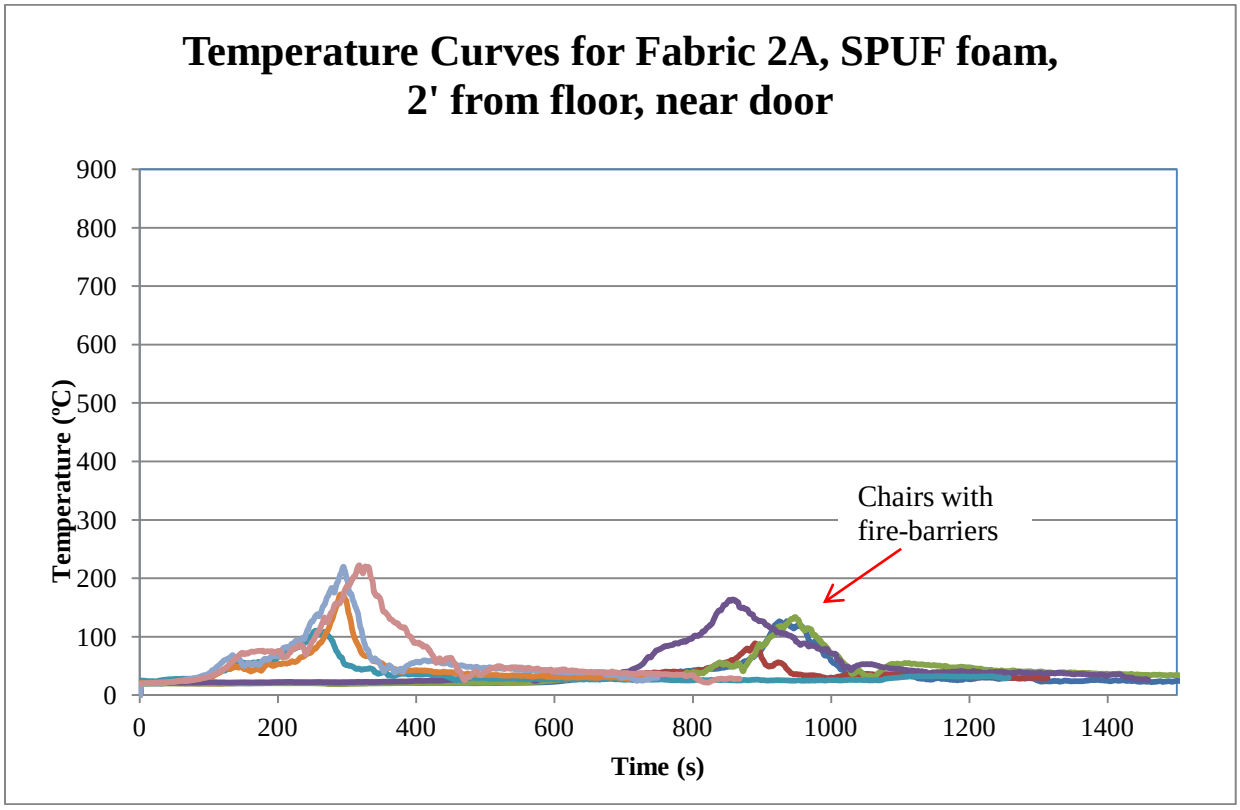
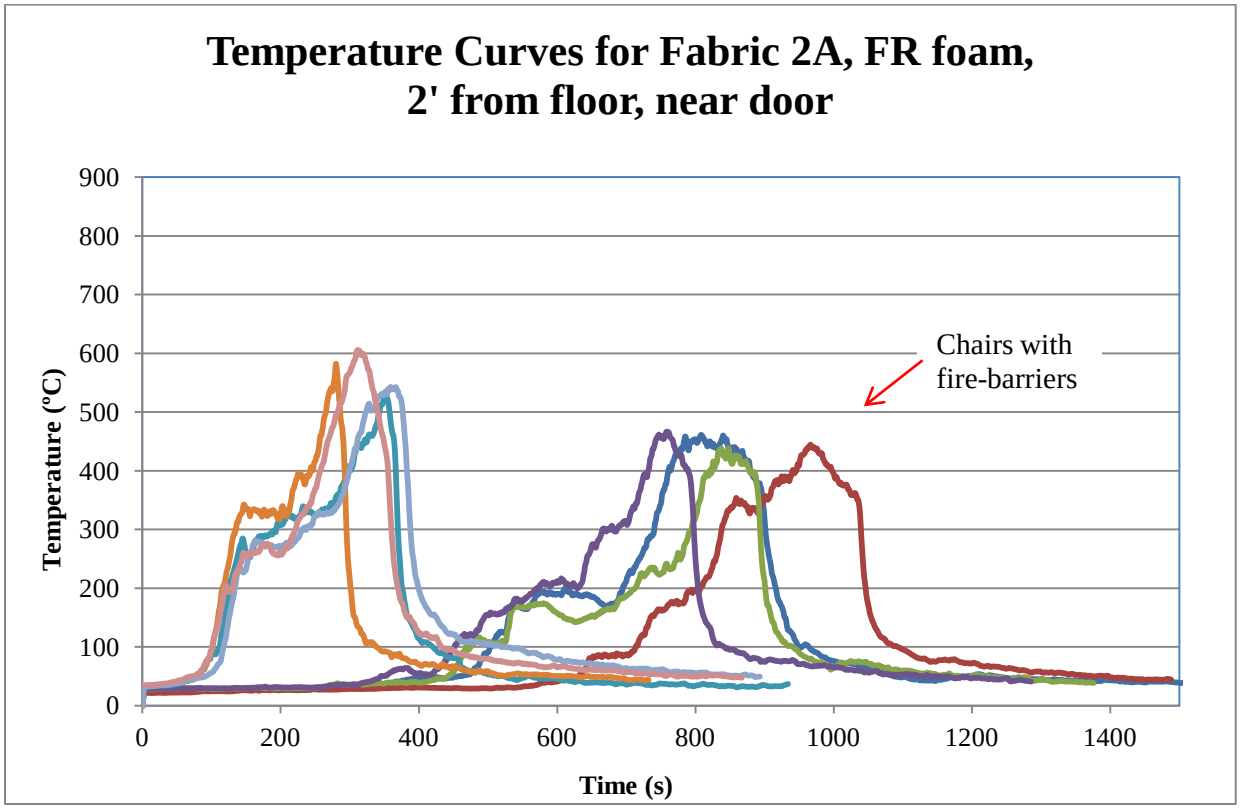
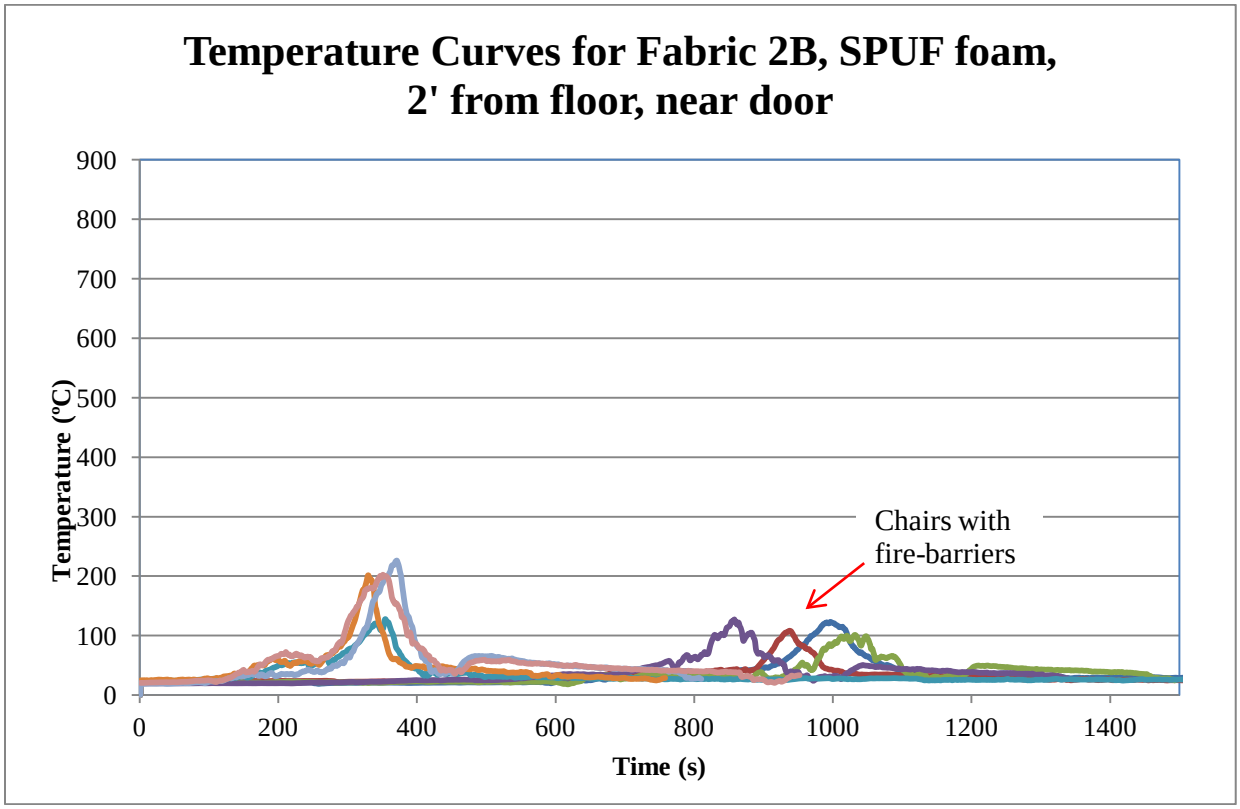
1000
1500
2000
2500
Time (s)
Chairs with
fire-barriers


Temperature Curves for Fabric 2A, SPUF foam,
2' from floor, near door
Temperature (ºC)
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
1400
Time (s)
Chairs with
fire-barriers


Temperature Curves for Fabric 2A, FR foam,
2' from floor, near door
Temperature (ºC)
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
1400
Time (s)
Chairs with
fire-barriers


Temperature Curves for Fabric 2B, SPUF foam,
2' from floor, near door
Temperature (ºC)
900
800
700
600
500
400
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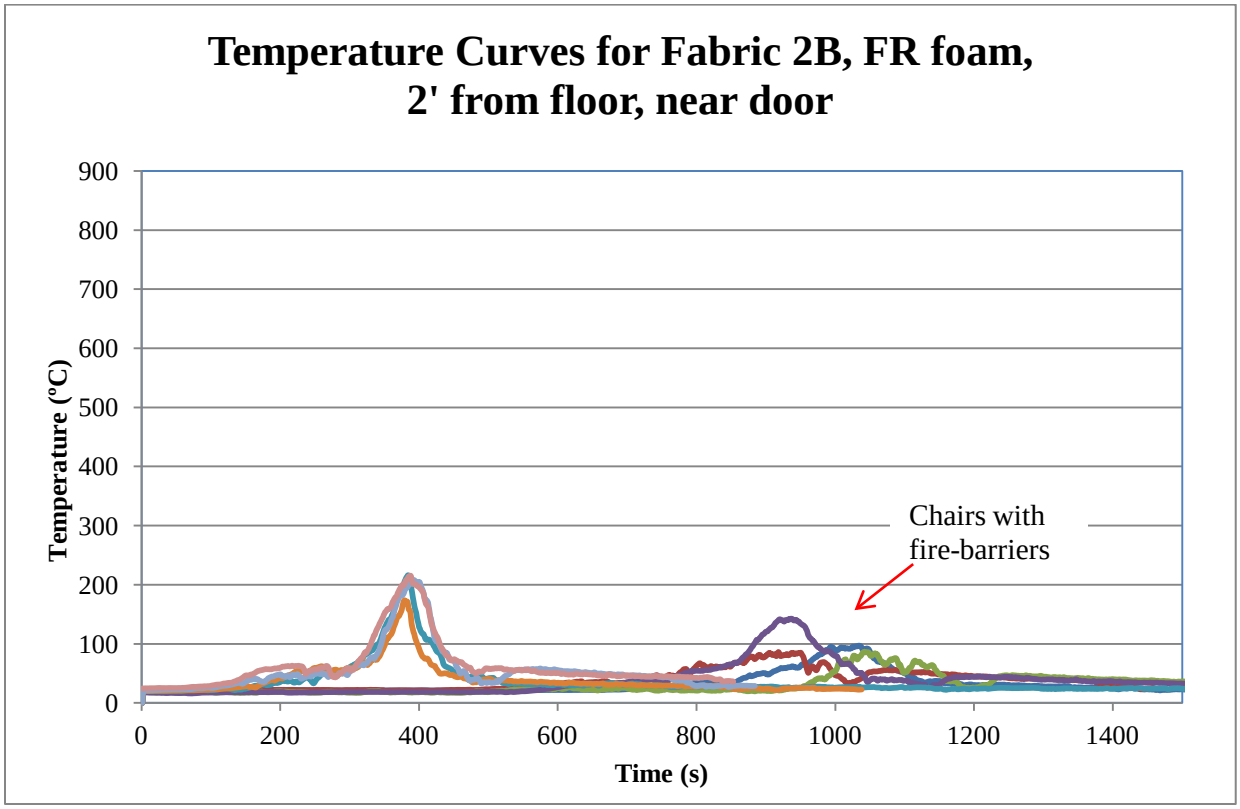
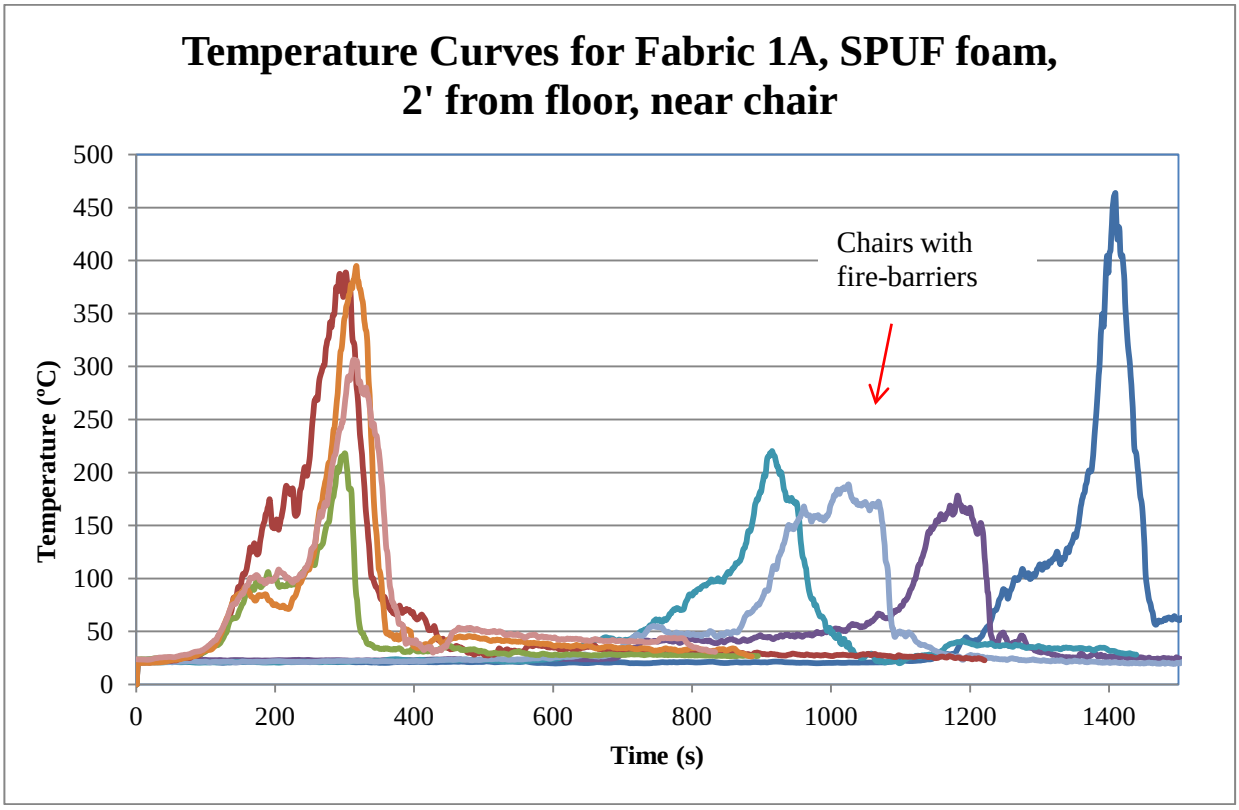
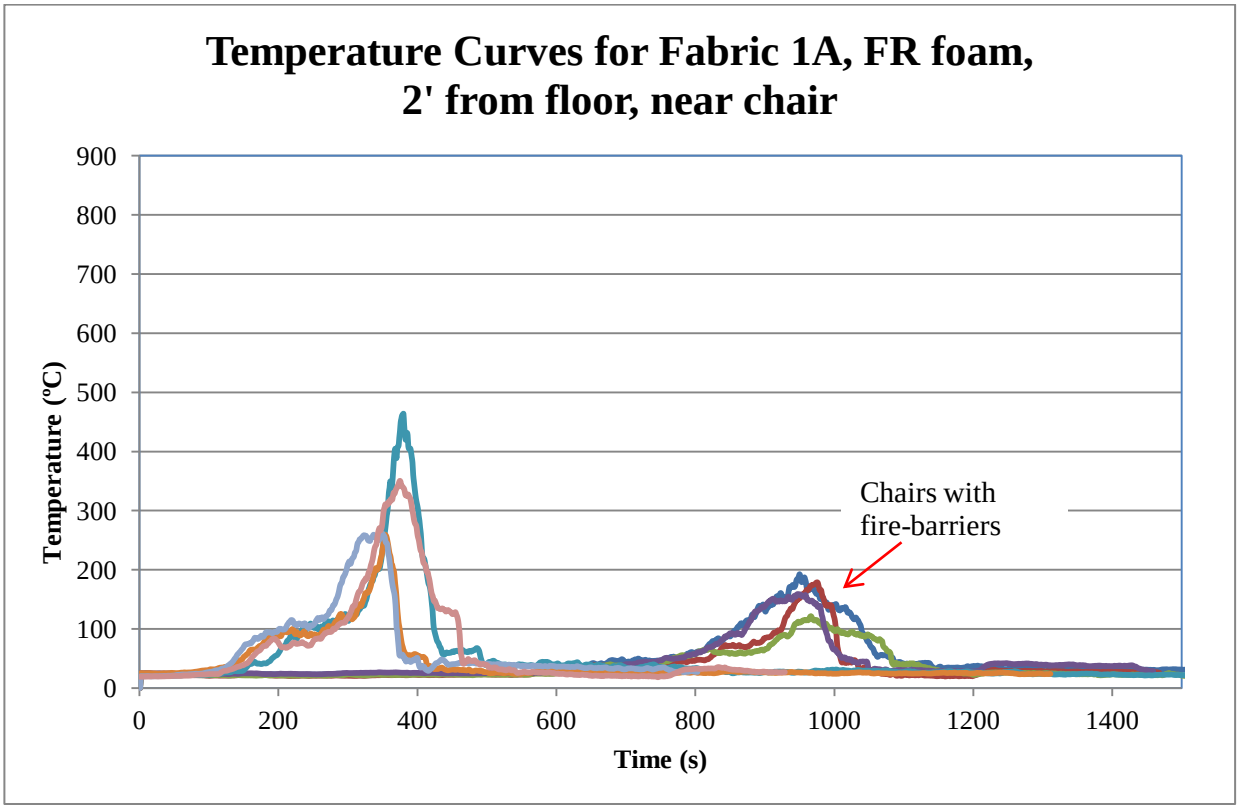
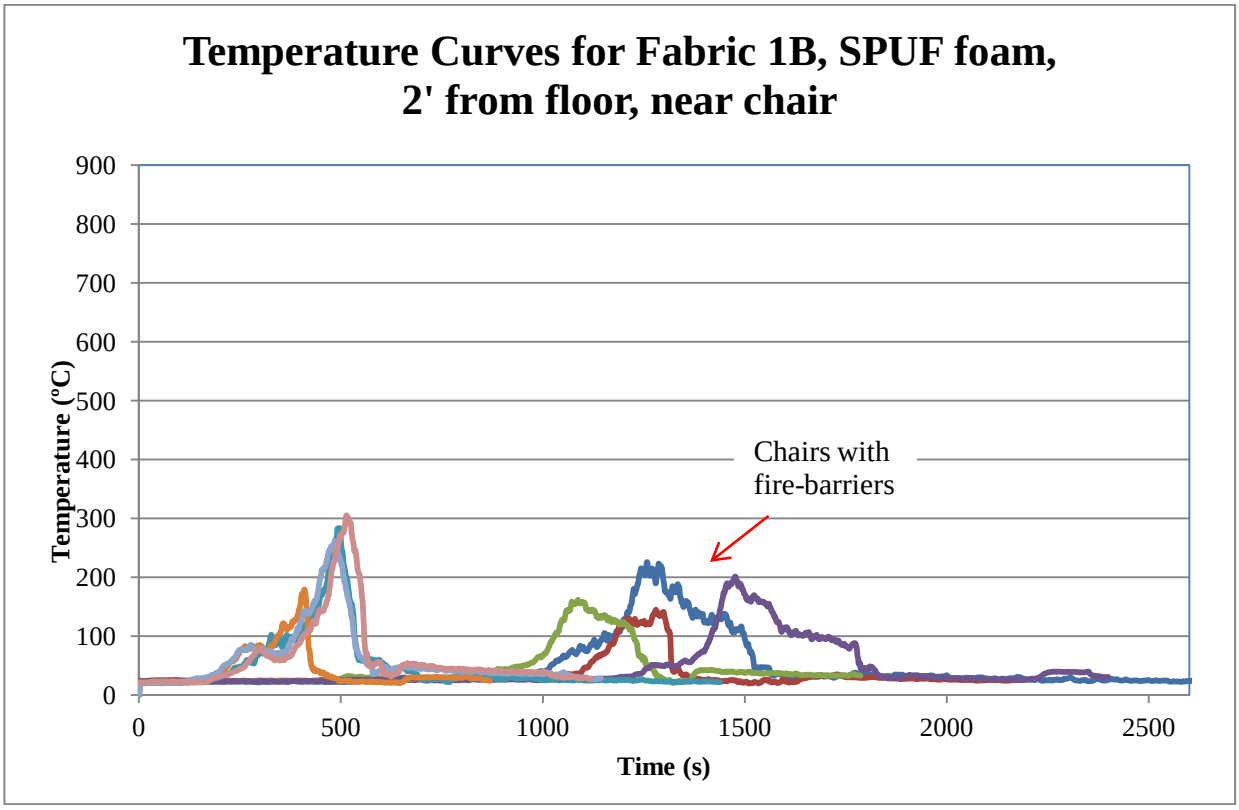
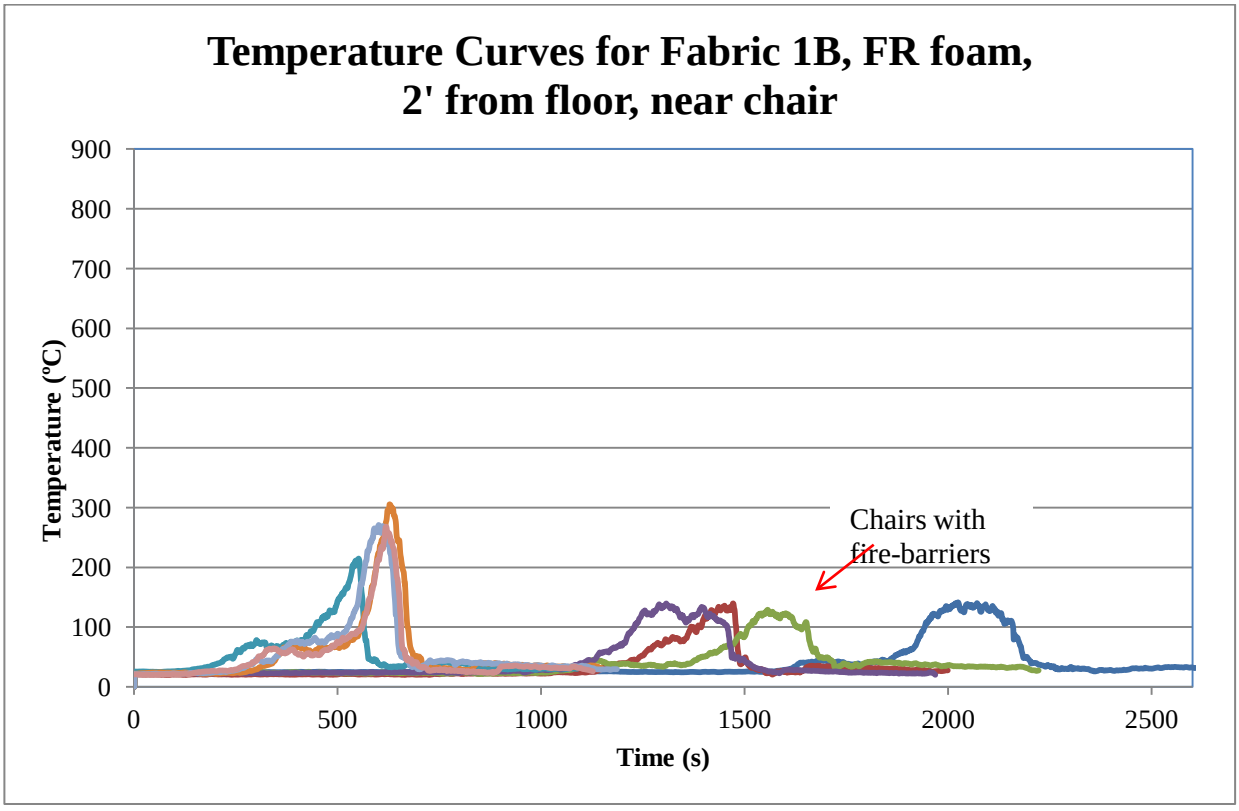
200
400
600
800
1000
1200
1400
Time (s)
Chairs with
fire-barriers

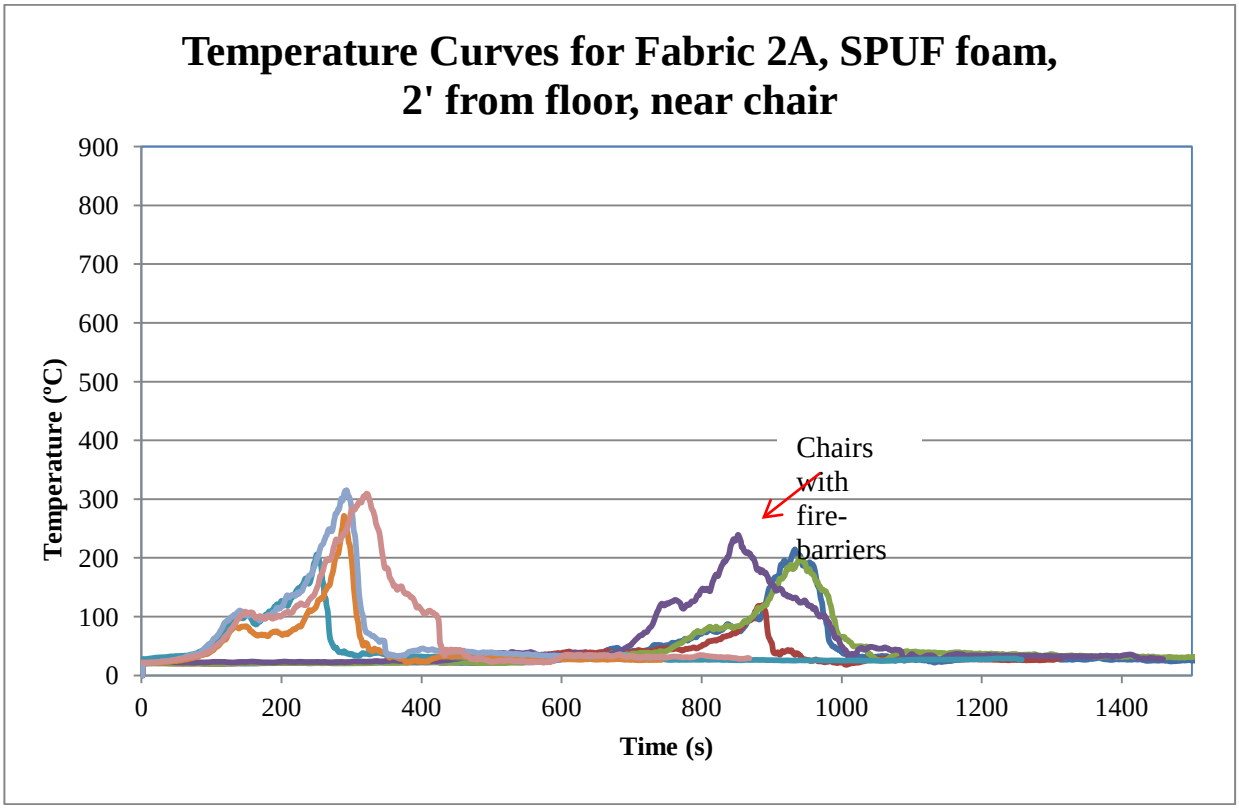

Temperature Curves for Fabric 2B, FR foam,
2' from floor, near door
Temperature (ºC)
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
1400
Time (s)
Chairs with
fire-barriers

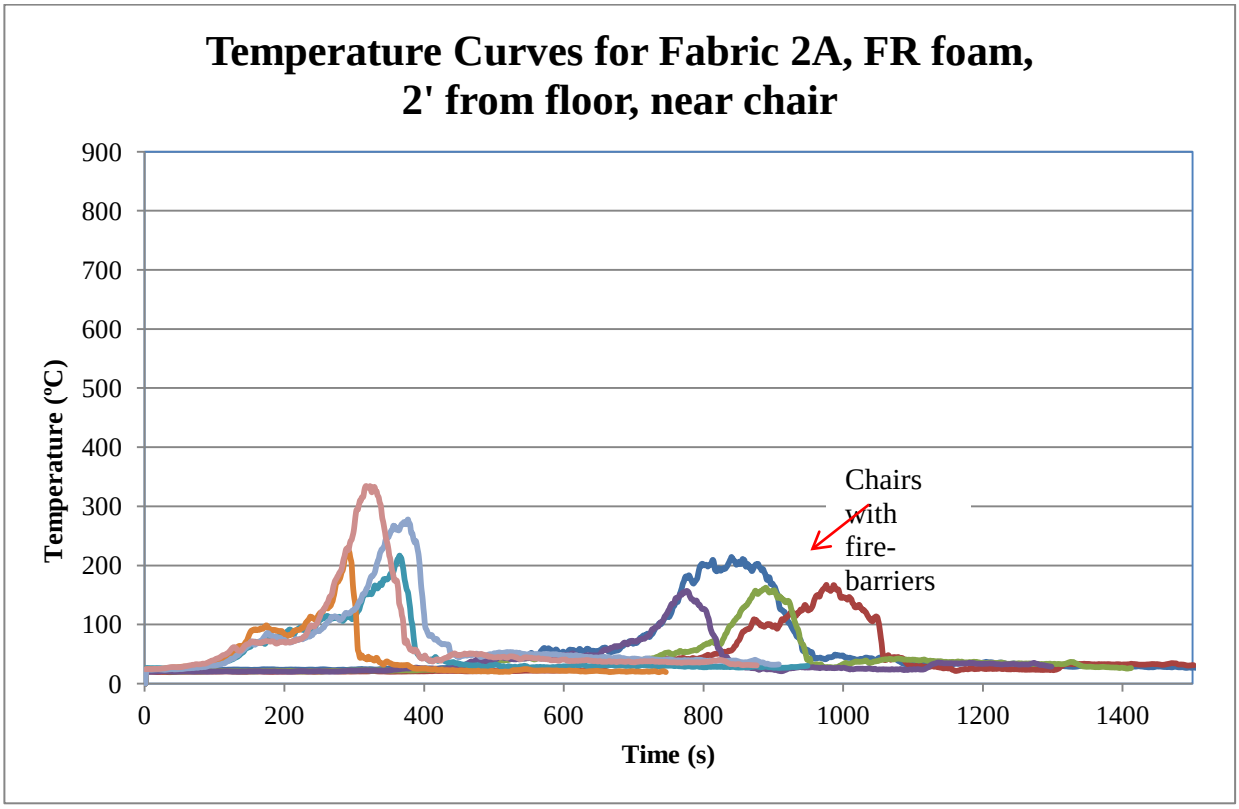

Temperature Curves for Fabric 1A, SPUF foam,
2' from floor, near chair
Temperature (°C)
500
450
400
350
300
250
200
150
100
50
0
0
200
400
600
800
1000
1200
1400
Time (s)
Chairs with
fire-barriers

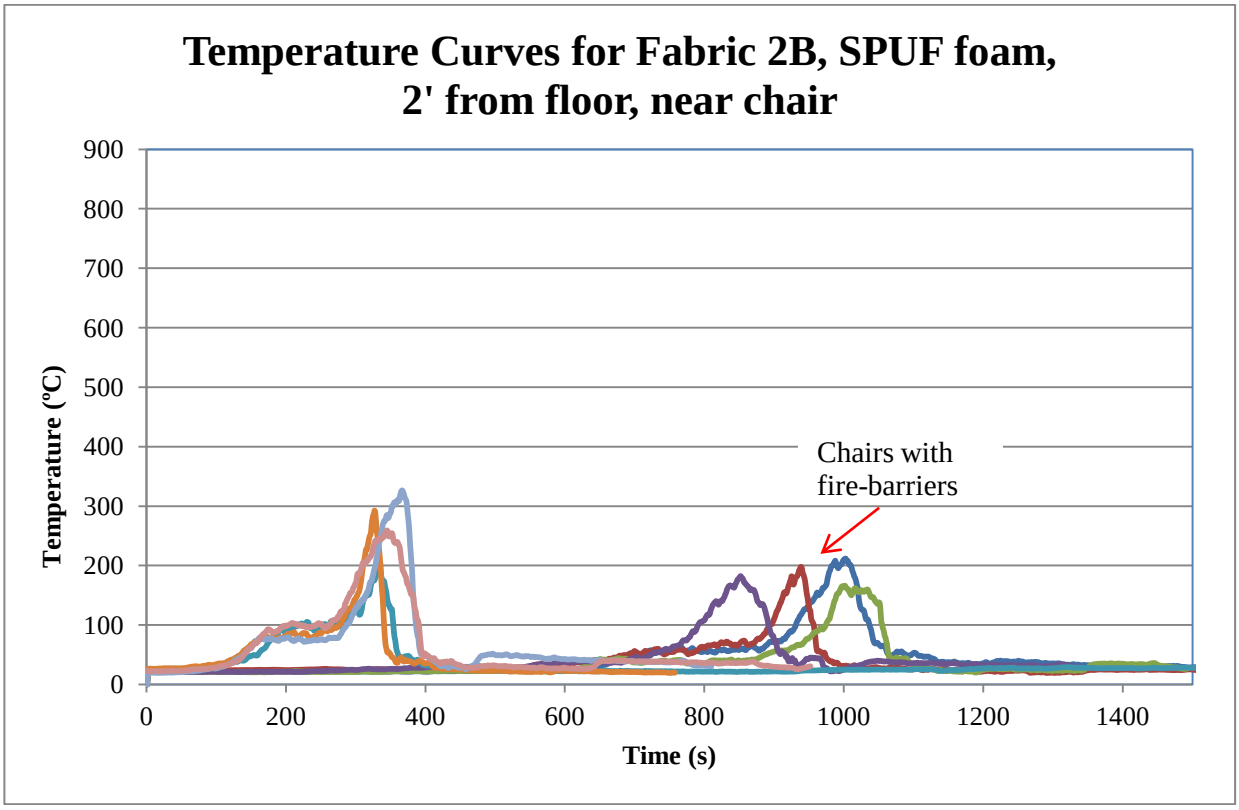

Temperature Curves for Fabric 1A, FR foam,
2' from floor, near chair
Temperature (°C)
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
1400
Time (s)
Chairs with
fire-barriers

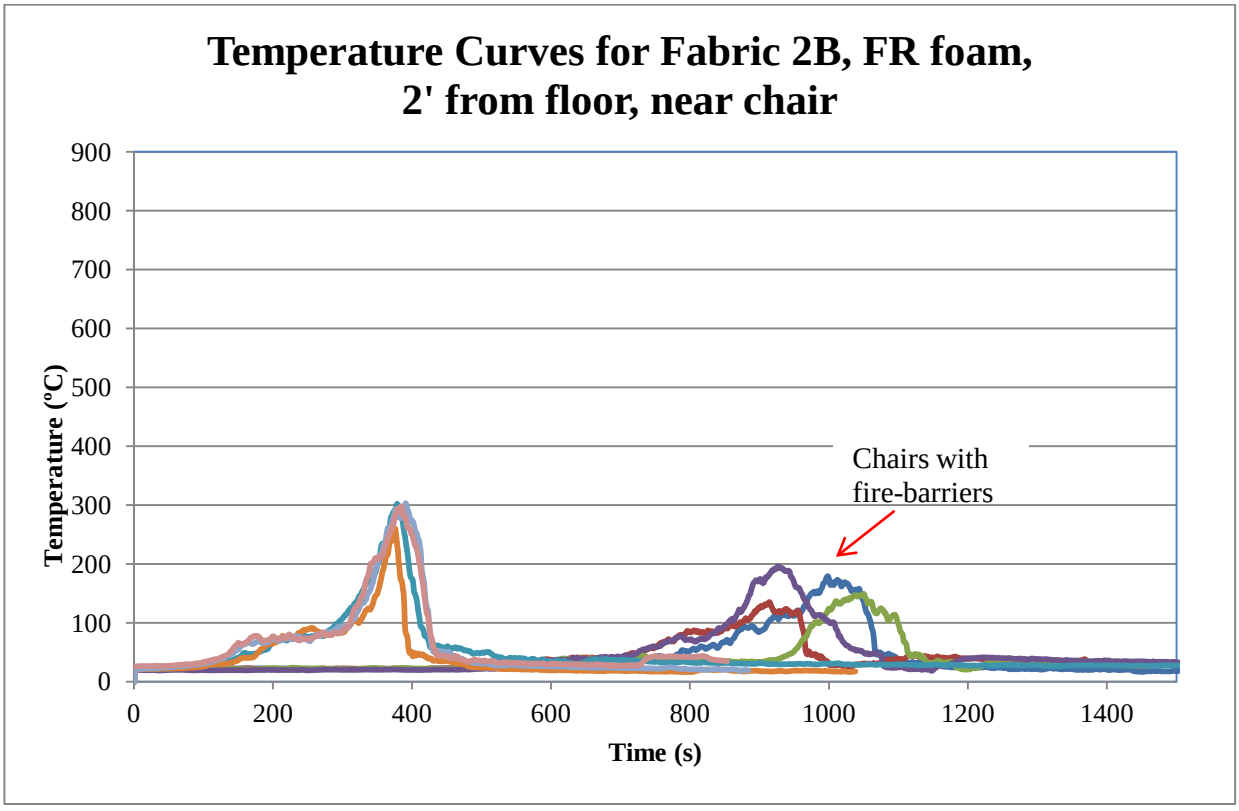

Temperature Curves for Fabric 1B, SPUF foam,
2' from floor, near chair
900
800
700
600
500
400
300
200
100
0
Temperature (ºC)
Chairs with
fire-barriers
0
500
1000
1500
2000
2500
Time (s)


Temperature Curves for Fabric 1B, FR foam,
2' from floor, near chair
900
800
700
600
500
400
300
200
100
0
Temperature (ºC)
Chairs with
fire-barriers
0
500
1000
1500
2000
2500
Time (s)

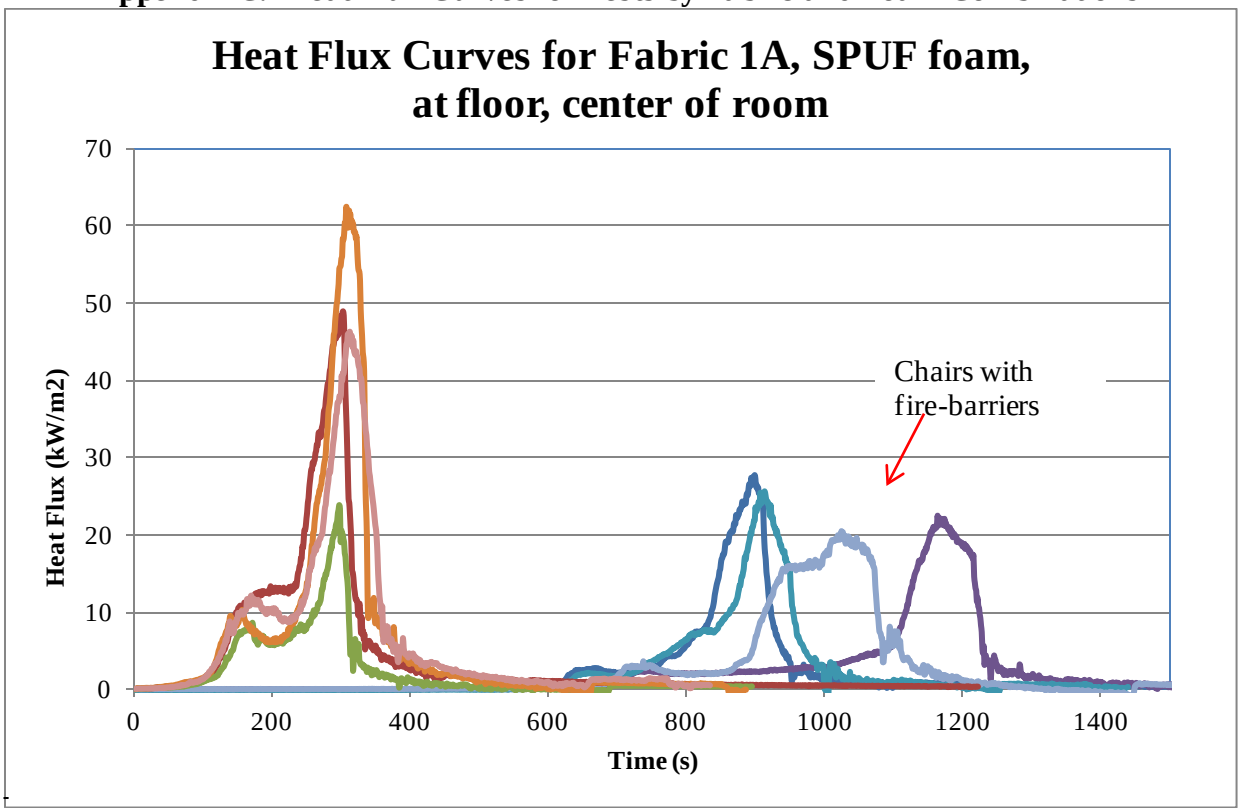

Temperature Curves for Fabric 2A, SPUF foam,
2' from floor, near chair
Temperature (ºC)
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
1400
Time (s)
Chairs with fire-barriers

