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NFPA 701

Fire Tests for Flame-Resistant Textiles and Films

1989 Edition

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

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Policy Adopted by NFPA Board of Directors on December 5, 1982

The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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NATIONAL FIRE PROTECTION ASSOCIATION

NFPA 701

Standard Methods of Fire Tests for

Flame-Resistant Textiles and Films

1989 Edition

This edition of NFPA 701, *Standard Methods of Fire Tests for Flame-Resistant Textiles and Films*, was prepared by the Technical Committee on Fire Tests and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 15-18, 1989 in Washington, DC. It was issued by the Standards Council on July 14, 1989, with an effective date of August 7, 1989, and supersedes all previous editions.

The 1989 edition of this document has been approved by the American National Standards Institute.

Origin and Development of NFPA 701

Requirements for flameproofing of textiles were adopted by the NFPA on recommendation of the Committee on Fireproofing and Preservative Treatments in 1938. These were amended in 1939, 1940, 1941, and 1951. This standard is now under the jurisdiction of the NFPA Committee on Fire Tests; the 1966 edition, which was an extensive revision of the previous edition, was prepared by that committee as were the 1968, 1969, 1975, 1976, and 1977 editions.

This 1989 edition represents a complete rewrite with significant changes to the small scale test.

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NOTE: Membership on a Committee shall not in and of itself constitute an endorsement of the Association or any document developed by the Committee on which the member serves.

Contents

NFPA 701

Standard Methods of Fire Tests for Flame-Resistant Textiles and Films

1989 Edition

Information on referenced publications can be found in Chapter 11.

Chapter 1 General

1-1 Scope.

1-1.1 These requirements apply to flame-resistant materials that are used extensively in the interior of buildings, in protective clothing for certain occupations and situations, and for protective outdoor coverings such as tarpaulins and tents. The flame-resistant requirements are not dependent on the type of treatment; however, where durability to laundering or weathering is claimed, the fabric or film is tested for flame resistance after being subjected to the applicable cleaning or exposure procedures.

1-1.2 These requirements also apply to plastic films, with or without reinforcing or backing, when used for decorative or other purposes inside buildings or as temporary or permanent enclosures for buildings under construction.

1-1.3 These requirements may not apply to multilayered fabrics or assemblies of fabrics.

NOTE: Limited experience has shown that multilayered fabrics may burn in a manner that is different from that of the burning behavior of the individual components (*see Appendix D*). Many materials may meet the test criteria of this standard because they shrink away from the flame, melt, ablate, or otherwise fail to support upward flames when heated. However, when such materials are in contact with a material that meets the test criteria of this standard and do not shrink away from the flame but instead char and maintain a degree of structural integrity, the material in question may not be able to evade the flame and could support upward burning.

1-1.4 If these materials are to be applied to surfaces of buildings or backing materials as interior finishes for use in buildings, the test shall be conducted and the material classified in accordance with NFPA 255, *Method of Test of Surface Burning Characteristics of Building Materials.*

1-2 Purpose.

1-2.1 It is the purpose of these requirements to provide tests to assess the propagation of flame beyond the area exposed to the source of ignition.

1-2.2 These performance tests do not necessarily indicate whether the material tested will resist the propagation of flame under severe exposure or when used in a manner that differs substantially from the test conditions.

1-3 General Description.

1-3.1 Two methods of assessing flame propagation resistance are described. Both methods provide a comparison among materials but do not necessarily indicate the behavior of a material in a large building fire or other conflagration.

1-3.1.1 The small scale test employs a relatively small sample and small igniting flame. It is simple and convenient for general use. The small scale test is commonly used to indicate susceptibility to flame spread from small ignition sources, but may also be used as a screening test prior to large scale testing.

1-3.1.2 The large scale test requires a much larger sample and applies a more severe fire exposure, which will more nearly approach severe fire conditions. Initial screening may be done with the small scale test. This method is also useful for investigating the flammability of fabrics when hung in folds.

1-3.2 Materials that are expected to retain their flame resistance through drycleaning, laundering, water leaching, or weathering exposures shall be subjected to the procedures of Chapter 8 before being tested.

1-4 Test Selection.

1-4.1 All materials covered in the scope of this method shall be capable of complying with the performance requirements of either the small or the large scale tests or both. The authority having jurisdiction shall determine whether both tests are required, depending on the purpose to be served or the nature of the materials tested.

1-4.2 For materials that show excessive melting or shrinkage or ongoing combustion at the junction of the specimen and its holder in the small scale test, the large scale test shall be considered applicable.

1-4.3 In the conduct of the large scale test, only folded specimens shall be tested.

Exception: Materials that cannot be readily prepared in the folded configuration shall be tested by the flat sheet portion of the large scale test, using the procedure specified in Chapter 6.

Chapter 2 Test Apparatus and Materials for Small Scale Test

2-1 Conditioning Oven.

2-1.1 A forced draft oven shall be used to condition test specimens properly prior to testing.

2-1.1.1 The interior of the oven shall be large enough to provide free air flow around each specimen contained.

2-1.1.2 The oven shall have adjustable temperature control capable of maintaining the interior at a temperature of 140-145 °F (60-63 °C).

2-2 Specimen Holder. A metal holder having clamps applied to compress the holder lightly along its edges shall be used to support and align the specimen. The ends of the specimen shall remain free.

2-3 Test Chamber and Gas Burner.

2-3.1 The test chamber, specimen holder, and burner shall be the metal cabinet, specimen holder, and burner specified for the Federal Children's Sleepwear Standard 16 CFR 1615.4 (FF 3-71).

2-3.2 The gas supply to the burner shall be at least 97 percent methane or natural or manufactured gas having a heat value of 800-1000 Btu per cu ft.

2-4 Hook and Weight. A hook and weight assembly shall be used to determine the length of char or destruction of the specimen. The combined weight of the assembly shall follow Table 2-4.

Table 2-4

Weight of Material Being Tested (Ounces Per Square Yard)	Total Tearing Weight for Determination of Length of Char (Pounds)
Less than 2	0.12
2 to 6 inclusive	0.25
Over 6 and not exceeding 15	0.50
Over 15 and not exceeding 23	0.75
Over 23	1.00

2-5 Timer. Stop watches or other timing devices that measure to 0.5 second shall be used to determine afterflame of burning specimens and the flame time of portions of residues that break away or drip from the test specimen and continue to flame after reaching the floor of the test chamber.

