United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

MEMORANDUM

DATE: April 30, 1997

TO : Dale Ray, Directorate for Economic Analysis,
Project Manager, Upholstered Furniture

Through: Andrew G. Ulsamer, Associate Executive Director, AGU
Directorate for Laboratory Sciences

FROM : John R. Murphy, Mechanical Engineer
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SUBJECT: Analysis of Preliminary Interlaboratory Study

BACKGROUND

As part of the upholstered furniture project, the Commission staff developed a draft test protocol to evaluate the resistance of upholstered furniture to small open flame ignition. This protocol specifies that a small butane flame be applied to mockups representing the seating area, the skirt, and the dust cover. Attached is a copy of the draft protocol used in this testing. The butane flame is applied by means of a test fixture that automatically controls the placement of the flame and the time of application.

The purpose of this memorandum is to report on the results of a limited interlaboratory study to verify that the test fixture is capable of being operated by other laboratories, that the experimental instructions are appropriate, and that similar test results are obtained when testing similar specimens. The Commission staff asked laboratories participating in this limited study to identify any problems that arose while performing the test procedures. This memorandum will also look at the data from the three participating laboratories and comments received from the three labs to determine whether substantive changes are needed to the test procedure.

TEST METHOD

Four upholstery fabrics and three dust cover fabrics were chosen for this study. These fabrics were chosen to represent a range of resistance to ignition from a small flame source. A description of the fabrics and their locations on upholstered furniture are listed in Table 1 below.

TABLE 1
UPHOLSTERY FABRICS AND LOCATIONS

FABRIC DESCRIPTION	LOCATION ON UPHOLSTERED FURNITURE
100% polypropylene - nonwoven	dust cover
100% aramid - nonwoven	dust cover
cotton polyester blend-woven	dust cover
60% rayon, 36%polyester, and 4% cotton, flame resistant backcoating (11.5 oz/yd^2)	skirt and seating area
100% wool (11.4 oz/yd^2)	skirt and seating area
100% cotton (12.0 oz/yd^2)	skirt and seating area
56% rayon, 34% polyester, and 10% cotton (10.0 oz/yd^2)	skirt and seating area

The wool and flame retardant (FR) treated fabric were chosen because they are resistant to small open flame. The cotton fabric was included in this interlaboratory evaluation because heavy weight cellulosic fabric offers an intermediate degree of resistance to small open flame by forming a char that protects the filling material underneath until the char splits. The cellulosic/thermoplastic upholstery fabric was chosen as it is relatively easy to ignite. The polypropylene dust cover fabric was chosen as it tends to melt and shrink away from the flame. The cotton/polyester dust cover fabric was chosen as it is very easy to ignite and burns rapidly. The 100% aramid fabric was chosen as it was inherently flame resistant.

The dust cover sample was a square piece of dust cover fabric approximately 254 mm x 254 mm (10 in x 10 in).

The skirt samples consisted of upholstery fabric that was hemmed approximately 127 mm (1/2 inch) at the bottom edge. These skirts were not intended to represent the types of constructions found in the marketplace. They are the simplest construction possible and are considered sufficient for this preliminary round of testing.

The seating area mockup frame is based on the mock-up used in the British Standard (BS 5852). The mockup consists of an upholstery fabric cover over non-FR foam having a density of

24.0 kg/m^3 (1.5 lbs/ft^3). The back of the mock-up frame measures 300 mm high by 450 mm wide (12 in x 18 in). The seat of the mock-up frame measures 450 mm wide by 150 mm in depth (18 in x 6 in).

The test samples were cut from bolts of fabric and assigned sample numbers. Four samples of dust covers and skirts were cut for each of the three labs for each fabric tested. Eight seating area samples were cut for each lab. The samples were distributed to the three laboratories based on a random drawing of sample numbers. Each sample was marked with a sample number and an arrow indicating fabric direction. This was done to make sure that each lab tested the fabric using the same orientation.

The dust cover and skirt samples were tested with a flame exposure of 5 seconds. The seat samples were tested with flame exposure times of 15 seconds and 20 seconds.

A one day training course was provided for participants from the three labs involved in the study. During the training course, the draft test protocol was reviewed and CPSC staff demonstrated how to assemble the mockups and operate the test fixture. Each participant used the test fixture to perform tests using the dust cover, skirt and seating area mockups under CPSC staff supervision. The training was considered important since a CPSC monitor was not available to observe tests at the participating laboratories. The participants were not told anything about the fabrics and filling materials used in the study.

Each laboratory was sent written instructions, the test protocol, and the operation manual for the test fixture. They were also sent the samples to be tested, the test fixture, burner, sample holders, and data sheets. One extra sample of each fabric used in the study was sent separately packaged with instructions indicating that the laboratories should contact CPSC staff before using the extra samples. One practice sample was sent for each of the three test locations. The practice samples were different fabrics than those used in the study. The practice samples were sent so each laboratory could run the tests before the interlaboratory study testing began.

Each laboratory was asked to provide the butane gas, flowmeter, pressure gages, and associated tubing. The laboratories photographed each sample when the test was completed. At the conclusion of the series of tests the labs were asked to return the fixture, burner and sample holders along with the completed data sheets to the CPSC. The laboratories were asked to record the following information on the data sheets: the flame application time, whether the sample ignited, whether the sample self-extinguished, and if after flame,

smoldering or after glow were present. In addition, the participants were also asked to record the temperature and humidity of the conditioning and test rooms.

RESULTS/DISCUSSION

The results for all three test locations are summarized in Table 2. The seating area location included two mockup tests, one with a 15 second flame application time and a second test with a 20 second flame application. These times were chosen for the purposes of these preliminary tests only and do not necessarily represent flame application times that might be used in a future standard. For all of the results, the CPSC experience is described first followed by the results obtained by the three participating laboratiories.

DUST COVER

Based on CPSC experience, the 100% aramid fabric was not expected to ignite or burn through during a five second flame exposure. The fabric usually becomes darkened over the flame and is otherwise undamaged. As shown in Table 2, all three labs reported zero ignitions while two labs reported zero self-extinguishment for all four tests of each material. Laboratory C indicated that a self-extinguishment had occurred during each of the four tests, but that there was no ignition, after flame, afterglow, or smoldering. Using the definitions assigned for this study, a self-extinguishment could not have occurred since ignition of the test sample was not reported. Review of the video tape and discussion with laboratory C indicated that self-extinguishment did not occur and that there was some confusion over the instructions.

Based on CPSC experience, the cellulosic/thermoplastic blend dust cover fabric ignited and burned until the fabric was completely consumed. All three labs reported four ignitions and no self-extinguishment with one exception. In one case laboratory C had an ignition with no observable after flame. The sample continued to smolder for 23 seconds and then self-extinguished. The test was repeated on an extra sample. The additional sample ignited and was completely consumed.

Based on CPSC experience, the 100% polypropylene dust cover fabric melted away from the flame. Laboratories B and C reported zero ignitions and zero self-extinguishment. Laboratory C reported that self-extinguishment had occurred but that there was no ignition, afterflame, afterglow, or smoldering. By the definitions used in this study, this can not occur. Review of the video tape provided by laboratory C indicated that no ignition and no self-extinguishment had occurred. Laboratory A reported that there were two ignitions and two self-extinguishment with afterflames of 17 and 10 seconds along with some dripping.