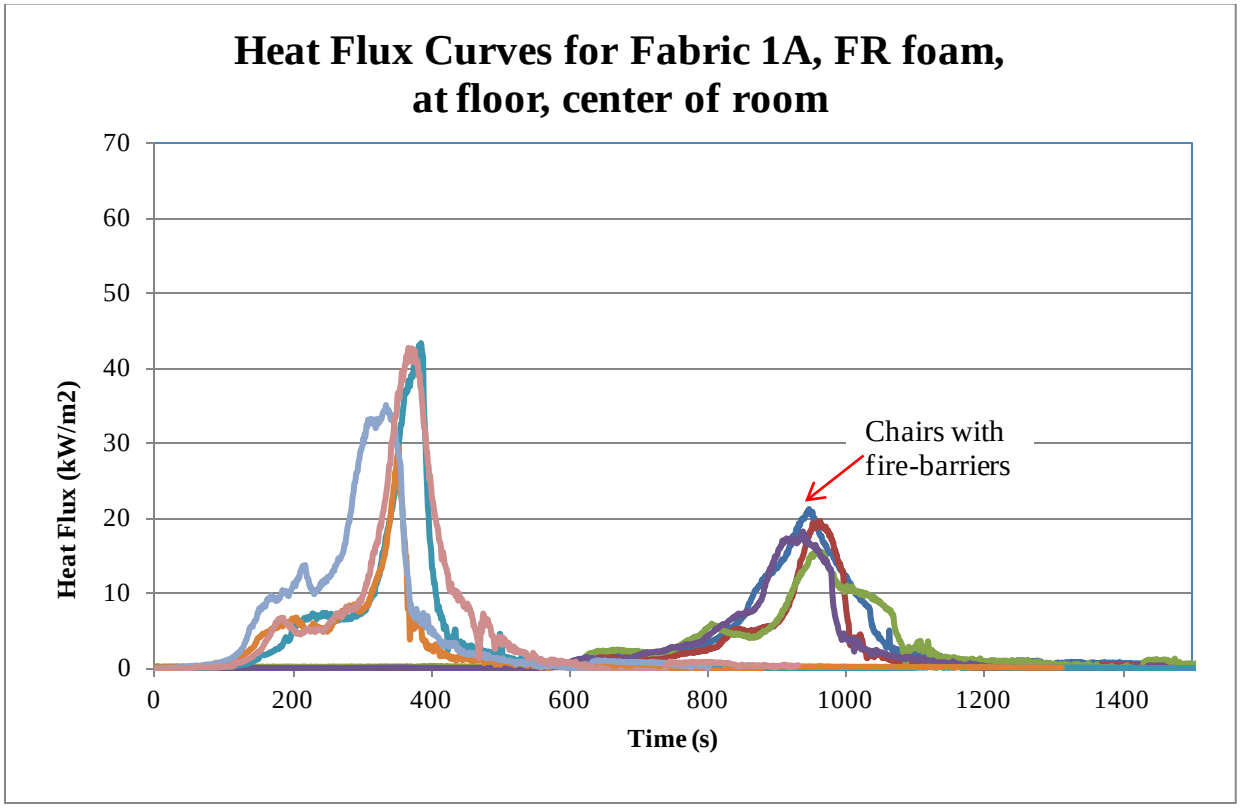

Temperature Curves for Fabric 2A, FR foam,
2' from floor, near chair
Temperature (ºC)
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
1400
Time (s)
Chairs with fire-barriers

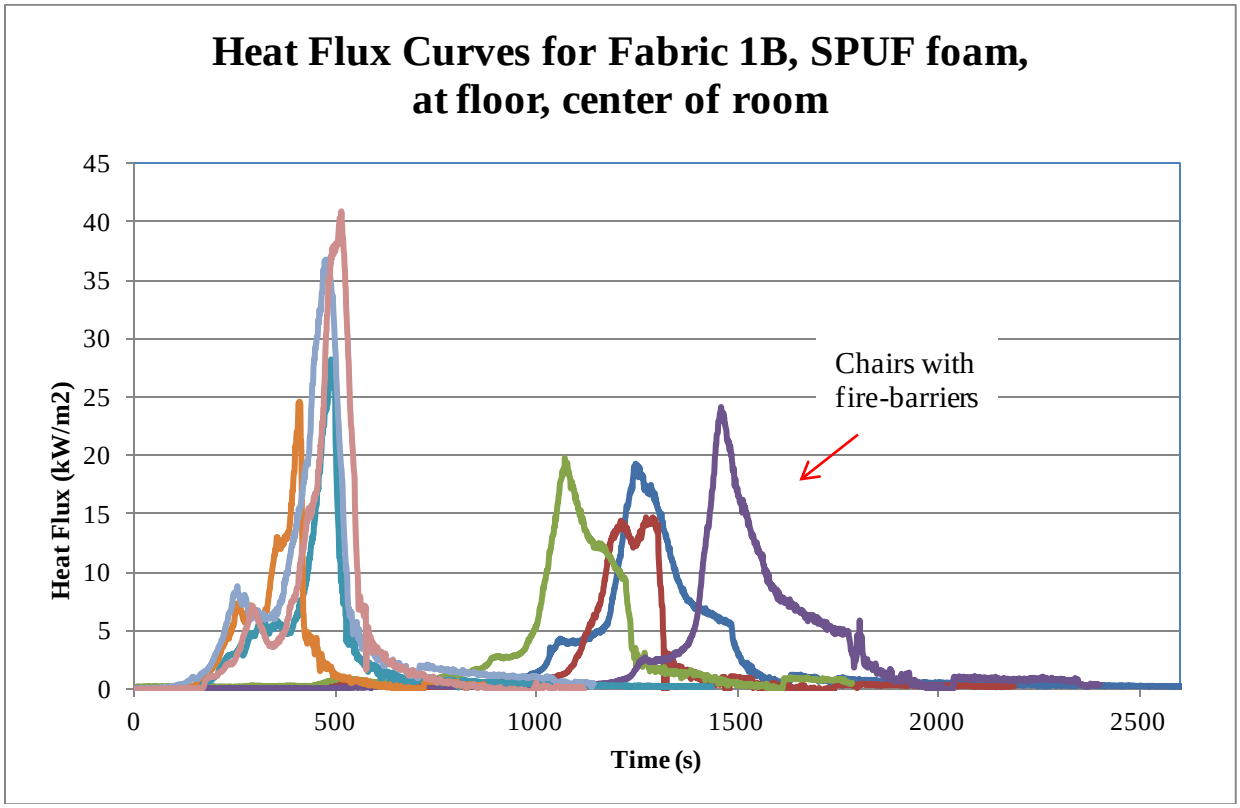

Temperature Curves for Fabric 2B, SPUF foam,
2' from floor, near chair
Temperature (ºC)
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
1400
Time (s)
Chairs with
fire-barriers

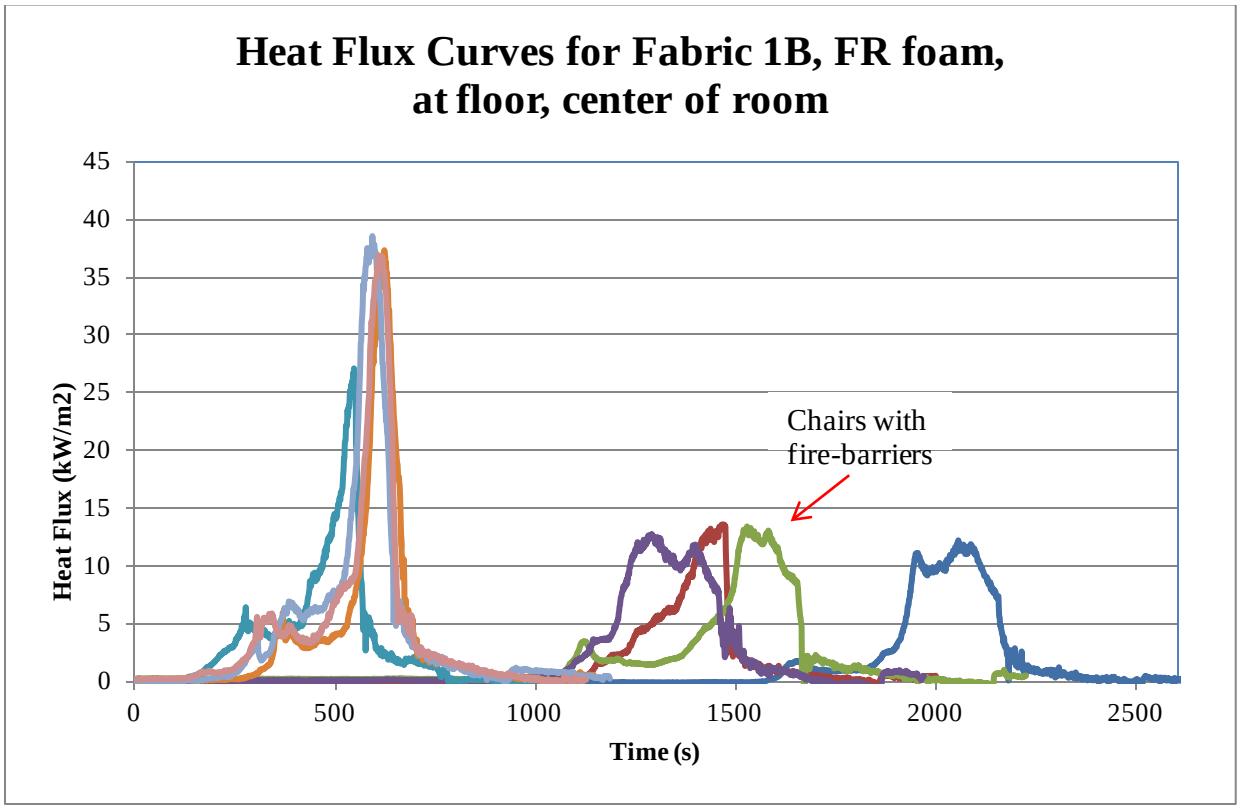

Temperature Curves for Fabric 2B, FR foam,
2' from floor, near chair
Temperature (ºC)
900
800
700
600
500
400
300
200
100
0
0
200
400
600
800
1000
1200
1400
Time (s)
Chairs with
fire-barriers

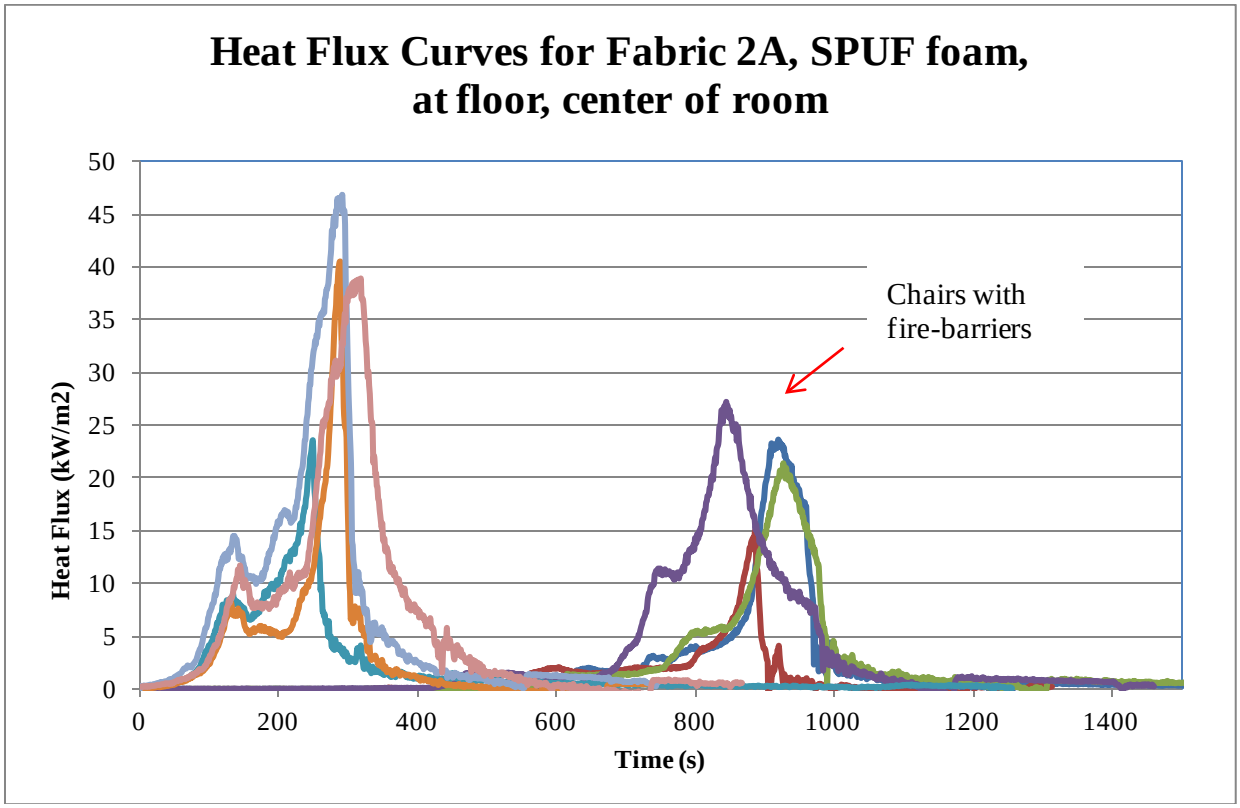
Appendix C. Heat Flux Curves for Tests by Fabric and Foam Combinations

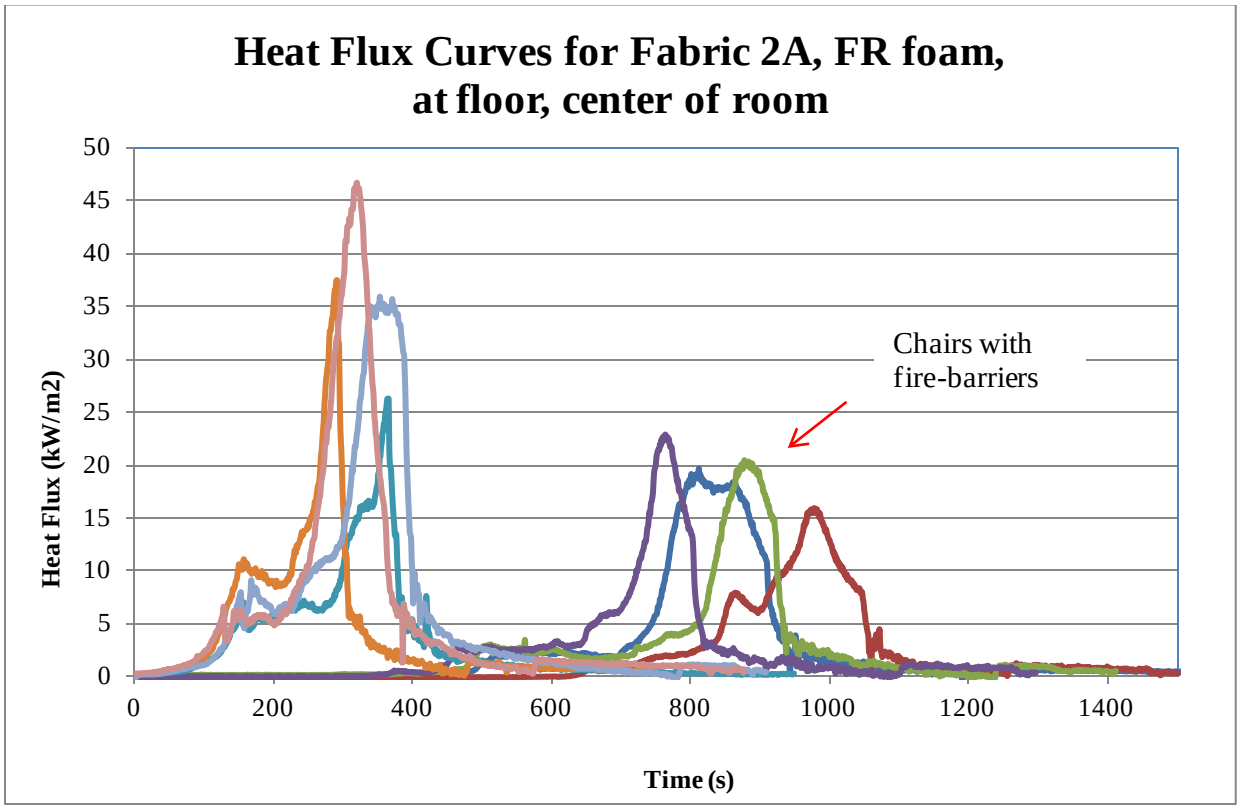





Heat Flux Curves for Fabric 1B, SPUF foam, at floor, center of room
Heat Flux (kW/m2)
45
40
35
30
25
20
15
10
5
0
0
500
1000
1500
2000
2500
Time (s)
Chairs with fire-barriers


Heat Flux Curves for Fabric 1B, FR foam, at floor, center of room
Heat Flux (kW/m2)
45
40
35
30
25
20
15
10
5
0
0
500
1000
1500
2000
2500
Time (s)
Chairs with fire-barriers


Heat Flux Curves for Fabric 2A, SPUF foam, at floor, center of room
Heat Flux (kW/m2)
Time (s)
Chairs with fire-barriers
0
5
10
15
20
25
30
35
40
45
50
0
200
400
600
800
1000
1200
1400


Heat Flux Curves for Fabric 2A, FR foam, at floor, center of room
Heat Flux (kW/m2)
Time (s)
Chairs with fire-barriers
0
5
10
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30
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45
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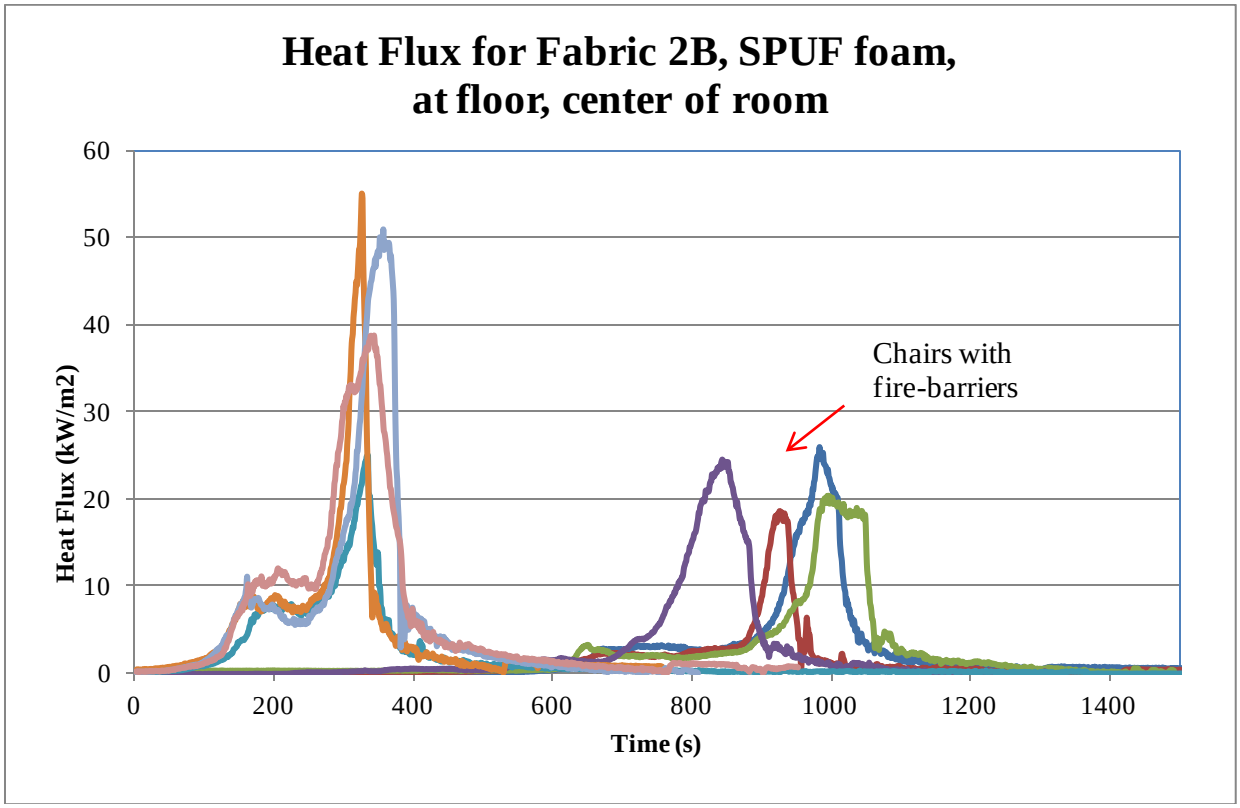
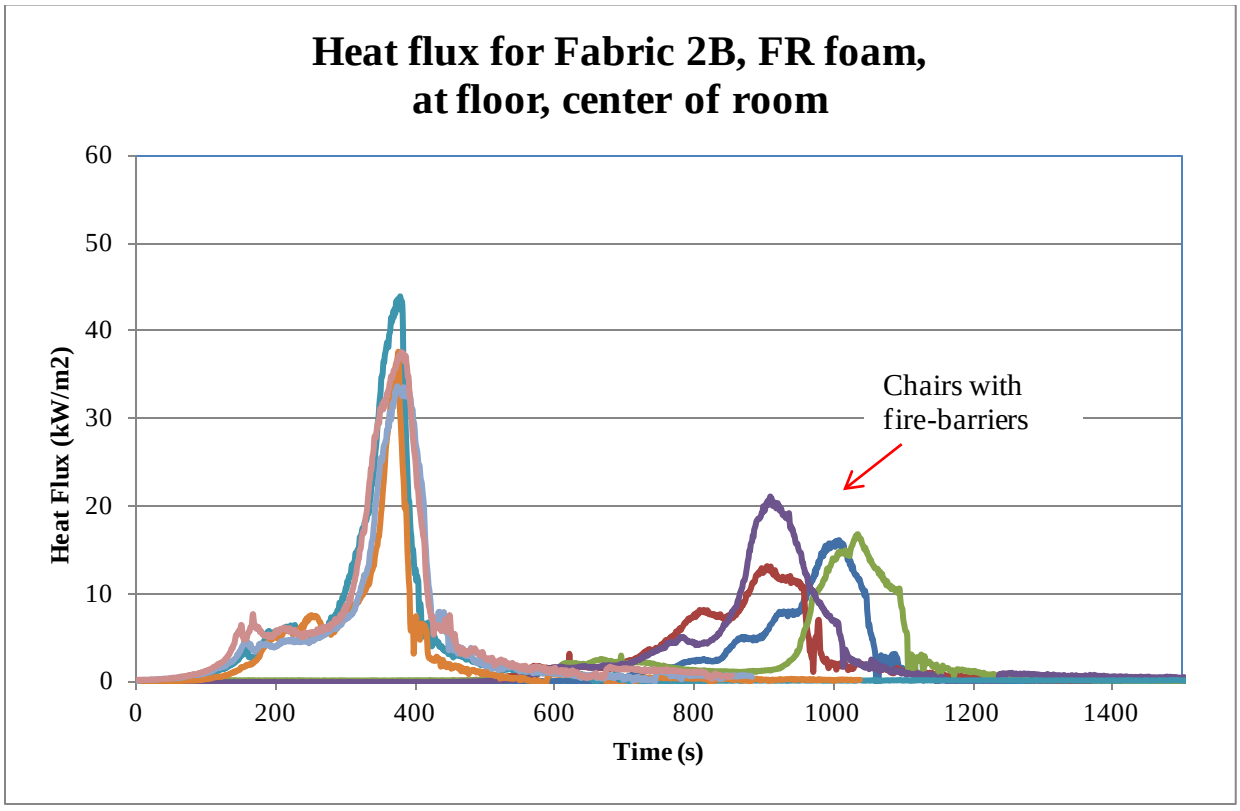
0
200
400
600
800
1000
1200
1400


Heat Flux for Fabric 2B, SPUF foam,
at floor, center of room
Heat Flux (kW/m2)
Time (s)
Chairs with
fire-barriers
0
10
20
30
40
50
60
0
200
400
600
800
1000
1200
1400


Heat flux for Fabric 2B, FR foam,
at floor, center of room
Heat Flux (kW/m2)
Time (s)
Chairs with
fire-barriers
0
10
20
30
40
50
60
0
200
400
600
800
1000
1200
1400

Appendix D. Upholstered Furniture Full-Scale Project Plan

Type II (Fire Barrier) Open-Flame Testing at NIST

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1 TEST PLAN INTRODUCTION

1.1 Background

The U.S. Consumer Product Safety Commission (‘‘CPSC’’) has proposed flammability standards for residential upholstered furniture under the Flammable Fabrics Act (‘‘FFA’’).[*] The proposal would establish: (1) performance requirements to reduce the likelihood of smoldering-induced ignition and (2) certification and labeling requirements for upholstered furniture. Manufacturers of specific types of upholstered furniture would choose one of two possible methods for compliance: They could use cover materials that are sufficiently smolder resistant to meet a cigarette-ignition performance test (*i.e.*, “Type I” furniture); or they could place fire barriers that meet smoldering- and small open-flame resistance tests between the cover fabric and interior filling materials (*i.e.*, “Type II” furniture). Manufacturers of upholstered furniture would be required to certify compliance with the standard and comply with certain record-keeping requirements, as specified in the proposal.

In developing the proposed flammability standard to address ignitions of specific types of residential upholstered furniture, the Commission considered the available hazard information, and existing standards development research, together with the latest CPSC laboratory data and technical information developed by other organizations. Economic, health, and environmental factors were also considered.

The proposed standard addresses resistance to smoldering ignition and limited fire growth by means of bench-scale performance tests for cover fabrics, and alternatively, for barriers. The performance requirements of the proposed standard are intended to reduce the risk of fire from smoldering ignition. If barriers are chosen as the means of compliance, they must meet both small open-flame and smoldering-resistance requirements. The proposal adapts elements and variations of existing standards, including California Technical Bulletin 117, ASTM E–1353 (tests from the UFAC voluntary industry guidelines) and United Kingdom regulations (based on British Standard BS–5852)[†].

CPSC staff is planning to conduct full-scale upholstered furniture chair testing to assess qualitatively the potential effectiveness/ benefits of the proposal. This will include an evaluation of Type I (smolder resistance of cover fabrics) and Type II- (smolder and small open-flame resistance of fire barriers) compliant upholstered furniture. In addition to collecting data on full-scale furniture fire performance, the response of smoke and carbon monoxide alarms will be

[*] Federal Register, March 4, 2008. Consumer Product Safety Commission, 16 CFR Part 1634, Standard for the Flammability of Residential Upholstered Furniture; Proposed Rule.

[†] BS-5852, Methods of test for assessment of the ignitability of upholstered seating by smouldering and flaming ignition sources. 1990.

examined in this study. This test plan covers the assessment of Type II open-flame examination of fire barriers that will be conducted at National Institute of Standard and Technology (NIST).

1.2 Goal and Objectives

The goal of this phase of full-scale testing is to develop test data on Type II upholstered furniture to demonstrate the potential effectiveness of the CPSC-proposed upholstered furniture flammability standard.

The objectives of this full-scale testing program are to:

- Obtain data on full-scale fire performance of upholstered furniture;
- Determine the extent to which the proposed bench-scale testing performance requirements can predict full-scale furniture fire performance;
- Incorporate knowledge gained from this test program to revise the proposed rule, if necessary; and
- Examine response characteristics of smoke and carbon monoxide alarms during large-scale testing.

2 PRODUCT DESCRIPTION AND SUBCOMPONENTS BEING TESTED

2.1 Full-Scale Upholstered Chair Sample Description

In FY 2008, CPSC staff issued a contract for the construction of full-scale upholstered furniture to conduct full-scale fire testing. CPSC staff specified information on upholstery and filling materials necessary to establish controls for the test procedures. The contractor purchased directly from specified manufacturers, the materials needed for the construction of the chairs and constructed furniture.

CPSC is providing NIST 64 chairs for Type II open-flame ignition testing. NIST is providing 7 weeks of time in the Large Fire Laboratory to complete testing of as many of the 64 chairs as possible. The chairs are upholstered, single-seat, “club chairs” (see Figures 1 and 2), with a contiguous seat, upholstered back and arms, and the chairs are constructed with a combination of fabric and filling materials.

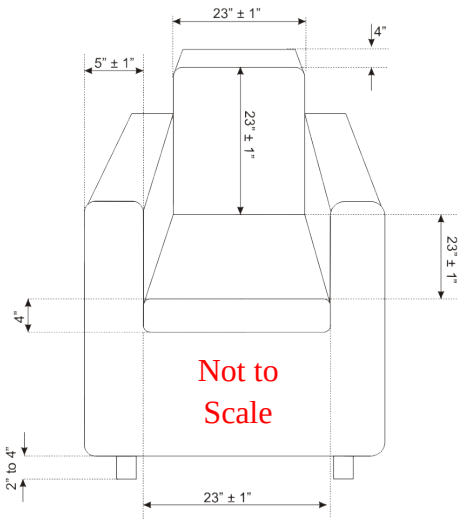


Figure1. Schematic of Sample

Figure 2. Prototype

2.2 Text Matrix

The following is the chair test matrix, showing the various combinations of upholstery cover fabrics, filling materials (*e.g.*, polyurethane foam, batting), and interior fire-barrier materials.

Combination Number	Foam	Poly Wrap	Barrier[+]	Fabric	Number of Chairs
1	SPUF	none	B1	1a	4
2	SPUF	P1	none	1a	4
3	FR	none	B1	1a	4
4	FR	P1	none	1a	4
5	SPUF	none	B1	1b	4
6	SPUF	P1	none	1b	4
7	FR	none	B1	1b	4
8	FR	P1	none	1b	4
9	SPUF	none	B1	2a	4
10	SPUF	P1	none	2a	4
11	FR	none	B1	2a	4
12	FR	P1	none	2a	4
13	SPUF	none	B1	2b	4
14	SPUF	P1	none	2b	4
15	FR	none	B1	2b	4
16	FR	P1	none	2b	4
Total					**64**

[+] Barrier B1 is a combination of nominal 4 oz. polyester batting over a fire-blocking barrier.

3 TYPE II OPEN-FLAME TESTING

CPSC will provide NIST with the testing details (Test Setup, Test Protocol, and Data Collection). CPSC may change any or all of the testing details at any time before or during testing. NIST will take necessary steps to comply with any and all changes to the test details. If NIST and/or CPSC believe the changes cannot be accommodated within a reasonable timeframe, NIST and CPSC Primary Investigators (PI) will determine the path forward. No immediate written record of changes is required. CPSC staff's report will describe any such changes.

3.1 Test Facilities and Instrumentation Setup

This section contains the necessary information to construct the testing environment; *i.e.*, type and location of instrumentation and room design. During testing, the PIs can change the test setup conditions, such as placement of smoke alarms; however, it is the initial assumption that the information contained in this section will not be a variable in this testing study. The role and

responsibilities for the activities in this section are explained in section 4, "Roles and Responsibilities":

- Tests are to be conducted in a NIST/ISO 9705-compliant room, instrumented as detailed in this section. If the fire substantially damages the room structure, then the instrumentation and drywall will be removed to allow for the required room reconstruction prior to reinstrumenting for the next test. The room layout is shown in Figure 3.
    - The walls will be two layers of Type C Gypsum board. Only the inner layer will be sealed. The outer layer will have joints offset from the inner layer to minimize loss of combustion products through the walls.
    - The paper will be burned off before testing because the paper can generate a sharp HRR spike.
    - The catch pan will contain Durock®; Kaowool® may be added to insulate the catch pan better and prevent warping, as needed.
    - The room air temperature must be below 50 °C before clean up. Room "cool down" will be accelerated using fans, but this could also increase the failure rate of the drywall, requiring more frequent rebuilds. The most efficient process will be determined during testing.
- Two thermocouple trees will be used to measure upper layer temperature and depth. The location of the thermocouple trees will be determined at the time of room construction.
- CO and CO_2 sensors will be used to measure CO and CO_2 levels in the upper layer. The sensors will be placed so as to measure at the top of the door opening. The exact location of the sensor will be determined on day 1 of testing.
- A heat flux gauge will be placed in the middle of the room, pointing through the floor directly toward the ceiling.
- Smoke obscuration will be measured as follows: A word will be written in the middle of the back wall about 4 feet above the floor. An observer will call out when the word is no longer visible.
- Heat Release Rate (HRR) will be measured.
- Two to three video cameras will be used to record each test. The exact location of the cameras is TBD.
- Six smoke and X CO alarm locations are TBD. The location and the frequency of using these alarms will be the responsibility of the CPSC.
- The door to the NIST/ISO 9705-compliant room will be open completely during testing.
- The ignition source and fuel are to be provided by the CPSC.
- The chair will be placed in the corner of the room with the front of the chair facing the door.

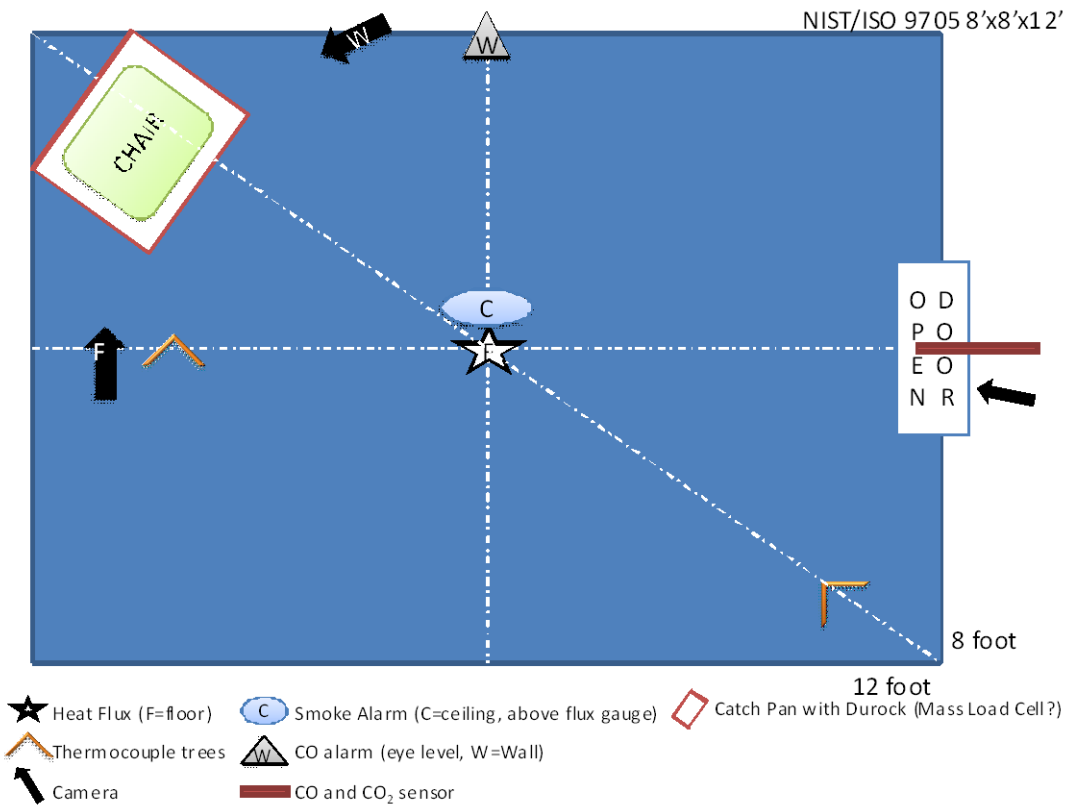


Figure 3. Schematic of Test Room, with Dimensions and Placement of Sample, Devices and Sensors Note: Not to Scale.

3.2 Test Procedure

The details of the testing protocol are in Appendix D1 of this document and include the following factors: NIST activities under the protocol are explained in section 4, "Roles and Responsibilities":

- Ignition sequence
- Testing sequence (randomization scheme, Appendix D3)
- Duration and termination parameters
- Data collection specifics, such as beginning and ending measurements, and sampling frequency
- If the room is damaged during testing, room reconstruction and reinstrumenting cannot occur until the room cools down to a level that the supervisor determines to be safe to perform these activities. The baseline assumption is that the nonbarrier chairs will release at least/approximately 500–600 kW of heat, which may require the room to be rebuilt after two to three tests; suppression activities will have a big impact on if and when the room will need to be rebuilt. Room reconstruction and reinstrumenting will take approximately half a day. NIST has suggested a testing rate of three chairs/day (barrier) and two chairs/day (non-barrier). However, NIST is not guaranteeing a testing rate or a total number of tests because there are a lot of unknowns (heat flux generated by

a chair). NIST will provide 7 weeks of LFL testing time and will do everything possible to complete as many of the 64 chairs, as long as "everything" falls within NIST's safety policies.

3.3 Data Collection

The data collected will include:

- Heat release rate vs. time. Within this measurement is data collection for CO, CO_2 and O_2 in the fire effluent.
- CO concentration vs. time. The location of the CO sensor in the room is TBD. It is expected to be placed at approximately eye level inside the test room. CO is also measured in the effluent stream of the hood.
- Time to smoke detector activation. Two brands of three types of hard-wired smoke detectors will be used: photoelectric, ionization, and combination. They will be located on the ceiling directly above the chair specimen with signal data capture.
- CO alarm performance.
- Heat flux meter data.
- Peak heat release rate.
- Time to peak heat release.
- Total energy release, as needed.
- Temperature of the test room vs. time. Thermocouple locations are TBD.
- Smoke obscuration, noted by a visual cue in the room.

3.4 Test Setup

Open-flame ignition testing of upholstered furniture will be conducted in a NIST/ISO 9705 room. This room will be built and instrumented as follows:

- Two thermocouple trees to measure upper layer temperature and depth;
- CO and CO_2 levels in the upper layer (as measured at the top of the door opening);
- Heat flux meter at center of room, pointed up at the ceiling;
- Smoke obscuration indication (*e.g.*, painted mark 4 ft. above the floor);
- Heat release rate;
- At least two video cameras;
- Smoke alarms and CO alarms; and
- The door of the room will be open to help the room size accentuate the build-up of heat and toxic gases.

4 ROLES AND RESPONSIBILITIES

Unless otherwise indicated, the CPSC and NIST will have the following responsibilities. The ownership of these responsibilities is subject to change, depending upon factors, such as equipment and personnel availability. Such deviation from the original assignment of activities

described in this test plan document requires only verbal approval by the PIs of CPSC (Rik Khanna) and NIST (Rick Davis) or other designees. No written or documented approval is required.

Safety

Safety conditions are the first and highest priority during every stage of this study. Every person involved has the right to express their safety concerns. The PIs are responsible for performing necessary safety risk assessments and ensuring all activities are being performed safely. Matthew Bundy (Building 205 supervisor) will also be responsible in safety discussions for all activities that involve Building 205. Because Dr. Bundy is the expert in Building 205, he will have absolute and final decision-making authority when it comes to safety conditions in Building 205.

4.1 CPSC

The upholstered furniture fire performance testing detailed in this document will be performed in Building 205 of NIST by CPSC personnel. CPSC will also be responsible for the following:

a. Complying with all NIST and Large Fire Laboratory safety guidelines
b. Providing and transporting to NIST, 64 upholstered furniture chairs for testing.
c. Providing a test plan that details a specific test protocol and randomization scheme.
d. Providing smoke and carbon monoxide (CO) alarms that are prewired to interface directly with NIST's data collection system. The location in the room and which tests will or will not use alarms will be determined by CPSC before testing but can be changed at any point in the test series with only verbal communication to the NIST PI (Rick Davis) and NIST staff.
e. As long as CPSC staff and the type of activity are in compliance with NIST's safety policies and practices, CPSC will provide personnel to help NIST with activities, such as, but not limited to, test set up, test performance, and cleanup activities,

4.2 NIST

NIST will provide technical expertise in conducting large-scale fire testing to assist CPSC staff. NIST will specifically be responsible for the following:

- Providing all scientists and visitors with appropriate safety training before testing begins.
- Supplying personnel and facilities for all NIST responsible activities.
- Furnishing up to 1 week of short-term storage of the upholstered furniture samples.
- Providing all instrumentation and materials necessary for performing these tests, except for smoke and CO alarms.
- Collecting and reporting all data as indicated in the Data Collection section.
- Set up, clean up, and operation of each fire performance test, as indicated in the Test Protocol section, with assistance from CPSC staff.