2-6 Hood. A hood or other suitable enclosure shall be used to provide a draft-free environment around the tester. The hood or enclosure shall have a fan or other suitable means of exhausting smoke and fumes produced during testing.

2-7 Pan Balance. A pan balance capable of weighing to the nearest 0.01 g shall be used for weighing specimens.

2-8 Test Specimens.

2-8.1 Five specimens of material, 3½ by 10 in., shall be cut with their long dimension parallel to the length direction, and five with the long dimension parallel to the width direction.

2-8.2 Each lot of five shall be cut from at least five places in the sample separated sufficiently to give indication as to the uniformity of the flammability performance.

2-8.3 No specimens nearer the selvedge than 1/10 of the width of the sample shall be used for testing.

Chapter 3 Flame Test Procedures for Small Scale Test

3-1 Conditioning of Test Specimens.

3-1.1 The test specimens shall be conditioned in an oven at temperatures of 140-145 °F (60-63 °C) for durations of not less than one hour nor more than one and one-half hours prior to mounting in the specimen holder and testing.

3-1.2 Materials that distort or melt at the above indicated oven exposure are to be conditioned at 60-80 °F (15-27 °C) and 25-50 percent relative humidity for not less than 24 hours.

3-1.3 Specimens shall be removed from the oven one at a time, mounted in the specimen holder, and subjected to the procedures described in Sections 3-2 and 3-3 within 30 seconds.

3-2 Mounting of Test Specimens.

3-2.1 Materials that are specified as being for use only as curtains and draperies and weighing less than 3.0 oz/yd² shall be weighed to the nearest 0.01 g prior to mounting in the specimen holder.

3-2.2 The specimens shall be placed on the specimen holder and clamped so that a strip 2 in. wide and 10 in. long is left exposed.

3-2.3 The specimen and its holder shall be supported within the test chamber so that its lower end will be ¾ in. above the top of the gas burner.

3-3 Conducting the Flame Test.

3-3.1 The gas burner shall be ignited and, with the air supply completely shut off (taping over the air inlet is recommended), shall be adjusted to give a luminous flame 1½ in. long. The ambient light level should be reduced so that the full extent of the flame may be seen for determining flame height.

3-3.2 The burner shall be moved under the specimen so that the flame is applied vertically to the lower end of the specimen, near the middle of its width. The flame shall be applied for 12 seconds and then withdrawn.

3-3.3 The duration of flaming combustion of melt drips on the floor of the test chamber shall be measured to the nearest 0.5 second and recorded.

3-3.4 The duration of burning of the specimen after the igniting flame has been removed shall be measured to the nearest 0.5 second and recorded.

3-3.5 After all flaming has ceased, purge the enclosure and cabinet with the exhaust fan prior to the next test.

3-4 Measurement of Length of Char or Material Destruction.

3-4.1 After all flaming and afterglow on the specimen has ceased, the length of char or material destruction shall be determined. The length of char in this test is defined as the distance from the end of the specimen that was ex-

posed to the flame to the end of a tear made lengthwise in the specimen through the center of the charred area in the following manner:

(a) The specimen shall be folded lengthwise and creased by hand along the line through the highest point in the charred area.

(b) The hook of the hook/weight assembly is inserted in the specimen, on one side of the charred area, ¼ in. in from the adjacent edge and ¼ in. up from the bottom.

(c) The specimen is then grasped on the opposite side of the charred area with the fingers and raised gently until it supports the weight. The specimen will tear through the charred area until material strong enough to carry the load is reached.

3-4.2 When it is not feasible to measure char, the material destruction can normally be judged as the measurement from the bottom of the sample to a horizontal line above which all material is sound and in original condition.

3-4.3 Specimens that have been weighed before testing shall be reweighed and the percent weight loss calculated. (*See 4-1.4.*)

Chapter 4 Flame Resistance Requirements for Small Scale Test

4-1 Test Criteria.

4-1.1 When subjected to the small scale test described in Chapter 3 no specimen shall continue flaming for more than two seconds after the test flame is removed from contact with the specimen.

Exception: This criterion shall not apply to fabrics weighing less than 10.0 ounces per square yard, which are specified as being for use as curtains and draperies [see 9-5(a)].

4-1.2 The vertical spread of flame and afterglow (smoldering combustion) on the material, as indicated by the length of char or the measurement from the bottom of the sample above which all material is sound and in original condition, shall not exceed the values shown in Table 4-1.

Exception: Fabrics weighing less than 10.0 ounces per square yard, which are specified as being for use as curtains and draperies [see 9-5(a)], may have a maximum average char length for ten specimens of up to 6.5 in. with no individual value exceeding 7.5 in.

4-1.3 At no time during or after the application of the test flame shall portions or residues of textiles or films that break or drip from any test specimens continue to flame after they reach the floor of the test chamber.

Exception: Fragments or residues from fabrics weighing less than 10.0 ounces per square yard, which are specified as being for use as curtains and draperies [see 9-5(a)], may continue to flame for an average of two seconds.

4-1.4 Some fabrics that are specified as being for use only as curtains and draperies [*see 9-5(a)*] and weighing less than 3.0 ounces per square yard may fail to meet the char length criteria because of melting beyond the prescribed limits. In such cases, if the weight loss of each specimen is less than 5 percent, the fabric will be considered to meet the char length requirements.

$$\% \text{ weight loss} = \frac{(\text{original weight} - \text{final weight}) \times 100}{\text{original weight}}$$

Table 4-1
Permissible Length of Char or Destroyed Material — Small Scale Test*

Weight of Material Being Tested (Oz per Sq Yd)	Maximum Average of 10 Specimens (Inches)	Maximum Individual for Each Specimen (Inches)
Over 10	3.5	4.5
Over 6 and not exceeding 10	4.5	5.5
Not exceeding 6	5.5	6.5

*For fabrics weighing less than 10.0 ounces per square yard, which are specified as being for use only as curtains and draperies [see 9-5(a)], see Exception to 4-1.2.

4-2 Retest. Samples for which only one of the ten specimens does not meet a given classification criterion may be retested using a new set of five specimens taken in the same direction as the specimen that did not meet the criteria. If all five of the new specimens meet the criteria, the sample shall be regarded as meeting the small scale test criteria.

Chapter 5 Test Apparatus and Materials for Large Scale Test

5-1 Conditioning Oven.

5-1.1 A forced draft oven shall be used to condition test specimens properly prior to testing.

5-1.1.1 The interior of the oven shall be large enough to provide free air flow around each specimen contained.

5-1.1.2 The oven shall have variable temperature control capable of maintaining the interior at a temperature of 140-145 °F (60-63 °C).