SPECIMEN TESTED	FABRIC DESCRIPTION	FABRIC CODE	NUMBER OF IGNITIONS VS. NO. OF SELF EXTINGUISHMENTS		
			LAB A	LAB B	LAB C
DUST COVER					
yellow non-woven	100% aramid	A1-A12	0 IG,0 SE	0 IG,0 SE	0IG,(0)4SE*
black woven	cellulosic/ thermoplastic blend	B1-B12	4 IG, 0 SE	4 IG, 0 SE	5 IG,1 SE
black non-woven	100% polypropylene	C1-C12	2 IG, 2 SE	0 IG, 0 SE	0 IG,(0)4SE*
SKIRT					
green	60% rayon, 36% polyester, 4% cotton w/FR backcoating	A1-A12	4 IG, 4 SE	4 IG, 4 SE	4 IG,4 SE
off white	100% cotton	B1-B12	4 IG, 0 SE	3 IG, 0 SE	4 IG,0 SE
grey	100% wool	C1-C12	1 IG, 1 SE	1 IG, 1 SE	(1)0IG,(1)4SE*
ivory	56% rayon, 34% polyester, 10%cotton	D1-D12	4 IG, 0 SE	4 IG, 0 SE	4 IG, 0 SE
SEAT					
green (15 s)	60% rayon, 36%polyester, 4%cotton w/FRbackcoating	A13-A24	0 IG, 0 SE	(4)2IG,(4)2 SE	(4)0 IG,4 SE*
green (20 s)	60% rayon, 36%polyester, 4%cotton w/FRbackcoating	A13-A24	0 IG, 0 SE	(4)1IG,(4)1 SE	(4)0 IG, 4 SE*
off white (15 s)	100% cotton	B13-B24	1 IG, 0 SE	0 IG, 0 SE	2 IG,(0)3 SE*
off white (20 s)	100% cotton	B13-B24	4 IG, 0 SE	4 IG, 0 SE	4 IG, 0 SE
grey (15 s)	100% wool	C13-C24	0 IG, 0 SE	2 IG, 2 SE	(4)0 IG,4 SE*
grey (20 s)	100% wool	C13-C24	0 IG, 0 SE	2 IG,(2)0 SE	(4)0 IG,4 SE*
ivory (15 s)	56% rayon, 34% polyester, 10%cotton	D13-D24	4 IG, 0 SE	4 IG, 0 SE	4 IG, 0 SE
ivory (20 s)	56% rayon, 34% polyester, 10%cotton	D13-D24	4 IG, 0 SE	4 IG, 0 SE	4 IG, 0 SE

*Review of actual data provided by labs B & C supported the corrections shown in parenthesis.

In summary, of the 37 dust cover tests completed by the three labs, there were three tests with inconsistent results: a cellulosic/thermoplastic blend that ignited without an observable flame, smoldered for 23 seconds and then self-extinguished, while other tests of this fabric ignited and burned until the sample was consumed. In two consecutive tests at laboratory A, the 100% polypropylene fabric ignited and burned with dripping, while the same fabric melted away from the flame in other tests.

SKIRT

Based on CPSC experience, the 60% rayon, 36% polyester, 4% cotton fabric with FR backcoating when tested as a skirt with a five second exposure, ignited and then self-extinguished. All three labs reported that the samples ignited and then self extinguished in all tests. The afterflame times ranged from four seconds to thirty seven seconds with an average afterflame of 17.9 seconds. Laboratories A and C reported smoldering and laboratory C reported afterglow times.

Based on CPSC experience, the 56% rayon, 34% polyester, 10% cotton fabric when tested as a skirt with a five second flame exposure, ignited and continued to burn. Laboratories A and C reported that all samples ignited and then did not self-extinguish. Laboratory B reported that three samples ignited and did not self-extinguish. The fourth sample did not ignite. The afterflame times ranged from 22 seconds to 30 seconds with an average time of 27 seconds.

Based on CPSC experience, the 100% wool fabric did not ignite or ignited and then self-extinguished. Laboratories A, B, and C all reported that three samples did not ignite and one sample did ignite with an afterflames of 9, 9, and 7.6 seconds respectively. There was no smoldering or afterglow reported. Laboratory C did report that three samples self-extinguished with no ignition, afterflame, smoldering, or afterglow. Review of the video tape provided by laboratory C indicated that self-extinguishment did not occur since the test samples did not ignite.

Based on CPSC experience, the 100% cotton fabric ignited and did not self-extinguish. All three laboratories reported that this fabric ignited in all tests and did not self-extinguish. Afterflames lasted from 9 seconds to 12.6 seconds. All samples had to be extinguished.

In summary, out of 48 skirt tests completed by the three labs, there were four tests with inconsistent results: a thermoplastic/cellulosic blend fabric that did not ignite while other tests of this fabric ignited, and in three tests, a wool

fabric ignited with a very short afterflame which self-extinguished while in other tests did not ignite. Since the afterflame times were so short in these three tests of the wool fabric they are not seriously inconsistent.

SEATING AREA 15 SECONDS

Based on CPSC experience, the 60% rayon, 36% polyester, 4% cotton fabric with FR backcoating ignited and then self-extinguished or did not ignite at all. Laboratory A reported that all four samples did not ignite. There is a comment at the top of the page, however, that indicates that the flow rate was only 37 ml/min. This flow value is outside the range of 45 ml/min $\pm$ 2 ml/min stated in the protocol. This condition lasted for the first 12 (eight tests with the 60% rayon, 36% polyester, 4% cotton fabric with FR backcoating and four tests with the 56% rayon, 34% polyester, 10% cotton fabric) seating area tests performed by laboratory A. The flow rate was reduced to 37 ml/min to obtain a 35 mm flame. The lab was told by CPSC staff to run subsequent tests at 45 ml/min, since the flow rate is directly related to the heat delivered to the sample. Laboratory B reported that two samples ignited and self-extinguished. Laboratory C reported no ignitions with smoldering that lasted from 9-12 seconds. There seemed to be some confusion about the definition of ignition. The data sheet for laboratory B indicates that two samples did not ignite and that there was smoldering for 8 and 1 seconds. Following the definitions used in this study, laboratory B should have recorded 4 ignitions for this fabric. The data sheet for laboratory C indicates that all samples did not ignite but smoldering was observed. Again, by definition laboratory C should have recorded 4 ignitions. As previously stated, the definition indicates that the presence of any combustion is an ignition. These two laboratories should have recorded this test data as ignitions on the data sheets. It appears that these tests were not recorded as ignitions, because no visible flames were observed. In summary, laboratory A reported no ignitions, although the flow rate was reduced during the tests to obtain a 35 mm flame. Labs B and C indicated that all samples ignited and then self-extinguished with in 15 seconds.

Based on CPSC experience, the 100% cotton fabric ignited and did not self-extinguish when tested with a 15 second flame application time. The participants reported a range of results from ignition with no self-extinguishment (2 tests) to no ignition (10 tests) when this fabric was tested at 15 seconds. Laboratory A reported one ignition that resulted in an afterflame that progressed to the top of the sample within 2 minutes. The other three tests resulted in no ignitions. There is a comment at the top of the page indicating that the flow rate was again only 37 ml/min during these tests. Laboratory B reported no

ignitions in all four tests. Laboratory C reported that one test resulted in an ignition that continued until the flame reached the top of the sample and was extinguished. The other three tests resulted in no ignitions. Laboratory C performed one additional test on a sample that did not ignite and it ignited in another location.

Based on CPSC experience, the 100% wool fabric did not ignite or ignited and then self-extinguished when tested in the seating test with a 15 second flame application time. Laboratory A reported all four tests resulted in no ignition. Laboratory B reported two non ignition tests and two tests that resulted in ignition with afterflames of 12 and 15 seconds. Laboratory C reported four ignitions with smoldering times of 3.7 and 3.8 seconds. There was confusion as to whether ignition had taken place since there was no visible flame.

Based on CPSC experience, the 56% rayon, 34% polyester, 10% cotton fabric ignited with a 15 second flame application time. All three labs reported that this fabric ignited in all tests with afterflame times of 10 to 23 seconds. There were no self-extinguishment reported.

In summary, the FR backcoated fabric either ignited and self-extinguished with afterflame and/or smoldering that lasted 1 to 15 seconds (8 tests) or did not ignite (4 tests). Since all samples self-extinguished within 15 seconds these variations do not appear significant. The cotton fabric ignited with three inconsistent results reported by two different labs. In these tests the samples ignited and did not self extinguish. The other tests resulted in no ignition. The wool fabric resulted in six no ignitions and six ignitions that self-extinguished in 3.7 to 15 seconds. The cellulosic/thermoplastic blend ignited and did not extinguish. In 48 tests there were only three tests where the results were inconsistent.