- Building and, if necessary, rebuilding with the assistance of CPSC staff, a NIST/ISO 9705 room with the following characteristics:
    - 8 ft x 12 ft x 8 ft (L x W x H). The framing will be wood, and the walls will be type C Gypsum Board. The room will have a standard interior door located at the middle of the 8 ft wall. The door must be operational and will remain open during testing.
- Collecting and reporting video, temperatures, CO, CO_2, heat flux, and heat release rate measurements, as instructed in the Test Setup, Test Protocol, and Data Collection sections.
- Providing and setting up two thermocouple trees, CO and CO_2 sensors, two heat flux gauges, and two video cameras. The set up of the all sensors, devices, and samples can be seen in Figure 3.
    - Submitting a data report to the CPSC by the end of the contract, or at a date to be agreed upon by the PIs. Note: analysis of the data by NIST is not required; analysis will be performed by CPSC staff.

5 CONTACT INFORMATION

Dr. Rick Davis
Material Research Engineer
Materials Flammability Group, NIST
Building and Fire Research Laboratory
100 Bureau Drive MS-8665
Gaithersburg, MD 20878
Office: (301) 975-5901
Mobile: (240) 246-5698
Rick.Davis@NIST.gov

Rik Khanna
U.S. Consumer Product Safety Commission
4330 East West Highway
Bethesda, MD 20814
(301) 504-7546
rkhanna@cpsc.gov

Shivani Mehta
U.S. Consumer Product Safety Commission
4330 East West Highway
Bethesda, MD 20814
(301) 504-6995
smehta@cpsc.gov

APPENDIX D1 – TEST PROTOCOL

Note: Have a means for extinguishing the sample. The exact chemical content of the FR foams is not known, so prepare appropriately.

A. Pretest–
   1. Sample to be tested is determined by the Randomization Scheme in Appendix D3 of the Test Plan.
   2. Record time that the sample was taken out of conditioning room.
   3. Record the initial total mass of the sample.
   4. Place sample chair in NIST/ISO room at a 45° angle in corner of the room so that the seat and back cushions face the doorway.
   5. Ensure Test ID is visible on placard and within the viewing frame of the video cameras.
   6. Record temperature and RH% inside the room.
   7. Clear all personnel from the room/under the hood.
   8. Turn on data acquisition system (including all sensors). Ensure appropriate readings. Begin background measurements.
      - The data should be taken in 1-second intervals.
   9. Start all video cameras.
   10. Photograph the sample in place.

B. Lighting the igniter flame–
   1. Open the butane tank slowly, and light the end of the burner tube. Adjust the gas flow to the appropriate rate to achieve a 240 mm flame. Allow the flame to stabilize for at least 2 minutes.

C. Performing the test–
   1. Apply the flame for 70 ± 1 seconds at the center of seat/back crevice of the sample, using the bent burner tube; then immediately remove ignition source from the sample.
      - This is the test "Start Time." Note in data acquisition system.
   2. Upon leaving room, operator shall leave door open.
   3. Once Peak HHR has been observed, the operator will decide how much longer to continue test. Also, there may be multiple peaks in HRR; the PI will determine the length of test (Note: If the instantaneous HRR of a sample under test is high and the fire is observed to be growing, the test may be terminated for safety reasons.
   4. Observe the sample combustion behavior for X minutes after a Peak HRR has been reached.
      (Note: If the instantaneous HRR of a sample under test is X, and the fire is observed to be growing, the test may be terminated for safety reasons. To be determined by the PIs and LFL safety officer)
   5. Record time of Smoke Alarm Activation, as seen in data.
   6. Record time of CO Alarm Activation, as seen in data.

7. Record time at which smoke obscuration mark is no longer visible.

D. Post-Test–
   1. Stop all measurements and video cameras.
   2. Collect “drift measurements.”

APPENDIX D2 – FULL-SCALE CHAIR TESTING DATA SHEET

Date:	_____	Temp (°C):	_____
Sample # :	_____	RH %:	_____
Fabric (circle one)	1A 1B 2A 2B	Sample retrieval time:	_____
Foam:	SPUF FR		
Barrier:	Yes No		
Initial Mass (kg):	_____	End Mass (kg):	_____
Test Start Time:	_____	Test End Time:	_____
Time to visual smoke obscuration	_____	Obscuration observed by:	_____
Smoke Alarm activation:	_____	CO Alarm Activation:	_____

Time	**Observation**

APPENDIX D3 – TESTING SEQUENCE

Note: Chairs with no barriers have polyester batting between the fabric and foam.

Test #	Fabric	Foam	Barrier	Replicate	Combination #
1	1A	FR	No	1	4
2	1A	SPUF	Yes	1	1
3	1B	FR	No	1	8
4	1B	SPUF	No	1	6
5	1A	SPUF	No	1	2
6	1B	SPUF	Yes	1	5
7	2A	FR	Yes	1	11
8	2B	SPUF	Yes	1	13
9	2B	FR	No	1	16
10	1A	FR	Yes	1	3
11	1B	FR	Yes	1	7
12	2B	SPUF	No	1	14
13	2A	FR	No	1	12
14	2A	SPUF	No	1	10
15	2A	SPUF	Yes	1	9
16	2B	FR	Yes	1	15
17	2B	SPUF	Yes	2	13
18	1A	SPUF	No	2	2
19	1A	FR	No	2	4
20	1B	SPUF	Yes	2	5
21	1A	SPUF	Yes	2	1
22	2A	FR	No	2	12
23	2B	SPUF	No	2	14
24	2B	FR	No	2	16
25	1A	FR	Yes	2	3
26	2A	SPUF	No	2	10
27	2A	SPUF	Yes	2	9
28	1B	FR	Yes	2	7
29	1B	SPUF	No	2	6
30	2B	FR	Yes	2	15
31	2A	FR	Yes	2	11
32	1B	FR	No	2	8

Test #	Fabric	Foam	Barrier	Replicate	Combination #
33	2A	SPUF	Yes	3	9
34	2B	FR	No	3	16
35	1A	SPUF	Yes	3	1
36	1B	FR	No	3	8
37	2B	FR	Yes	3	15
38	1B	SPUF	No	3	6
39	1B	FR	Yes	3	7
40	2A	FR	No	3	12
41	1B	SPUF	Yes	3	5
42	1A	SPUF	No	3	2
43	1A	FR	No	3	4
44	2A	SPUF	No	3	10
45	2A	FR	Yes	3	11
46	2B	SPUF	No	3	14
47	2B	SPUF	Yes	3	13
48	1A	FR	Yes	3	3
49	2B	SPUF	Yes	4	13
50	2A	FR	Yes	4	11
51	1B	FR	No	4	8
52	2B	SPUF	No	4	14
53	1B	SPUF	No	4	6
54	2B	FR	No	4	16
55	1A	FR	Yes	4	3
56	2A	FR	No	4	12
57	1A	SPUF	No	4	2
58	2B	FR	Yes	4	15
59	1A	SPUF	Yes	4	1
60	1B	FR	Yes	4	7
61	1B	SPUF	Yes	4	5
62	1A	FR	No	4	4
63	2A	SPUF	No	4	10
64	2A	SPUF	Yes	4	9

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MD 20814

Memorandum

Date: May 11, 2012

TO: Dale R. Ray
Directorate for Economic Analysis

THROUGH : Kathleen Stralka
Associate Executive Director
Directorate for Epidemiology

Stephen J. Hanway
Division Director
Division of Hazard Analysis

FROM: David Miller
Division of Hazard Analysis

SUBJECT: Analysis of Chair Open-Flame Data

Background:

In January 2008, the U.S. Consumer Product Safety Commission (CPSC) published a notice of proposed rulemaking (NPR) for upholstered furniture flammability. The proposed standard requires upholstered furniture manufacturers to use a smolder-resistant cover material or a qualified fire barrier. To be a qualified fire barrier, a barrier must be smolder resistant and open-flame resistant. The fire barrier is required to be open-flame resistant because if the cover material is not smolder-resistant and can transition to flaming, then the fire barrier would be called upon to protect filling materials from flaming combustion.

CPSC staff found a fire barrier that was effective in mockup testing in smoldering and open-flame resistance. CPSC staff purchased chairs to be open-flame tested at the National Institute of Standards and Technology (NIST). Some of the chairs were given the fire barrier that proved effective in mockup testing, and some had no fire barrier. The chairs had one of four different fabrics and one of two different foams.

Purpose:

The main purpose of the testing was to evaluate the effectiveness of the fire barrier for chairs of different fabrics and foams, as measured by the Peak Heat Release Rate and the Time to reach the Peak Heat Release. Additionally, staff hoped to learn something about the relative performance of chairs with standard polyurethane foam (SPUF) versus flame-retardant (FR) foam.

Results:

There were 64 chairs tested. There were four replicates each of 16 different fabric- foam- fire-barrier combinations of chairs. The four different cover fabrics were selected based on their likelihood to smolder when tested in the past on mockups. Two very smolder-prone fabrics were selected, as well as two moderately smolder-prone fabrics. The two very smolder-prone fabrics will be referred to as "1A and 1B," and the two moderately smolder-prone fabrics will be called "2A and 2B." The two foams were SPUF and FR. And the two levels for the fire barrier variable were "Fire Barrier" (for chairs with fire barriers) and "No Fire Barrier" (for chairs without fire barriers). Table 1 below gives the mean and standard deviation over the four replicates of Peak Heat Release Rate and Time to Peak Heat Release for the 16 different combinations.

Table 1. Peak Heat Release Rate and Time to Peak Heat Release for Open-Flame Chairs

Fabric	Foam	Fire Barrier	PHRR[1] mean	PHRR std deviation	Time[2] mean	Time std deviation
1A	SPUF	Yes	278.0	36.4	699.5	43.3
1A	SPUF	No	623.5	75.4	169.0	7.2
1A	FR	Yes	224.0	27.5	649.3	16.9
1A	FR	No	543.5	78.2	228.8	52.8
1B	SPUF	Yes	295.3	44.8	1136.3	177.9
1B	SPUF	No	450.8	35.1	281.8	32.8
1B	FR	Yes	274.0	70.8	1273.3	250.1
1B	FR	No	407.0	26.5	344.3	47.3
2A	SPUF	Yes	226.0	31.1	585.8	71.5
2A	SPUF	No	615.3	82.0	139.3	7.3
2A	FR	Yes	249.8	23.9	551.5	84.4
2A	FR	No	488.8	94.9	160.3	6.3
2B	SPUF	Yes	263.8	46.9	641.5	37.4
2B	SPUF	No	538.3	38.1	193.8	21.7
2B	FR	Yes	244.5	35.2	661.3	55.5
2B	FR	No	455.8	66.1	201.8	43.5

Analysis:

There are two dependent variables: (1) Peak Heat Release Rate (PHRR), and (2) Time to Peak Heat Release (Time). There are three independent variables or main effect variables. These are: (1) fabric, (2) foam, and (3) fire barrier. One dependent variable will be analyzed at a time. Since the independent variables are categorical, analysis of variance (ANOVA) is used to infer which independent variables are statistically significant in explaining the variability observed in the dependent variable measurements.

[1] Peak Heat Release Rate measured in kilowatts.

[2] Time (in seconds) until peak heat release rate is reached. For some of the tests, a range of time was recorded for time to peak. For these tests, the midpoint of this range was the value used.

Peak Heat Release Rate:

Box plots of PHRR measurements across fabrics can be seen in Appendix A on p. 12–14. These plots display graphically the range of differences suggested for both foams, with and without the fire barrier.

An analysis of variance was performed with PHRR as the dependent variable and fabric, foam, and fire barrier as the independent variables. SAS® was used to perform this analysis. All three two-way interactions and the three-way interaction were left in the model.

Checking normality:

In an ANOVA, the residuals[3] are assumed to be normally distributed. The residuals from this ANOVA appear to be right-tailed. The Anderson-Darling goodness of fit test for normality has a p-value of 0.046, which leads to rejection of the null hypothesis (at the alpha=.05 level) that the residuals are normally distributed. A log transformation of the data was done and an ANOVA was performed, where the independent variable is the natural log of PHRR. Again the interactions were left in the model.

With the log transformation of the dependent variable data, the residuals appear normal. The Anderson-Darling goodness of fit test for normality has a p-value greater than 0.25. ANOVAs tested on the log transformed dependent variables are referred to as log models.

Interactions:

In an ANOVA, before looking at the main effects, you must look at the interactions. In the full model, one with all the possible main effects and interactions left in the model, there are four interactions: three two-way interactions and one three-way interaction. Only one of them, the fabric/fire barrier interaction, was statistically significant. The full log model has an R^2 value of 0.900.

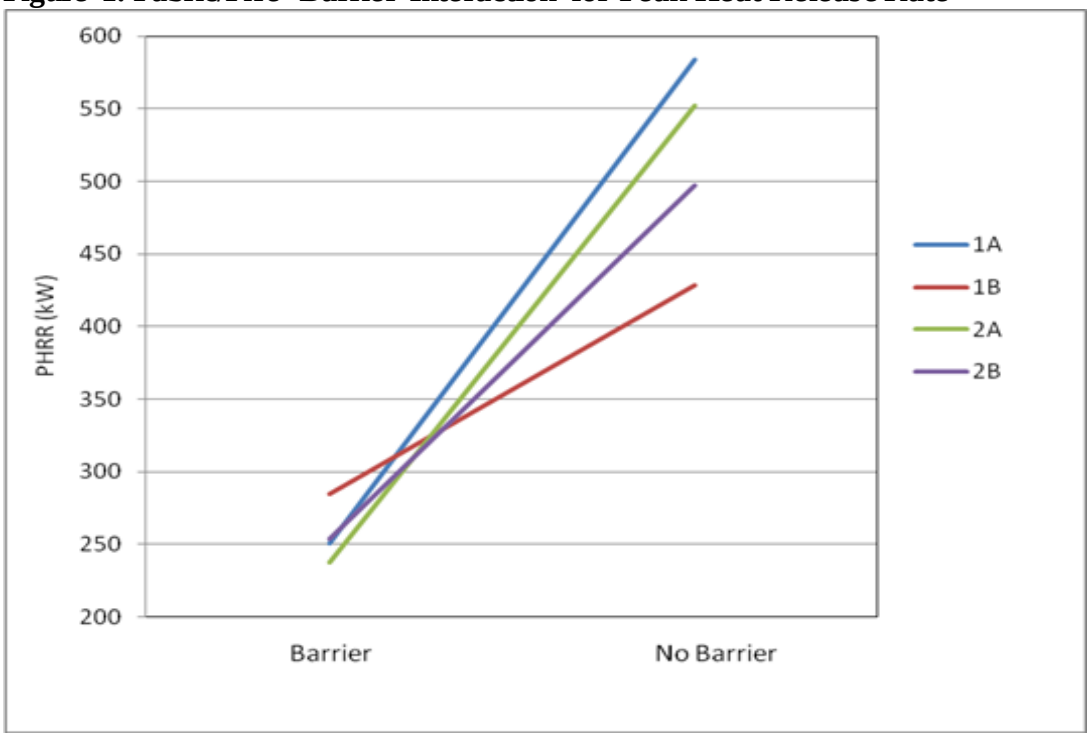
Table 2. Peak Heat Release Rate Full Log Model Interactions

Interaction	F-value	df	P-value
Fabric/Foam	0.45	3	0.7219
Foam/Fire Barrier	1.77	1	0.1895
Fabric/Fire Barrier	**7.75**	**3**	**0.0003**
Fabric/Foam/Fire Barrier	1.62	3	0.1981

This significant result for a fabric/fire barrier interaction calls for a look into this interaction. It gives strong evidence that the difference that the fire barriers make in the flammability performance of the chairs (as measured by PHRR) is dependent upon the fabric. It makes sense to look graphically at this interaction. For simplicity, Figure 1 plots PHRR instead of log (PHRR).

[3] A "residual" is the difference between an observation and the mean for the variable grouping for that observation.

Figure 1. Fabric/Fire Barrier Interaction for Peak Heat Release Rate



If there were no interaction, the lines in Figure 1 would be parallel or close to parallel. Although it is clear that having a fire barrier meant a lower PHRR for each fabric (the slopes are positive), the degree to which the fire barrier helped, varied from fabric to fabric (the slopes differ). Interestingly, the worst performing fabric (highest PHRR with a fire barrier was 1B, but that same fabric was the best performing fabric without a fire barrier. Significant interactions can mask the effect of the fabric on fire barriers when considered by themselves.

Main effects:

The main effects are the effect that each individual variable has on PHRR The main effects in this model are fire barrier, foam, and fabric. The fire barrier and foam effects are statistically significant, but the fabric effect is not. The fabric/fire barrier interaction may mask a fabric effect.

Table 3. Peak Heat Release Rate Main Effects

Effect	Estimate	Exp(Estimate)	F-value	P-value
Fire Barrier	**0.724**	**2.063**	**386.00**	**< 0.0001**
Foam	-0.070	0.932	10.65	0.0020
Fabric	1A = 0.059 1B = 0.117 2A = -0.149 [4]	1A = 1.061 1B = 1.125 2A = 0.862	1.24	0.3064

[4] Since there are four different fabrics, there is not a single estimate of the fabric effect. The effects of each fabric relative to fabric 2B are given.

In addition to the finding that the fire barrier and foam main effects are statistically significant, the estimates suggest the influence of the effect. Chairs with fire barriers, as speculated, had lower PHRRs than chairs without. Chairs with FR foam had lower PHRRs than chairs with SPUF. In the log model, the independent variables are seen as having a multiplicative effect instead of an additive effect. Exponentiating the estimate from the log model gives us the estimated multiplicative effect for the variable. It is estimated that not having the fire barrier in the chair results in a Peak Heat Release Rate that is 2.063 times higher[5] than for the chairs with fire barriers. SPUF foam in the chairs results in a PHRR an estimated 1.073 times higher[6] than for the chairs with FR foam. Fabric 1A provides a PHRR an estimated 1.061 times higher than does fabric 2B; fabric 1B results in an estimated 1.125 times greater PHRR than fabric 2B; and fabric 2B yields a PHRR an estimated 1.161 times greater than fabric 2A.

Multiple Comparison Tests:

As part of the analysis, multiple comparison tests were also performed. It was determined in advance of the chair testing that all of the individual fire barrier and foam comparisons would be made for each dependent variable, but fabric comparisons would not be made. This was because the primary interest was in evaluating barriers, and the secondary interest was in evaluating the effect of the foam. Increasing the number of comparisons means decreasing the power of each comparison test; so it was decided not to do the fabric comparison tests. There are eight fabric comparisons and eight foam comparisons for a total of 16 comparisons. A stepwise Bonferroni approach was used to adjust alpha so that the overall experimentwise Type 1 error rate would be 0.05.[7] The first p-values given in Table 4 are the raw p-values that are not adjusted for multiple comparisons. The adjusted p-values are adjusted by the stepwise Bonferroni method so that the significance cutoff is still 0.05. The last column tells the observed difference (in kilowatts) between the sample mean PHRR for the chairs with a barrier versus the chairs without a barrier for the given fabric-foam combination.

Table 4. Individual Fire Barrier Comparisons for Peak Heat Release Rate

Comparison	Across Fabric/Foam	Raw P-value	Adj P-value	Avg. Difference (kw)
Barrier vs. No Barrier	1A, SPUF	<0.0001	0.0012	345.5
Barrier vs. No Barrier	1A, FR	<0.0001	<0.0001	319.5
Barrier vs. No Barrier	1B, SPUF	<0.0001	0.0012	155.5
Barrier vs. No Barrier	1B, FR	0.0001	<0.0001	133.0
Barrier vs. No Barrier	2A, SPUF	<0.0001	0.0012	389.3
Barrier vs. No Barrier	2A, FR	<0.0001	<0.0001	239.0
Barrier vs. No Barrier	2B, SPUF	<0.0001	0.0012	274.5
Barrier vs. No Barrier	2B, FR	<0.0001	<0.0001	211.3

All eight of the fire barrier comparisons showed very significant differences with adjusted p-values of 0.0012 or below. The differences were that chairs with fire barriers had significantly lower Peak Heat Release Rates than chairs without fire barriers. None of the eight foam comparisons showed significant differences with the adjusted p-values.

[5] Exp(0.724).
[6] Exp(-(-0.070)).
[7] The chance of making a Type 1 error in a given test is the testwise error rate. The chance of making at least one Type 1 error in all 16 tests is the experimentwise error rate. A Type 1 error is a rejection of the null hypothesis (that there is no difference) even if there actually were no difference.

Table 5. Individual Foam Comparisons for Peak Heat Release Rate

Comparison	Across Fabric/Barrier	Raw P-value	Adj P-value	Avg. Difference (kw)
SPUF vs. FR	1A, Fire Barrier	0.0358	0.2506	54.0
SPUF vs. FR	1A, No Fire Barrier	0.1704	0.8500	80.0
SPUF vs. FR	1B, Fire Barrier	0.3703	1.000	21.3
SPUF vs. FR	1B, No Fire Barrier	0.3152	1.000	43.8
SPUF vs. FR	2A, Fire Barrier	0.3046	1.000	-23.8[8]
SPUF vs. FR	2A, No Fire Barrier	0.0220	0.1760	126.5
SPUF vs. FR	2B, Fire Barrier	0.4839	1.000	19.3
SPUF vs. FR	2B, No Fire Barrier	0.0914	0.5460	82.5

None of the eight foam comparisons seen in Table 5 showed significant differences with the adjusted p-values.

Time to Peak Heat Release:

Box plot presentations of the variability in Time to Peak Heat Release (Time) are in Appendix B on p. 15–17.

Just as with PHRR, an analysis of variance was performed for Time to Peak Heat Release. In this case, Time is the dependent variable and fabric, foam, and fire barrier are the independent variables.

Checking normality:

Running the full model (leaving in all independent variables and all possible interactions) on Time gives residuals that do not appear normal. There are data points farther out in the distribution tails than would be expected with normally distributed data. The Anderson-Darling goodness of fit test for normality has a p-value of less than 0.005, which means rejection of the null hypothesis that the residuals are normally distributed. So a natural log transformation was applied to the Time to Peak Heat Release measurement. An analysis of variance was performed where the natural log of the Time is the dependent variable.

The residuals for the log model appear normally distributed. The p-value for the Anderson-Darling test is greater than 0.250.

Interactions:

In the full model there are four possible interactions: three two-way interactions and one three-way interaction. The foam/fire barrier interaction is the only significant one. The full log model has an R^2 value of 0.976.

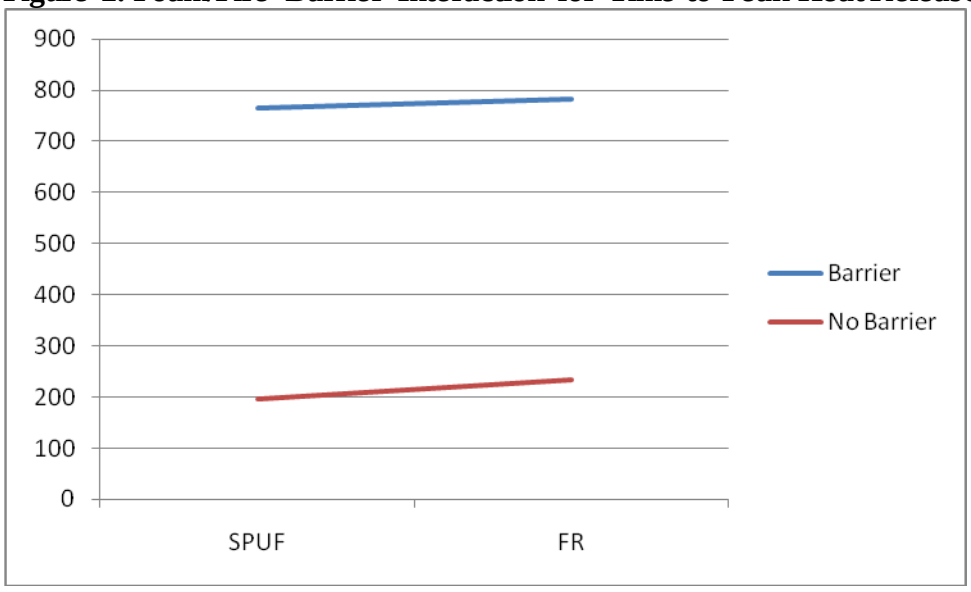
[8] The number is negative because, for 2A chairs with fire barriers, the FR chairs had a higher average PHRR than the SPUF chairs. This is not very surprising because the overall difference that FR chairs make appears to be small; so, with only four replicates for each combination, having one go against the trend does not seem very unlikely. It is important to note that for Fabric 2A, the chairs with fire barriers had a much lower PHRR than the chairs without the fire barriers for either foam. The large difference is made by the fire barrier, not the foam.

Table 6. Time to Peak Heat Release Full Log Model Interactions

Interaction	F-value	Df	P-value
Fabric/Foam	0.86	3	0.4676
Foam/Fire Barrier	**6.50**	**1**	**0.0140**
Fabric/Fire Barrier	1.20	3	0.3183
Fabric/Foam/Fire Barrier	1.49	3	0.2283

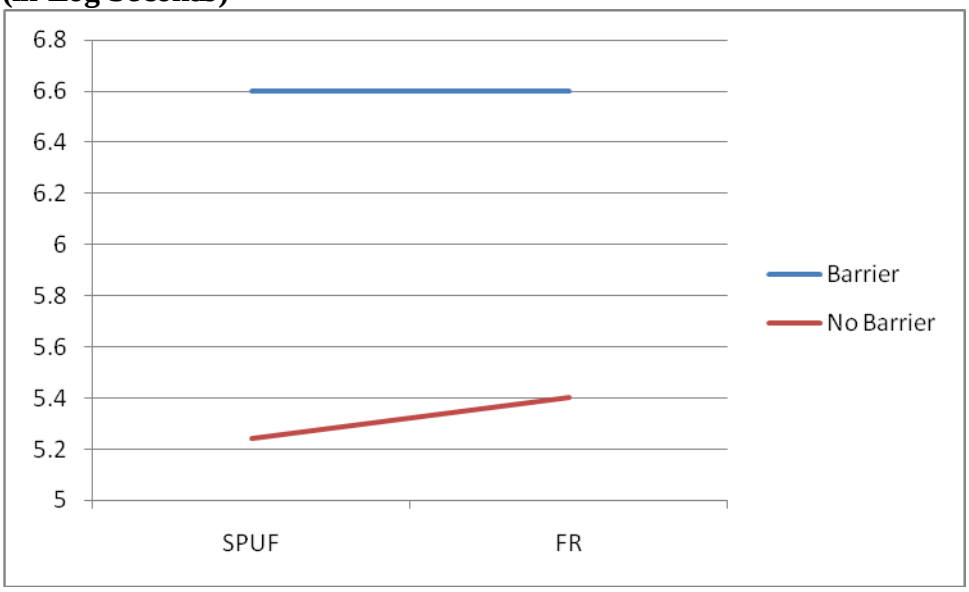
This significant foam/fire barrier interaction is evidence that the effect the fire barrier has on flammability performance (with regard to Time) is dependent upon whether the foam was FR or SPUF.

Figure 2. Foam/Fire Barrier Interaction for Time to Peak Heat Release



It does not appear that there would be any significant interaction here. The lines appear fairly parallel. However, the results do show that the FR foam does make statistically significantly more of an improvement in terms of time for the chairs without fire barriers than for the chairs with fire barriers. It is useful to look at the log of time here because that is the model used in the analysis. Figure 3 shows the Time to Peak Heat Release in log seconds by barrier and no barrier. This demonstrates more clearly that FR foam made more of a difference for chairs without barriers than for chairs with fire barriers.

Figure 3. Foam/Fire Barrier Interaction for Time to Peak Heat Release (in Log Seconds)



Main Effects:

The three main effects in this model are fire barrier, foam, and fabric. All three are highly significant. The data suggest that a fire barrier makes for a longer time before the Peak Heat Release is reached. To a lesser extent, FR foam, and fabric made a difference as well. Since it is a log model, the coefficients tell us about the estimated multiplicative effect of the fire barrier and the foam. It is estimated that having the fire barrier in the chair results in a Time to Peak Heat Release that is 3.323 (which is $\exp^{(-(-1.201))}$) times higher than for the chairs without fire barriers. FR foam in the chairs results in a Time to Peak Heat Release an estimated 1.030 times higher than for the chairs with SPUF. Fabric 1A provides an estimated 1.090 times higher Time to Peak Heat Release than does fabric 2B, fabric 1B results in an estimated 1.756 times greater Time than fabric 2B, and fabric 2B yields a Time an estimated 1.101 times greater than fabric 2A.

Table 7. Main Effects for Time to Peak Heat Release

Effect	Estimate	Exp(Estimate)	F-value	P-value
Fire Barrier	-1.201	0.301	1,618.51	< 0.0001
Foam	0.029	1.030	6.64	0.0131
Fabric	1A = 0.086 1B = 0.563 2A = -0.096 [9]	1A = 1.090 1B = 1.756 2A = 0.908	97.55	< 0.0001

Multiple Comparison Tests:

Just as with PHRR, it was agreed in advance that comparisons would be done for individual fire barrier and foam comparisons for Time to Peak Heat Release. As mentioned before, a stepwise Bonferroni approach was used to adjust alpha so that the overall experimentwise error rate would be 0.05.

[9] Since there are four different fabrics, there is not a single estimate of the fabric effect. The effects of each fabric relative to fabric 2B are given.

Table 8. Individual Fire Barrier Comparisons for Time to Peak Heat Release

Comparison	Across Fabric/Foam	Raw P-value	Adj P-value	Avg. Difference (seconds)
Barrier vs. No Barrier	1A, SPUF	<0.0001	0.0012	530.5
Barrier vs. No Barrier	1A, FR	<0.0001	<0.0001	420.5
Barrier vs. No Barrier	1B, SPUF	<0.0001	0.0012	854.5
Barrier vs. No Barrier	1B, FR	<0.0001	<0.0001	929.0
Barrier vs. No Barrier	2A, SPUF	<0.0001	0.0012	446.5
Barrier vs. No Barrier	2A, FR	<0.0001	<0.0001	391.3
Barrier vs. No Barrier	2B, SPUF	<0.0001	0.0012	447.8
Barrier vs. No Barrier	2B, FR	<0.0001	<0.0001	459.5

All eight of the fire barrier comparisons showed very significant differences with the adjusted p-values. In each case, the evidence is that the chairs with fire barriers had longer average Times to Peak Heat Release than the chairs without fire barriers.

Table 9. Individual Foam Comparisons for Time to Peak Heat Release

Comparison	Across Fabric/Barrier	Raw P-value	Adj P-value	Avg. Difference (seconds)
FR vs. SPUF	1A, Fire Barrier	0.4188	1.0000	-50.3[10]
FR vs. SPUF	**1A, No Fire Barrier**	**0.0020**	**0.0160**	**59.8**
FR vs. SPUF	1B, Fire Barrier	0.2258	1.0000	37.0
FR vs. SPUF	1B, No Fire Barrier	0.0320	0.2240	62.5
FR vs. SPUF	2A, Fire Barrier	0.4901	1.0000	-34.3[11]
FR vs. SPUF	2A, No Fire Barrier	0.1230	0.7380	21.0
FR vs. SPUF	2B, Fire Barrier	0.7479	1.0000	19.8
FR vs. SPUF	2B, No Fire Barrier	0.7550	1.0000	8.0

Only one of the eight foam comparisons showed a statistically significant difference after adjusting for multiple comparisons. That one was for Fabric 1A chairs without fire barriers. For those chairs, the ones with FR foam had a significantly longer Time to Peak Heat Release than those with SPUF foam. The foam comparison for 1B chairs without fire barriers would have been significant without the multiple comparison alpha adjustment. These two combinations of fabric and barrier appear to have a lot to do with the foam being a significant main effect.

Conclusions:

The fire barrier, fabrics, and foams used in the experiment are fixed effects. Therefore, our conclusions are limited to the particular fabrics, foams, and fire barrier used in the testing. The primary purpose of the testing was to assess the effectiveness of the fire barrier in reducing the Peak Heat Release of the burning chairs and to increase the time until the chairs reach their Peak Heat Release. Analyses of variance for the

[10] This number is negative because the average Time to Peak Heat Release for chairs with fire barriers and with 1A fabric was higher for those with SPUF foam than for those with FR foam.

[11] This number is negative because the average Time to Peak Heat Release for chairs with fire barriers and with 2A fabric was higher for those with SPUF foam than for those with FR foam. It's not very surprising to get a couple of combinations to go against the trend of the FR foam giving more time to peak since the overall effect of the foam appears to be small and there are only four replicates for each combination. The big difference in time to peak, as well as in PHRR, is made by the fire barrier.

log transformed models for both dependent variables (PHRR and Time) showed the fire barrier variable to be very statistically significant with p-values below 0.0001.

- The estimated effect of the fire barrier for PHRR is that chairs with fire barriers would have a PHRR 2.063 times lower than chairs without fire barriers.

- The estimated fire barrier effect on Time is that chairs with fire barriers would take 3.323 times longer to reach their Peak Heat Release Rate than chairs without fire barriers.

- Individual fire barrier comparisons for all eight different combinations of fabric and foam were all significant both for PHRR and Time (with adjusted p-values to control the experiment-wise Type 1 error rate). These individual comparisons showed the performance of the fire barrier chairs to be superior to the non-barrier chairs for fabrics and foams used in the experiment for both Peak Heat Release Rate and Time to Peak Heat Release.

These large differences between the fire barrier chairs and non-barrier chairs for all of the foam and fabric combinations and for both Peak Heat Release Rate (Appendix A) and Time to Peak Heat Release (Appendix B) can be seen graphically with the box plots in the appendices.

For the ANOVA for the log of PHRR, the foam effect was significant with a p-value of 0.002. Chairs with FR foam proved to have a lower Peak Heat Release Rate than chairs with SPUF foam. The estimated effect of the foam was a PHRR 1.073 times higher for chairs with SPUF than for chairs with FR foam. When the individual comparisons were done with the adjusted p-values to control the error rate, none of the eight foam comparisons (across all combinations of fabric and fire barrier) were significant. For the analysis of variance of Time to Peak Heat Release, the foam effect was significant with a p-value of 0.0131 despite a significant foam/fire barrier interaction. The estimated foam effect for Time was a Time to Peak Heat Release 1.03 times higher for chairs with FR foam than for chairs with SPUF. The individual foam comparisons showed one significant result - for chairs with yellow floral and no fire barrier. For those chairs the Time was statistically significantly longer for FR chairs than for SPUF chairs.

Summary of Findings:

The chairs tested in this experiment suggest the following:

Fire Barrier:

- The fire barrier tested reduced the Peak Heat Release Rate of the chairs.
- The fire barrier increased the Time to Peak Heat Release of the chairs.

Foams:

- To a much lesser extent than the fire barrier, FR foam generally[12] reduced the Peak Heat Release Rate of the chairs, as compared to SPUF foam.
- To a much lesser extent than the fire barrier, FR foam generally[12] increased the Time to Peak Heat Release of the chairs, as compared to SPUF foam.

[12] This was not true for every combination of fabric/barrier, but the overall effect was statistically significant.

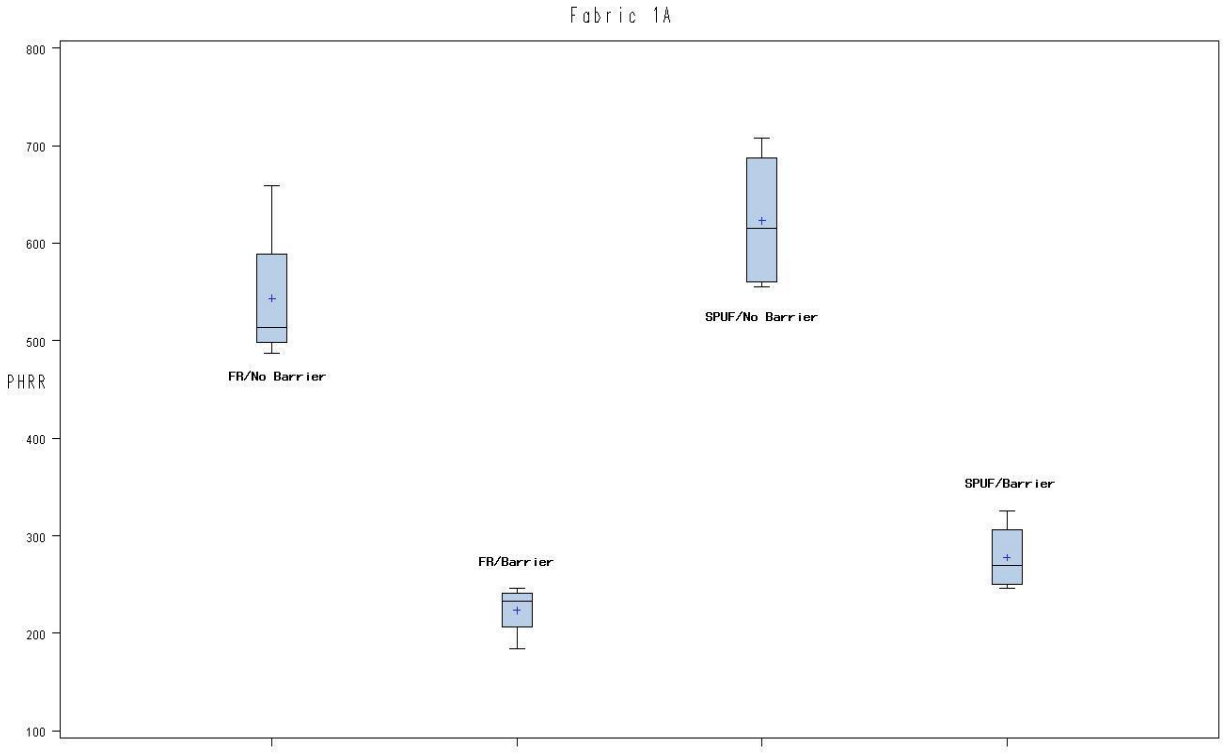
Appendix A

Box Plots of Peak Heat Release Rate Data

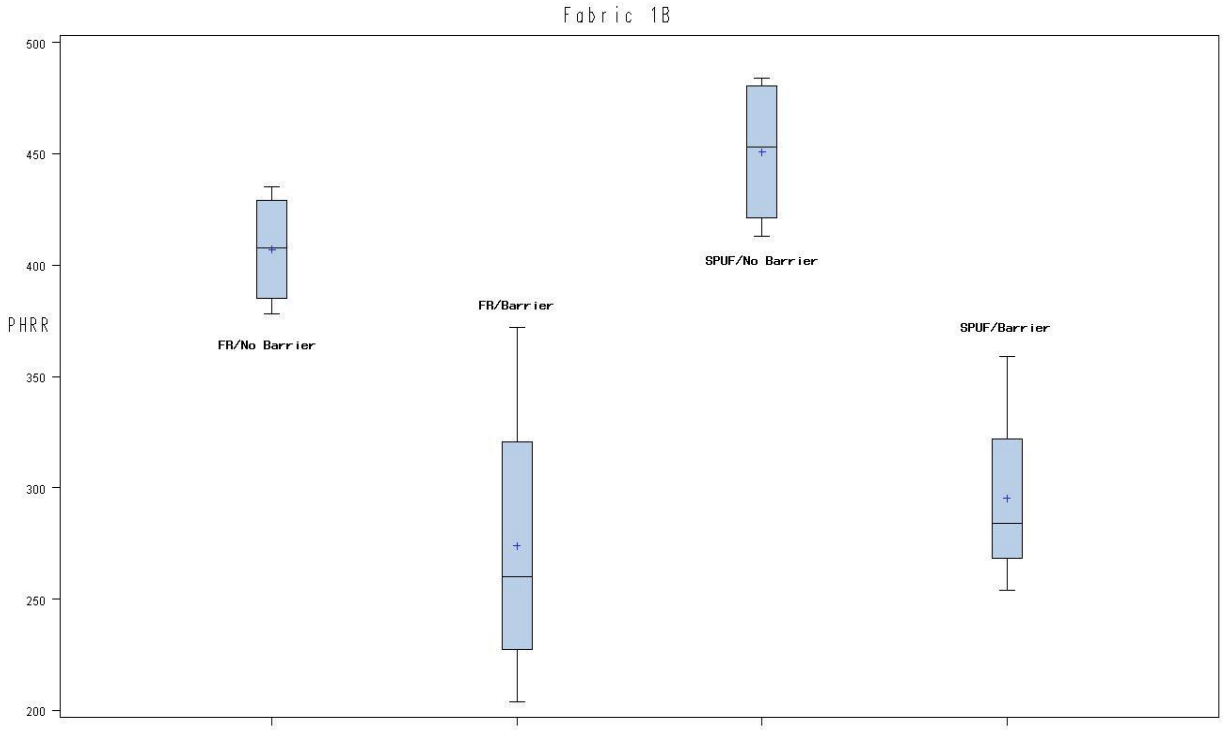
There are four box plots in Appendix A. Each one shows the PHRR[13] performance of fire barrier chairs versus no fire barrier chairs for both SPUF and FR foam.