5-2 Test Enclosure.

5-2.1 The test shall be carried out in a metal stack 12 in. square and 7 ft high with details as follows:

(a) The stack shall be supported 1 ft above the floor by legs and shall be open at the top and bottom.

(b) The stack shall be fitted with a wired-glass, or other suitable material, observation window(s) extending the full length of the front door.

(c) The stack shall have means for hanging the specimen as follows:

Top rod: 1/16 or ⅛ in. steel rod, 13 in. long sharpened to a point at one end. Holes in both sides of the stack aligned horizontally for location of the top rod.

Bottom rod: 1/8 in. steel rod, 10 in. long sharpened to a point at one end.

Vertical guide wires: Use copper or other suitable wire to make a pair of vertical guide wires on each side of the stack spaced 4 in. to the right and left of the vertical center of the stack, 8 in. apart. The two wires making up each pair shall be spaced 1 in. apart front to back and shall be parallel to each other and to the sides of the stack. Mount the vertical guide wires using a ¼ in. diameter rod fixed horizontally at the top and bottom of the stack. [*See Figure 5-2(c).*]

5-2.2 The stack shall be located in a room, chamber, or hood where the temperature is 40-75 °F (4-24 °C) and the relative humidity does not exceed 70 percent.

5-2.3 The testing chamber shall be free of drafts that affect the stability of the flame.

5-2.4 Test personnel should be equipped with protective devices if not isolated from the smoke.

5-2.5 Refer to Figures 5-2(a), (b), (c), 6-2(a), (b), and (c) for details regarding enclosure construction and facilities for properly mounting both flat and folded test specimens.

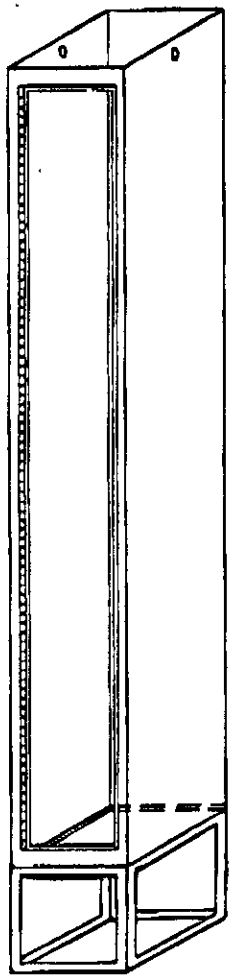

Figure 5-2(a) Orthographic view of flame testing apparatus.

5-3 Restraining Clamps. See 6-2.3.

5-4 Gas Burner. A bunsen burner having ⅜-in. tube diameter shall be used for the ignition source. If the burner is equipped with a gas flow controlling valve the valve shall be fully open so as not to restrict gas flow as the flow must be controlled by the needle valve preceding the rotameter as specified in 5-4.4.

5-4.1 The burner shall be fixed in a position so that the barrel is at a 25 degree angle with the vertical, with the upper tip of the burner 4 in. below the bottom edge of the test specimen.

5-4.2 The gas supply to the burner shall be at least 97 percent methane or manufactured or natural gas having a heat value of 800-1000 Btu per cu ft.

5-4.3 A rotameter shall be installed between the gas flow control valve and the burner. The upper limit of the rotameter shall be from 5 to 10 ft^3/hr.

5-4.4 A needle valve for gas flow control followed by a rotometer shall be placed in the gas line leading to the burner. A pressure gage shall be located between the gas supply line and the needle valve used for controlling the gas flow. The gas lines from the needle valve to the rotometer and from the rotometer to the burner shall have a bore of ¼ in. and shall not exceed a total length of 5 ft. Armored tubing is recommended for the last 2 ft leading to the burner. (*See Figure 5-4.*)

5-5 Timer. Stop watches or other timing devices that measure to 0.5 second shall be used to determine afterflame of burning specimens and the flame time of portions of residues that break away or drip from the test specimen and continue to flame after reaching the floor of the test chamber.

5-6 Test Specimens.

5-6.1 Remove selvedges from all samples before cutting and conditioning specimens. The test specimens shall be taken from as widely separated and symmetrically located sections as possible over the entire area of the sample of each material. One-half of the specimens shall be cut with the long dimension parallel to the length, and the balance of the specimens shall be cut with the long dimension parallel to the width of the material. It may be necessary to join sections with a flat seam to achieve the necessary 7 ft specimen length when the long dimension is parallel to the width of the material.

5-6.2 For conducting flame tests of materials in flat sheets, at least 10 specimens, 5 in. by 7 ft, shall be used.

5-6.3 For conducting flame tests of materials hung in folds, at least 4 specimens, 24 ± 1 in. by 7 ft ± 1 in., shall be cut. Each specimen shall be folded longitudinally to form four folds, each approximately 5 in. wide, uniformly over the length. Refer to Figure 6-2(c) to insure a proper folded appearance.