SEATING AREA 20 SECONDS

Based on CPSC experience, the 60% rayon, 36% polyester, 4% cotton fabric with FR backcoating either ignited and then self extinguished or did not ignite when exposed to the butane flame for 20 seconds. Laboratory A reported that all four samples did not ignite. There is a comment at the top of the page that indicates that the flow rate was only 37 ml/min. This is value is outside the range of 45 ml/min $\pm$ 2 ml/min stated in the protocol. Laboratory B reported one ignition with an 8 second afterflame followed by self-extinguishment, three other test samples did not ignite but smoldering was observed from 2 to 15 seconds. Laboratory C reported no ignitions but did report smoldering that lasted from 10-12 seconds. Again, there seemed to be some confusion about the defination for ignition. As

previously stated, the definition indicates that the presence of any combustion is considered an ignition. These two tests should have been coded as ignitions on the data sheets. It appears that the labs did not record these tests as ignitions, because there was no visible flame.

Based on CPSC experience, the 100% cotton fabric ignited and did not self-extinguish when tested in the seating configuration with a 20 second flame exposure. All three labs reported that the four tests resulted in ignitions with no self-extinguishment. The afterflame times ranged from 48 to 61 seconds.

Based on CPSC experience, the 100% wool fabric either ignited and self extinguished or did not ignite when tested in the seating area configuration with a 20 second flame application time. Laboratory A reported no ignitions. Laboratory B reported two ignitions with afterflames of 34 and 37 seconds that did not self extinguish and two non-ignitions. Laboratory C reported that all samples ignited and self extinguished with afterflame times of 3.8 to 5.5 seconds.

Based on CPSC experience, the 56% rayon, 34% polyester, 10% cotton blend generally ignited. All three labs reported that all tests ignited with afterflames of 10 to 20 seconds. There were no self-extinguishments reported.

In summary, the wool fabric demonstrated variability in the results at 20 seconds in two tests reported by laboratory B. In these two tests the fabrics ignited and did not self extinguish. while in all other tests, these fabrics either did not ignite or ignited and self extinguished.

OBSERVATIONS MADE BY PARTICIPANTS

The participating laboratories were asked to submit comments as part of this interlaboratory study. Two of the laboratories provided written comments concerning their experiences with the test fixture and draft protocol. A response from CPSC staff to each comment has also been included. Participating laboratories also reported a problem encountered when initially setting up the test fixture.

PROBLEMS ENCOUNTERED

Laboratory C indicated that after receiving and setting up the fixture,they found that the system was not working. After some basic trouble shooting, CPSC staff determined that several relays in the control box had come out of their sockets during

shipment. Once the relays were relocated in their proper sockets the system operated normally. Additionally, laboratory C reported that the thumb screw, part of the lateral position adjuster, was bent during shipment. Laboratory C had a new thumb screw made and was able to begin testing without any further problems.

Laboratory B also indicated that relays had come out of their sockets during shipment. Once the relays were relocated in their proper sockets the system operated normally.

Although not reported by laboratory participants, another problem was the apparent confusion among the test personnel in determining when there was an ignition and whether self extinguishment had occurred. In the future these definitions need to be emphasized and made clearer.

COMMENTS

Laboratory B indicated that there was a variable flicker in the flame from some very small air and convection currents that persisted with variable intensity and frequency in all the tests. Laboratory C indicated that flickering of the flame due to small air motions in the room, including air motion created by the movements of the operator existed. It was annoying at times, but was not unmanageable.

Response: CPSC test experience also indicates that the air needs to be very still during testing. This is due to the nature of the diffusion flame. If a hood is being used the fan needs to be off during testing. Laboratory A installed a flexible vinyl sweep to the bottom of the hood's sash to seal off the hood from any air movement and still allow the fixture to stick out into the room.

Laboratory B indicated that burner clogging was evident in the tests. There was a need to clean the burner after virtually all of the tests which went to ignition. Laboratories A and C indicated that burner clogging was not a problem.

Response: CPSC test experience indicates that burner clogging is not a problem. Although the burner needs to be inspected between tests to make sure that a blockage does not interfere with subsequent tests. If a blockage is found it can be cleaned with methyl alcohol and a size #6, #8 or #10 brass threaded rod as indicated in the operations manual.

Laboratory B indicated that the clamps used to mount the dust covers created some problems in elimination of wrinkling of the dust cover fabric. Preparation time of the sample was, in almost every case, 3-5 minutes with much tinkering to remove

wrinkles and puckers. Laboratory C commented that the attachment of the dust covers and skirts was a fairly simple, quick procedure. The most time consuming part was assembling of the seat/back mock-up.

Response: Specially designed spring loaded clamps could be used to attach the fabric to the mount. Only four clamps would be needed with specially designed clips. CPSC staff's experience has shown that, the time and effort required to attach the dust cover and skirt samples consistently and with sufficient tauntness is not excessive.

Laboratory B indicated that the test jig has two bolt heads that impede the motion of the insertion and extraction of the ignition source. The bolt heads are too close together that the burner tube collides with the bolt heads.

Response: There are two bolt heads located on the bottom of the movable shield that are very close to the path of the burner tube. The shield design can be reworked so that these bolts are be moved farther apart so that they are not in the path of the burner tube. Alternatively, they can be replaced with flat head screws that are counter sunk into the support bar so that they do not extend downward and interfer with the burner tube.

Laboratory B indicated that the removal of the shield created a blowing displacement action of the flame and displaced the flame by almost 90° for at least 1.5-2.0 seconds in both the dust cover and skirt tests.

Response: The CPSC's test experience also indicates that this happens. It can become a problem in tests with a very short flame exposure time. The CPSC recognizes that an undisturbed flame is an important goal. One possible mechanical fix would be to attach a dashpot to the shield to dampen the shield's movement. The staff will investigate how to reduce air disturbances as much as practical.

Laboratory B indicated that the skirt test was not a "real world" test. Skirts are rarely made by simply turning the fabric edge and sewing the border. Minimally, skirts are made with a stiffener glued or sewn to the cover fabric, making three complete layers for the cross section of a skirt.

Response: The CPSC staff agrees that the skirts used in this phase of testing are not "real world". They are the simplest construction possible so as to maximize the likelihood of achieving uniform results.

Laboratory B indicated that the crevice produced by the CPSC seat fixture is not a real-world seat/back or arm/back crevice

thus skewing the results badly. The seat mock-up metal frames had excessive play in the hinges and allowed a variability in the size of the crevice.

Response: The "standard" seating area mockup crevice with a straight back and flat seat area was chosen because of the problems that would be introduced trying to recreate the specific geometry of an individual furniture crevice. Properly assembled, the seat mock up should have little play in the hinge area.

Laboratory B indicated that in several seat area tests the flame extinguished twice or more in the same location on the same mock-up. The samples actually having ignitions did not show the tendency of the flame extinguishment when the flame was put in the crevice. The protocol contained no guidance as what to do when flame-out occurred.

Response: The CPSC did not experience this flame-out during testing. The flame will go out if the flexible tubing is jostled or kinked due to the low pressure. The staff will add directions to the protocol indicating that if the butane flame goes out during the period that the flame is in contact with the sample then the test should be considered invalid and the test should be repeated on a different sample.

Laboratory B indicated that ergonomically, the design for the seat test is unsafe. In order to place the seat mock-up into position, this heavy and bulky small scale seat must be carefully angled around the extended burner into the hood and onto the test apparatus. The potential for lower back strain while performing this maneuver and adjusting the mock-up for proper burner position would need to be addressed in any industrial laboratory environment. Laboratory A indicated that positioning the seating area mockups was not a problem. Laboratory C also commented that the seating mockup was heavy and suggested that a lighter metal be used.

Response: The modular design concept of the test fixture allows for easy movement of each component. In this case, the best advice would be to move the actuator assembly out of the way and roll the wheeled base toward the test operator.

Laboratory B indicated that the ignition times chosen for each test were purely arbitrary and certainly not quantitatively documented.