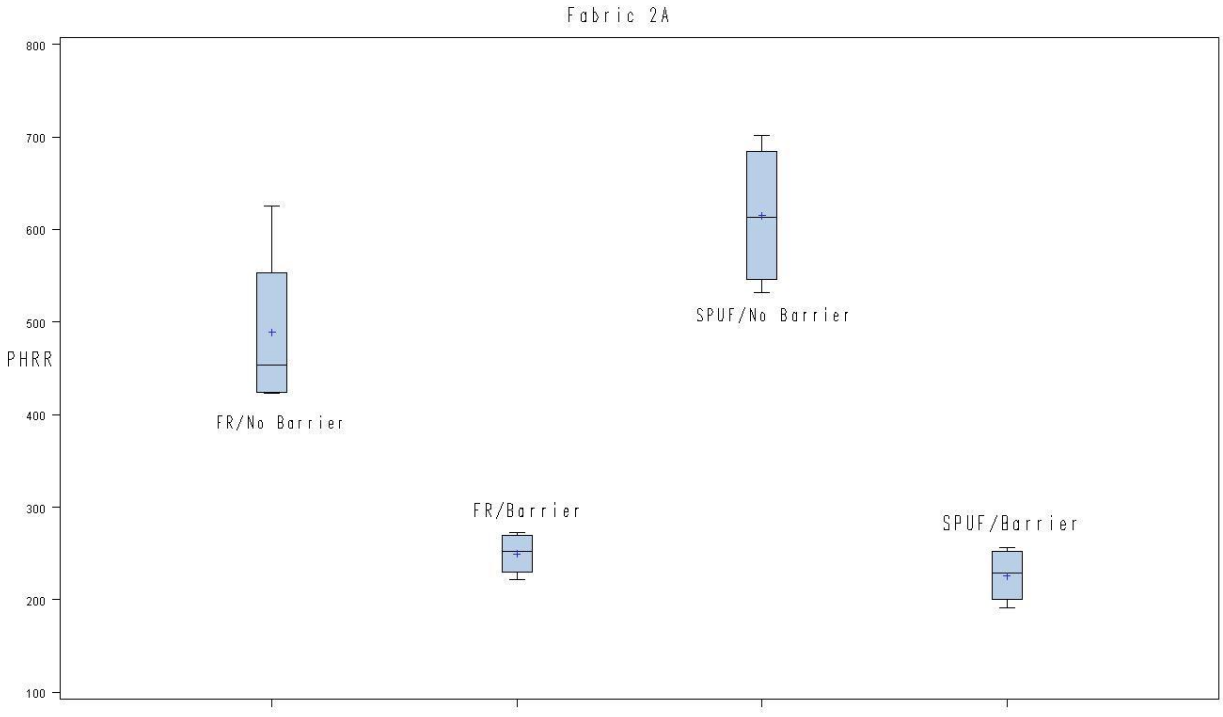
Box Plots:

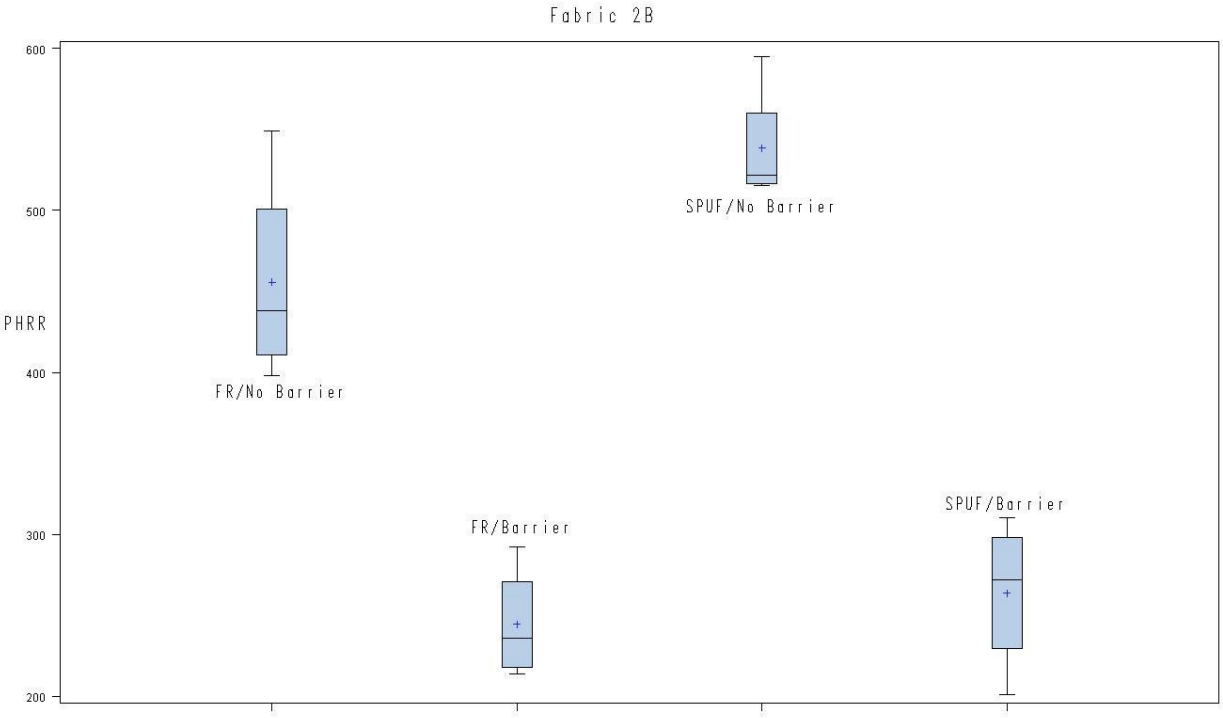
Each plot has four boxes—one for the four chairs tested with fire barriers and SPUF foam, one for chairs without fire barriers and SPUF foam, one for chairs with fire barriers and FR foam, and one for chairs without fire barriers and FR foam. The top of the box is at the 75th percentile, the bottom of the box is the 25th percentile, the horizontal line in the box is at the median (50th percentile) and the plus sign is at the mean. The horizontal line above the box is at the value of the maximum observation and the horizontal line below the box is at the value of the minimum observation.



[13] Note that the plots are of the PHRR (in kilowatts) and not of the log of PHRR.


Fabric 1B
PHRR
500
450
400
350
300
250
200
FR/No Barrier
FR/Barrier
SPUF/No Barrier
SPUF/Barrier

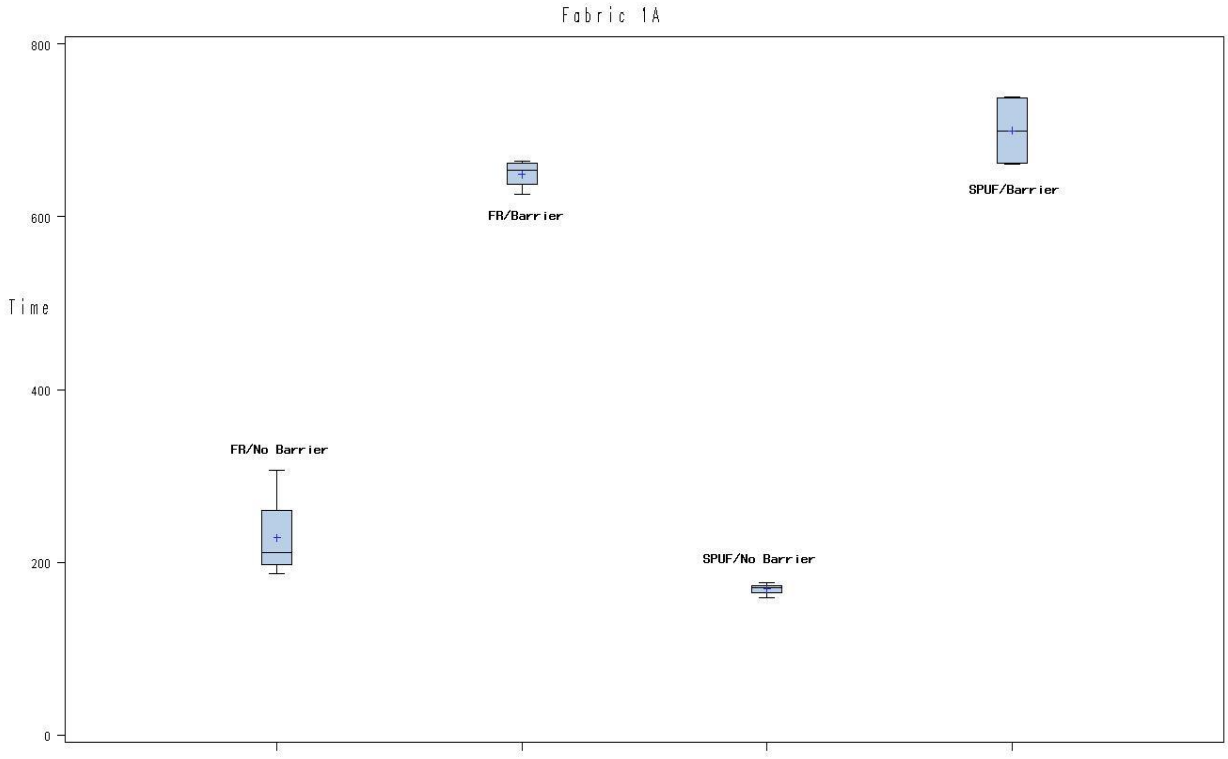

Fabric 2A
PHRR
800
700
600
500
400
300
200
100
FR/No Barrier
FR/Barrier
SPUF/No Barrier
SPUF/Barrier

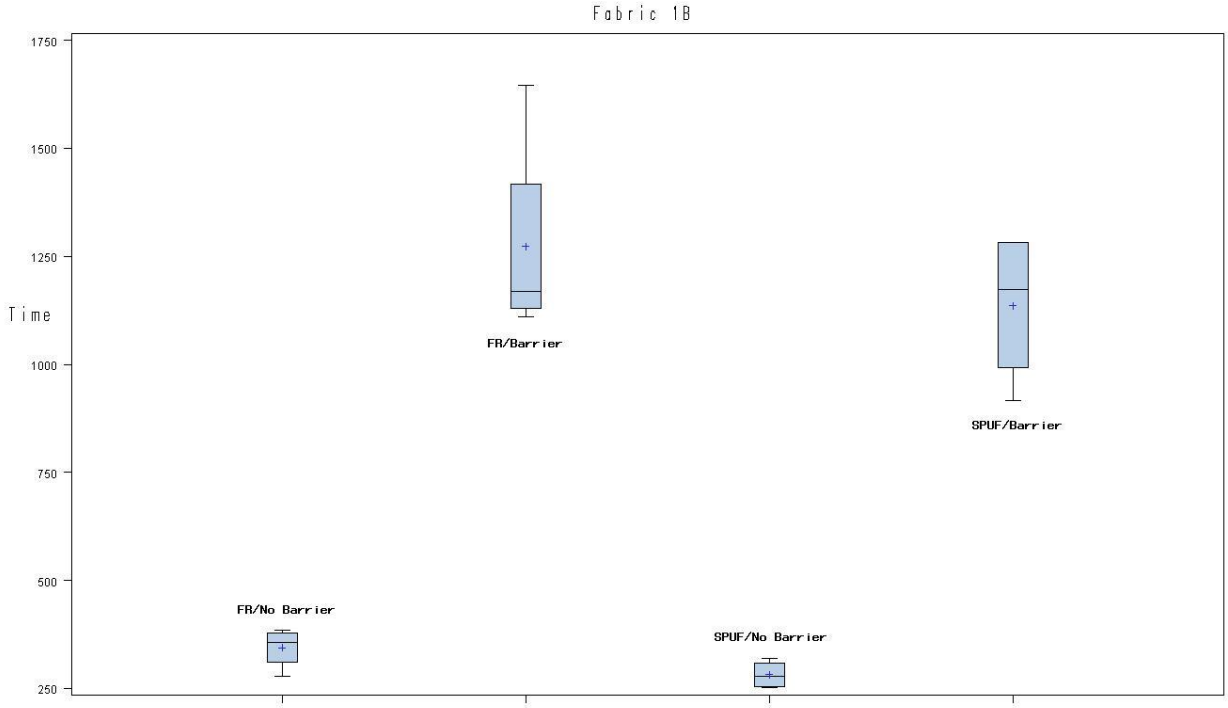

Fabric 2B
PHRR
600
500
400
300
200
FR/No Barrier
FR/Barrier
SPUF/No Barrier
SPUF/Barrier

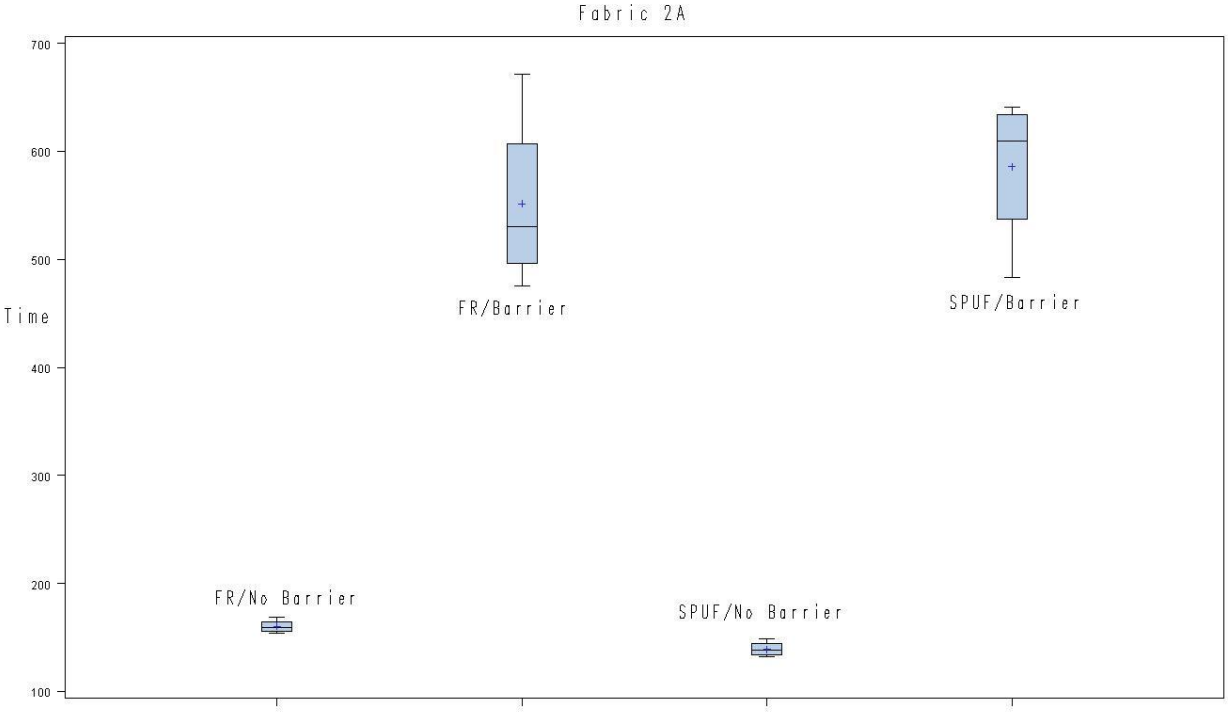
Appendix B

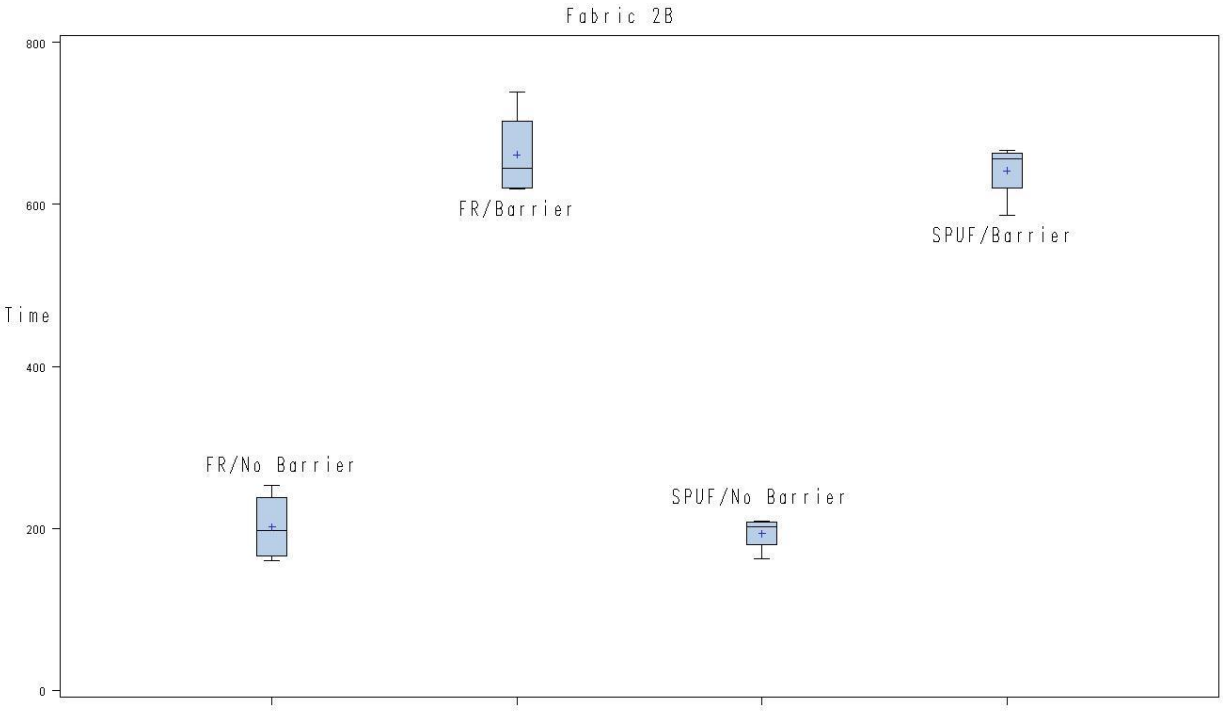
Box Plots of Time to Peak Heat Release Data

There are four box plots in Appendix B, just as in Appendix A. Each one shows the Time to Peak Heat Release (in seconds) performance of fire barrier chairs versus no barrier chairs for both SPUF and FR foam.




Fabric 1B
Time
1750
1500
1250
1000
750
500
250
FR/No Barrier
FR/Barrier
SPUF/No Barrier
SPUF/Barrier


Fabric 2A
Time
700
600
500
400
300
200
100
FR/No Barrier
FR/Barrier
SPUF/No Barrier
SPUF/Barrier


Fabric 2B
800
600
400
200
0
Time
FR/Barrier
SPUF/Barrier
FR/No Barrier
SPUF/No Barrier

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
BETHESDA, MD 20814

Memorandum

July 16, 2012

TO : Rohit Khanna, Project Manager, Upholstered Furniture
Office of Hazard Identification and Reduction

THROUGH : Andrew G. Stadnik, P.E., Associate Executive Director for Laboratory Sciences
Edward W. Krawiec, P.E., Division Director, Division of Engineering

FROM : Linda Fansler, Division of Engineering

SUBJECT : Mockup Test Program on Upholstery Fabrics and a Fire Barrier

INTRODUCTION

During the months of December 2008, and January and February 2009, the Laboratory Sciences staff of the U.S. Consumer Product Safety Commission (CPSC) conducted smoldering and open-flame mockup tests in support of staff's furniture test program. Using the test protocols in the draft proposed standard,[1] this mockup testing included: smoldering evaluations of six upholstery fabrics chosen to represent a range of smoldering propensities and smoldering tests of a fire barrier following the draft proposed standard's prescribed protocols for barrier materials. Open-flame evaluations of mockups with and without the same fire barrier used in the smoldering tests were also conducted.

BACKGROUND

In March 2008, CPSC staff published a proposed flammability standard for residential upholstered furniture under the Flammable Fabrics Act. The proposal would establish performance, certification, and labeling requirements for upholstered furniture. Manufacturers of upholstered furniture would choose to comply by using: (1) upholstery cover fabrics that are smolder resistant, (Type I furniture); or (2) a fire barrier between the upholstery cover fabric and interior filling materials, (Type II furniture).[1]

In the proposed standard, tests are conducted using seating mockups of fabric and filling materials. The goal is to reduce the smoldering propensity of upholstery cover materials and to limit the mass loss from combustion (smoldering, melting, or flaming) of the mockup's interior filling materials.[1] In support of the proposed regulation a validation study is under way, using upholstered chairs. To support this larger-scale study, and to compare results obtained using the smaller-scale mockups, tests were conducted using the same upholstery fabrics and fire barrier that were used in the upholstered furniture.

[1] Federal Register, March 4, 2008, Consumer Product Safety Commission, 16 CFR Part 1634, Standard for the Flammability of Residential Upholstered Furniture; Proposed Rule.

TEST PROGRAM

The testing consisted of three phases. In Phase 1, six upholstery cover fabrics were evaluated for smoldering ignition using non-flame-retardant (FR) polyurethane foam. Phase 2 was an evaluation of the smolder behavior of mockups with the standard cover fabric specified in the draft proposed furniture standard with and without the fire barrier. Phase 3 evaluated the open-flame resistance of the fire barrier with a standard cover specified in the draft proposed standard.

Phase 1

The test protocol used in Phase 1 is intended to measure the cigarette ignition resistance of upholstery cover fabrics used in upholstered furniture considered to be Type I furniture.[1]

Upholstery Fabrics

The upholstery fabrics included in Phase 1 were:

- Fabric 1a– 100% cotton, 8 oz/yd^2
- Fabric 1b– 100% cotton, 20 oz/yd^2
- Fabric 2a– 100% cotton, 7 oz/yd^2
- Fabric 2b – 100% cotton, 8 oz/yd^2
- Fabric 3a– 100% cotton, 7 oz/yd^2
- Fabric 3b– 56% rayon, 34% polyester, 10% cotton, 10 oz/yd^2

The upholstery cover fabrics used in the Phase 1 tests were identified through a series of mockup tests conducted at the CPSC Laboratory in spring 2008. In this study, the smoldering properties of the six upholstery fabrics were identified using mockups constructed with the upholstery fabrics over non-FR foam from manufacturer X. The smoldering properties of the upholstery fabrics ranged from heavy smolder-promoting fabrics (1a and 1b), to non-smolder-promoting fabrics (3a and 3b). Fabrics 2a and 2b were identified as borderline fabrics, meaning that sometimes they were smolder-promoting fabrics, and sometimes they were non-smolder-promoting fabrics.

Polyurethane Foam

The non-FR foam from manufacturer X was no longer being manufactured, so the foam used in this mockup test program was from a different source, manufacturer Y. Both foams were ordered to meet the foam specifications for Standard Polyurethane Untreated Foam (SPUF) in the draft proposed standard. Table 1 shows the specifications and qualification test performance for each foam, along with the requirements in staff's proposal.

Table 1. Foam Specifications.

Foam Source	Flammability Performance	Smoldering Performance	Density	Indentation Load Deflection	Air Permeability	Presence of Flame-Retardant Chemicals
Draft Proposed Furniture Standard	**Mass loss > 20% in < 2 min**	**Mass loss < 1%**	**1.8 lb/ft^3**	**25 to 30**	**> 4.0 ft^3/min**	**None present**
Manufacturer X	Avg: 25.5% @ 2 min$^+$	Avg: 0.81%$^+$	Avg 1.7 lb/ft^{3+}	30^{++}	4.1 ft$^{3/}$min^{++}	< 0.5% melamine$^+$
Manufacturer Y	Avg: 17.7% @ 2min$^+$	Avg: 0.68%$^+$	Avg 1.7 lb/ft^{3+}	28^{++}	3.5 $\pm$ 0.5 ft^3/min^{++}	none detectable$^+$

$^+$These data were determined by Laboratory Sciences staff analysis.
$^{++}$These data were provided by the manufacturer and not confirmed by Laboratory Sciences staff.

In confirmatory mockup testing in December 2008, Laboratory Sciences staff observed that the new combinations of upholstery fabrics and foam from manufacturer Y resulted in different smoldering performances than observed when these same upholstery fabrics were evaluated with foam from manufacturer X. Foam from manufacturer Y did not smolder as much as foam from manufacturer X. Table 2 shows the differences observed in the limited confirmatory mockup testing. The three most smolder-prone fabrics in this program were selected for the confirmatory screening tests. The tests were limited to three replicates each to conserve the supply of fabric and foam available for the full test matrix.

Table 2. Foam Confirmation Test Results.

Foam ID	Fabric ID	Percent Foam Mass Loss	Still Smoldering at 45 minutes
Manufacturer X	Fabric 1a	Avg: 15.68% Range: 9.8% - 27.5%	Yes, all 10 replicates still smoldering
Manufacturer Y	Fabric 1a	Avg: 0.61% Range: 0.55% - 0.67%	No, all 3 replicates cold
Manufacturer X	Fabric 1b	Avg: 23.78% Range: 33.2%-17.6%	Yes, all 10 replicates still smoldering
Manufacturer Y	Fabric 1b	Avg: 0.73% Range 0.66% - 0.80%	Yes, all 3 replicates still smoldering
Manufacturer X	Fabric 2b	Avg: 6.88% Range: 19.3% -0.6%	16 reps still smoldering; 14 reps cold
Manufacturer Y	Fabric 2b	Avg: 0.63% Range 0.53% - 0.68%	No, all 3 replicates cold

Chemical analysis was also conducted to determine if any flame-retardant chemicals were present in the foam from manufacturer Y (Table 1). Laboratory staff did not detect any melamine or FM550™; both chemicals are often found in chemically treated polyurethane foam. A decision was made with input from the project manager to continue on course and complete this mockup study in spite of the observed differences in foam performance.

Mockup Tests

Phase 1 tests of mockups constructed with the six fabrics and foam from manufacturer Y were conducted for 45 minutes employing the test procedure in the draft proposed[1] standard using the standard ignition source cigarettes purchased in 2007. Epidemiology staff provided a randomized testing scheme. Twenty-seven replicates were conducted for each upholstery fabric on foam from manufacturer Y. The percent of foam mass loss was recorded, along with any evidence of smoldering continuing beyond the 45-minute test duration.

Results of Phase 1 show that only the mockups covered with Fabric 1b were still smoldering at the end of the test. Twenty-five of 27 mockups with Fabric 1b had evidence of smoldering at 45

minutes. The average percent of foam mass loss for Fabric 1b was 1.37 percent. Comparatively, no replicates from the remaining five fabrics continued to smolder at the conclusion of the test. The individual mockup results, along with the randomized testing scheme, are presented in the Appendix, Table A.

Table 3. Average Mass Loss and Number Still Smoldering at End of Test.

Fabric	Average Mass Loss (%)	Number of Replicates Smoldering at End of Test
Fabric 1a	0.67	0
Fabric 1b	1.37	25
Fabric 2a	0.61	0
Fabric 2b	0.64	0
Fabric 3a	0.59	0
Fabric 3b	0.47	0

Phase 2

Phase 2 is intended to measure the cigarette ignition resistance of interior fire barrier materials used in Type II upholstered furniture.[1] The fire barrier used in Phase 2 is a commercial barrier product with a fiberglass base needle punched with polyester and modacrylic fibers. The fire barrier was identified through a series of mockup evaluations conducted in spring 2008. Laboratory staff found that layering 4 oz polyester batting on top of the fire barrier enhanced the smoldering resistance of the fire barrier material. So, in Phase 2 evaluations, the fire barrier was combined with the polyester batting, and the combination was treated as the barrier when the mockups were constructed.

In Phase 2, the mockups were built with the standard cotton velvet fabric (Fabric 24), specified in the draft proposed standard, either over the fire barrier layers, or directly over the non-FR foam. Non-FR foam from the same batch as used in Phase 1 from manufacturer Y was used in this mockup testing.

Tests were conducted for 45 minutes employing the test procedure in the draft proposed standard, using the standard ignition source cigarettes purchased in 2007. Epidemiology staff provided a randomized testing scheme for the 60 tests in Phase 2. The percent of foam mass loss was calculated, along with the presence of any smoldering.

Results of Phase 2 show that the mockups constructed with the fire barrier smoldered less than the mockups without the fire barrier present. Twenty-nine of the 30 mockups with the fire barrier present were not smoldering at the end of the test. Fourteen of the 30 mockups with just the cotton velvet fabric (Fabric 24), over non-FR foam were not smoldering at 45 minutes.

Overall, results for the mass loss of the mockups with fire barriers were not that different from the results for the mockups without fire barriers. Foam mass loss results were negligible for those mockups that did not smolder; less than 0.02 percent mass loss was recorded, within the measurement uncertainty of 0.07 percent.

The foam mass loss for the mockups still smoldering at 45 minutes was also minimal. The single mockup with the fire barrier had 0.01 percent foam mass loss, and the 16 mockups with cotton velvet directly over foam had an average of 0.1 percent foam mass loss. These results represent minimal foam damage near or below the measurement uncertainty of the test method. The individual mockup results, along with the randomized testing scheme, are presented in the Appendix, Table B.

Table 4. Summary of Mass Loss Averages.

Number of Tests	**Average Foam Mass Loss (%)**
Average without barrier, 30 tests	0.06
Average with barrier, 30 tests	0.01
Average no smoldering, without barrier, 14 tests	0.01
Average no smoldering, with barrier, 29 tests	0.01
Average smoldering, without barrier, 16 tests	0.10
Average smoldering, with barrier, 1 test	0.01

Phase 3

Open-flame mockup tests were conducted in Phase 3 of this test program. This evaluation is intended to measure the open-flame ignition resistance of interior fire barrier materials used in Type II upholstered furniture. The mockups were constructed with and without a fire barrier. The same polyester batting and commercial fire barrier combination as used in Phase 2 was used in this open-flame testing. In the series of mockup evaluations conducted in spring 2008, laboratory staff found that the layer of polyester batting did not compromise the fire (open-flame)-resistant properties of the fire barrier material.

In Phase 3, the mockups were constructed with the standard rayon fabric (Fabric 26), specified in the draft proposed standard, either over the fire barrier or directly over non-FR foam, as applicable. The non-FR foam used in the open-flame mockup testing was from manufacturer Y.

Tests were conducted for 45 minutes or until any flames self-extinguished, as directed in the draft proposed standard. Laboratory staff followed the randomized testing scheme provided by Epidemiology staff. Forty open-flame tests were conducted in Phase 3. The following data points were collected:

- Foam ignition time
- Time to full foam penetration
- Time to 20 percent mass loss
- Time to flames going out
- Percent of assembly mass loss
- Percent of assembly mass loss minus dripping of foam.

In this phase, the mockup is placed on a scale so that mass loss measurements are taken in real time. In the draft proposed standard, the percent of assembly mass loss is normally the only mass loss data recorded at the end of an open-flame mockup test. In these tests, the non-FR foam from manufacturer Y was found to drip dramatically more than expected, causing a visible mass loss

of the assembly that was not reflected in the mass measured by the scale. To account for the melted material, it was decided to record both the mass loss and the mass loss minus the melted foam, at the end of the test. Laboratory staff removed the mockup frame and residual materials from the scale at the end of the test, leaving behind the liquid, melted foam, and they weighed them on a second scale, thus, recording the percent of assembly mass loss minus the liquefied material.

The results of Phase 3 open-flame tests show that the fire barrier prevented foam ignition in the majority of the tests where the fire barrier was present. The foam ignited in two of the 20 mockups with fire barriers. Another mockup with the fire barrier present smoldered heavily, consuming the foam, and it was extinguished manually at 45 minutes. The foam ignited in all 20 mockups without a fire barrier present.

The average difference between the percent of mass loss and the percent of mass loss minus the liquid drips produced from the melted foam was approximately 21.5 percent. The information gained from these measurements may be useful to staff in modifying the current test protocol. The individual mockup results, along with the randomized testing scheme, are presented in the Appendix, Table C.

Table 5. Foam Mass Loss.

Test Condition	Average Mass Loss (%)	Average Mass Loss, Melted Foam Subtracted (%)	Mass Loss Difference* (%)
With barrier	11.61	10.46	-1.15
Without barrier	71.42	92.90	21.49

* Percent mass loss from column 2 subtracted from column 3.

SUMMARY

In the Phase 1 smoldering ignition source study, there did not seem to be any appreciable differences among the upholstery fabrics using non-FR foam from manufacturer Y. However, this was not the case in previous mockup tests, using non-FR foam from manufacturer X, where the fabrics presented considerably different smoldering results. Indeed, the fabrics selected for this test program were selected because of the range of foam mass loss damage reported in the previous mockup tests. The differences observed may be due to the use of foams from two different sources for the two different test series. Additional testing could explore these differences further.

Phase 2 of this study examined mockups constructed with the standard cotton velvet cover fabric and a fire barrier. Mockups constructed with the fire barrier smoldered less than those mockups without the fire barrier. However, the foam mass loss was not that different between those mockups with the fire barrier and those without the fire barrier. This may be due to the use of non-FR foam from manufacturer Y, which appears to inhibit smoldering.

In the Phase 3 open-flame study, the fire barrier prevented ignition of the foam filling materials in the majority of the tests. Laboratory staff developed a second method to capture the percent of assembly mass loss when a large quantity of melted foam is produced during the test. This information may be used in future modifications to the draft proposed standard.

APPENDIX: Randomization Scheme and Test Results for Mockup Study

Table A. Phase 1 Smoldering Results.

Test No.	Fabric ID	Replicate	Percent Mass Loss	Still Smoldering at 45 minutes
1	1b	1	1.04	yes
2	1a	1	0.59	no
3	3b	1	0.53	no
4	2b	1	0.77	no
5	2a	1	0.72	no
6	3a	1	0.64	no
7	3b	2	0.61	no
8	2b	2	0.77	no
9	3a	2	0.54	no
10	1a	2	0.74	no
11	2a	2	0.81	no
12	1b	2	0.95	no
13	3b	3	0.54	no
14	1b	3	0.95	yes
15	2a	3	0.65	no
16	2b	3	0.72	no
17	1a	3	0.70	no
18	3a	3	0.71	no
19	1a	4	0.64	no
20	3a	4	0.69	no
21	2a	4	0.62	no
22	1b	4	1.52	yes
23	3b	4	0.17	no
24	2b	4	0.66	no
25	2a	5	0.26	no
26	2b	5	0.71	no
27	3b	5	0.55	no
28	1a	5	0.73	no
29	1b	5	1.18	yes
30	3a	5	0.54	no
31	3a	6	0.63	no
32	1a	6	0.49	no
33	3b	6	0.47	no
34	2a	6	0.68	no
35	2b	6	0.80	no
36	1b	6	1.12	yes
37	2b	7	0.70	no
38	3a	7	0.80	no
39	3b	7	0.54	no
40	1a	7	0.75	no
41	1b	7	2.27	yes
42	2a	7	0.6	no
43	1b	8	7.35	yes
44	1a	8	0.78	no
45	2a	8	0.77	no
46	2b	8	0.72	no
47	3a	8	0.87	no
48	3b	8	0.55	no
49	1b	9	0.66	no

Test No.	Fabric ID	Replicate	Percent Mass Loss	Still Smoldering at 45 minutes
50	2b	9	0.51	no
51	3a	9	0.5	no
52	2a	9	0.49	no
53	1a	9	0.46	no
54	3b	9	0.30	no
55	3a	10	0.35	no
56	2a	10	0.44	no
57	2b	10	0.50	no
58	1b	10	0.95	yes
59	1a	10	0.53	no
60	3b	10	0.26	no
61	2b	11	0.55	no
62	1a	11	0.47	no
63	1b	11	1.81	yes
64	3a	11	0.40	no
65	3b	11	0.47	no
66	2a	11	0.58	no
67	3b	12	0.32	no
68	3a	12	0.52	no
69	1b	12	0.85	yes
70	1a	12	1.19	no
71	2b	12	0.58	no
72	2a	12	0.57	no
73	3b	13	0.28	no
74	2b	13	0.48	no
75	1a	13	0.49	no
76	2a	13	0.49	no
77	3a	13	0.58	no
78	1b	13	1.12	yes
79	3a	14	0.56	no
80	1b	14	0.67	yes
81	2a	14	0.55	no
82	3b	14	0.48	no
83	2b	14	0.68	no
84	1a	14	0.64	no
85	3a	15	0.51	no
86	2b	15	0.48	no
87	2a	15	0.44	no
88	1a	15	0.54	no
89	3b	15	0.42	no
90	1b	15	0.82	yes
91	3a	16	0.49	no
92	3b	16	0.47	no
93	1b	16	1.44	yes
94	2b	16	0.68	no
95	2a	16	0.70	no
96	1a	16	0.72	no
97	3a	17	0.71	no
98	3b	17	0.71	no
99	2b	17	0.65	no
100	1a	17	0.66	no
101	2a	17	0.74	no

Test No.	Fabric ID	Replicate	Percent Mass Loss	Still Smoldering at 45 minutes
102	1b	17	1.74	yes
103	3b	18	0.57	no
104	2b	18	0.57	no
105	2a	18	0.72	no
106	3a	18	0.68	no
107	1b	18	1.52	yes
108	1a	18	0.72	no
109	1a	19	0.69	no
110	2a	19	0.64	no
111	2b	19	0.65	no
112	3b	19	0.52	no
113	1b	19	2.35	yes
114	3a	19	0.74	no
115	1b	20	0.69	yes
116	3a	20	0.57	no
117	2a	20	0.62	no
118	2b	20	0.71	no
119	1a	20	0.77	no
120	3b	20	0.43	no
121	3b	21	0.47	no
122	1a	21	0.67	no
123	1b	21	0.61	yes
124	3a	21	0.64	no
125	2b	21	0.69	no
126	2a	21	0.64	no
127	3a	22	0.33	no
128	2b	22	0.72	no
129	1b	22	0.82	yes
130	3b	22	0.49	no
131	1a	22	0.64	no
132	2a	22	0.60	no
133	1b	23	0.86	yes
134	1a	23	0.63	no
135	3a	23	0.42	no
136	2a	23	0.55	no
137	3b	23	0.46	no
138	2b	23	0.48	no
139	2b	24	0.58	no
140	3b	24	0.60	no
141	1a	24	0.74	no
142	3a	24	0.65	no
143	2a	24	0.72	no
144	1b	24	0.80	yes
145	1b	25	0.79	yes
146	1a	25	0.81	no
147	2a	25	0.60	no
148	2b	25	0.70	no
149	3b	25	0.54	no
150	3a	25	0.62	no
151	2b	26	0.56	no
152	1a	26	0.71	no
153	2a	26	0.52	no

Test No.	Fabric ID	Replicate	Percent Mass Loss	Still Smoldering at 45 minutes
154	3b	26	0.44	no
155	1b	26	0.95	yes
156	3a	26	0.59	no
157	3b	27	0.47	no
158	3a	27	0.65	no
159	2a	27	0.66	no
160	1b	27	1.28	yes
161	2b	27	0.70	no
162	1a	27	0.64	no

Table B. Phase 2 Smoldering Results.

Test No.	Barrier Present	Replicate	Percent Mass Loss	Still Smoldering at 45 minutes
1	yes	1	0.006	no
2	yes	2	0.004	no
3	no	1	0.009	no
4	no	2	0.008	no
5	yes	3	0.005	no
6	no	3	0.007	no
7	yes	4	0.005	no
8	no	4	0.009	no
9	yes	5	0.005	no
10	yes	6	0.005	no
11	no	5	0.009	no
12	no	6	0.018	no
13	no	7	0.008	no
14	yes	7	0.004	no
15	no	8	0.012	yes
16	no	9	0.009	no
17	no	10	0.010	yes
18	yes	8	0.003	no
19	yes	9	0.006	no
20	no	11	0.011	no
21	yes	10	0.006	no
22	yes	11	0.007	no
23	no	12	0.322	yes
24	yes	12	0.006	no
25	yes	13	0.005	yes
26	no	13	0.126	yes
27	yes	14	0.006	no
28	no	14	0.010	no
29	no	15	0.230	yes
30	yes	15	0.006	no
31	no	16	0.007	yes
32	yes	16	0.006	no
33	yes	17	0.006	no
34	yes	18	0.007	no
35	no	17	0.010	no
36	yes	19	0.005	no
37	yes	20	0.004	no
38	no	18	0.262	yes
39	yes	21	0.006	no
40	yes	22	0.007	no
41	yes	23	0.008	no
42	yes	24	0.005	no
43	no	19	0.011	yes
44	no	20	0.180	yes
45	no	21	0.011	yes
46	yes	25	0.005	no
47	no	22	0.012	yes
48	yes	26	0.005	no
49	no	23	0.009	no
50	no	24	0.014	yes

Test No.	Barrier Present	Replicate	Percent Mass Loss	Still Smoldering at 45 minutes
51	no	25	0.015	no
52	yes	27	0.006	no
53	yes	28	0.006	no
54	no	26	0.160	yes
55	yes	29	0.004	no
56	no	27	0.008	no
57	no	28	0.008	yes
58	yes	30	0.006	no
59	no	29	0.200	yes
60	no	30	0.009	yes

Table C. Phase 3 Open-Flame Results.