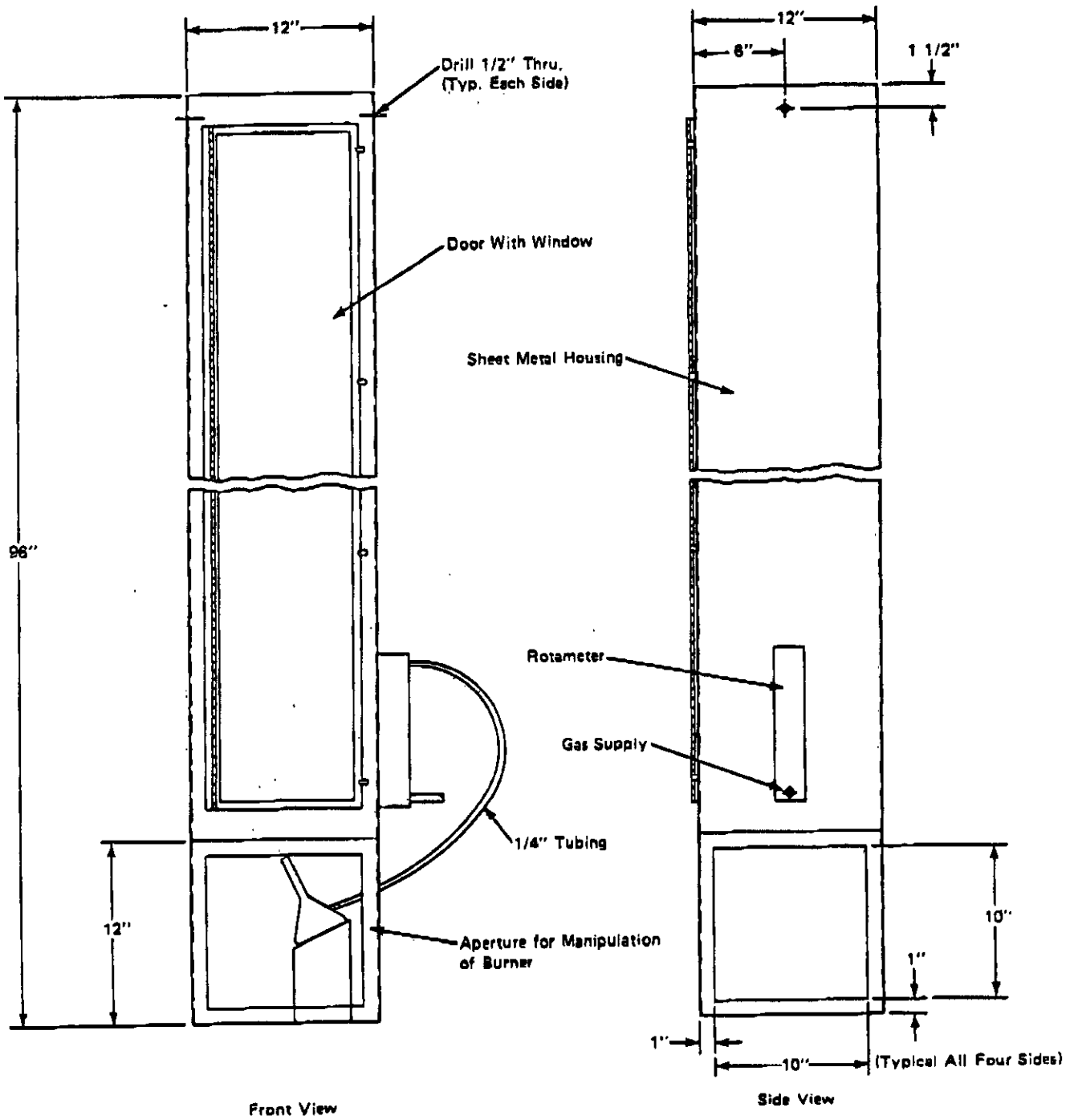

Figure 3-2(b) Outside views of apparatus.

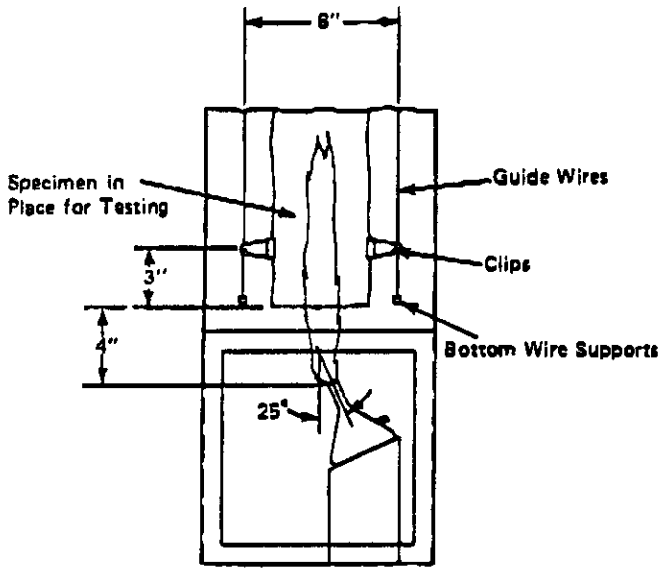

Figure 5-2(e) View inside at bottom of apparatus.

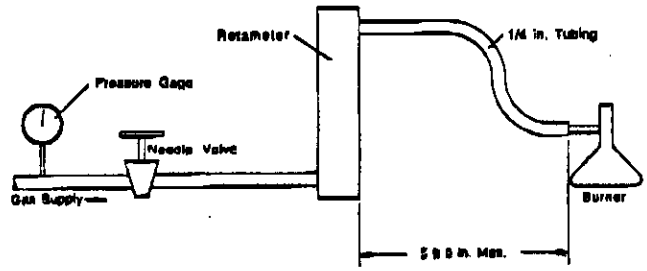

Figure 5-4 Gas line feed arrangement to burner.

Chapter 6 Flame Test Procedures for the Large Scale Test

6-1 Conditioning of Test Specimens.

6-1.1 The test specimens shall be conditioned in an oven, at temperatures of 140-145 °F (60-63 °C), for durations of not less than one hour nor more than one and one-half hours before testing.

6-1.2 Materials that distort or melt at the above indicated oven exposure shall be conditioned at 60-80 °F (15-27 °C) and 25-50 percent relative humidity for not less than 24 hours.

6-1.3 Specimens shall be removed from the oven one at a time and immediately subjected to the procedures described in Sections 6-2 and 6-3.

6-2 Mounting of Test Specimens.

6-2.1 The folded specimen shall be suspended vertically with the edges of the folds facing the observer (front of stack). The folds shall be spread apart about ½ in. by means of guide rods inserted at the top to support the specimen and half way down the specimen to help hold the folds in place. The bottom of the center portion of the section between the two middle folds shall be 4 in. above the bunsen burner.

6-2.2 The single flat sheet specimen shall be suspended vertically in the stack with its full width facing the observer (front of stack) so that the center of the bottom of the specimen will be 4 in. above the bunsen burner.

6-2.3 Test specimens shall be lightly restrained laterally at the mid-point of their length and within 3 in. of the bottom edge by suitable clamps (bulldog clips) and light chains attached to the vertical guide wires.

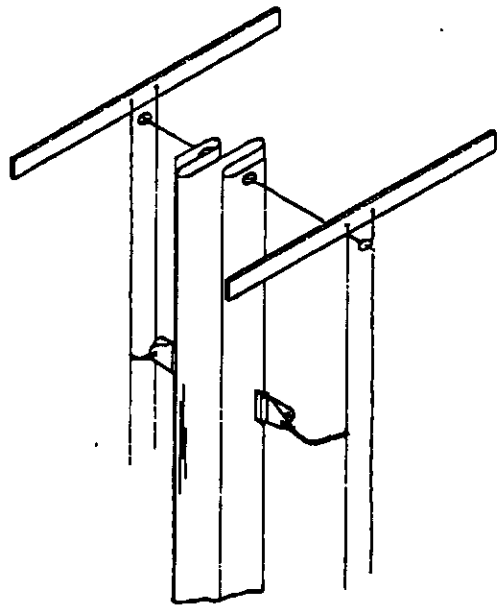

Figure 6-2(a) Test sample in folds.