Response: The ignition times were chosen for this series of tests to suit the fabrics included in this study and produce a range of results. They are not necessarily part of any eventual standard.

Laboratory B indicated that performing all of the tests for the three different protocols required 48 man-hours from three technicians working two eight hour days. Forty percent of this time was spent in sample preparations while fifty percent of the time was spent adjusting the equipment and ignition source. The remaining ten percent of the time was used for the actual tests and photographs.

Response: This was about the same amount of time it took CPSC staff members with the same amount of training and familiarity with the test procedure and fixture to perform the tests.

Laboratory B also indicated that these tests will be expensive to run in any laboratory using these draft protocols and the prototype equipment. Long-term, separate equipment for each test would seem a better way to reduce costs for each test.

Response: A separate test fixture for each test location would have advantages in productivity and in streamlining the designs. There is nothing to prevent a lab from setting up three test fixtures so that each one is dedicated to a specific test. Components that are not needed for the specific test could be eliminated, resulting in a reduced cost for each fixture. This would allow three technicians to perform all three tests at the same time.

Laboratory A indicated that it would be good to send the tygon tubing needed to connect the gas supply to the butane burner along with the test equipment, rather than require the labs to supply it. They also indicated that it might be good to include a section of copper tubing in the supply line to allow the temperature of the butane to equalize to room temperature.

Response: CPSC staff agrees that difficulties in obtaining the correct gas flow rate can occur if the butane is not at room temperature during testing. The temperature of the butane at the tank may be the most critical. Any gas/air in the line will likely be consumed in the initial "warm up" period of the lit burner tube and be replaced with gas directly from the tank. However, copper tubing should be added to the gas supply system if the gas cylinder is stored in an environment cooler than the defined test conditions or some distance away from the test room. Any flexible tubing can be used as long as the correct gas flow, outlet pressure and flame height is achieved.

CONCLUSION

This preliminary interlaboratory study is an important first step to a full interlaboratory study intended to determine the repeatability and reproducability of the test procedure. The goals of this study were met; it is possible for other laboratories/individuals with fire testing backgrounds to follow the test procedures, use the test equipment and get consistent results.

There was some confusion over the definition of ignition. The training for labs participating in a possible future interlaboratory study should emphasize that the protocol defines an ignition as the presence of any visible flaming, glowing, or smoldering after removal of the test flame. This includes glowing and smoldering as well as visible flaming. It should be emphasized that according to the protocol's definitions self-extinguishment cannot occur unless an ignition has occurred.

Laboratory B indicated in their comments that instructions need to be included in the test procedures on how to complete a test if the flame extinguishes before the proper application time has elapsed.

When the test equipment is shipped special precautions need to be taken to ensure that the relays remain in their sockets.

Attachment
Draft Test Protocol

BENCH SCALE TEST METHOD FOR UPHOLSTERED FURNITURE IGNITION RESISTANCE TO SMALL OPEN-FLAME SOURCES

Revision 10

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GENERAL

1.0 Scope and Application

This flammability test method measures the ability of upholstered furniture to resist ignition when subjected to a small open-flame source (e.g. match, candle, or cigarette lighter). The test does not address ignition resulting from smoldering ignition sources (such as cigarettes), larger open-flame sources, or fires caused as a result of arson, or incendiary acts.

2.0 Summary of Test Method

The CPSC Draft Protocol is a bench scale test method to be used to assess upholstered furniture flammability. Mock-ups of three furniture locations:

- DUST COVER: Horizontal test location
- SKIRT: Vertical test location
- SEATING AREA: Crevice/Vertical test location

are subjected to a standard test flame for a specified time. If ignition occurs, the duration of afterflame, afterglow, and smoldering are recorded. The presence of dripping and whether the combustion progresses to the edge of the sample within two minutes are also observed and recorded.

PERFORMANCE

3.0 Safety Precautions

3.1 Flammability testing can result in a large generation of heat and other products of combustion. Extreme caution is necessary.

3.2 The means of extinguishment shall be provided for the test specimens should be CO_2 or another inert gas. Test personnel should bear in mind that fire testing can result in hazardous conditions.

3.3 A self contained breathing apparatus and necessary training for test personnel shall be provided.

4.0 Test Apparatus

4.1* Specimen Holders and Frame: The specimen holders consist of metal frames used to mount the test specimens in the test fixture.

Specimen Holders and Mock-up Frame Dimensions

Test Location	Length/Height	Width	Depth
Dust Cover	254±2 mm (10±.08 in)	254±2 mm (10±.08 in)	N/A
Skirt	254±2 mm (10±.08 in)	254±2 mm (10 ±.08 in)	N/A
Seating Area Back Frame	300±2 mm (11.8±.08 in)	450±2 mm (17.7±.08 in)	N/A
Seating Area Base Frame	N/A	450±2 mm (17.7±.08 in)	150±2 mm (5.9±.08 in)

4.2* Seating Area Mock-up: The test frame shall consist of two rectangular frames hinged together and capable of locking at a right angle to each other. The frames shall be made of 24 mm x 3 mm ±.2 mm (.945 in x .118 in ± .008 mm) stainless steel flat bar and shall securely hold expanded steel platforms set 6 ± 1 mm (.244 in ±.04 in) below the top edge of the test frame.

4.3* Clips: Clips are used to secure the specimens to the holders.

4.4 Gas: The gas shall be c.p. grade butane.

4.5* Burner : Two burner tubes which consists of stainless steel tube with the following dimensions:

Burner Tube Dimensions

Test Location	Outside Diameter :Wall Thickness	Length
Skirt/Dust Cover	7.94 : 0.89 ± .1 mm (5/16 : 0.035 ± .004 in)	152 ± 5 mm (6.0 ± .20 in)
Seating Area	7.94 : 0.89 ± .1 mm (5/16 : 0.035 ± .004 in)	254 ± 5 mm (10.0 ± .20 in)

The burner tubes are connected by flexible tubing to a cylinder containing butane gas.

4.6 Gas Supply System: Consists of a pressure gage, flowmeter, fine control valve, and cylinder regulator providing an outlet pressure of 27.5 mbar (0.4 psi). The flowmeter shall be calibrated to supply the butane gas at a rate of 45 ± 2 ml/min (2.75 in/min) at 25° C (77° F). Under the above conditions, the burner should produce a flame approximately 35 mm (1.4 in) in height.

4.7 Gas Flow Control: It is essential that the gas flow rate to the burner complies with the flow rate specified. Some difficulties have been reported with the supply and measurement of the gas, particularly where the gas cylinder has to be stored in an environment cooler than the defined test conditions and/or some distance from the test specimen.

4.8* Test Fixture: A test fixture fabricated in accordance with the requirements of Appendix B shall be used.

5.0 Atmospheres for Conditioning and Testing

5.1 Test Enclosure: The test enclosure shall consist of either a room with a volume greater than 20 m^3 (706 ft^3) (which contains adequate air for testing), or a smaller enclosure with adequate airflow. Inlet and extraction systems shall provide an air flow rate of less than 0.2 m/s (.66 ft/s) in the proximity of the test specimen to provide adequate air without disturbing burning behavior.

5.2 Conditioning : The specimens to be tested shall be conditioned for at least 24 hours immediately before the tests in the following atmosphere:

* To be provided by CPSC

- Temperature: 25 ± 2° C (77 ± 6° F)
- Relative Humidity: 40 - 55 %

5.3 Testing Initiation: The test shall be performed in an atmosphere having a temperature between 10° - 30° C (50° - 86° F) and a relative humidity between 20% to 70%. If the test room does not meet the conditions of Section 5.2, then testing shall be initiated within **10 minutes** after the specimens are removed from the conditioning room. Otherwise recondition samples per Section 5.2.

* To be provided by CPSC

6A.0 Dust Cover Test Procedures

6A.1 Preparation:

6A.1.1 Dust Cover Material Samples*: The dust cover materials should be removed from any packaging prior to conditioning. One specimen measuring no less than 30.5 x 30.5 cm (12 in. x 12 in.) should be used for each dust cover test. A test sample consists of four specimens.