Test No.	Barrier Present	Foam Ignition (Time)	Flames Through Foam (Time)	20% Mass Loss (Time)	Flames Out (Time)	Percent Foam Mass Loss (%)	Percent Foam Mass Loss minus Drippings (%)
1	No	immediate	1 min	1 min 43 sec	10 min	69.80	93.90
2	No	immediate	46 sec	1 min 37 sec	10 min 12 sec	75.00	97.20
3	Yes	N/A*	N/A	N/A	16 min	7.14	7.40
4	Yes	N/A	N/A	N/A	30 min 5 sec	8.32	8.57
5	Yes	N/A	N/A	N/A	16 min 59 sec	9.07	9.70
6	No	immediate	36 sec	1 min 44 sec	11 min 32 sec	69.39	89.64
7	Yes	N/A	N/A	N/A	26 min 44 sec	8.79	9.57
8	Yes	N/A	N/A	N/A	19 min 16 sec	9.18	9.16
9	Yes	N/A	N/A	N/A	13 min 3 sec	8.63	9.03
10	No	immediate	1 min	1 min 6 sec	14 min 16 sec	70.02	91.23
11**	No	immediate	56 sec	1 min 55 sec	14 min 47 sec	100.00	100.00
12	Yes	28 min 30 sec	28 min 38 sec	25 min 28 sec	still flaming	32.76	41.12***
13	No	immediate	36 sec	1 min 45 sec	10 min 39 sec	68.35	91.53
14	No	immediate	41 sec	1 min 42 sec	11 min 47 sec	66.91	90.88
15**	No	immediate	40 sec	1 min 47 sec	9 min 17 sec	69.01	92.43
16	No	immediate	48 sec	1 min 43 sec	12 min 17 sec	69.89	91.59
17	Yes	N/A	N/A	N/A	13 min 36 sec	7.55	8.21
18	Yes	N/A	N/A	N/A	17 min 20 sec	8.25	8.64
19	Yes	N/A	N/A	N/A	31 min 30 sec	8.18	8.67
20	No	immediate	1 min	+	10 min 6 sec	69.70	92.18
21	No	immediate	50 sec	1 min 41 sec	10 min	67.14	91.99
22	Yes	N/A	N/A	N/A	13 min	7.39	7.86
23	No	immediate	47 sec	1 min 49 sec	10 min 13 sec	68.55	92.91
24	Yes	N/A	N/A	N/A	19 min 40 sec	7.30	8.46
25	No	immediate	40 sec	1 min 43 sec	8 min 50 sec	67.81	92.04
26	No	immediate	39 sec	1 min 42 sec	11 min 13 sec	69.54	92.69
27	Yes	N/A	N/A	N/A	12 min 34 sec	6.97	7.21
28	Yes	N/A	N/A	N/A	10 min 39 sec	7.26	7.90
29	Yes	26 min 58 sec	26 min 58 sec	21 min 23 sec	manually exting.++	36.49	36.10
30	Yes	N/A	N/A	N/A	16 min 27 sec	18.18	manually exting.+++
31	No	immediate	39 sec	1 min 47 sec	13 min 59 sec	65.69	90.35
32	No	immediate	38 sec	1 min 48 sec	13 min 47 sec	69.10	91.80
33	Yes	N/A	N/A	N/A	9 min 56 sec	7.2	8.38
34	Yes	N/A	N/A	N/A	11 min 58 sec	7.87	7.73
35**	No	immediate	41 sec	1 min 47sec	12 min 15 sec	88.04	98.37
36	No	immediate	35 sec	1 min 50 sec	11 min 32 sec	67.88	93.43
37	Yes	N/A	N/A	N/A	21 min 48 sec	15.75	15.49
38	No	immediate	30 sec	1 min 41 sec	13 min 24 sec	67.21	90.51
39	No	immediate	37 sec	1 min 43 sec	11 min 20 sec	69.28	93.40
40	yes	N/A	N/A	N/A	16 min 39 sec	9.87	10.24

*Not Applicable

**Pool fire

*** Mockup reignited while waiting to reweigh on second scale

+Computer not tracking properly so 20% mass loss not known

++Manually extinguished with CO_2

+++Manually extinguished with water

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
BETHESDA, MD 20814

Memorandum

Date: July 16, 2012

TO : Rohit Khanna Project Manager, Upholstered Furniture Project

THROUGH: Andrew G. Stadnik, P.E., Associate Executive Director, Directorate for Laboratory Sciences
Edward W. Krawiec, P.E., Division Director, Division of Engineering

FROM : Linda Fansler, Division of Engineering

SUBJECT : Summary of Data Collected During Smoldering Chair Tests

INTRODUCTION

In March 2008, the U.S. Consumer Product Safety Commission (CPSC) published a proposal[1] for an upholstered furniture flammability standard. The proposal included a smoldering test, where bench-scale upholstered furniture mockup combinations of (1) upholstery fabric and standard polyurethane foam (SPUF), or (2) standard cover fabric, fire barrier, and SPUF were evaluated. In support of the proposal, CPSC staff arranged to have full-scale upholstered chairs built with specific materials and construction techniques. The test series discussed in this memo included construction combinations with two upholstery fabrics, two foams: SPUF and flame-retardant (FR) foam, a fire barrier, and polyester battings. This memo summarizes the results of full-scale chair evaluations for smoldering ignition resistance conducted by the CPSC's Directorate for Laboratory Sciences.

TEST PROGRAM

The upholstered chairs were evaluated following the protocol outlined in the *Test Plan for the Smoldering Evaluation of Upholstered Chairs* (Appendix A). A total of 120 chairs were evaluated in this test series. The chairs were tested according to the randomization scheme provided by the CPSC's Directorate for Epidemiology[2] (Appendix A). Each chair was conditioned for 48 hours at a relative humidity between 50 percent and 66 percent and a temperature of $21 \pm 3^{\circ}$C prior to testing. The chairs were tested one at a time, with each chair placed under a hood with minimal air flow maintained during the test. Each test was recorded, and photographs were taken after the test. Pall Mall™ cigarettes were placed in four areas in each chair's seating area: (1) left-side crevice (locations 1, 2, and 3); (2) right-side crevice (locations 7, 8, and 9); (3) back crevice (locations 4, 5, and 6); and (4) the central seating surface (locations 10, 11, and 12). One cigarette was placed in each of the locations, for a total of 12 cigarettes. The cigarettes were covered with cotton sheeting squares. The test duration was 60

[1] Federal Register, March 4, 2008, Consumer Product Safety Commission, 16 CFR Part 1634, Standard for the Flammability of Residential Upholstered Furniture; Proposed Rule.
[2] Email from David Miller, CPSC, Directorate for Epidemiology, February 2010.

minutes. Char measurements were made at the end of the test, along with other observations concerning the smoldering activity level and the size of the area of damage by smoldering ignition at a particular location.

Test Materials

The smoldering properties of the fabrics and the fire barrier/thin-polyester batting combination were identified through a series of mockup tests conducted at the CPSC laboratory in spring 2008. Those materials were evaluated using non-FR smolder-prone foam. However, as that foam was no longer commercially available for construction of the full-scale upholstered chairs, another source for foam was found. A second non-FR foam that met the requirements for SPUF foam, as specified in staff's proposed furniture standard, was used in the construction of the full-scale chairs. However, when the mockup tests were repeated with the new SPUF foam, that foam smoldered[3] less than the non-FR foam from the first source, indicating that not all non-FR foam has the same smolder propensity. This information about the smoldering characteristic of the new SPUF was not available at the time the upholstered chairs were ordered for this test program.

Fabrics

Six fabrics were used in this test program; five of the fabrics were 100 percent cotton twill weave constructions, while the sixth fabric was 56 percent rayon, 34 percent polyester, and 10 percent cotton. The fiber content, fabric weight, and the likelihood of smoldering, as identified in prior tests,[3] are found in Table 1.

Table 1. Upholstery Fabric Characteristics.

Fabric ID	Fiber Content	Weight	Smoldering Potential[3]
1a	100% cotton	8 oz/yd^2	high
1b	100% cotton	20 oz/yd^2	high
2a	100% cotton	7 oz/yd^2	borderline
2b	100% cotton	8 oz/yd^2	borderline
3a	100% cotton	7 oz/yd^2	low
3b	56% rayon, 34% polyester, 10% cotton	10 oz/yd^2	low

Foams

The foam used in this study was purchased by the furniture contractor, who specified density (1.7 lbs/ft^3), Indentation Load Deflection (ILD), air permeability, and if either SPUF or FR-treated. CPSC staff conducted a chemical analysis of each type of foam and found the SPUF to be free of chemicals considered to be FRs. The FR foam was compliant with California's Technical Bulletin 117[4] and contained FM 550^{TM}[5] and 3.1 percent melamine. The two foams were obtained from the same manufacturer.

[3] Memorandum to D. Ray, Project Manager, From L. Fansler, LS, "Mockup Test Program on Upholstery Fabrics and a Fire Barrier," March 2009.

[4] Technical Bulletin 117, "Requirements Test Procedures and Apparatus for Testing the Flame Retardance of Resilient Filling Materials used in Upholstered Furniture," March 2000.

[5] The material safety data sheet for Fire Master 550^{TM} indicates it contains a mixture of halogenated aryl esters and aromatic phosphates such as triphenyl phosphate.

Fire Barrier/Polyester Batting Combination

The fire barrier used in this test program was a combination of a thin layer of polyester batting (nominal 4 oz/yd^2) over a sheet barrier containing 47 percent fiberglass, 50 percent modacrylic, and 3 percent polyester fibers. Mockup testing[3] conducted by CPSC staff established that the combination of these two materials met the requirements in the proposed furniture standard for both smoldering and open-flame performance.

Polyester Batting

Thicker polyester batting (7.2 oz/yd^2) was also used in some chair constructions to represent typical upholstery construction. The thicker polyester batting was used with SPUF foam.

RESULTS AND DISCUSSION

Large-Scale Chair Tests

The chairs were evaluated in three groups, according to the upholstery fabrics' smoldering potential. In the first group, there were eight combinations of materials evaluated. Each combination was evaluated six times for a total of 48 chairs. Table 2 is a summary of the material combinations for each chair and the number of cigarette locations still smoldering at the end of the test duration out of a maximum of 72 (6 replicates x 12 locations per replicate).

Table 2. Highly Smolder-Promoting Fabrics: Summary of Material Combinations and Number of Smoldering Locations at 60 Minutes.

Combination Number	Fabric ID	Fire Barrier*	Foam ID	Layer of Thicker Polyester Batting	Cigarette Test Locations[6] Still Smoldering at 60 Minutes
1	1a	Yes	SPUF	No	6
2	1a	No	SPUF	Yes	7
3	1a	Yes	FR	No	0
17	1a	No	SPUF	No	10
5	1b	Yes	SPUF	No	29
6	1b	No	SPUF	Yes	37
7	1b	Yes	FR	No	41
18	1b	No	SPUF	No	49

*Fire Barrier consists of a combination of a thin layer of polyester batting over a sheet barrier.

Overall, the chairs with fabric 1a had fewer test locations still smoldering at 60 minutes than the chairs covered with fabric 1b, regardless of the other materials used in the chair constructions. The results for combinations 17 and 18 indicate that the presence of a layer of polyester batting directly under the upholstery fabric can make a slight difference, as compared to the combinations simulating typical chair constructions (combinations 2 and 6). For the chairs

[6] Note: none of the seating surface locations 10, 11, and 12 were smoldering at the end of 60 minutes.

upholstered in fabric 1b, the presence of a fire barrier did not seem to affect smolder propensity, as there were still a large number of smoldering ignitions occurring on chairs covered with fabric 1b. However, the combination of FR foam and the fire barrier made a difference in smoldering ignitions in those chairs upholstered with fabric 1a, as smoldering ignitions did not occur. None of the cigarettes placed on the seating surface locations 10, 11, and 12 in any of the chair tests were still smoldering at the end of the test

The second group of chairs included 48 chairs upholstered with fabrics identified as borderline smolder-prone (fabrics 2a and 2b). These fabrics were considered to be borderline because in prior tests, some of the time they were smolder-promoting fabrics and sometimes non-smolder promoting fabrics. There were eight combinations of materials evaluated in this group. Each combination was evaluated six times for a total of 48 chairs. Table 3 is a summary of the material combinations for this group of chairs and the number of cigarette locations still smoldering at the end of the test duration.

Table 3. Borderline Fabrics: Summary of Material Combinations and Number of Smoldering Locations at 60 Minutes.

Combination Number	**Fabric ID**	**Fire Barrier***	**Foam ID**	**Layer of Thicker Polyester Batting**	**Cigarette Test Locations Still Smoldering[7] at 60 Minutes**
9	2a	Yes	SPUF	No	3
10	2a	No	SPUF	Yes	6
11	2a	Yes	FR	No	1
19	2a	No	SPUF	No	4
13	2b	Yes	SPUF	No	8
14	2b	No	SPUF	Yes	11
15	2b	Yes	FR	No	0
20	2b	No	SPUF	No	8

*Fire Barrier consists of a combination of a thin layer of polyester batting over a sheet barrier.

Overall, the chairs with fabric 2a had fewer test locations continuing to smolder than those covered with fabric 2b, regardless of the other materials used in the chair constructions. The chair combinations containing FR foam (combinations 11 and 15) had the least number of cigarette locations still smoldering at the end of the test. The barrier seemed to make a difference for the chairs upholstered with fabric 2a, combinations 9 and 11, although the FR foam in combination 11 may have also contributed to the results. None of the cigarettes placed on the seating surface locations 10, 11, and 12 in any of the chair tests were still smoldering at the end of the test

[7] Note: none of the seating surface locations 10, 11, and 12 were smoldering at the end of 60 minutes.

Although not part of the original test plan, a decision was made to continue the test beyond 60 minutes for two chairs because the cigarette locations were aggressively smoldering. The first chair construction was combination 13 with fabric 2b, SPUF foam, and the fire barrier. Cigarette location number four (seat/back crevice, far left location) was heavily smoldering at 60 minutes. At 73 minutes, flames appeared, and the fire was quickly extinguished.

The second chair construction was combination 20 with fabric 2b and SPUF foam. Cigarette location number 4 was heavily smoldering at 60 minutes. At 98 minutes, flames appeared, and the fire was quickly extinguished.

No measurements were possible since the chairs had to be cut open and thoroughly soaked in order to minimize the risk of re-ignition. However, in both cases, there was heavy smoke, and glowing present on the fabric, and the smoldering ignition progressed through the back cushions. Figure 1 is a photograph of chair combination 13 at 60 minutes. Figure 2 is a post-test photograph of chair combination 20.

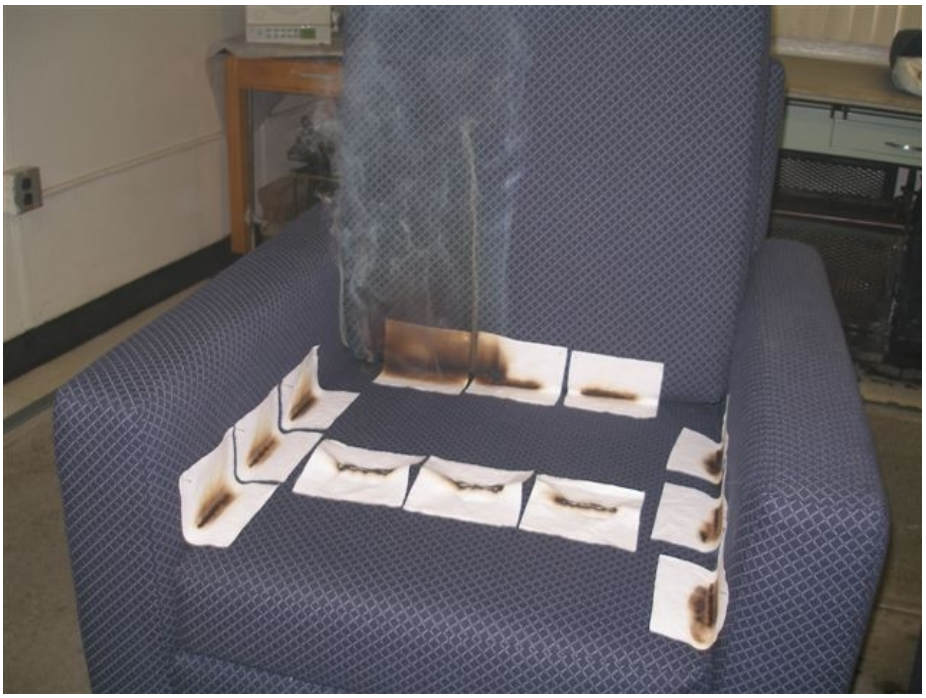


Figure 1. Chair Combination 13 at 60 minutes.

Figure 2. Chair Combination 20 post-test.

The third group consisted of chairs upholstered with non-smolder-promoting fabrics. There were four combinations of materials evaluated. Each combination was evaluated six times for a total of 24 chairs tested. Table 4 is a summary of the material combinations for this group and the number of cigarette locations still smoldering at the end of the test duration.

Table 4. Non-Smolder-Promoting Fabrics: Summary of Material Combinations and Number of Smoldering Locations at 60 Minutes.

Combination Number	**Fabric ID**	**Fire Barrier***	**Foam ID**	**Layer of Thicker Polyester Batting**	**Cigarette Test Locations Still Smoldering[8] at 60 Minutes**
21	3a	No	SPUF	No	4
22	3a	No	SPUF	Yes	0
23	3b	No	SPUF	Yes	1
24	3b	No	SPUF	No	0

*Fire Barrier consists of a combination of a thin layer of polyester batting over a sheet barrier.

As expected, this group of chairs, overall, had the least amount of cigarette test locations still smoldering at 60 minutes. There was little difference in the number of smoldering ignitions for chairs with or without a layer of polyester batting over the SPUF foam.

[8] Note: none of the seating surface locations was smoldering at the end of 60 minutes. The evaluation of the seating surface test locations was stopped with the statistician's permission after the third chair in this group.

Additional Observations

The data for each crevice location, per chair, is summarized in Appendix B, *Smoldering Results for 120 Chair Tests, Data for Cigarette Locations Number 1 through 9*. In addition to the smoldering observations, the following information is also included:

- maximum char measurements for each location,
- a smoldering activity rating (subjective),
- a description of the amount of damage to a cigarette location (also subjective),
- construction deficiencies that were noted and their potential impact on an individual cigarette test location.

The char length was measured in several directions, including into the seat or back cushion for each cigarette location where smoldering of the materials had occurred. The char length ranges for each group of chairs are found in Table 5.

Table 5. Char Length Ranges for Each Group of Chairs.

Chair Group Identification	**Char Length Ranges (inches)**
Highly Smolder Prone Fabrics (1a and 1b)	1/2 to 7-1/4
Borderline Fabrics (2a and 2b)	1/8 to 13
Non-Smolder Promoting Fabrics (3a and 3b)	1/4 to 7-7/8

Figure 3 is an example of how a char measurement was made for a cigarette test location.

Figure 3. An example of char measurement.

The subjective smoldering activity rating was based on the amount of progressive smoldering activity at the end of the test duration. There were three levels: high, medium and low, as identified by staff. Figure 4 is an example of a high level of progressive smoldering.

Figure 4. An example of progressive smoldering at the end of the test.

The amount of filling materials consumed during the test was described with subjective terms approximating ball sizes if the charred portion was somewhat round, or described as an enlarged cigarette shape. Figure 5 is an example of the charred areas at the end of the test.


Figure 5. An example of cigarette test locations at the end of a test.

CPSC staff recorded construction deficiencies noted during the tests. The deficiencies included: extra vertical seams in the fabric covering the sides of the seat and back cushions; remnants of polyester batting glued directly to the foam; and pieces of very thin, plastic film in the sides of the cushions. Figure 6 shows an example of a vertical side seam. Figure 7 shows an example of polyester batting remnants glued to the foam.

Figure 6. An example of a vertical seam in a seat cushion.

Figure 7. An example of glue (dark pink) and polyester remnants on foam, even though this construction did not call for polyester directly attached to the foam.

Results of the Full-Scale Chair Tests as Compared With Mockup Tests

In staff's proposed furniture standard, tests are conducted using mockups of fabric and filling materials. The goal of the proposed standard is to reduce the smoldering propensity of upholstery cover materials and limit the mass loss from combustion of the mockup's interior filling materials.

In support of the full-scale furniture study, in FY 2009, bench-scale mockup tests[3] were also conducted using the same upholstery fabrics and SPUF foam as used in these upholstered chairs. In the mockup tests, only fabric 1b was still smoldering at the end of the test duration (45 minutes). The average percent mass loss for those mockups and each of the upholstery fabrics used in both studies and SPUF foam is found in Table 6.

Table 6. Average Percent Mass Loss for Mockups and SPUF Foam.

Fabric ID	**Average % Mass Loss of SPUF Foam**
1a	0.67
1b	1.37
2a	0.61
2b	0.64
3a	0.59
3b	0.47

While a direct comparison cannot be made between the mockup tests and the full-scale furniture tests because different measurements were made, the ignition insult to the furniture for many of the cigarette test locations was greater than to the mockups for some of the upholstery fabrics.

SUMMARY

In staff's proposed furniture standard, a fire barrier is evaluated for smoldering ignition resistance, using a standard cover fabric (100% cotton velvet) and SPUF foam. When the combination of a thin layer of polyester batting over the fire barrier was evaluated following the test procedure in staff's proposed furniture standard, mockups with this construction smoldered less than the mockups without the polyester/fire barrier combination.

There were differences observed in the test results with the larger scale furniture tests. Based on the initial mockup tests used to qualify the fire barrier, it was expected that chairs constructed with the fire barrier would not demonstrate any smoldering ignitions. However, for many of the chairs, the smoldering ignition insult to the furniture was high. The fire barrier did not provide the same level of protection to the filling materials in the full-scale furniture tests as it did in the mockup tests, especially for the chairs covered with fabric 1b. Some of the differences observed may be due to construction differences between the furniture and the mockup, including the following:

- presence and height of the arm, and the amount of filling material and the air space found in the arm/chair side construction;
- the tension created by sewing the cover fabric versus pinning the cover fabric, as in the case of the mockup construction;

- multiple fabric layers found at the seams in the cushions and not found in the mockup constructions;
- the use of actual upholstery fabric on the furniture versus the standard cotton velvet fabric used in the mockup to qualify the fire barrier;
- total mass of the chair versus the mass of the mockup, and
- the overall basic geometry differences between the chair and the mockup.

APPENDIX A

Test Plan for the Smoldering Evaluation of Upholstered Chairs

INTRODUCTION

In March 2008, the U.S. Consumer Product Safety Commission (CPSC) published a proposal[9] for an upholstered furniture flammability standard. The proposal included a smoldering test where: (1) small mockup combinations of upholstery fabric and standard polyurethane foam (SPUF), or (2) standard cover fabric, a fire barrier, and SPUF foam are evaluated. In support of the proposal, CPSC staff has contracted with an upholstered furniture company to manufacture upholstered chairs with specific constructions. The construction combinations include six upholstery fabrics, SPUF foam, minimally flame-retardant (FR) foam, a fire barrier, and polyester batting. The upholstered chairs will be evaluated for smoldering ignition resistance at the CPSC's Laboratory Campus in Gaithersburg, Maryland.

The following outline provides details of the test plan:

OUTLINE

1. Goal
2. Objectives
3. Components Being Tested
4. Test Facility and Conditioning Requirements
5. Test Protocol and Procedures
    - Summary of Test Protocol
    - Test Materials
    - Upholstered Chair Test Specimens
    - Test Locations
    - Test Procedure
    - Data Collection
6. Test Matrix
7. Data Sheet

GOAL

The goal of this full-scale smoldering testing is to develop data that can be used to assess the impact that the proposed upholstered furniture standard may have on the smoldering ignition resistance of typical residential upholstered furniture.

OBJECTIVES

The objectives of this full-scale testing are to:

- Obtain data on full-scale smoldering fire performance of upholstered furniture, and
- Incorporate knowledge gained from this test program to evaluate the proposed rule, if necessary.

[9] Federal Register, March 4, 2008, Consumer Product Safety Commission, 16 CFR Part 1634, Standard for the Flammability of Residential Upholstered Furniture; Proposed Rule.

COMPONENTS BEING TESTED

The components used in the upholstered chairs were chosen by different means. The upholstery fabrics, a fire barrier, and the thin layer of polyester batting were identified through a series of mockup tests[10] conducted at the CPSC Laboratory. The foams met specific physical, chemical, and flammability properties identified by CPSC staff. The furniture manufacturer recommended the thicker layer of polyester batting as nominal polyester batting typically used in residential furniture.

Using the test protocol in the proposed furniture rule, CPSC staff identified materials, including upholstery fabrics, a fire barrier, and a 4 oz/yd^2 batting to use in the full-scale smoldering test program. The upholstery fabrics included fabrics identified by CPSC staff as having different smoldering propensities.

The fire barrier identified is a combination of a commercial fire-blocking barrier with a thin layer of polyester batting placed over the fire-blocking barrier. This combination "system" was established through mockup tests conducted at the CPSC Laboratory, which showed that the fire-blocking barrier alone did not comply with the smoldering test protocol in the proposed furniture rule. However, by adding a thin layer of polyester batting (4 oz/yd^2), the smoldering mockups met the requirement with a mass loss of less than 1 percent, yet they still passed the open-flame requirements with the added layer of polyester.

The foams used in this smoldering test program are: (1) SPUF foam, and (2) minimally treated FR foam. The FR foam is compliant[11] with California TB 117. Both of the foams used in this test program are from the same vendor.

A second polyester batting (7.2 oz/yd^2) will also be used over the SPUF foam in some of the chair constructions. This material combination will represent nominal current chair construction. The polyester was recommended by and obtained from the chair contractor. The details of each component material follow:

[10] The smoldering properties of the upholstery fabrics were identified using mockups constructed with upholstery fabric over non-FR SPUF foam from manufacturer X. The SPUF foam used in the smoldering chair test program was from manufacturer Y. In confirmatory mockup testing in December 2008, CPSC laboratory staff observed that the combinations of upholstery fabrics and the new SPUF foam from manufacturer Y resulted in different smoldering properties than were originally observed when SPUF foam from manufacturer X was used.

[11] Technical bulletin 117, "Requirements, Test Procedures, and Apparatus for Testing the Flame Retardance of Resilient Filling Materials Used in Upholstered Furniture," March 2000.

Fabrics Used in the Smoldering Test Program[12]

Fabric Code	Fiber Content	Weight (oz/yd$^{2)}$
1a	100% cotton	8
1b	100% cotton	20
2a	100% cotton	7
2b	100% cotton	8
3a	100% cotton	7
3b	56% rayon, 34% poly, 10% cotton	10

Foams Used in the Smoldering Test Program

Foam Identification	Density (lbs/ft^3)[13]	FR Chemical Identification[14]
Standard Polyurethane Foam (SPUF)	1.68 to 1.77 (1.7)	No FR chemicals present
FR Foam (TB-117 compliant)[3]	unknown[15]	FM550^{TM}[16] and 3.1% melamine

Battings and FR Barrier Used in the Smoldering Test Program

Material Identification	Fiber Content	Nominal Weight (oz/yd^2)
Lower loft batting	100% polyester	4
Higher loft batting	100% polyester	7.2
Sheet Fire Barrier	50% modacrylic/47% fiber glass/3% polyester	4.5

TEST FACILITY AND CONDITIONING REQUIREMENTS

The upholstered chairs will be tested in the burn room in Building A at the CPSC Laboratory. The burn room is approximately 15 ft x 14 ft x 8 ft and will have a slightly negative pressure. Replacement air is drawn into the room from the adjacent hallway and observation room. The chairs will be placed under a canopy hood during the test. The hood exhaust fan will be running just enough to exhaust the smoke directly into the hood. There will be a carbon monoxide (CO) sensor in the room to monitor the CO conditions for the test personnel.

The temperature and humidity of the test room will be monitored using a hygrothermograph placed in the test room. The doors leading into the burn room will be closed during the tests.

The upholstered chair specimens, sheeting squares, and cigarettes are required to be conditioned at a temperature of 21^o $\pm$ 3^{o}C (70^o $\pm$ 5 ^{o}F) and a relative humidity of between 50 percent and 66 percent for 48 hours. The burn room conditions will be maintained between 17^o $\pm$ 3^{o}C (62^o $\pm$

[12] When tested with SPUF foam from manufacturer X, fabric 1a and fabric 1b were smolder-promoting fabrics; fabrics 2a and 2b were borderline fabrics; and fabrics 3a and 3b were non-smolder-promoting fabrics.
[13] Density measurements were determined by CPSC staff.
[14] The presence or absence of FR chemicals was determined by CPSC staff.
[15] The density is unknown at this time, as LS staff does not have any of this foam to determine density.
[16] The material safety data sheet for Fire Master 550™ indicates that it contains a mixture of halogenated aryl esters and aromatic phosphates, such as triphenyl phosphate.

5°F), with a relative humidity of between 45 percent and 65 percent. However, if it is necessary to achieve these conditions in the burn room, there will be a delay in starting the next test while the room recovers after it has been exhausted of smoke from the prior test. The test will start within 10 minutes of removing the specimens from the conditioning area.

Each upholstered chair specimen will be photographed before the test begins. A video camera located in the observation room will record each test. The chair will be placed so that the front of the chair can be seen from the observation window in the door leading to the observation room.

Water will be used to extinguish any heavily smoldering portions of the upholstered chairs at the end of the test. At the first sign of flaming ignition, LS staff will extinguish any flames. As a safety precaution in case of a larger fire scenario, the test room is equipped with an overhead deluge system. A CO_2 extinguisher will also be available in the room.

Test personnel will be qualified for respirator use. Breathing air will be supplied to the test area.

TEST PROTOCOL AND PROCEDURE

Summary of Test Protocol

This test protocol is designed to observe the smoldering ignition of the upholstered chair test specimens by exposing the surface of the chair to lighted cigarettes in a draft-protected environment. The seating cavity locations include the back and side crevices and the seating surface. Three cigarettes will be placed in each test location.

Test Materials

The materials used in the tests are as follows:

1. The ignition source:
   The ignition source is non-reduced ignition propensity Pall Mall cigarettes purchased in 2008.
2. Sheeting fabric:
   The sheeting fabric is 100 percent white cotton purchased from a vendor, pre-laundered, and pre-cut into squares 127 x 127 mm (5 x 5 in).[17]

Upholstered Chair Test Specimens

The test specimens are full-size upholstered, single-seat, "club chairs" with upholstered back and arm surfaces and seat and back cushions. The typical dimensions can be seen in Figure 1. The chairs in this test series are covered with fabrics as described above. The combinations of fabrics, fire barrier, and foams are found in Table 1.

[17] The sheeting fabric is washed and dried one time, in accordance with sections 8.2.2 and 8.2.3 of American Association of Textile Chemists and Colorists (AATCC) Test Method 124-2001, "Appearance of Fabrics after Repeated Home Laundering." Washing is performed using water temperature (V) 60° ± 3 °C (140° ± 5 °F) specified in Table II of that method, and the water level, agitator speed, washing time, spin cycle specified in "normal/Cotton Sturdy" in Table III of the method. A maximum wash load is 8 pounds. After washing, follow the Tumble Dry method using the exhaust temperature (66° ± 5 °C; 150° ± 10 °F) and cool down time of 10 minutes specified in the "Durable Press' conditions of Table IV of the method.

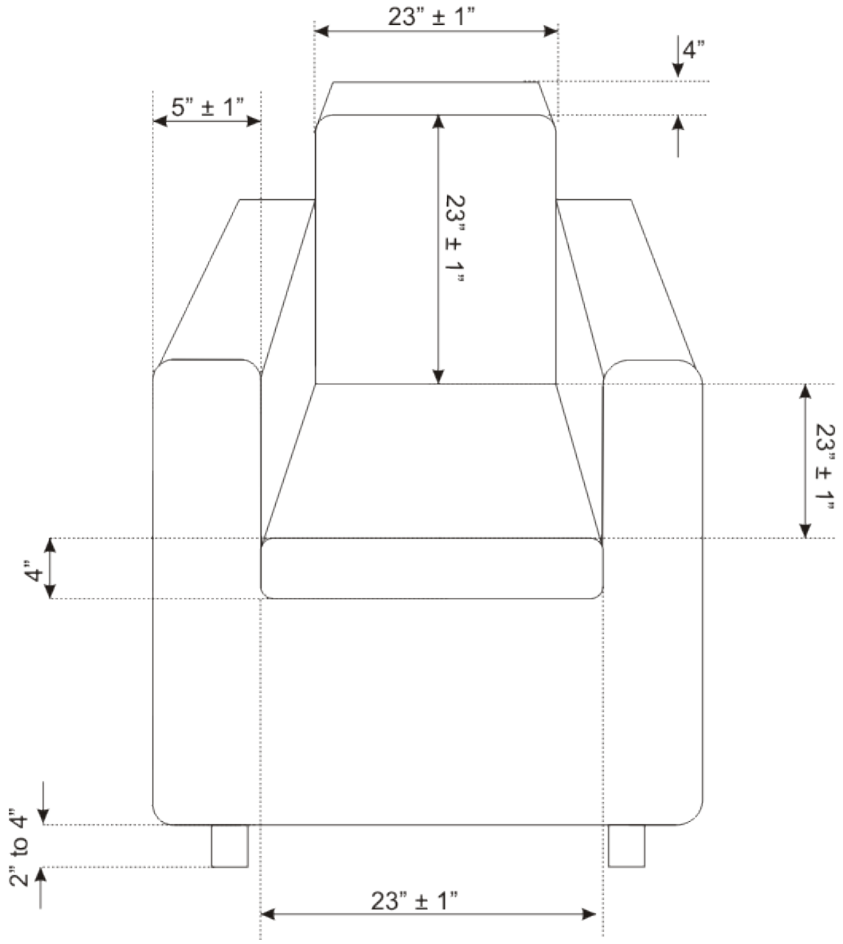


Figure 1. Typical Dimensions of Upholstered Chair Specimens.

Table 1. Chair material combinations for tests in this series.

Combination	Foam	Poly batting	Barrier	Fabric	No. of chairs
1	SPUF		✓	1a	6
2	SPUF	✓		1a	6
3	FR		✓	1a	6
17	SPUF			1a	6
5	SPUF		✓	1b	6
6	SPUF	✓		1b	6
7	FR		✓	1b	6
18	SPUF			1b	6
9	SPUF		✓	2a	6
10	SPUF	✓		2a	6
11	FR		✓	2a	6
19	SPUF			2a	6
13	SPUF		✓	2b	6
14	SPUF	✓		2b	6
15	FR		✓	2b	6
20	SPUF			2b	6
21	SPUF			3a	6
22	SPUF	✓		3a	6
23	SPUF	✓		3b	6
24	SPUF			3b	6

The upholstered chair samples will be removed from any packaging prior to conditioning. Immediately prior to testing, each chair will be vacuumed to remove any debris (lint, dust) in the locations where the ignition source (lit cigarettes) will be placed for testing.

Test Locations

Twelve cigarettes will be placed on each chair. The test locations of the cigarettes can be seen in Figure 2. Three cigarettes will be placed in each of the following locations:

- left side/seat crevice,
- right side/seat crevice,
- back/seat crevice, and
- seat center.

For the crevice locations, the cigarettes will be placed at least 6 inches from the corners, and the cigarettes are positioned so that the butt end is placed toward the corner. Cigarettes will be allowed to fall into crevices.

Figure 2. Cigarette Test Locations.

Test Procedure

Pre-test:

1. Photograph each chair.
2. Chair specimen to be tested is determined by the randomization scheme found in the Test Matrix section.
3. Record time the chair is removed from conditioning room.
4. Vacuum the chair test surfaces.
5. Place the chair in the test room in the designated location. The location will be marked on the floor of the test room for optimum video recording.
6. Record the temperature and relative humidity in the test room.
7. Turn on the exhaust fan to achieve an acceptable air flow used during smoldering ignition testing.
8. Start video camera.
9. Film ID placard.

Performing the test:

1. Light cigarettes so that no more than 4 mm (0.16 inch) is burned away, and place one cigarette in each test location. Immediately after placement of the lit cigarette, cover cigarettes with a cotton sheeting square, and run one finger over the sheet along the length of the covered cigarette to ensure good contact between the sheeting square and the burning cigarette.
2. Allow cigarette to burn its full length.
    - If a cigarette extinguishes before burning its full length, another lit cigarette is placed on another portion of the same location. A total of three attempts will be made with a lit cigarette for each cigarette test location. Record the number and locations of cigarette relights.
3. Test personnel leave the room making sure doors to the burn room are closed.
4. Set the timer for 60 minutes.
5. At 60 minutes, determine if the upholstered chair sample is still smoldering.
    - If before 60 minutes, any cigarette test location transitions to flaming, terminate the test, and extinguish the fire.
6. Record any unusual activity.

Post–Test

1. Stop video camera.
2. Record smoldering status of each cigarette.
3. Extinguish any areas demonstrating continued smoldering, if deemed a safety hazard by staff.
4. Photograph the chair, including all of the cigarette locations.
5. Remove remaining cotton sheeting from test locations.
6. Record the following data:
    - vertical char length up from the top of the cigarette (measurement is made on side or back location or seat surface), and
    - horizontal char length out (measurement is made on seat surface).

    These two measurements are made with the chair intact and are measured from the cigarette to the point of char farthest from the cigarette.
7. Remove the upholstery fabric, batting, and/or barrier system. Clean loose char debris from the foam, and make the following measurements:
    - horizontal char depth into the foam (measurement is made into side or back location or seat surface), and
    - vertical char depth into the foam (measurement is made down from crevice).

Data Collection

Report the following data:

1. Date, temperature, and % RH of the test room;
2. Chair sample ID, fabric, foam ID, and whether the FR barrier is present;
3. Sample retrieval time;
4. Test start and end times;
5. Cigarette test locations that required a relit cigarette;

6. Status of each cigarette test location at end of test;
7. Whether any cigarette test location progressed from smoldering to flaming;
8. Whether any cigarette test location was manually extinguished; and
9. Char length measurements for each cigarette test location (See Figure 3).

Figure 3. Cigarette Test Locations.

TEST MATRIX

The chairs included in this study will be tested in three groups. The first group of chairs is constructed with: (1) an upholstery fabric over the barrier system (polyester batting and fire barrier) over either SPUF or FR foam; (2) an upholstery fabric over polyester batting over SPUF foam; or (3) an upholstery fabric directly over the SPUF foam. The specific details and randomized testing order are found in the chart below.

Test No.	Combination	Fabric ID	Foam	Polyester	Barrier	Replicate
1	5	1b	SPUF	No	Yes	1
2	18	1b	SPUF	No	No	1
3	6	1b	SPUF	Yes	No	1
4	3	1a	FR	No	Yes	1
5	17	1a	SPUF	No	No	1
6	1	1a	SPUF	No	Yes	1
7	7	1b	FR	No	Yes	1
8	2	1a	SPUF	Yes	No	1
9	17	1a	SPUF	No	No	2
10	3	1a	FR	No	Yes	2

11	2	1a	SPUF	Yes	No	2
12	1	1a	SPUF	No	Yes	2
13	5	1b	SPUF	No	Yes	2
14	18	1b	SPUF	No	No	2
15	6	1b	SPUF	Yes	No	2
16	7	1b	FR	No	Yes	2
17	17	1a	SPUF	No	No	3
18	6	1b	SPUF	Yes	No	3
19	18	1b	SPUF	No	No	3
20	5	1b	SPUF	No	Yes	3
21	7	1b	FR	No	Yes	3
22	2	1a	SPUF	Yes	No	3
23	3	1a	FR	No	Yes	3
24	1	1a	SPUF	No	Yes	3
25	17	1a	SPUF	No	No	4
26	6	1b	SPUF	Yes	No	4
27	5	1b	SPUF	No	Yes	4
28	18	1b	SPUF	No	No	4
29	3	1a	FR	No	Yes	4
30	7	1b	FR	No	Yes	4
31	2	1a	SPUF	Yes	No	4
32	1	1a	SPUF	No	Yes	4
33	18	1b	SPUF	No	No	5
34	2	1a	SPUF	Yes	No	5
35	6	1b	SPUF	Yes	No	5
36	1	1a	SPUF	No	Yes	5
37	5	1b	SPUF	No	Yes	5
38	17	1a	SPUF	No	No	5
39	3	1a	FR	No	Yes	5
40	7	1b	FR	No	Yes	5
41	5	1b	SPUF	No	Yes	6
42	3	1a	FR	No	Yes	6
43	6	1b	SPUF	Yes	No	6
44	7	1b	FR	No	Yes	6
45	2	1a	SPUF	Yes	No	6
46	18	1b	SPUF	No	No	6
47	17	1a	SPUF	No	No	6
48	1	1a	SPUF	No	Yes	6

The second group of chairs is constructed with: (1) an upholstery fabric over the barrier system (polyester batting and fire barrier) over either SPUF or FR foam; (2) an upholstery fabric over polyester batting over SPUF foam; or (3) an upholstery fabric directly over the SPUF foam. The specific details and randomized testing order are found in the chart below.