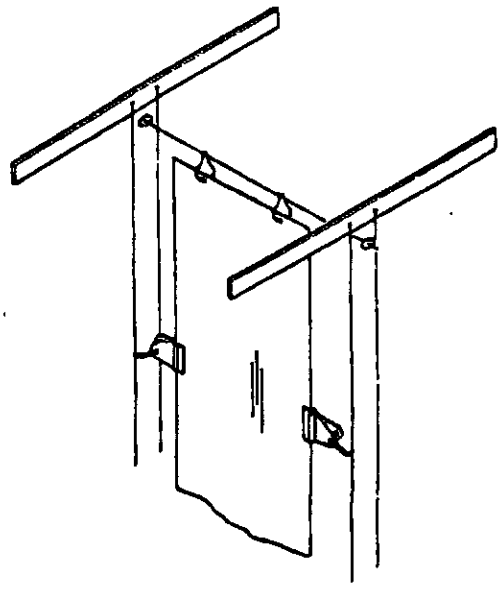

Figure 6-2(b) Test sample flat sheet.

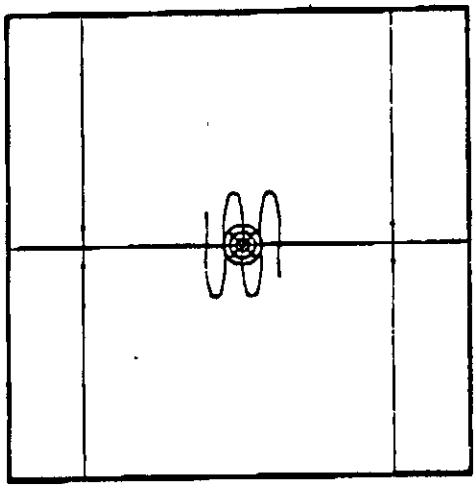

Figure 6-2(c) Bottom view of folded sample.

6-2.4 Refer to Figures 5-2(c), 6-2(a), (b), and (c), for details for properly mounting test specimens.

6-3 Conducting the Flame Test.

6-3.1 The gas burner shall be ignited and the gas pressure regulated at 2.25 to 2.75 psi with a flow rate of 4.0 ± 0.1 ft^3/hr.

6-3.2 The burner air inlets shall be sealed to prevent air from entering, and the gas adjusted to produce an 11 in. ± 0.5 in. flame. If the flame height cannot be achieved with specified gas pressure and flow rate, the burner may need cleaning or adjustment.

6-3.3 The flame shall be applied vertically near the middle of the width of the lower end of the specimen in a single sheet, or the middle segment of the specimen in folds [*see Figure 6-2(c)*]. The position of the specimen relative to the test flame shall be maintained by guide wires attached to the outer edges of the specimen. The test flame shall be applied to the specimen for two minutes, then withdrawn.

6-3.4 The duration of flaming combustion of melt drips on the floor of the test chamber shall be measured and recorded to the nearest 0.5 second.

6-3.5 The duration of burning of the specimen after the igniting flame has been removed shall be measured and recorded to the nearest 0.5 second.

6-3.6 After all flaming has ceased, purge the enclosure and stack prior to the next test.

6-4 Measurement of Length of Char. After all flaming and afterglow on the specimen has ceased, the length of char shall be determined. For purposes of this test, the length of char is defined as the vertical distance on the specimen from the top of the test flame to the top of the charred area resulting from spread of flame and afterglow. For synthetic textiles and films the length of char is defined as the vertical distance from the tip of the test flame to a horizontal line, above which all material is sound and in essentially original condition.

Chapter 7 Flame Resistance Requirements for the Large Scale Test

7-1 Test Criteria.

7-1.1 When subjected to the large scale test described in Chapter 6, no specimen shall continue flaming for more than two seconds after the test flame is removed from contact with the specimen.

7-1.2 The length of char on the individual folded specimens shall not exceed 35 in. above the tip of the test flame. The char length may be determined by measuring from the top of the specimen to the top of the damaged area and this value subtracted from the initial length of the specimen. If this is done the maximum value of the result shall not exceed 42 in. (35 in. plus the 7 in. in the flame).

7-1.3 The length of char on any single specimen of the material in flat sheets shall not exceed 10 in. above the tip of the test flame. This char length shall be measured as the distance from the tip of the test flame to the top of the charred area resulting from spread of flame and afterglow [or the distance from the top of the specimen to the top of the damaged area may be measured and subtracted from the initial length of the specimen, in which case the result must be less than 17 in. (10 in. + the 7 in. that has been exposed to the flame)].

7-1.4 At no time during or after the application of the test flame shall any portions or residues of the material being tested break or drip from the specimen and fall to the floor and continue flaming after reaching the floor of the test apparatus.

7-2 Retest.

7-2.1 In the event that one of the four folded specimens fails to meet the above requirements, test two new specimens cut in the same direction as the one that failed. If both of the new specimens meet the criteria, the sample shall be regarded as meeting the large scale test criteria.

7-2.2 In the event that one of the ten flat specimens fails to meet the above requirements, test five new specimens cut in the same direction as the one that failed. If all five of the new specimens meet the criteria, the sample shall be regarded as meeting the large scale test criteria.

Chapter 8 Cleaning and Weathering Procedures

8-1 General Considerations. The probable durability of a treatment relative to the life of the fabric is difficult to assess but, in general, flame retardant treatments tend to be either very tenacious or quite easily removed.

8-2 Application. Each fabric shall be subjected to those exposure procedures that are applicable to its intended use (laundering, drycleaning, weathering, and/or other exposure to water). Each material shall meet the flame resistance requirements of Chapter 4, or 7, or both after passing through the appropriate exposure cycles. It is believed that such accelerated exposure tests as those described in this section provide sufficient testing to permit a reasonable appraisal of the durability of the treatment (under the conditions for which it was designed) for the useful life of the fabric.

8-3 Accelerated Drycleaning.

8-3.1 The material to be tested shall be subjected to three full cycles of one of the following drycleaning procedures:

(a) A drycleaning procedure specified by the manufacturer or finisher for the routine care of the material. If such care instructions are provided by the manufacturer, preference shall be given to them.

(b) Conventional coin-op drycleaning.