6A.1.2 Ensure that the means of extinguishment is close at hand.

6A.1.3 Secure dust cover sample with metal clips in the specimen holder carefully to avoid wrinkles in the fabric. Pull sample tight around the edges to avoid any dipping or sagging.

6A.1.4 The specimen in its holder shall be suspended horizontally in the test fixture so that the tip of the flame reaches the center of the dust cover.

6A.2 Ignition Source Application:

6A.2.1 Light the gas emerging from the 152 mm (6.0 in) burner tube, adjust the gas flow rate (specified in Section 4-4) and allow the flame to stabilize for at least 2 minutes. Ensure the flame height is approximately 35 mm (1.4 in).

6A.2.2 Use test fixture to apply the burner flame vertically at the center of the specimen for **5 seconds**.

6A.2.3 Repeat dust cover test on the remaining three specimens.

6B.0 Test Observations

Record the following observations for 2 minutes after the test flame is removed:

6B.1 Record the ignition/non-ignition of the dust cover

6B.2 Record the afterflame, afterglow, and smolder time of the dust cover *(Note: If the flaming progresses to the edge of the sample within 2 minutes, stop the test, and record "flame progressed to edge of sample")*

6B.3 Record the presence of any dripping of dust cover material

6B.4 Record Self Extinguishment(Yes/No)

* To be provided by CPSC

7A Skirt Test Procedures

7A.1 Preparation:

7A.1.1 Skirt Material Samples*: The skirt materials should be removed from any packaging prior to conditioning. One specimen measuring no less than 30.5 cm (12 in) in width should be used for each skirt test. A test sample consists of four specimens.

7A.1.2 Ensure that the means of extinguishment is close at hand.

7A.1.3 Place and clip a specimen in the specimen holder so that the hemmed edge is flush with the open end (bottom) of the sample holder.

7A.1.4 The specimen and its holder should be supported vertically within the test fixture so that the tip of the flame reaches the bottom edge of the skirt sample.

7A.2 Ignition Source Application:

7A.2.1 Light the gas emerging from the 152 mm (6.0 in) burner tube, adjust the gas flow rate (specified in section 4-4) and allow the flame to stabilize for at least 2 minutes. (Ensure the flame height is approximately 35 mm(1.4 in)

7A.2.2 Use the test fixture to apply the burner flame vertically to the lower end of the skirt specimen, near the middle of the width, for **5 seconds**.

7A.2.3 Repeat skirt test on the remaining three specimens.

7B Test Observations

Record the following observations for 2 minutes after the test flame is removed:

7B.1 Record the ignition/non-ignition of the skirt

7B.2 Record the afterflame, afterglow, and smolder time of the skirt
(Note: If the flaming progresses to top of the sample within 2 minutes, stop the test, and record "flame progressed to top of sample")

7B.3 Record the presence of any dripping of skirt material

7.B.4 Record Self Extinguishment (Yes/No)

* To be provided by CPSC

8A.0 Seating Area Test Procedures

8A.1 Preparation:

8A.1.1 Test Samples*: The sample materials should be removed from any packaging prior to conditioning. The test materials shall be the cover fabric and foam filling. A specimen of the seating area mock-up is described below. A sample consists of four test specimens.

8A.1.2 Cover Fabric The cover fabric size needed for each test is 1018 ± 5 mm (40 ± .2 in) x 700 ± 5 mm (27.5 ± .2 in).

The cover fabric shall have triangular cut-outs 570 mm (22.5 in) from one end on both sides. The size of these cut-outs shall be approximately 55 ±5 mm (2.1 ± .2 in) x 140 ±5 mm (5.25 ±.2 in) high.

8A.1.3 Foam Two pieces, one 450 ± 5 mm x 300 ± 5 mm x 75 ± 2 mm (17.7 ± .2 in x 11.8 ±.2 in x 2.95 ± .2 in) thick, and the other 450 ± 5 mm x 83 ± 5 mm x 75 ± 2 mm (17.7 ± .2 in x 3.25 ±.2 in x 2.95 ± .2 in) thick are required for each test.

8A.1.4 Position seat mock-up in the upright position. Insert "arrow" end of fabric such that the 570 mm (22.4 in) dimension is placed on the vertical (back) portion of the seat mock-up.
Next, insert the 445 mm (17.5 in) fabric from behind around the hinged bar.

8A.1.5 Place smaller foam flush on front edge of seat frame with 75 mm (17.7 in) dimension vertical. (The horizontal dimensional will be marked "TOP"). Wrap both fabrics around entire contour of seat foam. Insert larger foam between the wrapped fabric and the vertical back of the seat mock-up.

8A.1.6 Wrap the larger dimension fabric around the foam to the back of the seat mock-up.

8A.1.7 Fasten all fabric edges cover to the top, bottom, and sides of the frame using metal clips. Ensure that the fabric is secured and under even tension. Pull fabric to eliminate air pockets between fabric and foam, but do not create a gap along the crevice.

8A.1.8 Install the seat mock-up on the test fixture rails, align and adjust such that the horizontal burner tube rests with equal force along the vertical and horizontal intersection of the crevice.

* To be provided by CPSC

8A.2 Ignition Source Application:

8A2.1 Light the gas emerging from the 254 mm (10.0 in) burner tube, adjust the gas flow rate (specified in Section 4.0) and allow the flame to stabilize for at least 2 minutes. (Ensure the flame height is approximately 35 mm (1.4 in)

8A.2.2 Use fixture to apply the burner tube axially along the junction between the seat and back for **15 seconds**, so that the flame is not less than 50 mm from the nearest side edge.

8A.2.3 Repeat the seating area test on the remaining three specimens.

8A.2.4 Repeat the seating area test on another sample set and increase the flame exposure time to **20 seconds**.

8B Test Observations

Record the following observations for 2 minutes after the test flame is removed:

8B.1 Record the ignition/non-ignition of the mock-up

8B.2 Record the afterflame, afterglow, and smolder time of the mock-up *(Note: If the flaming progresses to top of the sample within 2 minutes, stop the test, and record "flame progressed to top of sample")*

8.B.3 Record Self Extinguishment (Yes/No)

* To be provided by CPSC

REPORT

9.0 General

9.1 The test report shall include the following information in a tabular format:

9.1.1 Ambient conditions (temperature, relative humidity)

9.1.2 Description of the specimen being tested

9.1.3 Observations of the burning characteristics

* To be provided by CPSC

APPENDIX A Solving Gas Flow Problems

The rate of butane gas flow to the burner tube must conform to the specified flow rate. Difficulties can occur with the supply and measurement of butane when the cylinder is stored in an environment cooler than defined test conditions and/or a sufficient distance from the test fixture. In such cases, sufficient length of tubing inside the controlled environment (15 - 30° C (50 - 86° F) can help the butane gas to equilibrate to the required temperature before flow measurement. This can be accomplished by flowing butane through a length of metal tubing immersed in a water bath maintained at 25° C (77° F) so that the flow can correct for temperature variations.

Accurate setting and measurement of the butane flow rate is also essential. Direct reading flow meters, even those obtained with a direct butane calibration, need to be checked when initially installed and also at regular intervals during testing with a method capable of measuring the absolute butane flow at the burner tube. This can be done by connecting the burner tube with a short length of tubing (about 7 mm (.276 in) ID) to a soap bubble flow meter. The upward passage of a soap film meniscus in a glass tube of calibrated volume (e.g. a burette) over a know period of time gives an absolute measurement of the flow. Fine control valves which can each be preset to one of the desired butane flow rates, with simple switching means from one to the other are helpful.

* To be provided by CPSC

APPENDIX B Flammability Test Fixture Details

TO BE PROVIDED

* To be provided by CPSC

APPENDIX C Definitions

Afterflame The time for which a material continues to produce a visible flame after the ignition source has been removed.

Afterglow The time for which a material continues to glow after the removal of an external ignition source and after the cessation of flaming of the material.

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

Glow Combustion characterized by incandescence, without visible flame.