Test No.	**Combination**	**Fabric ID**	**Foam**	**Polyester**	**Barrier**	**Replicate**
1	9	2a	SPUF	No	Yes	1
2	14	2b	SPUF	Yes	No	1
3	19	2a	SPUF	No	No	1
4	11	2a	FR	No	Yes	1
5	9	2a	SPUF	No	Yes	2
6	19	2a	SPUF	No	No	2
7	20	2b	SPUF	No	No	1
8	10	2a	SPUF	Yes	No	1

9	13	2b	SPUF	No	Yes	1
10	15	2b	FR	No	Yes	1
11	9	2a	SPUF	No	Yes	3
12	11	2a	FR	No	Yes	2
13	20	2b	SPUF	No	No	2
14	10	2a	SPUF	Yes	No	2
15	20	2b	SPUF	No	No	3
16	11	2a	FR	No	Yes	3
17	11	2a	FR	No	Yes	4
18	13	2b	SPUF	No	Yes	2
19	15	2b	FR	No	Yes	2
20	20	2b	SPUF	No	No	4
21	14	2b	SPUF	Yes	No	2
22	15	2b	FR	No	Yes	3
23	15	2b	FR	No	Yes	4
24	20	2b	SPUF	No	No	5
25	9	2a	SPUF	No	Yes	4
26	14	2b	SPUF	Yes	No	3
27	14	2b	SPUF	Yes	No	4
28	10	2a	SPUF	Yes	No	3
29	13	2b	SPUF	No	Yes	3
30	14	2b	SPUF	Yes	No	5
31	13	2b	SPUF	No	Yes	4
32	9	2a	SPUF	No	Yes	5
33	20	2b	SPUF	No	No	6
34	19	2a	SPUF	No	No	3
35	13	2b	SPUF	No	Yes	5
36	13	2b	SPUF	No	Yes	6
37	10	2a	SPUF	Yes	No	4
38	15	2b	FR	No	Yes	5
39	11	2a	FR	No	Yes	5
40	19	2a	SPUF	No	No	4
41	11	2a	FR	No	Yes	6
42	10	2a	SPUF	Yes	No	5
43	19	2a	SPUF	No	No	5
44	10	2a	SPUF	Yes	No	6
45	15	2b	FR	No	Yes	6
46	14	2b	SPUF	Yes	No	6
47	9	2a	SPUF	No	Yes	6
48	19	2a	SPUF	No	No	6

The third group of chairs is constructed with: (1) an upholstery fabric over polyester batting over SPUF foam; or (2) an upholstery fabric directly over SPUF foam. The specific details and randomization testing order are found in the chart below.

Test No.	**Combination**	**Fabric ID/Code**	**Foam**	**Polyester**	**Barrier**	**Replicate**
1	21	3a	SPUF	No	No	1
2	22	3a	SPUF	Yes	No	1
3	21	3a	SPUF	No	No	2
4	24	3b	SPUF	No	No	1
5	22	3a	SPUF	Yes	No	2
6	23	3b	SPUF	Yes	No	1
7	21	3a	SPUF	No	No	3

8	24	3b	SPUF	No	No	2
9	21	3a	SPUF	No	No	4
10	22	3a	SPUF	Yes	No	3
11	21	3a	SPUF	No	No	5
12	22	3a	SPUF	Yes	No	4
13	24	3b	SPUF	No	No	3
14	24	3b	SPUF	No	No	4
15	22	3a	SPUF	Yes	No	5
16	22	3a	SPUF	Yes	No	6
17	23	3b	SPUF	Yes	No	2
18	23	3b	SPUF	Yes	No	3
19	23	3b	SPUF	Yes	No	4
20	23	3b	SPUF	Yes	No	5
21	23	3b	SPUF	No	No	6
22	24	3b	SPUF	No	No	5
23	21	3a	SPUF	No	No	6
24	24	3b	SPUF	No	No	6

DATA SHEET

FULL SCALE CHAIR TESTING DATA SHEET

Date_____ **Temperature ^{O}C _____**

Test Number_____ **RH (%) _____**

Combo Number_____ **Retrieval Time _____**

Fabric Code (circle one)
1a, 1b, 2a, 2b, 3a, 3b

Foam Code (circle one)
SPUF FR

Barrier (circle one)
Yes No

Polyester Batting (circle one)
Yes No

Test Start Time_____ **Test Completion Time_____**

Cigarette Location	No. of Relights	Smoldering at 45 min	Flaming at 45 min	Char length (inch)				Observations
				Vertical (up)	Horizontal (out)	Vertical (down)	Horizontal (in)	
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								

Appendix B. Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
1	5	1b	Y	SPUF	N	1. still smoldering	None	N/A	N/A	med	2" down side of seat cushion	Enlarged cigarette shape
1	5	1b	Y	SPUF	N	2. still smoldering	None	N/A	N/A	med	1 1/4" down side of seat cushion	Enlarged cigarette shape
1	5	1b	Y	SPUF	N	3. still smoldering	None	N/A	N/A	med	1" down side of seat cushion	Enlarged cigarette shape Small glow on fabric.
1	5	1b	Y	SPUF	N	4. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
1	5	1b	Y	SPUF	N	5. still smoldering	None	N/A	N/A	high	4 1/2" down side of back cushion	Baseball size hole. Aggressively smoldering
1	5	1b	Y	SPUF	N	6. still smoldering	None	N/A	N/A	med	1 1/2" up from seat cushion	char from cig 5 over took cig 6 test location Enlarged cig shape
1	5	1b	Y	SPUF	N	7. cold	None	N/A	N/A	N/A	1/2" up from seat cushion	
1	5	1b	Y	SPUF	N	8. still smoldering	None	N/A	N/A	med	1 1/2" down side of seat cushion	Enlarged cigarette shape
1	5	1b	Y	SPUF	N	9. still smoldering	None	N/A	N/A	med	2 1/2" down side of seat cushion	Enlarged cigarette shape
1	5	1b	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	1/2" down into seat cushion	
1	5	1b	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	3/8" down into seat cushion	
1	5	1b	Y	SPUF	N	12. cold	None	N/A	N/A	N/A	1/4" down into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments	
2	18	1b	N	SPUF	N	1.still smoldering	None	N/A	N/A	high	3" down side of seat cushion	Enlarged cigarette shape	Did not penetrate into the foam.
2	18	1b	N	SPUF	N	2. still smoldering	None	N/A	N/A	med	2 7/8" down side of seat cushion	Enlarged cigarette shape	Did not penetrate into the foam.
2	18	1b	N	SPUF	N	3. still smoldering	None	N/A	N/A	med	2" down side of seat cushion	Enlarged cigarette shape	Did not penetrate into the foam.
2	18	1b	N	SPUF	N	4. still smoldering	None	N/A	N/A	med	3" down side of seat cushion	Enlarged cigarette shape	Did not penetrate into the foam.
2	18	1b	N	SPUF	N	5. cold	None	N/A	N/A	N/A	1 1/2" into back cushion		
2	18	1b	N	SPUF	N	6. cold	None	N/A	N/A	N/A	2" into back cushion		
2	18	1b	N	SPUF	N	7.still smoldering	None	N/A	N/A	med	2" down side of seat cushion	Enlarged cigarette shape	Did not penetrate into the foam.
2	18	1b	N	SPUF	N	8. still smoldering	None	N/A	N/A	med	1 7/8" down side of seat cushion	Enlarged cigarette shape	Did not penetrate into the foam.
2	18	1b	N	SPUF	N	9. still smoldering	None	N/A	N/A	high	3" down side of seat cushion	Enlarged cigarette shape	Did not penetrate into the foam.
2	18	1b	N	SPUF	N	10. cold	None	N/A	N/A	N/A	1" out on seat cushion		
2	18	1b	N	SPUF	N	11. cold	None	N/A	N/A	N/A	7/8" down into seat cushion		
2	18	1b	N	SPUF	N	12. cold	None	N/A	N/A	N/A	7/8" down into seat cushion		

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
3	6	1b	N	SPUF	Y	1. still smoldering	None	N/A	N/A	high	3" out on seat cushion	softball sized hole
3	6	1b	N	SPUF	Y	2. still smoldering	None	N/A	N/A	med	1" out on seat cushion and down side of seat cushion	Enlarged cigarette shape
3	6	1b	N	SPUF	Y	3. still smoldering	None	N/A	N/A	high	4" out on seat cushion	melon sized hole
3	6	1b	N	SPUF	Y	4. still smoldering	None	N/A	N/A	med	1" up from seat cushion	Enlarged cigarette shape
3	6	1b	N	SPUF	Y	5. cold	None	N/A	N/A	N/A	1/2" up from seat cushion	
3	6	1b	N	SPUF	Y	6. cold	None	N/A	N/A	N/A	5/8" up from seat cushion	
3	6	1b	N	SPUF	Y	7. still smoldering	None	N/A	N/A	med	1 1/4" down from seat cushion	Enlarged cigarette shape
3	6	1b	N	SPUF	Y	8. still smoldering	None	N/A	N/A	med	1 1/4" down from seat cushion	Enlarged cigarette shape
3	6	1b	N	SPUF	Y	9. still smoldering	None	N/A	N/A	high	2" down side of seat cushion	Enlarged cigarette shape
3	6	1b	N	SPUF	Y	10. cold	None	N/A	N/A	N/A	1/2" into seat cushion	
3	6	1b	N	SPUF	Y	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
3	6	1b	N	SPUF	Y	12. cold	None	N/A	N/A	N/A	1/2" out on seat cushion and into seat cushion cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
4	3	1a	Y	FR	N	1. cold	None	N/A	N/A	N/A	5/8" out on seat cushion	
4	3	1a	Y	FR	N	2. cold	None	N/A	N/A	N/A	7/8" out on seat cushion	
4	3	1a	Y	FR	N	3. cold	None	N/A	N/A	N/A	3/4" out on seat cushion	
4	3	1a	Y	FR	N	4. cold	None	N/A	N/A	N/A	1/2" into back cushion	
4	3	1a	Y	FR	N	5. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
4	3	1a	Y	FR	N	6. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
4	3	1a	Y	FR	N	7. cold	None	N/A	N/A	N/A	1" out on seat cushion	
4	3	1a	Y	FR	N	8. cold	vertical seam in side of cushion	possibly	No	N/A	1" out on seat cushion	
4	3	1a	Y	FR	N	9. cold	None	N/A	N/A	N/A	1 1/4" out on seat cushion	
4	3	1a	Y	FR	N	10. cold	None	N/A	N/A	N/A	1/2" out on seat cushion	
4	3	1a	Y	FR	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
4	3	1a	Y	FR	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
5	17	1a	N	SPUF	N	1. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
5	17	1a	N	SPUF	N	2. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
5	17	1a	N	SPUF	N	3. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
5	17	1a	N	SPUF	N	4. still smoldering	None	N/A	N/A	high	7 1/4" on seat cushion	melon sized hole
5	17	1a	N	SPUF	N	5. cold	None	N/A	N/A	N/A	2" into back cushion	
5	17	1a	N	SPUF	N	6. still smoldering	None	N/A	N/A	high	6" on seat cushion	melon sized hole
5	17	1a	N	SPUF	N	7. cold	None	N/A	N/A	N/A	1/2" up from seat cushion and out on seat cushion	
5	17	1a	N	SPUF	N	8. cold	None	N/A	N/A	N/A	5/8" down side of seat cushion	
5	17	1a	N	SPUF	N	9. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
5	17	1a	N	SPUF	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
5	17	1a	N	SPUF	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
5	17	1a	N	SPUF	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
6	1	1a	Y	SPUF	N	1. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
6	1	1a	Y	SPUF	N	2. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
6	1	1a	Y	SPUF	N	3. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
6	1	1a	Y	SPUF	N	4. cold	no poly on zippered edge	Yes	No	N/A	1" into back cushion	
6	1	1a	Y	SPUF	N	5. cold	no poly on zippered edge	Yes	No	N/A	3/4" into back cushion	
6	1	1a	Y	SPUF	N	6. still smoldering	no poly on zippered edge	Yes	possibly progressive smoldering	high	5 1/2" on seat cushion	glowing on fabric softball sized hole
6	1	1a	Y	SPUF	N	7. cold	None	N/A	N/A	N/A	5/8" down side of seat cushion	
6	1	1a	Y	SPUF	N	8. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
6	1	1a	Y	SPUF	N	9. cold	None	N/A	N/A	N/A	5/8" up from seat cushion and down side of seat cushion	
6	1	1a	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
6	1	1a	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
6	1	1a	Y	SPUF	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
7	7	1b	Y	FR	No	1.cold	None	N/A	N/A	N/A	1/2" down side of seat cushion	
7	7	1b	Y	FR	No	2. still smoldering	None	N/A	N/A	med	1 3/4" down side of seat cushion	Enlarged cigarette shape
7	7	1b	Y	FR	No	3. still smoldering	None	N/A	N/A	med	1" down side of seat cushion	Enlarged cigarette shape
7	7	1b	Y	FR	No	4. cold	2" gap in poly on back and seat cushions	possibly	No	N/A	3/8" into back cushion	
7	7	1b	Y	FR	No	5. cold	2" gap in poly on back and seat cushions	possibly	No	N/A	1" into back cushion	
7	7	1b	Y	FR	No	6. cold	2" gap in poly on back and seat cushions	possibly	No	N/A	1/2" into back cushion	
7	7	1b	Y	FR	No	7. still smoldering	None	N/A	N/A	med	1 1/8" down side of seat cushion	Enlarged cigarette shape
7	7	1b	Y	FR	No	8. cold	None	N/A	N/A	N/A	1/2" up from seat cushion and down side of seat cushion	Enlarged cigarette shape
7	7	1b	Y	FR	N	9. still smoldering	None	N/A	N/A	high	4 1/2" down side of seat cushion	Enlarged cigarette shape glowing embers
7	7	1b	Y	FR	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
7	7	1b	Y	FR	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
7	7	1b	Y	FR	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
8	2	1a	N	SPUF	Y	1. cold	None	N/A	N/A	N/A	7/8" out on seat cushion also down side of seat cushion	
8	2	1a	N	SPUF	Y	2. still smoldering	None	N/A	N/A	high	3 1/2" out on seat cushion also 3 1/2" down side of seat cushion	baseball sized hole
8	2	1a	N	SPUF	Y	3. cold	None	N/A	N/A	N/A	1 1/2" down side of seat cushion	
8	2	1a	N	SPUF	Y	4. cold	None	N/A	N/A	N/A	3/4" up from seat cushion	
8	2	1a	N	SPUF	Y	5. cold	None	N/A	N/A	N/A	5/8" into back cushion	
8	2	1a	N	SPUF	Y	6. cold	None	N/A	N/A	N/A	1" into back cushion	
8	2	1a	N	SPUF	Y	7. still smoldering	None	N/A	N/A	high	4 1/2" out on seat cushion	softball sized hole
8	2	1a	N	SPUF	Y	8. cold	vertical seam on side of cushion	possibly	No	N/A	7/8" out on seat cushion	
8	2	1a	N	SPUF	Y	9. still smoldering	None	N/A	N/A	high	4" out on seat cushion	softball sized hole
8	2	1a	N	SPUF	Y	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
8	2	1a	N	SPUF	Y	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
8	2	1a	N	SPUF	Y	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
9	17	1a	N	SPUF	N	1. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
9	17	1a	N	SPUF	N	2. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
9	17	1a	N	SPUF	N	3. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
9	17	1a	N	SPUF	N	4. cold	None	N/A	N/A	N/A	1 1/2" into back cushion	
9	17	1a	N	SPUF	N	5. cold	None	N/A	N/A	N/A	1 1/2" into back cushion	
9	17	1a	N	SPUF	N	6. cold	None	N/A	N/A	N/A	1 1/4" into back cushion	
9	17	1a	N	SPUF	N	7. cold	None	N/A	N/A	N/A	7/8" down side of seat cushion	
9	17	1a	N	SPUF	N	8. cold	None	N/A	N/A	N/A	3/4" up from seat cushion	
9	17	1a	N	SPUF	N	9. still smoldering	None	N/A	N/A	low	1 1/4" down side of seat cushion	Enlarged cigarette shape
9	17	1a	N	SPUF	N	10. cold	None	N/A	N/A	N/A	1/4" into seat cushion	
9	17	1a	N	SPUF	N	11. cold	None	N/A	N/A	N/A	1/4" into seat cushion	
9	17	1a	N	SPUF	N	12. cold	None	N/A	N/A	N/A	1/4" into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
10	3	1a	Y	FR	N	1.cold	None	N/A	N/A	N/A	3/8" out on seat cushion also 3/8" down side of seat cushion	
10	3	1a	Y	FR	N	2. cold	vertical seam on side of cushion	possibly	No	N/A	1/4" up from seat cushion, out on seat cushion and down side of seat cushion	seam on side of cushion midway on left side. Cig no. 2 centered on seam.
10	3	1a	Y	FR	N	3. cold	None	N/A	N/A	N/A	3/8" out on seat cushion	
10	3	1a	Y	FR	N	4. cold	gap in poly in back cushion also 2" gap in poly, foam exposed in seat cushion	possibly	No	N/A	1/2" up from seat cushion	
10	3	1a	Y	FR	N	5. cold	gap in poly in back cushion also 2" gap in poly, foam exposed in seat cushion	possibly	No	N/A	1/2" up from seat cushion, out on seat cushion and into back cushion	

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
10	3	1a	Y	FR	N	6. cold	gap in poly in back cushion also 2" gap of poly, foam exposed in seat cushion	possibly	No	N/A	3/8" up from seat cushion	
10	3	1a	Y	FR	N	7. cold	None	N/A	N/A	N/A	1/2" up from seat cushion, and out on seat cushion	
10	3	1a	Y	FR	N	8. cold	None	N/A	N/A	N/A	3/8" down side of seat cushion	
10	3	1a	Y	FR	N	9. cold	None	N/A	N/A	N/A	1/4" up from seat cushion, out on seat cushion and down side of seat cushion	
10	3	1a	Y	FR	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
10	3	1a	Y	FR	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
10	3	1a	Y	FR	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
11	2	1a	N	SPUF	Y	1. cold	None	N/A	N/A	N/A	1/2" down side of seat cushion	
11	2	1a	N	SPUF	Y	2. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
11	2	1a	N	SPUF	Y	3. cold	None	N/A	N/A	N/A	3/4 down side of seat cushion	
11	2	1a	N	SPUF	Y	4. cold	None	N/A	N/A	N/A	5/8" down side of seat cushion	
11	2	1a	N	SPUF	Y	5. cold	None	N/A	N/A	N/A	5/8" down side of seat cushion	
11	2	1a	N	SPUF	Y	6. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
11	2	1a	N	SPUF	Y	7. cold	None	N/A	N/A	N/A	1 3/8" down side of seat cushion	
11	2	1a	N	SPUF	Y	8. cold	None	N/A	N/A	N/A	1 1/4" down side of seat cushion	
11	2	1a	N	SPUF	Y	9. cold	None	N/A	N/A	N/A	1 1/2" down side of seat cushion	
11	2	1a	N	SPUF	Y	10. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	
11	2	1a	N	SPUF	Y	11. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	
11	2	1a	N	SPUF	Y	12. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
12	1	1a	Y	SPUF	N	1. cold	None	N/A	N/A	N/A	3/8" up from seat cushion	
12	1	1a	Y	SPUF	N	2. cold	None	N/A	N/A	N/A	3/8" down side of seat cushion	
12	1	1a	Y	SPUF	N	3. cold	None	N/A	N/A	N/A	1/4" up from seat cushion, out on seat cushion and down side of seat cushion	
12	1	1a	Y	SPUF	N	4. cold	2" gap in poly in back cushion	possibly	No	N/A	1 1/4" down side of seat cushion	
12	1	1a	Y	SPUF	N	5. cold	2" gap in poly in back cushion	possibly	No	N/A	3/4" down side of seat cushion	
12	1	1a	Y	SPUF	N	6. cold	2" gap in poly in back cushion	possibly	No	N/A	1 3/8" down side of seat cushion	
12	1	1a	Y	SPUF	N	7. cold	None	N/A	N/A	N/A	5/8" out on seat cushion	
12	1	1a	Y	SPUF	N	8. cold	None	N/A	N/A	N/A	1/2" out on seat cushion	
12	1	1a	Y	SPUF	N	9. cold	None	N/A	N/A	N/A	1/2" down side of seat cushion	
12	1	1a	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	
12	1	1a	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
12	1	1a	Y	SPUF	N	12. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
13	5	1b	Y	SPUF	N	1. still smoldering	None	N/A	N/A	high	2 1/4" down on side of seat cushion	Enlarged cigarette shape
13	5	1b	Y	SPUF	N	2. still smoldering	None	N/A	N/A	low	5/8" down on side of seat cushion	Enlarged cigarette shape
13	5	1b	Y	SPUF	N	3. still smoldering	None	N/A	N/A	low	7/8" down on side of seat cushion	Enlarged cigarette shape
13	5	1b	Y	SPUF	N	4. still smoldering	2" gap on back and seat cushions	possibly	No	low	1 3/4" down into back cushion	Enlarged cigarette shape
13	5	1b	Y	SPUF	N	5. still smoldering	2" gap on back and seat cushions	possibly	No	high	5 1/2" into the back cushion	softball size hole
13	5	1b	Y	SPUF	N	6. still smoldering	2" gap on back and seat cushions	possibly	No	high	2 1/4"down into the seat cushion	Enlarged cigarette shape
13	5	1b	Y	SPUF	N	7. still smoldering	None	N/A	N/A	low	3/4" up from seat cushion also down on side of seat cushion	Enlarged cigarette shape
13	5	1b	Y	SPUF	N	8.still smoldering	None	N/A	N/A	low	7/8" down on side of seat cushion	Enlarged cigarette shape
13	5	1b	Y	SPUF	N	9. still smoldering	None	N/A	N/A	low	1 1/8" down on side of seat cushion	Enlarged cigarette shape
13	5	1b	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
13	5	1b	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
13	5	1b	Y	SPUF	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
14	18	1b	N	SPUF	N	1. still smoldering	None	N/A	N/A	low	1 1/2" down on side of seat cushion	Enlarged cigarette shape
14	18	1b	N	SPUF	N	2. still smoldering	None	N/A	N/A	med	2 3/4" down on side of seat cus	Enlarged cigarette shape
14	18	1b	N	SPUF	N	3. cold	None	N/A	N/A	N/A	1 1/2" down side of seat cushion	Enlarged cigarette shape
14	18	1b	N	SPUF	N	4. still smoldering	None	N/A	N/A	high	4 1/2" down back of seat cushion	glowing on fabric intense smoldering Melon sized hole
14	18	1b	N	SPUF	N	5. still smoldering	None	N/A	N/A	high	4" down back of seat cushion	Melon sized hole
14	18	1b	N	SPUF	N	6. cold	None	N/A	N/A		7/8" down side of seat cushion	
14	18	1b	N	SPUF	N	7. still smoldering	None	N/A	N/A	low	1 3/4" down side of seat cushion	Enlarged cigarette shape
14	18	1b	N	SPUF	N	8. cold	None	N/A	N/A		1 3/8" down side of seat cushion	
14	18	1b	N	SPUF	N	9. still smoldering	None	N/A	N/A	med	2" down side of seat cushion	Enlarged cigarette shape
14	18	1b	N	SPUF	N	10. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and down into seat cushion	
14	18	1b	N	SPUF	N	11. cold	None	N/A	N/A	N/A	1/2" into seat cushion	
14	18	1b	N	SPUF	N	12. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and down into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments	
15	6	1b	N	SPUF	Y	1. cold	None	N/A	N/A	N/A	1 3/8" down side of seat cushion		
15	6	1b	N	SPUF	Y	2. still smoldering	None	N/A	N/A	low	1 1/2" down side of seat cushion	Enlarged cigarette shape	glow spots on fabric
15	6	1b	N	SPUF	Y	3. cold	None	N/A	N/A	N/A	1 1/8" down side of seat cushion		
15	6	1b	N	SPUF	Y	4. still smoldering	None	N/A	N/A	low	3/4" up from the seat cushion	Enlarged cigarette shape	
15	6	1b	N	SPUF	Y	5. cold	None	N/A	N/A	N/A	1/2" up from seat cushion also down side of seat cushion		
15	6	1b	N	SPUF	Y	6. still smoldering	None	N/A	N/A	low	7/8" up from seat cushion	Enlarged cigarette shape	glow spots on fabric
15	6	1b	N	SPUF	Y	7.still smoldering	thin plastic in side of seat cushion	No	No	low	1 1/2" down side of seat cushion	Enlarged cigarette shape	
15	6	1b	N	SPUF	Y	8.still smoldering	thin plastic in side of seat cushion	No	No	low	1 1/4" down side of seat cushion	Enlarged cigarette shape	
15	6	1b	N	SPUF	Y	9. still smoldering	thin plastic in side of seat cushion	No	No	med	2" down side of seat cushion	Enlarged cigarette shape	
15	6	1b	N	SPUF	Y	10. cold	None	N/A	N/A	N/A	1/2" out on seat cushion		
15	6	1b	N	SPUF	Y	11. cold	None	N/A	N/A	N/A	1/2" into seat cushion		
15	6	1b	N	SPUF	Y	12. cold	None	N/A	N/A	N/A	1/2" into seat cushion		

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
16	7	1b	Y	FR	N	1. still smoldering	None	N/A	N/A	low	11/4" down side of seat cushion	Enlarged cigarette shape
16	7	1b	Y	FR	N	2. still smoldering	None	N/A	N/A	low	1 1/4" down side of seat cushion	Enlarged cigarette shape
16	7	1b	Y	FR	N	3. still smoldering	None	N/A	N/A	low	1 3/8" down side of seat cushion	Enlarged cigarette shape
16	7	1b	Y	FR	N	4. cold	3" gap in poly on seat cushion	possibly	No	N/A	3/8" up from seat cushion	
16	7	1b	Y	FR	N	5. still smoldering	3" gap in poly on seat cushion	possibly	No	low	1 3/8" into back cushion	Enlarged cigarette shape
16	7	1b	Y	FR	N	6. still smoldering	3" gap in poly on seat cushion	possibly	No	high	3 5/8" into back cushion	glow on fabric baseball size hole
16	7	1b	Y	FR	N	7. still smoldering	None	N/A	N/A	low	1 1/4" down side of seat cushion	Enlarged cigarette shape
16	7	1b	Y	FR	N	8. still smoldering	None	N/A	N/A	low	1 1/4" down side of seat cushion	Enlarged cigarette shape
16	7	1b	Y	FR	N	9. still smoldering	None	N/A	N/A	low	3/4" down side of seat cushion	Enlarged cigarette shape
16	7	1b	Y	FR	N	10. cold	None	N/A	N/A	N/A	3/4" out on seat cushion	
16	7	1b	Y	FR	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
16	7	1b	Y	FR	N	12. cold	None	N/A	N/A	N/A	3/4" into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
17	17	1a	N	SPUF	N	1. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
17	17	1a	N	SPUF	N	2. still smoldering	None	N/A	N/A	high	2 1/2" down side of seat cushion	golf ball size hole
17	17	1a	N	SPUF	N	3. cold	None	N/A	N/A	N/A	1 1/8" down side of seat cushion	
17	17	1a	N	SPUF	N	4. still smoldering	None	N/A	N/A	high	3 1/4" into the back cushion	cig no. 4 actively smoldering golf ball size hole
17	17	1a	N	SPUF	N	5. still smoldering	None	N/A	N/A	high	4" into the back cushion	golf ball size hole
17	17	1a	N	SPUF	N	6. cold	None	N/A	N/A	N/A	2 7/8" down side of seat cushion	
17	17	1a	N	SPUF	N	7. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
17	17	1a	N	SPUF	N	8. cold	vertical seam on side of cushion	possibly	No	N/A	5/8" down side of seat cushion	
17	17	1a	N	SPUF	N	9. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
17	17	1a	N	SPUF	N	10. cold	None	N/A	N/A	N/A	3/8" into seat cushion	
17	17	1a	N	SPUF	N	11. cold	None	N/A	N/A	N/A	3/8" into seat cushion	
17	17	1a	N	SPUF	N	12. cold	None	N/A	N/A	N/A	3/8" into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
18	6	1b	N	SPUF	Y	1. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
18	6	1b	N	SPUF	Y	2. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
18	6	1b	N	SPUF	Y	3. still smoldering	None	N/A	N/A	low	1 1/4" down side of seat cushion	Enlarged cigarette shape
18	6	1b	N	SPUF	Y	4. cold	None	N/A	N/A	N/A	1/2" up from seat cushion	
18	6	1b	N	SPUF	Y	5. still smoldering	None	N/A	N/A	high	4 3/4" down side of seat cushion	baseball sized hole
18	6	1b	N	SPUF	Y	6. cold	None	N/A	N/A	N/A	5/8" up from seat cushion	
18	6	1b	N	SPUF	Y	7. still smoldering	None	N/A	N/A	high	2 1/8" down side of seat cushion	Enlarged cigarette shape
18	6	1b	N	SPUF	Y	8. cold	None	N/A	N/A	N/A	1/2" out on seat cushion and down side of seat cushion	
18	6	1b	N	SPUF	Y	9. still smoldering	None	N/A	N/A	high	2 3/8" down side of seat cushion	Enlarged cigarette shape
18	6	1b	N	SPUF	Y	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
18	6	1b	N	SPUF	Y	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
18	6	1b	N	SPUF	Y	12. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
19	18	1b	N	SPUF	N	1. still smoldering	None	N/A	N/A	low	1 1/4" down on side of seat cushion	Enlarged cigarette shape
19	18	1b	N	SPUF	N	2. still smoldering	None	N/A	N/A	med	1 1/2" down side of seat cushion	Enlarged cigarette shape Fabric glowing
19	18	1b	N	SPUF	N	3. still smoldering	None	N/A	N/A	med	2 1/4" down on side of seat cushion	Enlarged cigarette shape
19	18	1b	N	SPUF	N	4. still smoldering	None	N/A	N/A	high	4 1/2" down back of seat cushion also into back cushion	Softball size hole fabric glowing
19	18	1b	N	SPUF	N	5. still smoldering	None	N/A	N/A	high	4 1/2" into back cushion	Softball size hole fabric glowing
19	18	1b	N	SPUF	N	6. still smoldering	None	N/A	N/A	high	4 1/2" down side of seat cushion also into back cushion	Softball size hole fabric glowing
19	18	1b	N	SPUF	N	7. still smoldering	None	N/A	N/A	med	2 1/8" down side of seat cushion	Enlarged cigarette shape
19	18	1b	N	SPUF	N	8. still smoldering	None	N/A	N/A	med	1 3/8" down side of seat cushion	Enlarged cigarette shape
19	18	1b	N	SPUF	N	9. still smoldering	None	N/A	N/A	med	2" down side of seat cushion	Enlarged cigarette shape
19	18	1b	N	SPUF	N	10. cold	None	N/A	N/A	N/A	3/4" out on seat cushion	
19	18	1b	N	SPUF	N	11. cold	None	N/A	N/A	N/A	3/8" out on seat cushion	
19	18	1b	N	SPUF	N	12. cold	None	N/A	N/A	N/A	5/8" out on seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
20	5	1b	Y	SPUF	N	1. still smoldering	None	N/A	N/A	low	3/4" down on side of seat cushion	Enlarged cigarette shape
20	5	1b	Y	SPUF	N	2. cold	None	N/A	N/A	N/A	3/8" down side of seat cushion See comment	cig only burned 1 3/4 inch did not notice until end of test.
20	5	1b	Y	SPUF	N	3. still smoldering	None	N/A	N/A	low	5/8" down side of seat cushion	Enlarged cigarette shape fabric glowing
20	5	1b	Y	SPUF	N	4. still smoldering	2" gap in poly on back cushion and 4" gap on seat cushion	possibly	possibly progressive smoldering	high	4" into the back cushion	golf ball size hole
20	5	1b	Y	SPUF	N	5. still smoldering	2" gap in poly on back cushion and 4" gap on seat cushion	possibly	possibly progressive smoldering	high	4 1/4" into the back cushion	baseball sized hole
20	5	1b	Y	SPUF	N	6. cold	2" gap in poly on back cushion and 4" gap on seat cushion	possibly	No	N/A	1/2" down side of seat cushion	
20	5	1b	Y	SPUF	N	7. still smoldering	None	N/A	N/A	low	1" down side of seat cushion	Enlarged cigarette shape
20	5	1b	Y	SPUF	N	8. still smoldering	None	N/A	N/A	low	1/2" up from seat cushion also down side of seat cushion	Enlarged cigarette shape
20	5	1b	Y	SPUF	N	9. still smoldering	None	N/A	N/A	low	3/8" down side of seat cushion	Enlarged cigarette shape fabric glowing

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
20	5	1b	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	
20	5	1b	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	
20	5	1b	Y	SPUF	N	12. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
21	7	1b	Y	FR	N	1. still smoldering	None	N/A	N/A	low	1 1/2" down on side of seat cushion	Enlarged cigarette shape
21	7	1b	Y	FR	N	2. cold	None	N/A			1 3/4" down side of seat cushion	
21	7	1b	Y	FR	N	3. still smoldering	None	N/A	N/A	med	1 1/2" down side of seat cushion	Enlarged cigarette shape
21	7	1b	Y	FR	N	4. still smoldering	3 1/4" gap in poly on seat cushion	possibly	No	med	1 1/2" up from seat cushion	Enlarged cigarette shape fabric glowing
21	7	1b	Y	FR	N	5. still smoldering	4 1/4" gap in poly on seat cushion	possibly	No	med	1" up from seat cushion	Enlarged cigarette shape fabric glowing
21	7	1b	Y	FR	N	6. cold	3 1/4" gap in poly on seat cushion	possibly	No		5/8" down side of seat cushion	
21	7	1b	Y	FR	N	7. still smoldering	None	N/A	N/A	low	1" down side of seat cushion	Enlarged cigarette shape
21	7	1b	Y	FR	N	8. still smoldering	None	N/A	N/A	low	1 1/4" down side of seat cushion	Enlarged cigarette shape
21	7	1b	Y	FR	N	9. still smoldering	None	N/A	N/A	low	1" down side of seat cushion	Enlarged cigarette shape
21	7	1b	Y	FR	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
21	7	1b	Y	FR	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
21	7	1b	Y	FR	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
22	2	1a	N	SPUF	Y	1. still smoldering	None	N/A	N/A	low	1.3/4" down side of seat cushion	Enlarged cigarette shape
22	2	1a	N	SPUF	Y	2. cold	vertical seam on side of cushion	possibly	No	N/A	1 1/4" down side of seat cushion	
22	2	1a	N	SPUF	Y	3. cold	None	N/A	N/A	N/A	2 3/8" down side of seat cushion	
22	2	1a	N	SPUF	Y	4. cold	None	N/A	N/A	N/A	3/8" down side of seat cushion	
22	2	1a	N	SPUF	Y	5. cold	None	N/A	N/A	N/A	1/2" down side of seat cushion	
22	2	1a	N	SPUF	Y	6. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
22	2	1a	N	SPUF	Y	7. cold	None	N/A	N/A	N/A	1 5/8" down side of seat cushion	
22	2	1a	N	SPUF	Y	8. cold	None	N/A	N/A	N/A	1 3/8" down side of seat cushion	
22	2	1a	N	SPUF	Y	9. cold	vertical seam on side of cushion	possibly	No	N/A	3/4" down side of seat cushion	
22	2	1a	N	SPUF	Y	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
22	2	1a	N	SPUF	Y	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
22	2	1a	N	SPUF	Y	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
23	3	1a	Y	FR	N	1. cold	bits of poly & adhesive directly on foam	probably not	No	N/A	5/8" down side of seat cushion	
23	3	1a	Y	FR	N	2. cold	bits of poly & adhesive directly on foam	probably not	No	N/A	1/2" down side of seat cushion	
23	3	1a	Y	FR	N	3. cold	bits of poly & adhesive directly on foam	probably not	No	N/A	3/4" down side of seat cushion	
23	3	1a	Y	FR	N	4. cold	1" gap in poly on back cushion and a 2" gapon seat cushion	possibly	No	N/A	1/2" up from seat cushion also down side of seat cushion	
23	3	1a	Y	FR	N	5. cold	1" gap in poly on back cushion and a 2" gap on seat cushion	possibly	No	N/A	5/8" up from seat cushion	
23	3	1a	Y	FR	N	6. cold	1" gap in poly on back cushion and a 2" gap on seat cushion	possibly	No	N/A	3/8" up from seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

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Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
23	3	1a	Y	FR	N	7. cold	bits of poly & adhesive directly on foam	probably not	No	N/A	3/8" down side of seat cushion	
23	3	1a	Y	FR	N	8. cold	vertical side seam	possibly	No	N/A	5/8" down side of seat cushion	
23	3	1a	Y	FR	N	9. cold	bits of poly & adhesive directly on foam	probably not	No	N/A	1/2" down side of seat cushion	
23	3	1a	Y	FR	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
23	3	1a	Y	FR	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
23	3	1a	Y	FR	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

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Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
24	1	1a	Y	SPUF	N	1. cold	thin plastic on side of seat cushion	No	No	N/A	3/4" down side of seat cushion	
24	1	1a	Y	SPUF	N	2. cold	thin plastic on side of seat cushion	No	No	N/A	1/2" up from seat cushion and out on seat cushion	
24	1	1a	Y	SPUF	N	3. cold	thin plastic on side of seat cushion	No	No	N/A	5/8" up from seat cushion	
24	1	1a	Y	SPUF	N	4. cold	4 1/2" gap in poly on back and seat cushions	possibly	No	N/A	1/4" up from seat cushion, out on seat cushion and down side of seat cushion	
24	1	1a	Y	SPUF	N	5. cold	5 1/2" gap in poly on back and seat cushions	possibly	No	N/A	3/4" down side of seat cushion	
24	1	1a	Y	SPUF	N	6. cold	6 1/2" gap in poly on back and seat cushions	possibly	No	N/A	3/8" up from seat cushion	
24	1	1a	Y	SPUF	N	7. cold	None	N/A	N/A	N/A	3/8" up from seat cushion	
24	1	1a	Y	SPUF	N	8. cold	None	N/A	N/A	N/A	1/4" up from seat cushion and out on seat cushion	
24	1	1a	Y	SPUF	N	9. still smoldering	vertical side seam	possibly	Yes	high	1/4" up from seat cushion and out on seat cushion	melon sized hole