(c) Conventional commercial drycleaning using either perchloroethylene or Stoddard solvent as the cleaning medium.

8-3.2 Test specimens shall then be cut from the drycleaned sample for testing. (*See Section 2-8, or 5-6, or both.*)

8-4 Accelerated Laundering.

8-4.1 The material to be tested shall be subjected to five full cycles of one of the following laundering procedures:

(a) A laundering procedure specified by the manufacturer or finisher for the routine care of the material. If such care instructions are provided by the manufacturer, preference shall be given to them.

(b) Conventional commercial laundering.

(c) Conventional home laundering using the following steps:

(1) Fill washer to high water level with hot (120 ° ± 5 °F or 50 ° ± 3 °C) water.

(2) Add the amount of a conventional home laundry detergent recommended by the detergent manufacturer.

(3) Place the material to be tested in the washing machine. Add dummy load to make the total dry weight of material in the washer equal to 4 ± 0.25 lb (1.8 ± 0.1 kg).

(4) Set the control on the washer so as to run a conventional full wash cycle (normally this will provide a 12 minute wash cycle).

(5) At the end of the final spin cycle, place the entire load into the dryer.

(6) Dry at the high setting for 45 ± 5 minutes.

NOTE: All details are given in AATCC Test Method 130-1981, *Soil Resistance; Oily Stain Release Method.*

8-4.2 Test specimens shall then be cut from the laundered material for testing. (*See Sections 2-8 and 5-6.*)

8-5 Accelerated Water Leaching.

8-5.1 A sample of the treated material shall be totally immersed in a vessel containing tap water at room temperature for a period of 72 hours. The vessel shall have a capacity of at least four gallons.

8-5.2 The water shall be drained from the vessel and replenished at 24-hour intervals during the immersion period.

8-5.3 At the conclusion of the immersion period, the sample shall be removed from the vessel and dried at room temperature.

8-5.4 Test specimens shall then be cut from the leached material for testing. (*See Sections 2-8 and 5-6.*)

8-6 Accelerated Weathering.

8-6.1 Limitations imposed by the weathering equipment make it possible to only expose specimens for the small scale test.

8-6.2 Cut the specimens for the small scale test before the accelerated weathering. (*See Section 2-8.*)

8-6.3 Expose the specimens for 100 hours using the apparatus and procedure specified in AATCC Test Method 111A-1984, *Water Resistance—Sunshine Arc Lamp Exposure with Wetting.*

Chapter 9 Reporting

9-1 General Considerations. The description of the materials tested, test conditions, accelerated refurbishing or weathering treatments, and results shall be reported.

9-2 Sample Description.

9-2.1 The composition and form of the sample shall be described. The description shall include the composition of the material and its form. If flame retardants have been added they shall be described along with the method of application. The description shall include weight and construction of the material.

9-2.2 The intended application of the material shall be described, if known.

9-3 Test Conditions.

9-3.1 The test report shall state whether the small scale test, the large scale test, or both were performed on the sample.

9-3.2 The test conditions shall be described, particularly if they deviate in any way from those prescribed in the test method.

9-4 Refurbishing or Weathering Conditions. If any refurbishing or accelerated weathering procedures were applied to the sample, the procedures shall be described along with the number of cycles used.

9-5 Test Results. The results from individual specimens as well as the sample average shall be reported for the following measurements or observations:

(a) Weight of material per unit area (ounces per square yard); for the small scale test for fabrics weighing less than

10.0 ounces per square yard, specify whether or not the material shall be used for draperies and curtains.

(b) Char length to the nearest 0.1 in.

(c) Afterflame time to the nearest 0.5 second.

(d) Time of burning of any material that falls to the bottom of the cabinet to the nearest 0.5 second.

(e) For curtain and drapery fabrics weighing less than 3.0 ounces per square yard the weight before and after the test shall be reported. The percent weight loss shall also be computed and reported.

(f) Any unusual behavior of the sample shall be reported.

9-6 Final Conclusion. The report shall include a statement as to whether the sample meets or does not meet the applicable criteria given in the test method.

Chapter 10 Field Test: Match Flame Test (See Appendix C)

10-1 General.

10-1.1 This field test shall not be used in place of either the small scale or large scale tests described in earlier chapters. It is intended for use in indicating flame resistance of those field installations for which reliable laboratory data are not available.

10-1.2 Successfully passing the match flame test does not constitute certification of having passed NFPA 701.

10-2 Materials.

10-2.1 Specimens shall be dry and shall be a minimum 1½ in. wide and 4 in. long.

10-2.2 The fire exposure shall be the flame from a common wood kitchen match (approximate length: 2⅜ in.; approximate weight: 29 grams per hundred), which is reasonably equivalent to that of a standard small scale test described in 3-3.1, applied for 12 seconds.

10-3 Method.

10-3.1 The test shall be performed in a draft-free and safe location.

10-3.2 The sample shall be suspended (preferably held with a spring clip, tongs, or some similar device) with the long axis vertical, with the flame applied to the center of the bottom edge, and the bottom edge ¾ in. above the bottom of the flame.

10-3.3 After 12 seconds of exposure, the match is to be removed gently away from the sample.

10-4 Requirements.

10-4.1 During the exposure, flaming shall not spread over the complete length of the sample or in excess of 4 in. from the bottom of the sample (for larger size samples).

10-4.2 There shall be not more than two seconds of afterflame.

10-4.3 Materials that break and drip flaming particles shall be rejected if the materials continue to burn after they reach the floor.

Chapter 11 Referenced Publications

11-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

11-1.1 NFPA Publication. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 255-1984, *Standard Method of Test of Surface Burning Characteristics of Building Materials.*

11-1.2 Other Publications.

AATCC 111A-1984, *Water Resistance—Sunshine Arc Lamp Exposure with Wetting*

AATCC 130-1981, *Soil Resistance; Oily Stain Release Method*

16 CFR 1615.4 (FF 3-71), *Code of Federal Regulations*, Title 16—Commercial Practices, Part 1615—Standard for the Flammability of Children's Sleepwear: Sizes 0 through 6X, available from Superintendent of Documents, Government Printing Office, Washington, DC 20402.