Ignition Presence of any visible flaming, glowing, or smoldering after removal of the test flame.

Self-Extinguishment The termination of any visible flaming, glowing, or smoking before the specimen is consumed.

Skirt The hanging piece of fabric (usually pleated or gathered) that is attached to the bottom of a chair or sofa; it covers some or all of the area between the bottom of the frame and floor.

Small Open-Flame Ignition source used that simulates the heat output of a match, candle, or cigarette lighter.

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

Specimen A specific portion of a material or a laboratory sample upon which a test is performed.

Upholstered Furniture A unit of interior furnishing with a resilient surface covered, in whole or in part, with fabric or related material, that is intended for use or may be expected to be used in homes, offices, or other places of assembly, and is intended or promoted for sitting or reclining upon.

* To be provided by CPSC

* To be provided by CPSC

United States
CONSUMER PRODUCT SAFETY COMMISSION
Washington, D.C. 20207

MEMORANDUM

DATE: May 28, 1997

TO : Dale R. Ray
Project Manager, Upholstered Furniture
Directorate for Economic Analysis

Through: Andrew G. Stadnik
Associate Executive Director
Directorate for Engineering Sciences.

FROM : James F. Hoebel
Chief Engineer for Fire Hazards
Directorate for Engineering Sciences

SUBJECT: European Test Data, Open Flame and Cigarette Ignition of Upholstered Furniture Materials

Consumer Product Safety Commission (CPSC) staff recently obtained unpublished data from a European industry research project on upholstered furniture flammability. A comprehensive series of laboratory tests of ignition performance was conducted with combinations of many fabrics and filling materials. Results and observations from these tests can be very useful to CPSC in support of the current development of a flammability performance standard for open flame ignition of upholstered furniture. However, since the test results have not yet been published and thereby affirmed by the participants, caution must be exercised in analyzing the results and drawing appropriate conclusions.

I. The Test Program

Seven different European research laboratories tested combinations of furniture fabrics and furniture filling materials in mock-up form for conformance to CEN[1] test standards for both open flame ("match" test) and cigarette ignition resistance. Twenty different fabrics (cover materials) and 18 different filling materials (some with interliners) were tested, so 360 different combinations were tested by each of seven laboratories. Table I lists the fabrics and filling materials tested. Little specific information has been provided so far about the test materials, other than the identification provided in the table, thereby limiting the ability to fully interpret and understand the results.

The cigarette ignition test used was CEN standard prEN 1021-1:1993, in which a cigarette was placed in a simulated seating area crevice and allowed to burn completely. The

[1]European Committee for Standardization

sample was judged to fail if progressive smoldering or flaming was observed over a period of an hour. The open flame test used was CEN standard prEN 1021-2:1993, which is somewhat similar to the CPSC seating area test method in that a 35 mm flame fueled by butane flowing at 45 ml/min was delivered to a simulated crevice, with the exceptions that the flame exposure time was 15 seconds rather than 20 seconds and that actual filling materials were used rather than a standard foam.

II. Test Results

The test data were presented as the number of laboratories reporting a passing result, for each of the 360 different fabric/filling combinations and test type (cigarette or open flame). As is true in almost any test series involving several laboratories, there was some variability in test results. The following observations include only those instances where there was substantial agreement among the seven laboratories: where either six or all seven laboratories reported the same result (pass or fail). Table II is a summary of these observations illustrating the specific combinations of fabrics and filling materials that exhibited clear passing or failing results, where at least six of the seven laboratories agreed.[2]

Of the total of 360 possible combinations, 142 (or 39 percent) passed both the open flame and the cigarette test (see Table III). On the other hand, 34 (or 9 percent) failed both tests (see Table IV).

Considering the fabrics that tended to pass both tests (see Table III), only one - the expanded PVC cotton covered fabric - passed every test regardless of the filling material. The viscose/wool/polyester blend and the leather fabric clearly passed both tests with 16 of the 18 filling materials. [The other two results for the blend were cigarette failures but the laboratories did not agree on the other two cigarette results for the leather]. The wool fabric passed both tests with 15 of the 18 fillings, while the modacrylic/viscose, the FR polyester, and the polyacrylic/polyester (FR treated) fabrics passed both tests with 12 of the 18 filling materials. The fabrics that were unable to pass both tests with any filling included the viscose/polyester, polyester/polyacryl/viscose, cotton, polyacrylic, polyurethane coated polyester, polyacrylic/cotton, and polyacrylic/polyester (Raschel knitted). The polypropylene and the linen were not much better, passing both tests with only three or fewer fillings.

Considering the filling materials that tended to pass both tests (also in Table III), nine fillings clearly passed both tests with 10, 11, or 12 of the 20 fabrics: none clearly passed both tests with more than 12 fabrics. These nine were flame retardant polyurethane foam,

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[2]As previously noted, each combination of fabric and filling material (360 in total) was tested by each of seven laboratories, for both match (open flame) and cigarette ignition resistance. Thus, there were a total of 720 results. Table II blank spaces indicate those combinations in which there was no clear agreement on passing or failing results among the seven laboratories, i.e., where fewer than six of the seven laboratories obtained the same result. Substantial or clear agreement (defined as at least six laboratories observing the same passing or failing result) was obtained in 635 cases, 88 percent of the possible total of 720 results.

high resilience polyurethane foam, combustion modified (melamine) PU foam, thermal bonded polyester dry, polyester loose fibre (balls) dry, 100% cotton wadding, standard polyurethane foam with FR impregnated PU foam interliner, standard polyurethane foam with thermal bonded polyester interliner, and standard polyurethane foam with aromatic interliner. The problem filling materials tended to be the standard latex foam cored (passed both tests with only one fabric), the modified melting latex foam cored (passed both tests with two fabrics), the standard latex foam cored with a 100 % FR cotton interliner (passed both tests with three fabrics), the standard latex foam cored with an aromatic interliner (passed both tests with three fabrics), and the FR latex foam cored (passed both tests with four fabrics).

Considering the fabrics that tended to fail both tests, five fabrics clearly failed both tests with five or six of the 18 filling materials:viscose/polyester, cotton, polyacrylic, polyacrylic/cotton, and polyacrylic/polyester (Raschel knitted). No other fabric clearly failed both tests with more than two filling materials. The main filling material culprit seemed to be latex foam fillings: Standard latex foam cored clearly failed both tests with 10 of the 20 fabrics. Modified melting latex foam cored failed both tests in 8 cases, FR latex foam cored in 5 cases, and standard latex foam cored with an aromatic interliner in 5 cases.

Of the possible 360 combination, 62 (17 percent) clearly passed the cigarette test but failed the open flame test (see Table V). Four of the fabrics displayed this kind of performance with more than half of the 18 filling materials: polyacrylic/polyester (Raschel knitted) (12 cases), viscose/polyester (11 cases), polyacrylic/cotton (11 cases), and polyacrylic (10 cases).

Of the possible 360 combinations, 41 (11 percent) clearly passed the open flame test but failed the cigarette test (see Table VI). However, none of the fabrics exhibited this performance with more than half of the 18 filling materials. Linen (9 cases) and FR cotton (8 cases) exhibited this performance most frequently. The same observation can be made for the filling materials: none passed open flame and failed cigarette with more than half of the fabrics. The standard latex foam cored, modified melting latex foam cored, and standard latex foam cored with the 100% FR cotton interliner all behaved in this manner in 7 cases.

III. Discussion

A. Ignition Process Effects

While 17 percent of the combinations passed the cigarette test but failed the open flame test (Table V), it is likely that more than 17 percent of combinations would pass the cigarette test but fail the match test if the open flame exposure time was greater than 15 seconds, such as the 20 second time in the CPSC draft proposed standard. On the other hand, while 11 percent of the combinations passed the 15 second open flame test but failed the cigarette test (Table VI), it is likely that fewer combinations would have passed a 20 second open flame-based test and failed the cigarette tests.