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
24	1	1a	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
24	1	1a	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
24	1	1a	Y	SPUF	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
25	17	1a	N	SPUF	N	1. cold	None	N/A	N/A	N/A	1 1/4" down side of seat cushion	
25	17	1a	N	SPUF	N	2. cold	None	N/A	N/A	N/A	1 1/4" down side of seat cushion	
25	17	1a	N	SPUF	N	3. cold	None	N/A	N/A	N/A	1 1/2" down side of seat cushion	
25	17	1a	N	SPUF	N	4. cold	None	N/A	N/A	N/A	6 1/2"into back cushion	soft ball sized hole noted although cig went out before 60 minutes
25	17	1a	N	SPUF	N	5. still smoldering	None	N/A	N/A	N/A	7" across the seat cushion	melon sized hole
25	17	1a	N	SPUF	N	6. cold	None	N/A	N/A	N/A	2" down side of seat cushion	
25	17	1a	N	SPUF	N	7. cold	None	N/A	N/A	N/A	1 1/4" down side of seat cushion	
25	17	1a	N	SPUF	N	8. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
25	17	1a	N	SPUF	N	9. cold	vertical side seam	possibly	No	N/A	2" down side of seat cushion	char followed seam
25	17	1a	N	SPUF	N	10. cold	None	N/A	N/A	N/A	3/8" into seat cushion	
25	17	1a	N	SPUF	N	11. cold	None	N/A	N/A	N/A	3/8" into seat cushion	
25	17	1a	N	SPUF	N	12. cold	None	N/A	N/A	N/A	3/8" into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
26	6	1b	N	SPUF	Y	1. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
26	6	1b	N	SPUF	Y	2. still smoldering	None	N/A	N/A	med	3/4" out on seat cushion and down side of seat cushion	Enlarged cigarette shape fabric glowing
26	6	1b	N	SPUF	Y	3. cold	None	N/A	N/A	N/A	1 1/2" down side of seat cushion	
26	6	1b	N	SPUF	Y	4. still smoldering	None	N/A	N/A	high	2" up from seat cushion	Enlarged cigarette shape fabric glowing
26	6	1b	N	SPUF	Y	5. cold	None	N/A	N/A	N/A	1/2" up from seat cushion	
26	6	1b	N	SPUF	Y	6. still smoldering	None	N/A	N/A	low	3/4" up from seat cushion	Enlarged cigarette shape fabric glowing
26	6	1b	N	SPUF	Y	7. still smoldering	None	N/A	N/A	low	1 3/8" down side of seat cushion	Enlarged cigarette shape fabric glowing
26	6	1b	N	SPUF	Y	8. cold	None	N/A	N/A	N/A	1/2" down side of seat cushion	
26	5	1b	N	SPUF	Y	9. still smoldering	None	N/A	N/A	low	1 1/2 down side of seat cushion	Enlarged cigarette shape fabric glowing
26	6	1b	N	SPUF	Y	10. cold	None	N/A	N/A	N/A	1/2" into seat cushion	
26	6	1b	N	SPUF	Y	11. cold	None	N/A	N/A	N/A	7/8" out on seat cushion	
26	6	1b	N	SPUF	Y	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
27	5	1b	Y	SPUF	N	1. still smoldering	None	N/A	N/A	high	4 1/2" into back cushion	grapefruit size hole
27	5	1b	Y	SPUF	N	2. still smoldering	None	N/A	N/A	low	1 1/2" out from seat cushion	enlarged cigarette shape
27	5	1b	Y	SPUF	N	3. still smoldering	None	N/A	N/A	high	5 1/4" out from seat cushion	melon size hole
27	5	1b	Y	SPUF	N	4. cold	3" gap in poly, on seat cushion. Poly appears to be cut short	possibly	N/A	N/A	1/4" out on seat cushion, down side of seat cushion and into back cushion	back cushion hangs over the seat cushion cigs placed under overhang
27	5	1b	Y	SPUF	N	5. cold	3" gap in poly, on seat cushion. Poly appears to be cut short	possibly	N/A	N/A	5/8" down side of seat cushion	back cushion hangs over the seat cushion cigs placed under overhang
27	5	1b	Y	SPUF	N	6. cold	3" gap in poly, on seat cushion. Poly appears to be cut short	possibly	N/A	N/A	7/8" down side of seat cushion	back cushion hangs over the seat cushion cigs placed under overhang
27	5	1b	Y	SPUF	N	7. cold	None	N/A	N/A	N/A	5/8" into back cushion	
27	5	1b	Y	SPUF	N	8. cold	None	N/A	N/A	N/A	3/8" out on seat cushion also into back cushion	
27	5	1b	Y	SPUF	N	9. cold	None	N/A	N/A	N/A	3/8" into back cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
27	5	1b	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	7/8" into seat cushion	
27	5	1b	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and down into seat cushion	
27	5	1b	Y	SPUF	N	12. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and down into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
28	18	1b	N	SPUF	N	1. still smoldering	None	N/A	N/A	low	1 7/8" down side of seat cushion	Enlarged cigarette shape
28	18	1b	N	SPUF	N	2. still smoldering	None	N/A	N/A	low	2" down side of seat cushion	Enlarged cigarette shape
28	18	1b	N	SPUF	N	3. still smoldering	None	N/A	N/A	high	4" out on seat cushion and into back cushion	grapefruit sized hole
28	18	1b	N	SPUF	N	4. still smoldering	None	N/A	N/A	high	5" up from side of seat cushion	melon size hole
28	18	1b	N	SPUF	N	5. still smoldering	None	N/A	N/A	high	2 7/8" down side of seat cushion	grapefruit sized hole
28	18	1b	N	SPUF	N	6. still smoldering	None	N/A	N/A	med	3 5/8" up from side of seat cushion	grapefruit sized hole
28	18	1b	N	SPUF	N	7. still smoldering	None	N/A	N/A	low	1 1/2" down side of seat cushion and into back cushion	enlarged cigarette shape
28	18	1b	N	SPUF	N	8. still smoldering	None	N/A	N/A	low	1 3/8" down side of seat cushion	Enlarged cigarette shape
28	18	1b	N	SPUF	N	9. still smoldering	None	N/A	N/A	low	1 1/2" down side of seat cushion	Enlarged cigarette shape
28	18	1b	N	SPUF	N	10. cold	None	N/A	N/A	N/A	7/8" into seat cushion	
28	18	1b	N	SPUF	N	11. cold	None	N/A	N/A	N/A	3/8" out onto seat cushion	
28	18	1b	N	SPUF	N	12. cold	None	N/A	N/A	N/A	3/8" out onto seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
29	3	1a	Y	FR	N	1. cold	Bits of poly & adhesive directly on foam	probably not	No	N/A	5/8" down from seat cushion	extra seam on back cushion on left side
29	3	1a	Y	FR	N	2. cold	Bits of poly & adhesive directly on foam	probably not	No	N/A	1/2" down from seat cushion	
29	3	1a	Y	FR	N	3. cold	Bits of poly & adhesive directly on foam	probably not	No	N/A	1/2" down from seat cushion	
29	3	1a	Y	FR	N	4. cold	2" gap in poly,on back cushion, 4" gap in poly on seat cushion. Poly appears to be cut short. Bits of poly & adhesive directly on foam	possibly	No	N/A	3/8" up from seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
29	3	1a	Y	FR	N	5. cold	2" gap in poly, on back cushion. and 4" gap in poly on seat cushion. Poly appears to be cut short. Bits of poly & adhesive directly on foam.	possibly	No	N/A	3/8" up from seat cushion	
29	3	1a	Y	FR	N	6. cold	2" gap in poly, on back cushion. Poly appears to be cut short. Bits of poly & adhesive directly on foam.	possibly	No	N/A	3/8" up from seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
29	3	1a	Y	FR	N	7. cold	4" gap in poly, on seat cushion. Poly appears to be cut short. Bits of poly & adhesive directly on foam.	possibly	No	N/A	5/8" down side of seat cushion	
29	3	1a	Y	FR	N	8. cold	4" gap in poly, on seat cushion. Poly appears to be cut short. Bits of poly and adhesive directly on foam.	possibly	No	N/A	3/8" down side of seat cushion	seam on side of seat cushion near cigarette location no. 8
29	3	1a	Y	FR	N	9. cold	4" gap in poly, on seat cushion. Poly appears to be cut short. Bits of poly & adhesive directly on foam.	possibly	No	N/A	3/8" down side of seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
29	3	1a	Y	FR	N	10. cold	None	N/A	N/A	N/A	1/4" into seat cushion	
29	3	1a	Y	FR	N	11. cold	None	N/A	N/A	N/A	3/8" into seat cushion	
29	3	1a	Y	FR		12. cold	None	N/A	N/A	N/A	3/8" into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
30	7	1b	Y	FR	N	1. still smoldering	None	N/A	N/A	low	1 1/4" down side of seat cushion	Enlarged cigarette shape
30	7	1b	Y	FR	N	2. still smoldering	None	N/A	N/A	low	1" down side of seat cushion	Enlarged cigarette shape
30	7	1b	Y	FR	N	3. still smoldering	None	N/A	N/A	low	7/8" down side of seat cushion	Enlarged cigarette shape
30	7	1b	Y	FR	N	4. cold	2" gap in poly Poly short in seat and back cushion	possibly	No	N/A	7/8" into back cushion	
30	7	1b	Y	FR	N	5. cold	2" gap in poly Poly short in seat and back cushion	possibly	No	N/A	1/2" into back cushion	
30	7	1b	Y	FR	N	6. still smoldering	2" gap in poly Poly short in seat and back cushion	possibly	No	low	1 1/2" into back cushion	Enlarged cigarette shape
30	7	1b	Y	FR	N	7. still smoldering	None	N/A	NA	low	1" into back cushion	Enlarged cigarette shape
30	7	1b	Y	FR	N	8. still smoldering	None	N/A	N/A	med	1 1/4" into back cushion	Enlarged cigarette shape heavily smoldering
30	7	1b	Y	FR	N	9. still smoldering	None	N/A	N/A	med	1" down side of seat cushion	Enlarged cigarette shape heavily smoldering
30	7	1b	Y	FR	N	10. cold	None	N/A	N/A	N/A	1/2" into seat cushion	
30	7	1b	Y	FR	N	11. cold	None	N/A	N/A	N/A	1/2" into seat cushion	
30	7	1b	Y	FR	N	12. cold	None	N/A	N/A	N/A	1/2" into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
31	2	1a	N	SPUF	Y	1. cold	None	N/A	N/A	N/A	1/2" down side of seat cushion	
31	2	1a	N	SPUF	Y	2. cold	None	N/A	N/A	N/A	1 1/8" down side of seat cushion	
31	2	1a	N	SPUF	Y	3. cold	None	N/A	N/A	N/A	7/8" down side of seat cushion	
31	2	1a	N	SPUF	Y	4. cold	None	N/A	N/A	N/A	1/4" into seat cushion	
31	2	1a	N	SPUF	Y	5. cold	None	N/A	N/A	N/A	1/4" into seat cushion	
31	2	1a	N	SPUF	Y	6. cold	None	N/A	N/A	N/A	1/4" up from side of seat cushion, out on seat cushion and into back cushion	
31	2	1a	N	SPUF	Y	7. cold	None	N/A	N/A	N/A	1 1/4" down side of seat cushion	
31	2	1a	N	SPUF	Y	8. still smoldering	None	N/A	N/A	low	1" down side of seat cushion and into back cushion	Softball size hole
31	2	1a	N	SPUF	Y	9. cold	None	N/A	N/A	N/A	3" down side of seat cushion and into back cushion	
31	2	1a	N	SPUF	Y	10. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	
31	2	1a	N	SPUF	Y	11. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
31	2	1a	N	SPUF	Y	12. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
32	1	1a	Y	SPUF	N	1. cold	vertical seam thin plastic on side of seat cushion	possibly	No	N/A	3/8" up from seat cushion and out on seat cushion	vertical seam on side of seat cushion between cigarette locations 1 & 2
32	1	1a	Y	SPUF	N	2. cold	thin plastic on side of seat cushion	possibly	No	N/A	3/8" up from seat cushion and down side of seat cushion	
32	1	1a	Y	SPUF	N	3. still smoldering	thin plastic on side of seat cushion	possibly	No	high	4" up from seat cushion and down side of seat cushion	melon size hole to decking burned through seat cushion
32	1	1a	Y	SPUF	N	4. cold	None	No	No	N/A	5/8" into back cushion	
32	1	1a	Y	SPUF	N	5. cold	None	No	No	N/A	1 1/2" up from seat cushion and into back cushion	
32	1	1a	Y	SPUF	N	6. cold	None	No	No	N/A	3/8" into out onto seat cushion and into back cushion	
32	1	1a	Y	SPUF	N	7. still smoldering	None	No	No	N/A	4 1/2" down side of seat cushion	small melon size hole
32	1	1a	Y	SPUF	N	8. cold	None	No	No	N/A	3/6" up from seat cushion	2nd relight cigarette went out halfway though cig and no room to place 3rd cigarette
32	1	1a	Y	SPUF	N	9. cold	None	No	No	N/A	1" down side of seat cushion	
32	1	1a	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
32	1	1a	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
32	1	1a	Y	SPUF	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
33	18	1b	N	SPUF	N	1. still smoldering	None	No	No	med	2" down side of seat cushion	golf ball size hole
33	18	1b	N	SPUF	N	2. still smoldering	None	No	No	med	2 3/4" down side of seat cushion	tennis ball size hole
33	18	1b	N	SPUF	N	3. still smoldering	None	No	No	med	3" down side of seat cushion	baseball size hole
33	18	1b	N	SPUF	N	4. cold	None	N/A	N/A	N/A	3/4" into back cushion	
33	18	1b	N	SPUF	N	5. still smoldering	None	N/A	N/A	high	4" down side of seat cushion and into back cushion	melon size hole
33	18	1b	N	SPUF	N	6. still smoldering	None	N/A	N/A	high	4" down side of seat cushion and into back cushion	melon size hole
33	18	1b	N	SPUF	N	7. still smoldering	None	N/A	N/A	low	4" down side of seat cushion and into back cushion	Enlarged cigarette shape
33	18	1b	N	SPUF	N	8. cold	None	N/A	N/A	N/A	2 1/2" down side of seat cushion	racquetball size hole
33	18	1b	N	SPUF	N	9. still smoldering	None	N/A	N/A	low	2 1/4" down side of seat cushion	racquetball size hole
33	18	1b	N	SPUF	N	10. cold	None	N/A	N/A	N/A	1/2" out on seat cushion and into seat cushion cushion	
33	18	1b	N	SPUF	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion cushion	
33	18	1b	N	SPUF	N	12. cold	None	N/A	N/A	N/A	3/4" out on seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
34	2	1a	N	SPUF	Y	1. cold	None	N/A	N/A	N/A	1/2" up from seat cushion and down from seat cushion	
34	2	1a	N	SPUF	Y	2. cold	None	N/A	N/A	N/A	1/2" up from seat cushion and down from seat cushion	
34	2	1a	N	SPUF	Y	3. cold	None	N/A	N/A	N/A	3/4" out on seat cushion and down from seat cushion	
34	2	1a	N	SPUF	Y	4. cold	double layer of poly	No	No	N/A	5/8" up from seat cushion	
34	2	1a	N	SPUF	Y	5. cold	double layer of poly	No	No	N/A	1/2" up from seat cushion	
34	2	1a	N	SPUF	Y	6. cold	double layer of poly	No	No	N/A	3/8" up from seat cushion, out on seat cushion and into back cushion	
34	2	1a	N	SPUF	Y	7. cold	None	N/A	N//A	N/A	3/4" down from seat cushion	
34	2	1a	N	SPUF	Y	8. cold	vertical seam on side of seat cushion	No	No	N/A	3/4" down from seat cushion	vertical seam on side of cushion near cig no. 8, cig was not placed on seam
34	2	1a	N	SPUF	Y	9. cold	None	N/A	N/A	N/A	5/8" down from seat cushion	
34	2	1a	N	SPUF	Y	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
34	2	1a	N	SPUF	Y	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
34	2	1a	N	SPUF	Y	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
35	6	1b	N	SPUF	Y	1. still smoldering	thin plastic on side of seat cushion	No	No	low	1" down side of seat cushion	Enlarged cigarette shape
35	6	1b	N	SPUF	Y	2. still smoldering	thin plastic on side of seat cushion	No	No	low	1 1/2" down side of seat cushion	Enlarged cigarette shape
35	6	1b	N	SPUF	Y	3. still smoldering	thin plastic on side of seat cushion	No	No	low	2 1/2" down side of seat cushion	Enlarged cigarette shape
35	6	1b	N	SPUF	Y	4. cold	None	N/A	N/A	N/A	1/2" out on seat cushion	
35	6	1b	N	SPUF	Y	5. still smoldering	None	N/A	N/A	low	3/4" up from seat cushion and into back cushion	Enlarged cigarette shape
35	6	1b	N	SPUF	Y	6. still smoldering	None	N/A	N/A	low	3/4" out on seat cushion and into back cushion	Enlarged cigarette shape
35	6	1b	N	SPUF	Y	7. still smoldering	thin plastic on side of seat cushion	No	No	low	1 1/2" down from seat cushion	Enlarged cigarette shape
35	6	1b	N	SPUF	Y	8. still smoldering	thin plastic on side of seat cushion	No	No	low	1 1/2" down from seat cushion	Enlarged cigarette shape
35	6	1b	N	SPUF	Y	9. still smoldering	thin plastic on side of seat cushion	No	No	low	1 1/2" down from seat cushion	Enlarged cigarette shape
35	6	1b	N	SPUF	Y	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
35	6	1b	N	SPUF	Y	11. cold	None	N/A	N/A	N/A	1/2" out on seat cushion and into seat cushion	
35	6	1b	N	SPUF	Y	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
36	1	1a	Y	SPUF	N	1. still smoldering	vertical seam on side of cushion. 4" gap in poly, on seat cushion. Poly appears to be cut short.	possibly	possibly	med	3 1/2" down side of seat cushion	vertical seam on side of cushion near cig no. 1, cig placement spanned seam. Melon size hole
36	1	1a	Y	SPUF	N	2. cold	4" gap in poly, on seat cushion. Poly appears to be cut short.	possibly	No	N/A	2/4" down side of seat cushion	
36	1	1a	Y	SPUF	N	3. cold	4" gap in poly, on seat cushion. Poly appears to be cut short.	possibly	No	N/A	1/4" up from seat cushion, out on seat cushion, and down side of seat cushion	
36	1	1a	Y	SPUF	N	4. cold	4" gap in poly, on back cushion. Poly appears to be cut short.	possibly	No	N/A	3/4" into back cushion	

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
36	1	1a	Y	SPUF	N	5. cold	4" gap in poly, on back cushion. Poly appears to be cut short.	possibly	No	N/A	1/4" up from seat cushion	
36	1	1a	Y	SPUF	N	6. still smoldering	4" gap in poly, on back cushion. Poly appears to be cut short.	possibly	possibly	high	3 3/4" into back cushion	softball size hole
36	1	1a	Y	SPUF	N	7. cold	4" gap in poly, on seat cushion. Poly appears to be cut short.	possibly	No	N/A	1/2" down from seat cushion	
36	1	1a	Y	SPUF	N	8. cold	4" gap in poly, on seat cushion. Poly appears to be cut short.	possibly	No	N/A	1/2" down from seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
36	1	1a	Y	SPUF	N	9. cold	4" gap in poly, on seat cushion. Poly appears to be cut short.	possibly	No	N/A	1/2" down from seat cushion	
36	1	1a	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	
36	1	1a	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	
36	1	1a	Y	SPUF	N	12. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
37	5	1b	Y	SPUF	N	1. still smoldering	None	N/A	N/A	high	4" out on seat cushion	softball size hole
37	5	1b	Y	SPUF	N	2. still smoldering	None	N/A	N/A	high	4" out on seat cushion	softball size hole
37	5	1b	Y	SPUF	N	3. still smoldering	None	N/A	N/A	high	4" out on seat cushion	softball size hole
37	5	1b	Y	SPUF	N	4. cold	None	N/A	N/A	N/A	3/8" out on seat cushion, down side of seat cushion and into back cushion	
37	5	1b	Y	SPUF	N	5. cold	None	N/A	N/A	N/A	3/8" into back cushion	
37	5	1b	Y	SPUF	N	6. cold	None	N/A	N/A	N/A	1/4" up from seat cushion and down from seat cushion	
37	5	1b	Y	SPUF	N	7. cold	None	N/A	N/A	N/A	3/8" up from seat cushion and down from seat cushion	
37	5	1b	Y	SPUF	N	8. cold	None	N/A	N/A	N/A	3/8" down from seat cushion	
37	5	1b	Y	SPUF	N	9. cold	None	N/A	N/A	N/A	1/4" up from seat cushion, out on seat cushion and down from seat cushion	
37	5	1b	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
37	5	1b	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
37	5	1b	Y	SPUF	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
38	17	1a	N	SPUF	N	1. cold	None	N/A	N/A	N/A	1 1/4" down side of seat cushion	
38	17	1a	N	SPUF	N	2. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
38	17	1a	N	SPUF	N	3. cold	None	N/A	N/A	N/A	1 1/4" down side of seat cushion	
38	17	1a	N	SPUF	N	4. still smoldering	None	N/A	N/A	high	4" into back cushion	melon size hole
38	17	1a	N	SPUF	N	5. cold	None	N/A	N/A	N/A	2 1/8" into back cushion	golf ball size hole
38	17	1a	N	SPUF	N	6. cold	None	N/A	N/A	N/A	1 1/4" into back cushion	
38	17	1a	N	SPUF	N	7. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
38	17	1a	N	SPUF	N	8. cold	Vertical seam	No	No	N/A	2 1/8" down side of seat cushion	
38	17	1a	N	SPUF	N	9. cold	None	N/A	N/A	N/A	1 1/4" down side of seat cushion	
38	17	1a	N	SPUF		10. cold	None	N/A	N/A	N/A	1/2" into seat cushion	
38	17	1a	N	SPUF		11. cold	None	N/A	N/A	N/A	1/2" into seat cushion	
38	17	1a	N	SPUF		12. cold	None	N/A	N/A	N/A	1/2" into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
39	3	1a	Y	FR	N	1. cold	4" gap in poly, on seat cushion.	possibly	No	N/A	1" down side of seat cushion	
39	3	1a	Y	FR	N	2. cold	4" gap in poly, on seat cushion. Vertical seam	possibly	No	N/A	1/2" up from seat cushion, out on seat cushion and down side of seat cushion	vertical seam
39	3	1a	Y	FR	N	3. cold	4" gap in poly, on seat cushion.	possibly	No	N/A	3/8" out on seat cushion	
39	3	1a	Y	FR	N	4. cold	3" gap in poly, on back cushion.	possibly	No	N/A	3/4" out on seat cushion	
39	3	1a	Y	FR	N	5. cold	3" gap in poly, on back cushion.	possibly	No	N/A	5/8" up from seat cushion and down side of seat cushion	
39	3	1a	Y	FR	N	6. cold	3" gap in poly, on back cushion.	possibly	No	N/A	3/4" up from seat cushion	
39	3	1a	Y	FR	N	7. cold	4" gap in poly, on seat cushion.	possibly	No	N/A	1/2" up from seat cushion	
39	3	1a	Y	FR	N	8. cold	4" gap in poly, on seat cushion.	possibly	No	N/A	5/8" out on seat cushion and down side of seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
39	3	1a	Y	FR	N	9. cold	4" gap in poly, on seat cushion.	possibly	No	N/A	1/2" up from seat cushion	
39	3	1a	Y	FR	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
39	3	1a	Y	FR	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
39	3	1a	Y	FR	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments	
40	7	1b	Y	FR	N	1. still smoldering	4" gap in poly, on seat cushion.	possibly	No	low	2 1/2" down side of seat cushion	Enlarged cigarette shape	Fabric glowing
40	7	1b	Y	FR	N	2. cold	4" gap in poly, on seat cushion.	possibly	No	N/A	3/4" up from seat cushion and out on seat cushion	fabric glowing	
40	7	1b	Y	FR	N	3. still smoldering	4" gap in poly, on seat cushion.	possibly	No	low	1" out on seat cushion	Enlarged cigarette shape	
40	7	1b	Y	FR	N	4. still smoldering	3" gap in poly, on back cushion.	possibly	No	low	1 1/2" into back cushion	Enlarged cigarette shape	
40	7	1b	Y	FR	N	5. still smoldering	3" gap in poly, on back cushion.	possibly	No	low	1 3/4" into back cushion	Enlarged cigarette shape	
40	7	1b	Y	FR	N	6. still smoldering	3" gap in poly, on back cushion.	possibly	No	low	2" into back cushion	Enlarged cigarette shape	
40	7	1b	Y	FR	N	7. still smoldering	4" gap in poly, on seat cushion.	possibly	No	low	1 1/8" down side of seat cushion	Enlarged cigarette shape	
40	7	1b	Y	FR	N	8. still smoldering	4" gap in poly, on seat cushion.	possibly	No	low	1 1/8" down side of seat cushion	Enlarged cigarette shape	
40	7	1b	Y	FR	N	9. still smoldering	4" gap in poly, on seat cushion.	possibly	No	low	7/8" down side of seat cushion	Enlarged cigarette shape	

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Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
40	7	1b	Y	FR	N	10. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
40	7	1b	Y	FR	N	11. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
40	7	1b	Y	FR	N	12. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
41	5	1b	Y	SPUF	N	1. cold	4" gap in poly, on seat cushion.	possibly	No	N/A	5/8" down side of seat cushion	Approximately 1 1/2" cigarette unburned
41	5	1b	Y	SPUF	N	2.. still smoldering	4" gap in poly, on seat cushion.	possibly	No	low	1 3/4" down side of seat cushion	Approximately 1" cigarette unburned Coconut size hole
41	5	1b	Y	SPUF	N	3. cold	4" gap in poly, on seat cushion.	possibly	No	N/A	1 1/8" down side of seat cushion	Approximately 1" cigarette unburned
41	5	1b	Y	SPUF	N	4. still smoldering	None	N/A	N/A	high	4" into seat cushion	melon size hole
41	5	1b	Y	SPUF	N	5. cold	None	N/A	N/A	N/A	7/8" into seat cushion	
41	5	1b	Y	SPUF	N	6. cold	None	N/A	N/A	N/A	5/8" into seat cushion	
41	5	1b	Y	SPUF	N	7. cold	4" gap in poly, on seat cushion.	possibly	No	N/A	1/2" up from seat cushion and out on seat cushion	
41	5	1b	Y	SPUF	N	8. cold	4" gap in poly, on seat cushion.	possibly	No	N/A	1/2" up from seat cushion and down side of seat cushion	
41	5	1b	Y	SPUF	N	9. still smoldering	4" gap in poly, on seat cushion.	possibly	No	low	1" down side of seat cushion	Enlarged cigarette shape
41	5	1b	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
41	5	1b	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
41	5	1b	Y	SPUF	N	12. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
42	3	1a	Y	FR	N	1. cold	Bits of poly & adhesive directly on foam.	No	No	N/A	1" down side of seat cushion	
42	3	1a	Y	FR	N	2. cold	Vertical seam Bits of poly & adhesive directly on foam	No	No	N/A	1" down side of seat cushion	
42	3	1a	Y	FR	N	3. cold	Bits of poly & adhesive directly on foam.	No	No	N/A	1/2" down side of seat cushion	
42	3	1a	Y	FR	N	4. cold	Bits of poly & adhesive directly on foam.	No	No	N/A	1" into back cushion	
42	3	1a	Y	FR	N	5. cold	Bits of poly & adhesive directly on foam.	No	No	N/A	1" down the side of seat cushion	
42	3	1a	Y	FR	N	6. cold	Bits of poly & adhesive directly on foam.	No	No	N/A	7/8" down the side of seat cushion and into back cushion	
42	3	1a	Y	FR	N	7. cold	Bits of poly & adhesive directly on foam.	No	No	N/A	1/2" up from seat cushion	

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Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
42	3	1a	Y	FR	N	8. cold	Bits of poly & adhesive directly on foam.	No	No	N/A	3/4" vertical down side of seat cushion	
42	3	1a	Y	FR	N	9. cold	Bits of poly & adhesive directly on foam.	No	No	N/A	3/8" vertical up from seat cushion, out on seat cushion, and down side of seat cushion	
42	3	1a	Y	FR	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
42	3	1a	Y	FR	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
42	3	1a	Y	FR	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
43	6	1b	N	SPUF	Y	1. still smoldering	None	N/A	N/A	low	1 5/8" vertical down side of seat cushion	Enlarged cigarette shape
43	6	1b	N	SPUF	Y	2. still smoldering	None	N/A	N/A	low	1" vertical down side of seat cushion	Enlarged cigarette shape
43	6	1b	N	SPUF	Y	3. still smoldering	None	N/A	N/A	low	1" vertical down side of seat cushion	Enlarged cigarette shape
43	6	1b	N	SPUF	Y	4. cold	None	N/A	N/A	low	1/4" out on seat cushion	
43	6	1b	N	SPUF	Y	5. still smoldering	None	N/A	N/A	low	1" into back cushion	Enlarged cigarette shape
43	6	1b	N	SPUF	Y	6. still smoldering	None	N/A	N/A	low	1 1/2" into back cushion	Enlarged cigarette shape
43	6	1b	N	SPUF	Y	7. still smoldering	None	N/A	N/A	low	1 5/8" down side of seat cushion	Enlarged cigarette shape
43	6	1b	N	SPUF	Y	8. cold	None	N/A	N/A	N/A	5/8" up from seat cushion	Approximately half of the cigarette was unburned
43	6	1b	N	SPUF	Y	9. still smoldering	None	N/A	N/A	low	1 1/4" down side of seat cushion	Enlarged cigarette shape
43	6	1b	N	SPUF	Y	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
43	6	1b	N	SPUF	Y	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
43	6	1b	N	SPUF	Y	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
44	7	1b	Y	FR	N	1. cold	3" gap in poly, on seat cushion.	possibly	No	N/A	1/2" out on seat cushion and down side of seat cushion	
44	7	1b	Y	FR	N	2. cold	3" gap in poly, on seat cushion.	possibly	No	N/A	1/2" down side of seat cushion	
44	7	1b	Y	FR	N	3. cold	3" gap in poly, on seat cushion.	possibly	No	N/A	5/8" down side of seat cushion	
44	7	1b	Y	FR	N	4. still smoldering	None	N/A	N/A	med	3 1/2" up from seat cushion	Enlarged cigarette shape fabric glowing
44	7	1b	Y	FR	N	5. still smoldering	None	N/A	N/A	med	1 3/4" up from seat cushion	Enlarged cigarette shape
44	7	1b	Y	FR	N	6. still smoldering	None	N/A	N/A	med	2 1/2" up from seat cushion	Enlarged cigarette shape fabric glowing
44	7	1b	Y	FR	N	7. still smoldering	3" gap in poly, on seat cushion.	possibly	No	med	1 1/2" down side of seat cushion	Enlarged cigarette shape fabric glowing
44	7	1b	Y	FR	N	8. still smoldering	3" gap in poly, on seat cushion.	possibly	No	low	2" down side of seat cushion	Enlarged cigarette shape
44	7	1b	Y	FR	N	9. still smoldering	3" gap in poly, on seat cushion.	possibly	No	low	1" up from seat cushion and down side of seat cushion	Enlarged cigarette shape
44	7	1b	Y	FR	N	10. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
44	7	1b	Y	FR	N	11. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
44	7	1b	Y	FR	N	12. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
45	2	1a	N	SPUF	Y	1. cold	thin plastic on side of seat cushion vertical seam	No	No	N/A	1 1/8" down side of seat cushion	Vertical seam on side of cushion near cig no. 1. Seam did not interfere with cig no. 1 placement.
45	2	1a	N	SPUF	Y	2. cold	thin plastic on side of seat cushion	No	No	N/A	1/2" down side of seat cushion	
45	2	1a	N	SPUF	Y	3. cold	thin plastic on side of seat cushion	No	No	N/A	1" down side of seat cushion	
45	2	1a	N	SPUF	Y	4. cold	None	N/A	N/A	N/A	3/4" up from seat cushion	
45	2	1a	N	SPUF	Y	5. cold	None	N/A	N/A	N/A	1/2" up from seat cushion and into back cushion	
45	2	1a	N	SPUF	Y	6. cold	None	N/A	N/A	N/A	5/8" into back cushion	
45	2	1a	N	SPUF	Y	7. still smoldering	thin plastic on side of seat cushion	No	No	low	1 7/8" down side of seat cushion	orange size hole
45	2	1a	N	SPUF	Y	8. still smoldering	thin plastic on side of seat cushion	No	No	low	1 7/8" down side of seat cushion	orange size hole
45	2	1a	N	SPUF	Y	9. cold	thin plastic on side of seat cushion	No	No	N/A	5/8" down side of seat cushion	
45	2	1a	N	SPUF	Y	10. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
45	2	1a	N	SPUF	Y	11. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	
45	2	1a	N	SPUF	Y	12. cold	None	N/A	N/A	N/A	1/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
46	18	1b	N	SPUF	N	1. still smoldering	thin plastic on side of seat cushion	No	No	low	1 3/4" down side of seat cushion	Enlarged cigarette shape
46	18	1b	N	SPUF	N	2. still smoldering	thin plastic on side of seat cushion	No	No	low	2 " down side of seat cushion	Enlarged cigarette shape
46	18	1b	N	SPUF	N	3. still smoldering	thin plastic on side of seat cushion	No	No	med	2 1/4 " down side of seat cushion	Enlarged cigarette shape
46	18	1b	N	SPUF	N	4. still smoldering	None	N/A	N/A	high	5 1/2 " up from seat cushion	melon size hole
46	18	1b	N	SPUF	N	5. still smoldering	None	N/A	N/A	N/A	4 1/2 " up from seat cushion	melon size hole
46	18	1b	N	SPUF	N	6. cold	None	N/A	N/A	N/A	1 3/4 " into back cushion	golf ball size hole
46	18	1b	N	SPUF	N	7. still smoldering	None	N/A	N/A	N/A	1 5/8 " down from seat cushion	Enlarged cigarette shape
46	18	1b	N	SPUF	N	8. still smoldering	None	N/A	N/A	N/A	1 1/2 " down from seat cushion	Enlarged cigarette shape
46	18	1b	N	SPUF	N	9. still smoldering	None	N/A	N/A	N/A	1 3/8 " down from seat cushion	Enlarged cigarette shape
46	18	1b	N	SPUF	N	10. cold	None	N/A	N/A	N/A	1" into seat cushion	
46	18	1b	N	SPUF	N	11. cold	None	N/A	N/A	N/A	5/8" out on seat cushion	
46	18	1b	N	SPUF	N	12. cold	None	N/A	N/A	N/A	1/2" into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
47	17	1a	N	SPUF	N	1. cold	None	N/A	N/A	N/A	1" up from seat cushion and down side of seat cushion	
47	17	1a	N	SPUF	N	2. cold	None	N/A	N/A	N/A	1" up from seat cushion	
47	17	1a	N	SPUF	N	3. cold	None	N/A	N/A	N/A	7/8" down side of seat cushion	
47	17	1a	N	SPUF	N	4. still smoldering	None	N/A	N/A	low	3" into back cushion	orange size hole
47	17	1a	N	SPUF	N	5. still smoldering	None	N/A	N/A	low	3" into back cushion	orange size hole
47	17	1a	N	SPUF	N	6. cold	None	N/A	N/A	N/A	2" into back cushion	
47	17	1a	N	SPUF	N	7. cold	None	N/A	N/A	N/A	3/4" down from seat cushion	
47	17	1a	N	SPUF	N	8. cold	Vertical seam	No	No	N/A	1 1/8" down from seat cushion	Vertical seam on side of cushion near cig no. 8. Seam did not interfere with cig no. 8 placement.
47	17	1a	N	SPUF	N	9. cold	None	N/A	N/A	N/A	1 1/4" down from seat cushion	
47	17	1a	N	SPUF	N	10. cold	None	N/A	N/A	N/A	1/4" into seat cushion	
47	17	1a	N	SPUF	N	11. cold	None	N/A	N/A	N/A	1/4" into seat cushion	
47	17	1a	N	SPUF	N	12. cold	None	N/A	N/A	N/A	1/4" into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments	
48	1	1a	Y	SPUF	N	1. cold	None	N/A	N/A	N/A	1/2" up from seat cushion and out onto seat cushion		
48	1	1a	Y	SPUF	N	2. cold	None	N/A	N/A	N/A	1" down side of seat cushion		
48	1	1a	Y	SPUF	N	3. still smoldering	None	N/A	N/A	low	1 1/4" down side of seat cushion	Enlarged cigarette shape	
48	1	1a	Y	SPUF	N	4. still smoldering	no poly on end of back cushion and barrier layers bunched up	possibly	possibly	high	4 1/2" into back cushion	Melon size hole	Fabric glowing
48	1	1a	Y	SPUF	N	5. still smoldering	no poly on end of back cushion and barrier layers bunched up	possibly	possibly	high	4 1/2" into back cushion		
48	1	1a	Y	SPUF	N	6. cold	no poly on end of back cushion and barrier layers bunched up	possibly	No	N/A	1" into back cushion	melon size hole	
48	1	1a	Y	SPUF	N	7. cold	None	N/A	N/A	N/A	1/2" up from seat cushion		
48	1	1a	Y	SPUF	N	8. cold	None	N/A	N/A	N/A	1/2" up from seat cushion		

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
48	1	1a	Y	SPUF	N	9. cold	None	N/A	N/A	N/A	3/8" up from seat cushion and out onto seat cushion	
48	1	1a	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
48	1	1a	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
48	1	1a	Y	SPUF	N	12. cold	None	N/A	N/A		1/4" out on seat cushion and into seat cushion	
49	9	2a	Y	SPUF	N	1. cold	None	N/A	N/A	N/A	3/8" up from seat cushion and out onto seat cushion	
49	9	2a	Y	SPUF	N	2. cold	None	N/A	N/A	N/A	1/2" down side of seat cushion	
49	9	2a	Y	SPUF	N	3. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
49	9	2a	Y	SPUF	N	4. cold	3" gap in poly, on seat & back cushions.	potentially	No	N/A	1/4" out onto seat cushion	
49	9	2a	Y	SPUF	N	5. cold	3" gap in poly, on seat & back cushions	potentially	No	N/A	1/4" out onto seat cushion	
49	9	2a	Y	SPUF	N	6. cold	3" gap in poly, on seat & back cushions.	potentially	No	N/A	3/8" out onto seat cushion	
49	9	2a	Y	SPUF	N	7. cold	None	N/A	N/A	N/A	1 5/8" down side of seat cushion	golf ball sized hole