Appendix A Commentary

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

During the period 1980 through May, 1987, a subcommittee of the Fire Tests Committee worked on a revision of NFPA 701 to bring it up to date with modern practice. Also recognized in the study was the introduction of new curtain and drapery fabrics that had been shown to perform well in a room fire test and had lost less than 20 percent weight when ignited by a wastebasket containing 2 lbs of waxed cardboard in a 6 ft × 8 ft × 10 ft high conical vented ceiling test chamber and yet would not meet the criteria specified for the small scale test. The modifications appearing in this version of NFPA 701 eliminate many test method ambiguities and clarify many of the test conditions. They also include modifications of the small scale test criteria that eliminate the bias against many thermoplastic fabrics that tended to fail the older version by virtue of continued burning along the edges of the specimen mounting frame.

The specification changes for curtain and drapery fabrics were arrived at after considerable study. Full scale burn tests of 14 manufactured draperies showed that they could

be segmented into two categories after the ignition source was removed. One group burned totally and also failed the small scale test. The second group had less than 20 percent of the area consumed and was self extinguishing. Six thermoplastic fabrics that were in the second category failed the small scale test. Subsequent interlaboratory tests involving eight facilities and 12 commercially available fabrics showed that the small scale test was failing all thermoplastic fabrics while all but two passed the large scale folded test. On the basis of this work on curtain and drapery fabrics the decision was made to revise the pass/fail criteria for such fabrics.

Since films and heavy fabrics for other applications were not included in the body of the work, no changes have been made in the acceptance criteria for them. However, this revision includes a number of improvements in the description of the test for all fabrics and films.

Appendix B Comments with Respect to Scope and Applicability of NFPA 701

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

B-1 General Considerations.

B-1.1 While it is not possible to make combustible textiles and films completely resistant to charring and decomposition when exposed to flame or high temperature, a degree of flame resistance can be achieved. Both natural and synthetic fiber textiles can be treated chemically to increase their flame resistance. Such treatments may be fugitive and hence not durable to laundering, drycleaning, or water leaching, while other treatments are very durable and will withstand many cycles of laundering, drycleaning, or water leaching. Furthermore some synthetic fibers are made from polymers that contain flame retardants in their basic structure. Both approaches may be necessary to impart flame resistance to materials in which different types of fibers are blended. It should be noted, however, that combinations of the flame-resistant fibers with relatively small percentages of non-flame resistant fibers may interfere with the flame resistant effect.

B-1.2 The hazards introduced by combustible textiles may, of course, be avoided entirely where the use of such noncombustible fibers as glass is practical.

B-1.3 Many flame-resistant synthetic materials will soften and melt when exposed to heat and fire. They may also be subject to twisting, shrinking, dripping, and elongation when subjected to fire conditions.

B-2 Applications of Flame-Resistant Fabrics.

B-2.1 Standards for theatre scenery, curtains, and furnishings in assembly occupancies are commonly set by law.

B-2.2 Flame-resistant fabrics are used in hotels, hospitals, and similar occupancies in the interest of the preservation of lives and property from fire.

B-2.3 Flame-resistant fabrics are also used as work clothing in industries where exposure to heat, open flames, and flash fire is a possibility.

B-2.4 Fabrics treated for flame and weather resistance are used for tents, tarpaulins, and other outdoor protective covering.

B-2.5 Reinforced plastic films with flame-resistant qualities are used in membrane structures.

B-2.6 Transparent plastic films are often used as a temporary enclosure for greenhouses and for construction work.

B-3 Flame Retardant Treatments.

B-3.1 An increasing range of flame retardant treatments for natural and synthetic fiber materials is becoming available. The selection of a particular treatment is governed by the intended use of the treated fabric.

B-3.2 Topical treatments based on water soluble chemicals are generally the least expensive and most easily applied, but they are subject to removal by the leaching action of water in laundering, scrubbing, or exposure to weather.

B-3.3 Some treatments may be impaired by the action of the solvents used in drycleaning and some may gradually lose their effectiveness under conditions of storage and use not involving leaching.

B-3.4 Relatively temporary treatments are suitable only where proper retreatment and renewal can be assured, or for decorations and other items that are used briefly, then discarded.

B-3.5 Situations where retreatment is uncertain or not feasible indicate the choice of one of the durable treatments that are suitable for clothing and decorative fabrics. A number of these will withstand extensive laundering and drycleaning, although they are higher in cost and require professional application.

B-3.6 For outdoor use, treatments have been developed that may be expected to remain effective for the useful life of the fabric under normal conditions of weather exposure.

B-3.7 It should be noted that painting or coating a treated or noncombustible fabric or film may impair its flame-resistant qualities unless the coating is itself flame-resistant.

B-4 Physical Properties of Treated Fabrics.

B-4.1 A number of factors, which will vary in importance depending on the end use of the fabric, should be considered in selecting a flame retardant treatment.

B-4.1.1 The effect on the appearance, texture, and flexibility of the fabric is often of primary concern.

Appendix C Discussion of Match Flame Test

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

C-1 General.

C-1.1 Field tests for flame resistance — what are they or what should they be, what do they mean, how dependable are they? These are complex and controversial questions, and the answers can vary considerably depending upon many factors and circumstances. If field tests are to be used as part of a regulatory program, it is vitally important that their function and validity be understood.

C-1.2 With rare exceptions, small scale field tests leave something to be desired and are not as good or as reliable as formal laboratory tests. Therefore, it is strongly recommended that, whenever possible, tests should be performed strictly in accordance with the requirements of Chapters 3 and 6 for the laboratory test. The greatest deficiency in field tests is that in most instances the size and number of samples that can be taken for test are very limited. In the context of this field test, the test flame can be subject to much variation, and a completely draft-free location for testing is seldom available.

C-2 Application/Specific Limitations.

C-2.1 Field tests may be useful to regulatory officials in the field for the purpose of indicating under the uncontrolled conditions of the field test whether a material being used or installed burns very easily or may be moderately flame-resistant as indicated by (a) extinguishing when the igniting flame is removed, (b) failing to burn at all, or (c) continuing to burn nonaggressively after the igniting flame is removed. The material may or may not pass the laboratory version of NFPA 701. The field test only has value when the authority having jurisdiction has no reliable laboratory data about what is being tested and, therefore, is forced to rely solely on the field test findings.

C-2.2 There are only two types of decorative materials for which field tests can be deemed to provide foolproof and totally adequate results: those made entirely of noncombustible inorganic material, and those that ignite and burn readily on exposure to a small flame. For example, with only a little experience an inspector will have no difficulty in identifying an all-glass fabric by means of a very small scale field test, and nothing more is necessary. The only effect of a small fire exposure on a glass fabric is to burn off the surface coloring, if any, leaving the threads themselves virtually undamaged. This result is not obtained with any other type of decorative fabric and it is readily recognized. At the other extreme, if a material ignites and burns readily with a very small scale test, showing no semblance of flame resistance, again nothing more is necessary since the material obviously is not acceptable.