The observation that some combinations passed the cigarette test but failed the match test, and other combinations failed the cigarette test but passed the match test, supports the

view that the process of cigarette ignition is different from the process of open flame ignition. It is generally accepted in the fire science field that the combustion chemistry of open flame ignition is different from the combustion chemistry of cigarette ignition. Thus, it is possible that a standard based on an open flame test alone may not adequately protect against both the risk of open flame ignition and the risk of cigarette ignition for all possible combinations of materials that could be used. This issue will need to be carefully considered in the standard-developing process for upholstered furniture.

B. Use of a Standard Test Filling Material

The CPSC draft proposed standard for small open flame ignition would require testing fabrics with a standard polyurethane foam, rather than testing with the filling material to be used in furniture production. The European data tend to support this approach. Referring to Table II, the summary chart, it can be seen that in almost all instances (179 times), a fabric that would pass the open flame test with standard polyurethane foam would pass with another filling material. The very few exceptions to this observation (three) were the FR polyester in combination with either the standard latex foam cored or the modified melting latex foam cored, and the modacrylic with the standard latex foam cored. This means that it would be highly unlikely that a fabric that passes a test with the standard polyurethane foam would fail a test with another filling material (and possibly represent a risk of small open flame ignition in full scale furniture). On the other hand, a fabric that failed in combination with standard polyurethane foam also failed with another filling material 97 times. A fabric that failed in combination with standard polyurethane foam passed with another filling material 16 times (12 of which were with the same fabric, the FR polyester used in the UK legislation). This means that testing with polyurethane foam would only occasionally reject a fabric that might pass with another filling material. Thus, the use of a standard filling material in the CPSC draft seating area test is probably reasonable.

Table I
Fabrics (Cover Materials) Tested

1. Viscose/polyester
2. Polyester/polyacryl/viscose
3. Viscose/wool/polyester
4. Modacrylic/viscose
5. Cotton
6. FR polyester
7. Linen
8. FR cotton
9. Polypropylene
10. Leather
11. Polyacrylic
12. Modacrylic
13. Cotton/acrylic (backcoated)
14. Expanded PVC cotton covered
15. Polyurethane coated polyester
16. Wool
17. FR polyester used in UK legislation
18. Polyacrylic/cotton
19. Polyacrylic/polyester (Raschel knitted)
20. Polyacrylic/polyester (FR treated)

Filling Materials and Interliners Tested

A. Standard PU foam
B. Flame retardant PU foam
C. High resilience PU foam
D. Combustion modified (melamine) PU foam
E. Standard latex foam cored
F. Modified melting latex foam cored
G. Thermal bonded polyester dry
H. Polyester loose fibre (balls) dry
I. 100% cotton wadding
J. FR latex foam cored
A+i Standard PU foam + 100% FR cotton
A+ii Standard PU foam + FR impregnated PU foam
A+iii Standard PU foam + thermal bonded polyester
A+iv Standard PU foam + aromatic
E+i Standard latex foam cored + 100% FR cotton
E+ii Standard latex foam cored + FR impregnated PU foam
E+iii Standard latex foam cored + thermal bonded polyester
E+iv Standard latex foam cored + aromatic

Table II
Summary, European Data, Ignition of Upholstered Furniture Materials

Legend: PM At least six of seven laboratories passed match (open flame) test
FM At least six of seven laboratories failed match (open flame) test
PC At least six of seven laboratories passed cigarette test
FC At least six of seven laboratories failed cigarette test

	Filling materials + interliners / Cover materials	A Standard PU foam	B Flame retardent PU foam	C High Resilience PU foam	D Combustion modified (melamine) PU foam	E Standard latex foam cored	F Modified melting latex foam cored	G Thermal bonded polyester dry	H Polyester loose fibre (batts) dry	I 100% cotton wadding	J FR latex foam cored	A+i Standard PU foam + 100% FR cotton	A+ii Standard PU foam + FR impregnated PU foam	A+iii Standard PU foam + Thermal bonded polyester	A+iv Standard PU foam + Aramatic	E+i Standard latex foam cored + 100% FR cotton	E+ii Standard latex foam cored + FR impregnated PU foam	E+iii Standard latex foam cored + Thermal bonded polyester	E+iv Standard latex foam cored + Aramatic
1	Viscose/Polyester	FM PC	FM PC	FM PC	FM PC	FM FC	FM FC	FM PC	FM PC	FM PC	FM FC	PC	FM PC	FM PC	FM PC	FC	FM	FM	FM FC
2	Polyester/Polyacryl/ Viscose	PC	PC	PC	PC	FC	FC	PC	PC	PC	FC		PC	FM PC	PC	PM FC		PC	FC
3	Viscose/Wool/ Polyester	PM PC	PM PC	PM PC	PM PC	PM FC	PM FC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC
4	Modacrylic/Viscose	PM PC	PM PC	PM PC	PM PC	PM FC	PM FC	PM PC	PM PC	PM PC	PM	PM	PM PC	PM PC	PM PC	PM	PM PC	PM PC	PM FC
5	Cotton	FM	FM	FM	FM PC	FM FC	FM FC	FM PC	FM	FM FC	FM FC	FC	FM PC	FM PC	FM	FC	FM FC	FM PC	FM FC
6	FR Polyester	PM PC	PM PC	PM PC	PM PC	FM FC	FM FC	PM PC	PM PC	PM PC	FC	PM PC	PM PC	PM PC	PM PC	PM FC	PM PC	PC	PM
7	Linen	PM FC	PM	PM FC	PM PC	PM FC	PM FC	PM	PM FC	PM FC	PM	PM	PM PC	PM PC	PM FC	PM FC	PM	PM	PM FC
8	FR Cotton	PM FC	PM	PM PC	PM PC	PM FC	PM FC	PM PC	PM PC	PM PC	PM FC	PM	PM PC	PM PC	PM FC	PM FC	PM FC	PM	PM FC
9	Polypropylene	FM PC	PC	PC	PC	FM FC	FM FC	PC	PC	FM PC	FC	PM PC	PC	PM PC	PC	FC	PM	FM PC	PM FC
10	Leather	PM PC	PM PC	PM PC	PM PC	PM	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM
11	Polyacrylic	FM PC	FM PC	FM PC	FM PC	FM FC	FM FC	FM PC	FM PC	FM PC	FM FC	FM	FM PC	FM PC	FM PC	FM FC	FM FC	FM	FM FC
12	Modacrylic	PM PC	PM PC	PM PC	PM PC	FM FC	FC	PM PC	PM PC	PM PC	PM FC	PM PC	PM PC	PC	PM PC	PM	PM PC	PC	PM
13	Cotton/Acrylic (backcoated)	PM	PM PC	PM PC	PM PC	PM FC	PM FC	PM PC	PM PC	PM PC	PM FC	PM	PM PC	PM PC	PM PC	PM FC	PM	PM PC	PM FC
14	Expanded PVC cotton covered	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC
15	Polyurethane coated Polyester	FM PC	PC	FM PC	PC	FM FC	FM	FM PC	FM PC	FM PC		PC	PC	FM PC	PC	PM	PC	FM PC	FM
16	Wool	PM PC	PM PC	PM PC	PM PC	PM FC	PM FC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM PC	PM	PM PC	PM PC	PM PC
17	FR Polyester used in Dutch legislation	FM PC	PM PC	PM PC	PM PC	FM FC	FM FC	PM PC	PC	PM PC	PM FC	PM PC	PM PC	PC	PM PC	PM FC	PM PC	FC	PM FC
18	Polyacrylic/Cotton	FM PC	FM PC	FM PC	FM PC	FM FC	FM FC	FM PC	FM PC	FM PC	FM FC	FM PC	PC	PM PC	PC	FC	FM	PC	FM FC
19	Polyacrylic/Polyester (Fleischel knitted)	FM PC	FM PC	FM PC	FM PC	FM FC	FM FC	FM PC	FM PC	FM PC	FM FC	FM PC	PC	PC	PC	FC	FM PC	FC	FM FC
20	Polyacrylic/Polyester (FR treated)	PM PC	PM PC	PM PC	PM PC	PM FC	PM FC	PM PC	PM PC	PM PC	PM FC	PM PC	PC	PC	PC	FC	PM	PC	PM FC