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
49	9	2a	Y	SPUF	N	8. still smoldering	None	N/A	N/A	low	5 1/4" into seat cushion	soft ball sized hole
49	9	2a	Y	SPUF	N	9. cold	None	N/A	N/A	N/A	3/8" down side of seat cushion	
49	9	2a	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
49	9	2a	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
49	9	2a	Y	SPUF	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
50	14	2b	N	SPUF	Y	1. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
50	14	2b	N	SPUF	Y	2. cold	None	N/A	N/A	N/A	1/2" up from cig and down side of seat cushion	
50	14	2b	N	SPUF	Y	3. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
50	14	2b	N	SPUF	Y	4. cold	None	N/A	N/A	N/A	5/8" up from cigarette	
50	14	2b	N	SPUF	Y	5. cold	None	N/A	N/A	N/A	1" up from cigarette	
50	14	2b	N	SPUF	Y	6. cold	None	N/A	N/A	N/A	1/2" up from cigarette	
50	14	2b	N	SPUF	Y	7. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
50	14	2b	N	SPUF	Y	8. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
50	14	2b	N	SPUF	Y	9. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
50	14	2b	N	SPUF	Y	10. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
50	14	2b	N	SPUF	Y	11. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
50	14	2b	N	SPUF	Y	12. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
51	19	2a	N	SPUF	N	1. cold	None	N/A	N/A	N/A	2" into seat cushion	
51	19	2a	N	SPUF	N	2. cold	None	N/A	N/A	N/A	1 1/4" into seat cushion	
51	19	2a	N	SPUF	N	3. cold	None	N/A	N/A	N/A	1 1/2" into seat cushion	
51	19	2a	N	SPUF	N	4. cold	None	N/A	N/A	N/A	1 3/8" into seat cushion	
51	19	2a	N	SPUF	N	5. cold	None	N/A	N/A	N/A	1 3/4" into seat cushion	
51	19	2a	N	SPUF	N	6. cold	None	N/A	N/A	N/A	1" down side of seat cushion & into seat cushion	
51	19	2a	N	SPUF	N	7. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
51	19	2a	N	SPUF	N	8. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
51	19	2a	N	SPUF	N	9. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
51	19	2a	N	SPUF	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
51	19	2a	N	SPUF	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
51	19	2a	N	SPUF	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
52	11	2a	Y	FR	N	1. cold	None	N/A	N/A	N/A	3/8" out onto seat cushion	
52	11	2a	Y	FR	N	2. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
52	11	2a	Y	FR	N	3. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
52	11	2a	Y	FR	N	4. cold	3" gap in poly, on seat & back cushions	potentially	No	N/A	3/8" up from cigarette and out onto seat cushion	Although poly short on back cushion, cigarettes ended up being placed on poly for cig locations 4, 5 & 6
52	11	2a	Y	FR	N	5. cold	3" gap in poly, on seat & back cushions	potentially	No	N/A	3/8" up from cigarette and out onto seat cushion	Although poly short on back cushion, cigarettes ended up being placed on poly for cig locations 4, 5 & 6
52	11	2a	Y	FR	N	6. cold	3" gap in poly, on seat & back cushions	potentially	No	N/A	3/8" up from cigarette and out onto seat cushion	Although poly short on back cushion, cigarettes ended up being placed on poly for cig locations 4, 5 & 6
52	11	2a	Y	FR	N	7. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
52	11	2a	Y	FR	N	8. still smoldering	None	N/A	N/A	Low	3/4" out onto seat cushion and down side of seat cushion	Enlarged cigarette shape
52	11	2a	Y	FR	N	9. cold	None	N/A	N/A	N/A	1 1/4" down side of seat cushion	
52	11	2a	Y	FR	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
52	11	2a	Y	FR	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
52	11	2a	Y	FR	N	12. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
53	9	2a	Y	SPUF	N	1. cold	None	N/A	N/A	N/A	1/2" up from cigarette	
53	9	2a	Y	SPUF	N	2. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
53	9	2a	Y	SPUF	N	3. cold	None	N/A	N/A	N/A	1/2" down side of seat cushion	
53	9	2a	Y	SPUF	N	4. cold	3" gap in poly, on seat & back cushions	potentially	No	N/A	1" into seat cushion	
53	9	2a	Y	SPUF	N	5. still smoldering	3" gap in poly, on seat & back cushions	potentially	Yes	med	6 1/2 into seat cushion	Cig No. 5 just caught the edge of poly and then started smoldering on the barrier fabric itself. Coconut sized hole.
53	9	2a	Y	SPUF	N	6. cold	3" gap in poly, on seat & back cushions	potentially	No	N/A	1" into seat cushion	
53	9	2a	Y	SPUF	N	7. cold	None	N/A	N/A	N/A	1/2" up from cigarette	
53	9	2a	Y	SPUF	N	8. cold	None	N/A	N/A	N/A	3/4" down side of seat cushion	
53	9	2a	Y	SPUF	N	9. cold	None	N/A	N/A	N/A	3/8" up from cigarette and out onto seat cushion	
53	9	2a	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
53	9	2a	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
53	9	2a	Y	SPUF	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
54	19	2a	N	SPUF	N	1. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
54	19	2a	N	SPUF	N	2. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
54	19	2a	N	SPUF	N	3. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
54	19	2a	N	SPUF	N	4. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
54	19	2a	N	SPUF	N	5. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
54	19	2a	N	SPUF	N	6. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
54	19	2a	N	SPUF	N	7. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
54	19	2a	N	SPUF	N	8. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
54	19	2a	N	SPUF	N	9. cold	None	N/A	N/A	N/A	1 1/4" down side of seat cushion	
54	19	2a	N	SPUF	N	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
54	19	2a	N	SPUF	N	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
54	19	2a	N	SPUF	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
55	20	2b	N	SPUF	N	1. cold	None	N/A	N/A	N/A	1 5/8" down side of seat cushion	
55	20	2b	N	SPUF	N	2. still smoldering	None	N/A	N/A	low	3" down side of seat cushion	soft ball sized hole
55	20	2b	N	SPUF	N	3. cold	None	N/A	N/A	N/A	1 3/4" down side of seat cushion	
55	20	2b	N	SPUF	N	4. cold	thin plastic on side of seat cushion	No	No	N/A	1" up from cigarette and into seat cushion	
55	20	2b	N	SPUF	N	5. cold	thin plastic on side of seat cushion	No	No	N/A	1" into seat cushion	
55	20	2b	N	SPUF	N	6. cold	thin plastic on side of seat cushion	No	No	N/A	1" into seat cushion	
55	20	2b	N	SPUF	N	7. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
55	20	2b	N	SPUF	N	8. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
55	20	2b	N	SPUF	N	9. cold	None	N/A	N/A	N/A	1 1/4" down side of seat cushion	
55	20	2b	N	SPUF	N	10. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
55	20	2b	N	SPUF	N	11. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
55	20	2b	N	SPUF	N	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
56	10	2a	N	SPUF	Y	1. still smoldering	None	N/A	N/A	low	4" down side of seat cushion	soft ball sized hole
56	10	2a	N	SPUF	Y	2. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
56	10	2a	N	SPUF	Y	3. cold	None	N/A	N/A	N/A	1 1/8" down side of seat cushion	
56	10	2a	N	SPUF	Y	4. cold	None	N/A	N/A	N/A	1/2"into seat cushion	
56	10	2a	N	SPUF	Y	5. cold	None	N/A	N/A	N/A	1/2"into seat cushion	
56	10	2a	N	SPUF	Y	6. cold	None	N/A	N/A	N/A	1/2"into seat cushion	
56	10	2a	N	SPUF	Y	7. still smoldering	None	N/A	N/A	low	2 1/2"down side of seat cushion	orange size hole
56	10	2a	N	SPUF	Y	8. cold	None	N/A	N/A	N/A	1 1/2"down side of seat cushion	
56	10	2a	N	SPUF	Y	9. cold	None	N/A	N/A	N/A	1 1/2"down side of seat cushion	
56	10	2a	N	SPUF	Y	10. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
56	10	2a	N	SPUF	Y	11. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
56	10	2a	N	SPUF	Y	12. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
57	13	2b	Y	SPUF	N	1. cold	thin plastic on side of seat cushion	No	No	N/A	3/8" up from cigarette and out onto seat cushion	
57	13	2b	Y	SPUF	N	2. cold	thin plastic on side of seat cushion	No	No	N/A	1 1/2" down side of seat cushion	
57	13	2b	Y	SPUF	N	3. cold	thin plastic on side of seat cushion	No	No	N/A	3/8" up from cigarette and out onto seat cushion and down side of seat cushion	
57	13	2b	Y	SPUF	N	4. cold	3" gap in poly, on seat & back cushions	potentially	No	N/A	1/4" out onto seat cushion	Although poly short on back cushion, cigarettes ended up being placed on poly for cig locations 4, 5 & 6
57	13	2b	Y	SPUF	N	5. cold	3" gap in poly, on seat & back cushions	potentially	No	N/A	1/4" out onto seat cushion	Although poly short on back cushion, cigarettes ended up being placed on poly for cig locations 4, 5 & 6
57	13	2b	Y	SPUF	N	6. cold	3" gap in poly, on seat & back cushions	potentially	No	N/A	3/8" out onto seat cushion	Although poly short on back cushion, cigarettes ended up being placed on poly for cig locations 4, 5 & 6
57	13	2b	Y	SPUF	N	7. cold	None	N/A	N/A	N/A	1 down side of seat cushion	
57	13	2b	Y	SPUF	N	8. cold	None	N/A	N/A	N/A	1 " down side of seat cushion	
57	13	2b	Y	SPUF	N	9. cold	None	N/A	N/A	N/A	1 1/4" down side of seat cushion	
57	13	2b	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
57	13	2b	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
57	13	2b	Y	SPUF	N	12. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
58	15	2b	Y	FR	N	1. cold	None	N/A	N/A	N/A	3/8" up from cigarette and out onto seat cushion	
58	15	2b	Y	FR	N	2. cold	None	N/A	N/A	N/A	3/8" up from cigarette and out onto seat cushion	
58	15	2b	Y	FR	N	3. cold	None	N/A	N/A	N/A	3/8" up from cigarette and out onto seat cushion	
58	15	2b	Y	FR	N	4. cold	3" gap in poly, on back cushion	potentially	No	N/A	1 " down side of seat cushion	
58	15	2b	Y	FR	N	5. cold	3" gap in poly, on back cushion	potentially	No	N/A	1 3/8" up from cigarette	
58	15	2b	Y	FR	N	6. cold	3" gap in poly, on back cushion	potentially	No	N/A	1 " down side of seat cushion	
58	15	2b	Y	FR	N	7. cold	None	N/A	N/A	N/A	3/8" out onto seat cushion	
58	15	2b	Y	FR	N	8. cold	None	N/A	N/A	N/A	1/2" up from cigarette and out onto seat cushion	
58	15	2b	Y	FR	N	9. cold	None	N/A	N/A	N/A	1/2" up from cigarette and out onto seat cushion	
58	15	2b	Y	FR	N	10. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
58	15	2b	Y	FR	N	11. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
58	15	2b	Y	FR	N	12. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
59	9	2a	Y	SPUF	N	1. cold	None	N/A	N/A	N/A	3/8" out onto seat cushion	
59	9	2a	Y	SPUF	N	2. cold	None	N/A	N/A	N/A	3/8" out onto seat cushion	
59	9	2a	Y	SPUF	N	3. cold	thin plastic on side of seat cushion	No	No	N/A	3/8" up from cigarette and out onto seat cushion	
59	9	2a	Y	SPUF	N	4. cold	None	N/A	N/A	N/A	3/8" out onto seat cushion	
59	9	2a	Y	SPUF	N	5. cold	None	N/A	N/A	N/A	3/8" out onto seat cushion	
59	9	2a	Y	SPUF	N	6. cold	None	N/A	N/A	N/A	3/8" out onto seat cushion	
59	9	2a	Y	SPUF	N	7. cold	None	N/A	N/A	N/A	3/8" up from cigarette and out onto seat cushion and down side of seat cushion	
59	9	2a	Y	SPUF	N	8. cold	None	N/A	N/A	N/A	1/2 " down side of seat cushion	
59	9	2a	Y	SPUF	N	9. cold	None	N/A	N/A	N/A	1/2" out onto seat cushion and down side of seat cushion	
59	9	2a	Y	SPUF	N	10. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
59	9	2a	Y	SPUF	N	11. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
59	9	2a	Y	SPUF	N	12. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
60	11	2a	Y	FR	N	1. cold	None	N/A	N/A	N/A	3/8" up from cigarette and out onto seat cushion	
60	11	2a	Y	FR	N	2. cold	thin plastic on side of seat cushion	No	No	N/A	1/2" out onto seat cushion	
60	11	2a	Y	FR	N	3. cold	None	N/A	N/A	N/A	3/8" up from cigarette and out onto seat cushion	
60	11	2a	Y	FR	N	4. cold	gap in poly	potentially	No	N/A	3/8" up from cigarette and out onto seat cushion	
60	11	2a	Y	FR	N	5. cold	gap in poly	potentially	No	N/A	3/8" up from cigarette and out onto seat cushion	
60	11	2a	Y	FR	N	6. cold	gap in poly	potentially	No	N/A	3/8" up from cigarette and out onto seat cushion	
60	11	2a	Y	FR	N	7. cold	None	N/A	N/A	N/A	3/8" up from cigarette and out onto seat cushion	
60	11	2a	Y	FR	N	8. cold	None	N/A	N/A	N/A	3/8" up from cigarette and out onto seat cushion	
60	11	2a	Y	FR	N	9. cold	None	N/A	N/A	N/A	3/8" up from cigarette and out onto seat cushion	
60	11	2a	Y	FR	N	10. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
60	11	2a	Y	FR	N	11. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
60	11	2a	Y	FR	N	12. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
61	20	2b	N	SPUF	N	1. cold	None	N/A	N/A	N/A	1 3/8" down side of seat cushion	
61	20	2b	N	SPUF	N	2. cold	None	N/A	N/A	N/A	1 1/8" down side of seat cushion	
61	20	2b	N	SPUF	N	3. cold	None	N/A	N/A	N/A	1 3/4" down side of seat cushion	
61	20	2b	N	SPUF	N	4. still smoldering	thin plastic on side of seat cushion	No	No	high	3 5/8" into seat cushion	heavily smoldering; softball sized hole
61	20	2b	N	SPUF	N	5. cold	thin plastic on side of seat cushion	No	No	N/A	1" into seat cushion	
61	20	2b	N	SPUF	N	6. still smoldering	thin plastic on side of seat cushion	No	No	high	4 1/4" into seat cushion	heavily smoldering; melon sized hole
61	20	2b	N	SPUF	N	7. cold	None	N/A	N/A	N/A	1 1/4" down side of seat cushion	
61	20	2b	N	SPUF	N	8. cold	None	N/A	N/A	N/A	1 7/8" down side of seat cushion	
61	20	2b	N	SPUF	N	9. cold	None	N/A	N/A	N/A	1 3/4" down side of seat cushion	
61	20	2b	N	SPUF	N	10. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
61	20	2b	N	SPUF	N	11. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
61	20	2b	N	SPUF	N	12. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
62	10	2a	N	SPUF	Y	1. cold	Bits of poly & adhesive directly on foam.	potentially	No	N/A	3/8" out onto seat cushion and down side of seat cushion	
62	10	2a	N	SPUF	Y	2. cold	Bits of poly & adhesive directly on foam.	potentially	No	N/A	3/8" up from cigarette and out onto seat cushion and down side of seat cushion	
62	10	2a	N	SPUF	Y	3. cold	Bits of poly & adhesive directly on foam.	potentially	No	N/A	1/2" out onto seat cushion and down side of seat cushion	
62	10	2a	N	SPUF	Y	4. cold	Bits of poly & adhesive directly on foam.	potentially	No	N/A	1/2" up from cigarette and down side of seat cushion	
62	10	2a	N	SPUF	Y	5. cold	Bits of poly & adhesive directly on foam.	potentially	No	N/A	5/8" down side of seat cushion	
62	10	2a	N	SPUF	Y	6. cold	Bits of poly & adhesive directly on foam.	potentially	No	N/A	5/8" down side of seat cushion	
62	10	2a	N	SPUF	Y	7. cold	Bits of poly & adhesive directly on foam.	potentially	No	N/A	1/2" out onto seat cushion and down side of seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
62	10	2a	N	SPUF	Y	8. cold	Bits of poly & adhesive directly on foam.	potentially	No	N/A	1/2" down side of seat cushion	
62	10	2a	N	SPUF	Y	9. cold	Bits of poly & adhesive directly on foam.	potentially	No	N/A	3/8" out onto seat cushion and down side of seat cushion	
62	10	2a	N	SPUF	Y	10. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
62	10	2a	N	SPUF	Y	11. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	
62	10	2a	N	SPUF	Y	12. cold	None	N/A	N/A	N/A	1/4" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
63	20	2b	N	SPUF	N	1. cold	None	N/A	N/A	N/A	1 1/4" down side of seat cushion	
63	20	2b	N	SPUF	N	2. cold	None	N/A	N/A	N/A	1 3/8" down side of seat cushion	
63	20	2b	N	SPUF	N	3. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
63	20	2b	N	SPUF	N	4. cold	None	N/A	N/A	N/A	1 5/8" down side of seat cushion	
63	20	2b	N	SPUF	N	5. cold	None	N/A	N/A	N/A	1" down side of seat cushion	
63	20	2b	N	SPUF	N	6. still smoldering	None	N/A	N/A	high	4 3/8" down side of seat cushion. 13" in length	Fabric glowing, heavily smoldering. Watermelon sized hole.
63	20	2b	N	SPUF	N	7. cold	None	N/A	N/A	N/A	1 1/8" down side of seat cushion	
63	20	2b	N	SPUF	N	8. cold	None	N/A	N/A	N/A	1 1/8" down side of seat cushion	
63	20	2b	N	SPUF	N	9. cold	None	N/A	N/A	N/A	1 1/2" down side of seat cushion	
63	20	2b	N	SPUF	N	10. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
63	20	2b	N	SPUF	N	11. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	
63	20	2b	N	SPUF	N	12. cold	None	N/A	N/A	N/A	3/8" out on seat cushion and into seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

Smoldering Results for Tests 1 - 120
Data for Cigarette Test Locations 1 -9

Test No.	Chair Combo	Fabric ID	Barrier	Foam ID	Poly Batt	Results by cigarette @ 60 min	Con-struction Issue	Potential Impact	Actual Impact	Smold rating high, med, low	Max Char (inches) (plus/minus1/8 inch)	Comments
64	11	2a	Y	FR	N	1. cold	thin plastic on side of seat cushion	No	No	N/A	5/8" out onto seat cushion and down side of seat cushion	
64	11	2a	Y	FR	N	2. cold	thin plastic on side of seat cushion Vertical seam	No	No	N/A	3/4" down side of seat cushion	Extra seam near cigarette location number 2.
64	11	2a	Y	FR	N	3. cold	thin plastic on side of seat cushion	No	No	N/A	5/8 down side of seat cuhion	
64	11	2a	Y	FR	N	4. cold	None	N/A	N/A	N/A	3/8" out onto seat cushion	
64	11	2a	Y	FR	N	5. cold	None	N/A	N/A	N/A	3/8" out onto seat cushion	
64	11	2a	Y	FR	N	6. cold	None	N/A	N/A	N/A	3/8" out onto seat cushion	
64	11	2a	Y	FR	N	7. cold	thin plastic on side of seat cushion	No	N/A	N/A	3/8" up from cigarette and down side of seat cushion	
64	11	2a	Y	FR	N	8. cold	thin plastic on side of seat cushion	No	N/A	N/A	3/8" up from cigarette and out onto seat cushion	
64	11	2a	Y	FR	N	9. cold	thin plastic on side of seat cushion	No	N/A	N/A	1/2" out onto seat cushion	

Note Cigarette Test Locations 10, 11 and 12 were never smoldering at 60 minutes

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MD 20814

Memorandum

Date: May 11, 2012

TO: Shivani Mehta
Directorate for Engineering Sciences

THROUGH : Kathleen Stralka
Associate Executive Director
Directorate for Epidemiology

Stephen Hanway
Division Director
Division of Hazard Analysis

FROM: David Miller
Division of Hazard Analysis

SUBJECT: Analysis of Chair Smoldering Data[1]

Background:

In January 2008, the U.S. Consumer Product Safety Commission (CPSC) published a notice of proposed rulemaking (NPR)[2] for upholstered furniture flammability. The proposed standard requires upholstered furniture to be constructed with either a smolder-resistant cover material or a qualified fire barrier. A qualified fire barrier must be smolder resistant and open-flame resistant. The fire barrier is required to be open-flame resistant because if the cover material is not smolder resistant and can transition to flaming, then the fire barrier would be called upon to protect filling materials from flaming combustion.

CPSC staff purchased chairs for burn testing to examine the fire behavior of full-scale chairs when challenged with open-flame ignition, as well as lit cigarettes. The open-flame testing showed that the barriers were effective in reducing the peak heat release of the burning chairs as well as increasing the time to peak heat release.

Before smolder testing of the full-scale chairs was performed, bench scale mockup versions of the chairs (per the proposed standard) made from the same fabrics and foams as the full-scale chairs were tested for smolder resistance.[3] The mockup results were not as expected. The mockups, even the ones without barriers and with fabrics that had proven to be very smolder-prone in previous bench scale tests, demonstrated virtually no smoldering. These unexpected mockup results are thought to be caused by the relatively low smoldering propensity of the foam that was used in these mockup and chair tests, which was produced by a different manufacturer than the foam used in previous mockup tests. Technical staff decided to continue with the full-scale smoldering tests. It was believed that something could still be learned from the chair tests even if the foam was less smolder-prone then had been expected.

[1] This analysis was prepared by CPSC staff and has not been reviewed or approved by, and may not necessarily reflect the views of, the Commission.
[2] 73 FR 11702.
[3] These tests were conducted with 2008 vintage Pall Mall cigarettes.

Purpose:

The main purpose of the testing was to learn whether mockup tests were sufficient to predict the behavior of full-scale furniture. CPSC staff evaluated the smoldering behavior of full-scale chairs constructed with different fabrics, foams, and barrier/batting combinations when lit cigarettes were placed in different locations of the chairs. Staff hoped to learn specifically about the relative performance of chairs with and without barriers, with standard polyurethane foam (SPUF) versus flame-retardant (FR) foam, the effect of polyester batting on smoldering chair performance, and the effect of cigarette location.

For each lit cigarette placed, technical staff recorded whether all smoldering had stopped within 60 minutes[4] of the time the lit cigarette was placed on the chair. This is the pass/fail criterion that serves as the dependent variable in this analysis. The independent variables are: (1) the types of fabrics tested; (2) the types of foam tested; (3) presence or absence of a barrier; (4) the presence or absence of batting; and (5) the cigarette location on the chair.

Chair Characteristics:

The chairs were custom made for the test and had the same geometric structure, but they varied a few different ways in their makeup. Each chair was constructed with one of six different cover fabrics, one of two different foams, with or without a barrier between the fabric and foam, and with or without cotton batting between the fabric and foam. Cigarettes were placed on one of three different locations on each chair. The independent variables are therefore as follows:

(1) Fabric – 1a, 1b, 2a, 2b, 3a, 3c
(2) Foam – Standard Polyurethane Foam (SPUF), Flame-retardant Foam (FR)
(3) Barrier – Yes or No
(4) Batting – Yes or No
(5) Cigarette Location – Flat Surface, Back Crevice, Side Crevice

Fabrics 1a and 1b historically have been smolder-prone fabrics when tested with mockups. Fabrics 2a and 2b have been borderline (sometimes they show a lot of smoldering behavior and the mockups have high mass loss, but sometimes they have very little smoldering activity and mass loss), and fabrics 3a and 3b have been non-smoldering fabrics.

Chairs were not constructed with all possible combinations because it is possible to evaluate the different variables of interest without testing every combination. Table 1 provides details on the quantity of the different types of chairs tested.

[4] The draft standard mockup test stops the test at 45 minutes, but staff decided to let the chair tests go for 60 minutes to observe further charring for the tests that were still smoldering because char volume was also of interest. The two observation periods were not intended to be equivalent; smoldering beyond the observation time is an indicator of likely continued combustion.

Table 1. Number of Chairs Tested by Fabric, Foam, Barrier/Batting Combination

Foam Type	Barrier/Batting Condition	Fabric Type						
		1a	1b	2a	2b	3a	3b	Total
SPUF	Barrier Only	6	6	6	6	0	0	24
	Batting Only	6	6	6	6	6	6	36
	Neither	6	6	6	6	6	6	36
FR	Barrier Only	6	6	6	6	0	0	24
	Total	*24*	*24*	*24*	*24*	*12*	*12*	*120*

Note that the only type of chair tested with FR foam also had a barrier. These FR foam tests were included because the proposed rule says that if a barrier qualifies with a standard foam, then it can be used with any foam. Therefore staff aimed to demonstrate that the FR foam would not perform worse than the SPUF foam for these chairs with qualified barriers. Also note that no tests were conducted of chairs with barriers and with the non-smoldering fabrics (3a and 3b). This is because there would be no need to have a barrier for a chair with a non-smoldering fabric.

The initial plan was to place 12 cigarettes on each chair for testing. These cigarettes were to be placed into three different types of locations: (1) flat surface, (2) side crevice, and (3) back crevice. There were to be three cigarettes placed on the flat surface, three cigarettes in the back crevice, and six cigarettes in the side crevice. After many of the tests were conducted and none of the cigarettes on the flat surface demonstrated any smoldering behavior, it was agreed to stop placing cigarettes on the flat surface and test only nine cigarettes per chair. Every cigarette that had been placed on the flat surface passed (did not result in smoldering beyond the allotted 60 minutes). Those results are removed from this analysis and there are two remaining location categories: side crevice and back crevice. For the purposes of this analysis each chair provided nine pass/fail data points.

Results

Mockup Testing:

The same six upholstered furniture cover fabrics that were tested on the chairs were also tested on furniture mockups in the CPSC Lab.[5] The same non-FR SPUF foam that was used on the chairs was also used as well as the same type of cigarettes (2008 vintage Pall Mall). Under the proposed rule, lit cigarettes are placed in the crevice of the mockup and left there for 45 minutes. After 45 minutes if there is any continued smoldering, any flaming ignition, or more than 10 percent mass loss of the foam substrate, then the mockup fails the test. Otherwise it passes.

Previous testing of these cover fabrics on mockups over what was expected to be similar performing non-FR foam (but from a different manufacturer) showed smoldering activity and large mass loss for some of the fabrics. That was not the case with these mockup tests, however. A total of 162 mockups were tested, 27 replicates for each of the six fabrics. For five of the six fabrics, none of the 27 mockup tests resulted in a failure (*i.e.*, smoldering did not persist, fabric did not ignite, and there was less than 10 percent mass loss of foam). For fabric 1b, 25 of the 27 mockups failed. None of these 25 failures were due to the mass loss; they all failed because there was still smoldering after 45 minutes. The average mass loss for the fabric 1b mockups was 1.37 percent.

[5] L. Fansler, "Mockup Test Program on Upholstery Fabrics and a Fire Barrier," CPSC, March 2009.

Table 2. Fabric Mockup Testing

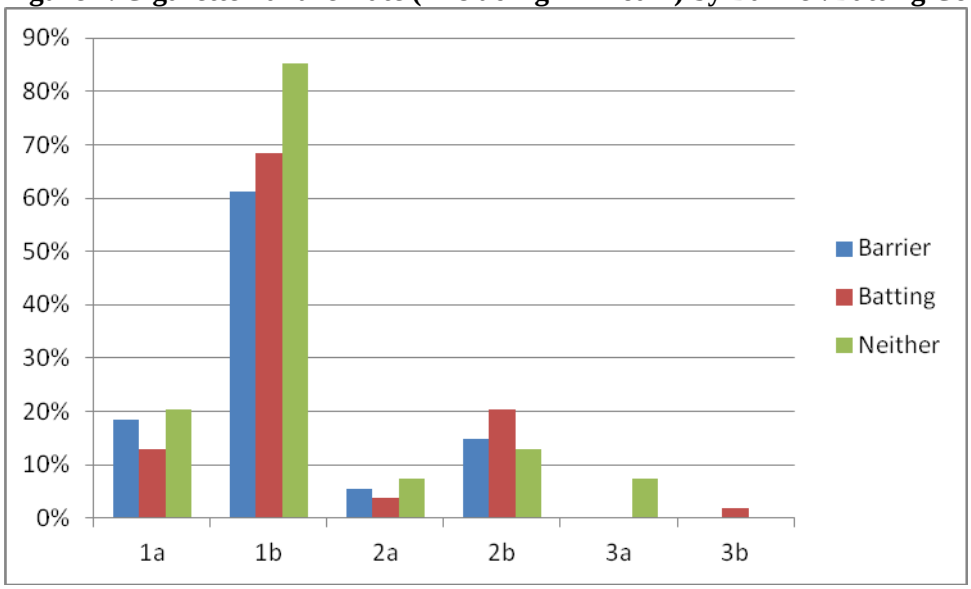
Fabric	# Tests	# Failed	Proportion of Failures	95% CI for p[6]
1a	27	0	0%	(0%, 13%)
1b	27	25	93%	(76%, 99%)
2a	27	0	0%	(0%, 13%)
2b	27	0	0%	(0%, 13%)
3a	27	0	0%	(0%, 13%)
3b	27	0	0%	(0%, 13%)

Chair Testing:

Excluding the flat surface cigarettes, a total of 1,080 cigarettes (120 chairs, with 9 cigarettes per chair, 3 in the back crevice, and 3 in each side crevice) were placed on chairs for these tests. Of these, 853 cigarettes (79%) did not result in smoldering beyond 60 minutes (passed), and the remaining 227 cigarettes (21%) resulted in smoldering after 60 minutes (failed).

Figure 1 shows the failure rate of cigarettes on chairs with SPUF foam by fabric and barrier/batting combination. These results are pooled across the crevice locations and exclude the chairs with FR foam. Note that there were no chairs with barriers tested on the smolder-resistant fabrics 3a or 3b. For all of the other combinations represented below, there were six chairs and a total of 54 cigarettes tested. For example, there were six chairs and 54 cigarettes tested for chairs with barriers only and fabric 1b. That bar is at 61 percent because 33 of the 54 cigarette tests on these chairs resulted in failures.

Figure 1. Cigarette Failure Rate (Excluding FR Foam) by Barrier/Batting Combo and Fabric

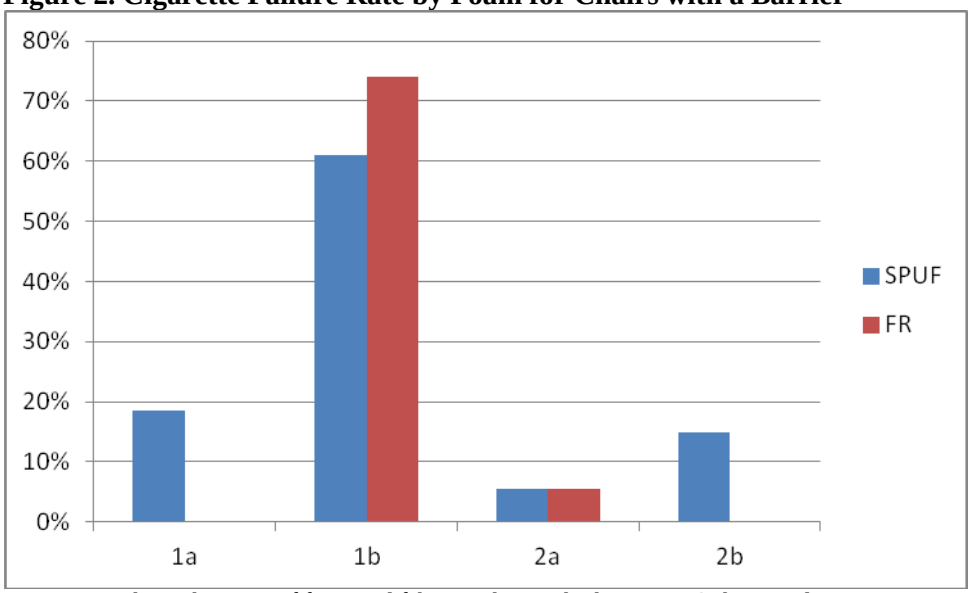


[6] This column provides the exact 95 percent confidence interval for the binomial probability parameter p, which in this case is the probability that a given test on a mockup with this fabric will result in a failure.

Fabric 1b had a high proportion of failures, regardless of the barrier or batting condition. Fabrics 1a and 2b failed more than 10 percent of the full-scale chair cigarette tests for each barrier and batting condition after passing every mockup test. For example, cigarettes on chairs with batting and fabric 2b had a failure rate of 20 percent (11 of 54). Figure 1 also shows the relative rankings of failure rates between different combinations of barrier and batting across fabrics. For fabrics 1a and 2a, the chairs with batting had the lowest failure rate; for fabric 1b, it was chairs with barriers that had the lowest failure rate; and for fabric 2b, it was chairs with neither barrier nor batting that had the lowest failure rate. These results are pooled over cigarette location.

To address the foam effect, Figure 2 compares chairs with a barrier and SPUF foam to chairs with a barrier and FR foam. The only FR foam chairs tested were ones with barriers. There were no tests done with chairs with barriers and fabric 3a or 3b.

Figure 2. Cigarette Failure Rate by Foam for Chairs with a Barrier



Note: For each combination of foam and fabric in the graph, there were 6 chairs and 54 cigarettes tested.

Again, cigarettes on chairs with fabric 1b had the highest rate of failure (*i.e.*, there was continued smoldering after 60 minutes). Interestingly for fabric 1b, the cigarettes on FR foam chairs had a higher rate of failure than the ones on SPUF chairs. This was not true for fabrics 1a and 2b where there were no failing cigarettes on FR foam chairs. For fabric 2a, cigarettes on chairs with SPUF foam had the same failure rate (3/54) as those on chairs with FR foam.

In Figures 1 and 2 there is evidence that the fabric makes a large difference in smoldering failure rate, while the effects of the batting, barrier, and foam are unclear. The data in these graphs were pooled over cigarette location so the effect of location is also unclear at this point.

Table 3 provides failure rates and confidence intervals (based on the observed failure rates) for combinations of all variables. They are ordered by highest failure rate to lowest.

Table 3. Cigarette Observed Failure Rates and Confidence Intervals

Fabric	Foam	Barrier	Batting	Location	Failure Rate	95% CI for p[7]
1b	SPUF	No	No	SC[8]	92%	(77%, 98%)
1b	FR	Yes	No	SC	81%	(64%, 92%)
1b	SPUF	No	Yes	SC	75%	(58%, 88%)
1b	SPUF	No	No	BC	72%	(47%, 90%)
1b	SPUF	Yes	No	SC	67%	(49%, 81%)
1b	FR	Yes	No	BC	61%	(36%, 83%)
1b	SPUF	No	Yes	BC	56%	(31%, 78%)
1b	SPUF	Yes	No	BC	50%	(26%, 74%)
1a	SPUF	No	No	BC	39%	(17%, 64%)
2b	SPUF	Yes	No	BC	33%	(13%, 59%)
2b	SPUF	No	Yes	SC	31%	(16%, 48%)
1a	SPUF	Yes	No	BC	22%	(6%, 48%)
2b	SPUF	No	No	BC	22%	(6%, 48%)
1a	SPUF	No	Yes	SC	19%	(8%, 36%)
1a	SPUF	Yes	No	SC	17%	(6%, 33%)
2a	SPUF	No	No	BC	17%	(4%, 41%)
3a	SPUF	No	No	BC	17%	(4%, 41%)
1a	SPUF	No	No	SC	11%	(3%, 26%)
2a	FR	Yes	No	BC	11%	(1%, 35%)
2b	SPUF	No	No	SC	8%	(2%, 22%)
2a	SPUF	Yes	No	SC	6%	(1%, 19%)
2b	SPUF	Yes	No	SC	6%	(1%, 19%)
2a	SPUF	No	Yes	SC	6%	(1%, 19%)
2a	SPUF	Yes	No	BC	6%	(0%, 27%)
3b	SPUF	No	Yes	SC	3%	(0%, 15%)
2a	SPUF	No	No	SC	3%	(0%, 15%)
3a	SPUF	No	No	SC	3%	(0%, 15%)
2a	FR	Yes	No	SC	3%	(0%, 15%)
1a	SPUF	No	Yes	BC	0%	(0%, 19%)
2a	SPUF	No	Yes	BC	0%	(0%, 19%)
2b	SPUF	No	Yes	BC	0%	(0%, 19%)
3a	SPUF	No	Yes	BC	0%	(0%, 19%)
3b	SPUF	No	Yes	BC	0%	(0%, 19%)
3b	SPUF	No	No	BC	0%	(0%, 19%)
1a	FR	Yes	No	BC	0%	(0%, 19%)
2b	FR	Yes	No	BC	0%	(0%, 19%)
3a	SPUF	No	Yes	SC	0%	(0%, 10%)
3b	SPUF	No	No	SC	0%	(0%, 10%)
1a	FR	Yes	No	SC	0%	(0%, 10%)
2b	FR	Yes	No	SC	0%	(0%, 10%)

[7] This column provides the exact 95 percent confidence interval for the parameter p, which in this case is the likelihood that a cigarette will fail.

[8] SC = side crevice. BC = back crevice

The combinations with fabric 1b occupy the top eight rows and even the lower confidence bounds for these combinations are all fairly high—26 percent or higher. It is also worth noting that the combinations of foam, barrier, batting, and cigarette location that make for the highest failure rate are not always the same from fabric to fabric.

Logistic Regression Modeling:

To gain a better understanding of the variability displayed by these data, a logistic regression analysis was conducted. The independent variables in the analysis were fabric, foam, barrier, batting, and location. The dependent variable is the binary variable determined by whether smoldering stopped within 60 minutes. A value of 1 (pass) was assigned to a test if the smoldering stopped within 60 minutes; otherwise a value of 0 (fail) was assigned to tests where there was smoldering beyond 60 minutes. The statistical model was a repeated measures model with the independent variables nested within the chair variable to account for the chair-to-chair variability within each combination of the independent variables.

The fitted model indicated that fabric and the location*batting interaction were statistically significant. Figures 3 and 4 provide a graphical depiction of the location*batting interaction.

Figure 3. Failure Rate for Cigarettes by Location and Batting

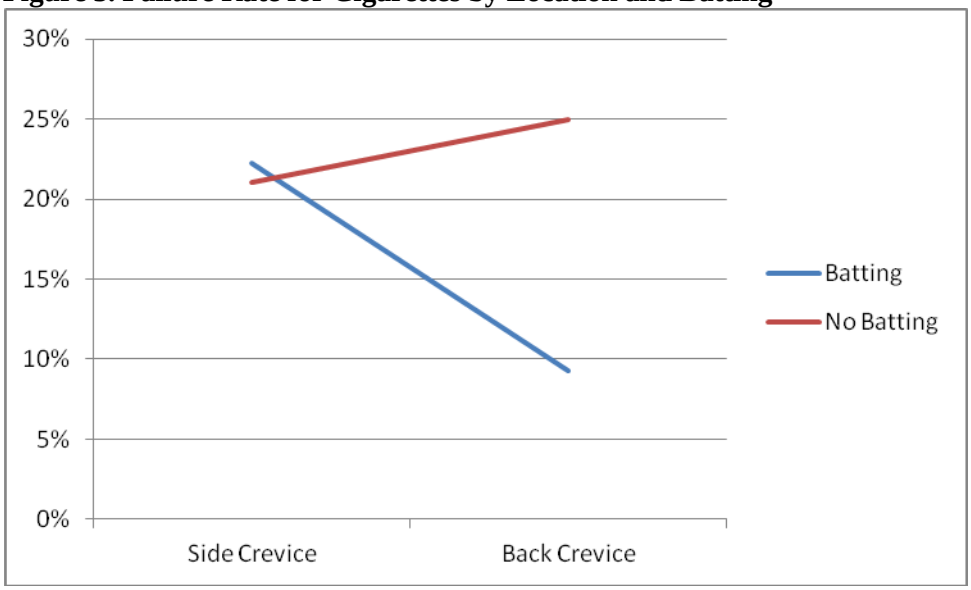
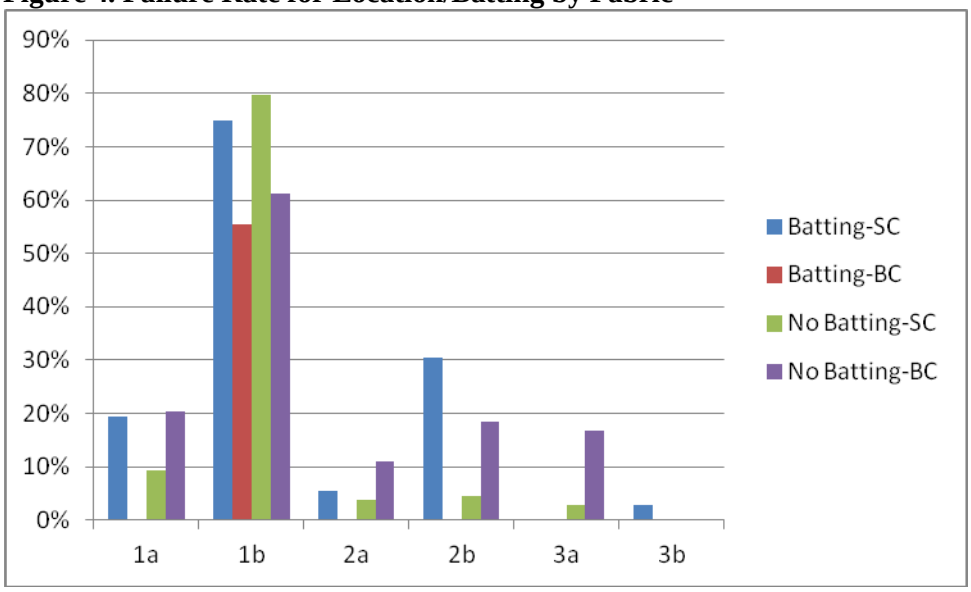


Figure 3 suggests that for chairs with no batting, a cigarette dropped in a back crevice is more likely to smolder for more than 60 minutes with a failure rate of 25 percent (63 out of 252) as opposed to 21 percent (106 out of 504) for the side crevice. However for the chairs with batting, the side crevice has a much higher failure rate – 22 percent (48 out of 216) as opposed to 9 percent (10 out of 108) for cigarettes in the back crevice. In the side crevice the failure rates were similar for cigarettes with or without batting (22% for chairs with batting and 21% for chairs without batting). In the back crevice, the failure rate is higher for cigarettes in chairs without batting (25%) than for chairs with batting (9%).

Figure 4 illustrates that the batting*location interaction also can be seen when including fabric.

Figure 4. Failure Rate for Location/Batting by Fabric



Fabric 1b was the only fabric that had any failures in the back crevice for chairs with batting. However chairs with batting had failure rates of more than 10 percent in the side crevice even for fabrics 1a and 2b. Other than fabric 1b (and 3b which had no failures anywhere for chairs without batting), the chairs without batting had a higher failure rate in the back crevice than the side crevice. Fabric 1b was exceptional and had a much higher failure rate in the side crevice whether the chair had batting or not.

The fabric main effect was statistically significant. The failure rate was much higher for fabric 1b than for the other fabrics. Fabrics 3a and 3b had a considerably lower failure rate than the other fabrics. The effect of the barrier was not statistically significant.

The estimated coefficient in the logistic regression model for fabric 1b was the largest (-4.02) followed by the location*batting interaction (-2.42). A positive estimate means that level of the variable led to a lower failure rate, and a negative estimate means a higher failure rate. The estimated model was used to generate predicted failure rates for all combinations of the independent variables. Table 4 records these predicted failure rates ordered by highest predicted failure rate to lowest.

Table 4. Cigarette Predicted Failure Probabilities and Confidence Intervals

Fabric	Foam	Barrier	Batting	Location	Predicted Failure Rate	95% CI for Predicted Rate
1b	SPUF	No	No	BC	88%	(77%, 94%)
1b	SPUF	No	Yes	SC	83%	(70%, 92%)
1b	SPUF	Yes	No	BC	81%	(57%, 93%)
1b	SPUF	No	No	SC	80%	(70%, 87%)
1b	SPUF	Yes	No	SC	69%	(47%, 84%)
1b	FR	Yes	No	SC	65%	(50%, 77%)
1b	FR	Yes	No	BC	58%	(34%, 79%)
1b	SPUF	No	Yes	BC	46%	(34%, 58%)
1a	SPUF	No	No	BC	26%	(16%, 40%)
2b	SPUF	No	No	BC	24%	(14%, 39%)
1a	SPUF	No	Yes	SC	19%	(11%, 32%)
2b	SPUF	No	Yes	SC	18%	(8%, 33%)
1a	SPUF	Yes	No	BC	16%	(7%, 32%)
1a	SPUF	No	No	SC	16%	(9%, 25%)
2b	SPUF	Yes	No	BC	15%	(6%, 32%)
2b	SPUF	No	No	SC	14%	(9%, 23%)
2a	SPUF	No	No	BC	12%	(6%, 23%)
1a	SPUF	Yes	No	SC	9%	(4%, 18%)
2b	SPUF	Yes	No	SC	9%	(4%, 17%)
2a	SPUF	No	Yes	SC	8%	(4%, 17%)
1a	FR	Yes	No	SC	8%	(4%, 15%)
2b	FR	Yes	No	SC	7%	(4%, 14%)
2a	SPUF	Yes	No	BC	7%	(3%, 17%)
2a	SPUF	No	No	SC	7%	(3%, 13%)
3a	SPUF	No	No	BC	6%	(2%, 19%)
1a	FR	Yes	No	BC	6%	(2%, 16%)
2b	FR	Yes	No	BC	6%	(2%, 15%)
3a	SPUF	No	Yes	SC	4%	(1%, 12%)
2a	SPUF	Yes	No	SC	4%	(2%, 8%)
1a	SPUF	No	Yes	BC	4%	(2%, 7%)
2b	SPUF	No	Yes	BC	3%	(2%, 7%)
3a	SPUF	No	No	SC	3%	(1%, 10%)
2a	FR	Yes	No	SC	3%	(1%, 7%)
2a	FR	Yes	No	BC	2%	(1%, 8%)
3b	SPUF	No	No	BC	2%	(0%, 10%)
2a	SPUF	No	Yes	BC	%	(1%, 3%)
3b	SPUF	No	Yes	SC	1%	(0%, 8%)
3b	SPUF	No	No	SC	1%	(0%, 6%)
3a	SPUF	No	Yes	BC	1%	(0%, 2%)
3b	SPUF	No	Yes	BC	0%	(0%, 1%)

The predicted failure rates in Table 4 look fairly similar to the observed failure rates in Table 3. The confidence intervals are narrower for the predicted probabilities of failure than they are for the observed failure rates in Table 3. Again, the eight combinations with fabric 1b have the highest predicted failure rate and occupy the top eight rows.

Conclusions:

The mockup tests demonstrated very little smoldering and mass loss. This might be attributable to the SPUF foam used being less of a smolder promoter than the SPUF foam used in previous mockup tests. Still, 25 of the 27 mockup tests failed with fabric 1b, albeit without much mass loss. In the chair tests, fabric 1b was also the one fabric identified as performing very poorly, with failure rates in excess of 60 percent for all combinations of batting, foam, and barrier. This result reflects positively on the mockup tests' ability to identify smolder-prone fabrics. However there were no failures for any other fabrics in the mockup tests, while for chairs, there were failure rates in excess of 10 percent for 11 of the 32 experimental conditions that did not use fabric 1b. That reflects negatively on the mockup tests' ability to identify smolder-prone fabrics.

The barrier did not provide clear protection against smoldering. The failure rate for cigarettes on chairs with barriers and fabric 1b, while better than the chairs without barriers and fabric 1b, was still very high (61%). The logistic regression model did not identify the barrier as a statistically significant predictor of passing the cigarette test. The two factors that appear to be driving the differences in failure rates are the fabric and the interaction between batting and cigarette location. The factors in the model (fabric, foam, barrier, batting, and location) are fixed effects. Therefore conclusions are limited to these particular chairs and their components and cannot be generalized to all fabrics, foams, barriers, and battings in general.

Chairs with batting demonstrated a lower failure rate in the back crevice whereas chairs without batting had a higher failure rate in the back crevice. This interaction may not be observed in other furniture constructions but perhaps provides an idea that different furniture constructions (beyond just types of materials) may lead to differences in the likelihood of continued smoldering.

Post-hoc deconstruction of the chairs revealed a lack of uniformity of construction across chairs that were intended to be identical. Any future testing should reduce or control this source of variability. In addition, the cigarettes used in the test were not standard reference material cigarettes and the foam used in the test was not a standard reference material foam. Any further testing should also reduce or control these sources of variability.