Table III

European Data. Ignition of Upholstered Furniture Materials

Fabric/Filling Combinations that Passed* Both Match (Open Flame) Test and Cigarette Test

	Cover materials \ Filling materials + interliners	A Standard PU foam	B Flame retardant PU foam	C High Resilience PU foam	D Combustion modified (melamine) PU foam	E Standard latex foam cored	F Modified melting latex foam cored	G Thermal bonded polyester dry	H Polyester loose fibre (bats) dry	I 100% cotton wadding	J FR latex foam cored	A+i Standard PU foam + 100% FR cotton	A+ii Standard PU foam + FR impregnated PU foam	A+iii Standard PU foam + Thermal bonded polyester	A+iv Standard PU foam + Aromatic	E+i Standard latex foam cored + 100% FR cotton	E+ii Standard latex foam cored + FR impregnated PU foam	E+iii Standard latex foam cored + Thermal bonded polyester	E+iv Standard latex foam cored + Aromatic
1	Viscose/Polyester																		
2	Polyester/Polyacryl/ Viscose																		
3	Viscose/Wool/ Polyester	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X
4	Modacrylic/Viscose	X	X	X	X			X	X	X			X	X	X		X	X	
5	Cotton																		
6	FR Polyester	X	X	X	X			X	X	X		X	X	X	X		X		
7	Linen				X								X	X					
8	FR Cotton			X	X			X	X	X			X	X					
9	Polypropylene											X							
10	Leather	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	
11	Polyacrylic																		
12	Modacrylic	X	X	X	X			X	X	X		X	X		X		X		
13	Cotton/Acrylic (backcoated)		X	X	X			X	X	X			X	X	X			X	
14	Expanded PVC cotton covered	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
15	Polyurethane coated Polyester																		
16	Wool	X	X	X	X			X	X	X	X	X	X	X	X		X	X	X
17	FR Polyester used in UK legislation		X	X	X			X		X		X	X		X		X		
18	Polyacrylic/Cotton																		
19	Polyacrylic/Polyester (Raschel knitted)																		
20	Polyacrylic/Polyester (FR treated)	X	X	X	X			X	X	X		X	X	X	X			X	

* At least six of seven laboratories agreed

Table IV

European Data. Ignition of Upholstered Furniture Materials

Fabric/Filling Combinations that Failed* Both Match (Open Flame) Test and Cigarette Test

	Filling materials + Interliners / Cover materials	A Standard PU foam	B Flame retardant PU foam	C High Resilience PU foam	D Combustion modified (melamine) PU foam	E Standard latex foam cored	F Modified melting latex foam cored	G Thermal bonded polyester dry	H Polyester loose fibre (batts) dry	I 100% cotton wadding	J FR latex foam cored	A+i Standard PU foam + 100% FR cotton	A+ii Standard PU foam + FR impregnated PU foam	A+iii Standard PU foam + Thermal bonded polyester	A+iv Standard PU foam + Aromatic	E+i Standard latex foam cored + 100% FR cotton	E+ii Standard latex foam cored + FR impregnated PU foam	E+iii Standard latex foam cored + Thermal bonded polyester	E+iv Standard latex foam cored + Aromatic
1	Viscose/Polyester					X	X				X								X
2	Polyester/Polyacryl/ Viscose																		
3	Viscose/Wool/ Polyester																		
4	Modacrylic/Viscose																		
5	Cotton					X	X			X	X						X		X
6	FR Polyester					X	X												
7	Linen																		
8	FR Cotton																		
9	Polypropylene					X	X												
10	Leather																		
11	Polyacrylic					X	X				X					X	X		X
12	Modacrylic					X													
13	Cotton/Acrylic (backcoated)																		
14	Expanded PVC cotton covered																		
15	Polyurethane coated Polyester					X													
16	Wool																		
17	FR Polyester used in UK legislation					X	X												
18	Polyacrylic/Cotton					X	X				X	X							X
19	Polyacrylic/Polyester (Raschel knitted)					X	X				X					X			X
20	Polyacrylic/Polyester (FR treated)																		

* At least six of seven laboratories agreed

Table V

European Data. Ignition of Upholstered Furniture Materials Fabric/Filling Combinations that Passed* Cigarette Test and Failed* Match (Open Flame) Test

	Filling materials + interliners / Cover materials	A Standard PU foam	B Flame retardant PU foam	C High Resilience PU foam	D Combustion modified (melamine) PU foam	E Standard latex foam cored	F Modified melting latex foam cored	G Thermal bonded polyester dry	H Polyester loose fibre (balls) dry	I 100% cotton wadding	J FR latex foam cored	A+i Standard PU foam + 100% FR cotton	A+ii Standard PU foam + FR impregnated PU foam	A+iii Standard PU foam + Thermal bonded polyester	A+iv Standard PU foam + Aramello	E+i Standard latex foam cored + 100% FR cotton	E+ii Standard latex foam cored + FR impregnated PU foam	E+iii Standard latex foam cored + Thermal bonded polyester	E+iv Standard latex foam cored + Aramello
1	Viscose/Polyester	X	X	X	X			X	X	X	X		X	X	X				
2	Polyester/Polyacryl/ Viscose													X					
3	Viscose/Wool/ Polyester																		
4	Modacrylic/Viscose																		
5	Cotton				X			X					X	X				X	
6	FR Polyester																		
7	Linen																		
8	FR Cotton																		
9	Polypropylene	X								X				X				X	
10	Leather																		
11	Polyacrylic	X	X	X	X			X	X	X			X	X	X				
12	Modacrylic																		
13	Cotton/Acrylic (Saccharidal)																		
14	Expanded PVC cotton covered																		
15	Polyurethane coated Polyester	X		X				X	X	X					X				X
16	Wool																		
17	FR Polyester (used in U.K. legislation)																		
18	Polyacrylic/Cotton	X	X	X	X			X	X	X				X	X	X			X
19	Polyacrylic/Polyester (Fluochel knitted)	X	X	X	X			X	X	X			X	X	X	X		X	
20	Polyacrylic/Polyester FR treated																		

* At least six of seven laboratories agreed

Table VI

European Data, Ignition of Upholstered Furniture Materials

Fabric/Filling Combinations that Passed* Match (Open Flame) Test and Failed Cigarette Test

	Filling materials + interliners / Cover materials	A Standard PU foam	B Flame retardant PU foam	C High Resilience PU foam	D Combustion modified (melamine) PU foam	E Standard latex foam cored	F Modified melting latex foam cored	G Thermal bonded polyester dry	H Polyester loose fibre (bells) dry	I 100% cotton wadding	J FR latex foam cored	A+i Standard PU foam + 100% FR cotton	A+ii Standard PU foam + FR impregnated PU foam	A+iii Standard PU foam + Thermal bonded polyester	A+iv Standard PU foam + Aromatic	E+i Standard latex foam cored + 100% FR cotton	E+ii Standard latex foam cored + FR impregnated PU foam	E+iii Standard latex foam cored + Thermal bonded polyester	E+iv Standard latex foam cored + Aromatic
1	Viscose/Polyester																		
2	Polyester/Polyacryl/ Viscose															X			
3	Viscose/Wool/ Polyester					X	X												
4	Modacrylic/Viscose					X	X												X
5	Cotton																		
6	FR Polyester															X			
7	Linen	X		X		X	X		X	X					X	X			X
8	FR Cotton	X				X	X				X				X	X	X		X
9	Polypropylene																		X
10	Leather																		
11	Polyacrylic																		
12	Modacrylic										X								
13	Cotton/Acrylic fabric/plastic					X	X				X					X			X
14	Expanded PVC foam covered																		
15	Polyurethane coated Polyester																		
16	Wool					X	X												
17	FR Polyester used in U.K. legislation										X					X			X
18	Polyacrylic/Cotton																		
19	Polyacrylic/Polyester (Raschel knitted)																		
20	Polyacrylic/Polyester (FR treated)					X	X				X					X			X

* At least six of seven laboratories agreed