C-2.3 Between these two extremes, field tests have a limited and a varying degree of reliability. In this large group, comprising the great majority of materials the inspector is likely to encounter in the field, the most reliable results will be obtained in the testing of cellulose-based materials (cotton, rayon, and paper), flame retardant treated with the common inorganic salt formulations. These materials retain their shape reasonably during testing, and the results are not greatly affected by differences in sample size or severity of fire exposure. On the other hand, the least reliable results are obtained with chemically treated fabrics of synthetic fibers or flexible plastic films and laminates. These materials are subject to a variety of physical changes when exposed to fire, such as shrinking, curling, melting, elongating, and similar distortions, making the testing of small samples quite difficult and the results ambiguous. Furthermore, some of these thermoplastic materials are apt to appear flame resistant with small flame exposures, but ignite and burn fiercely with larger and longer exposures.

C-3 Number of Specimens.

C-3.1 Probably the most difficult and controversial question relates to the minimum number of specimens that should be tested. The answer must be dictated by a number of factors, and certainly a good general rule would be the more specimens, the better; but, in all cases, the inspector must exercise good judgment. The variety of circumstances that can be encountered is perhaps illustrated by some specific examples:

(a) A dance in a school gymnasium, student-decorated with a profusion of paper banners, crepe paper streamers, figures made of pieces of tissue paper stuffed in chicken wire molds, hay and straw, painted fabrics, dry palm fronds, and you-name-it, all supposed to be flame resistant: In this situation, the inspector has neither reason nor excuse to be inhibited in his taking of samples for tests. The materials are inexpensive, more than likely are not intended to be reused, and the taking of samples for tests will cause little if any change to the decorative effect.

(b) A large assembly tent made of supposedly treated canvas but with no identifying marks and no confirming evidence of such treatment: The life hazard is acute, tent canvas can readily be patched, and, therefore, the situation calls for nothing less than the taking of sufficient samples from all sections of canvas for the inspector to be satisfied that the quality and uniformity of the treatment are acceptable.

(c) A nightclub with very expensive draperies known to be adequately flame retardant treated when installed two years ago: Is the quality of flame resistance still acceptable? The only way to be sure is to take a sample, but this is where, in the interest of maintaining good public relations, the inspector must be very diplomatic and very persuasive. Almost always, a place can be found where a small sample, hopefully large enough, can be extracted without causing any readily visible damage, and often this is all the inspector can hope to get.

C-4 Other Technical Complications.

C-4.1 There can be complications of a technical nature. Decorative fabrics sometimes are installed overhead, in or near a horizontal position. Some plastic films or fabrics woven of thermoplastic synthetic fibers will successfully resist continued burning in the normal vertical position of test, but will exhibit continued burning if exposed in a horizontal position. Fabrics or films installed horizontally may be a serious threat to safety in a fire situation, and, therefore, the inspector is justified in testing the material in a horizontal position.

C-4.2 A somewhat similar problem can exist with some of the new and increasingly popular decorative fabrics with one or more types of fibers in the threads along the length (warp) and different fibers in the threads along the widths (fill). This can result in a different burning behavior in the two directions of the fabric, to the extent that where a flame retardant treatment has been applied, tests for flame resistance in one direction may be acceptable, but the fabric could show continued burning in the other direction. Where visual examination of the fabric indicates this condition might exist, the inspector should test samples cut with the long dimension paralleling both the length and width of the fabric.

C-5 Experience of Inspector/Accuracy of Method.

C-5.1 By far the greatest benefit can be derived from field tests when the inspector has had the opportunity to practice and experiment on a variety of decorative materials, and particularly make comparisons between the results of more formal laboratory tests and the less precise field tests. Here, too, experience is the best teacher, and it is strongly recommended that inspectors who may be involved in this activity familiarize themselves with a wide variety of treated and inherently flame resistant fabrics of many types and their typical behavior under a variety of test conditions. With this background, the inspector is much more capable of properly interpreting field test results.

C-5.2 The deficiencies and limitations of field tests can lead to misleading or erroneous results, and the error can be in both directions. It is quite possible to have a too-small sample show several seconds of afterflaming, and the material may be rejected when full-scale tests would show it to conform. This, of course, is unfair to the owner, but at least the error is in the direction of safety. Unfortunately, it is equally possible for improper or inadequate field tests to indicate satisfactory flame resistance, whereas formal testing would show an unacceptable degree of flame resistance. Obviously, this can be a dangerous error.

C-6 Summary.

C-6.1 Field tests certainly are better than nothing, but they must be used with good judgment and their limitations recognized.

C-6.2 Field tests must not be relied upon as the sole means for insuring adequate flame resistance of decorative materials but are useful to augment a comprehensive regulatory program.

Appendix D Bibliography

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

D-1 Bibliography.

(a) Arnold, G., Fisher, A., and Frohnsdorff, G., *Gillette Research Institute Final Report (March 26, 1973)*, abstracted in the "Proceedings of the 1974 International Symposium on Flammability and Fire Retardants" (Editor: V.M. Bhatnager), Technomic Publishing Company, Lancaster, PA 17604.

(b) Belles, D.W., and Beitel, J.J., "Do Multi-Layer Draperies Pass the Single-Layer Fire Test?" *Fire Journal*, September-October 1988, pp 25-30, 90-91.

(c) Krasny, J.F., and Fisher, A.L., Laboratory Modeling of Garment Fires, *Textile Research Journal*, 43, 272-283 (1973).

(d) McCullough, E.A., and Noel, C.J., *Flammability Characteristics of Layered Fabric Assemblies*, in "Proceedings of the 12th Annual Meeting, Information Council on Fabric Flammability," 1978, pp. 175-184.

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INSTRUCTIONS

Please use the forms which follow for submitting proposed amendments. Use a separate form for each proposal.

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3. In the space identified as "Proposal" include the wording you propose as new or revised text, or indicate if you wish to delete text.

4. In the space titled "Statement of Problem and Substantiation for Proposal" state the problem which will be resolved by your recommendation and give the specific reason for your proposal including copies of tests, research papers, fire experience, etc. If a statement is more than 200 words in length, the technical committee is authorized to abstract it for the Technical Committee Report.

5. Check the box indicating whether or not this proposal is original material, and if it is not, indicate source.

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Date 5/18/85 Name John B. Smith Tel. No. 617-555-1212

Address 9 Seattle St., Seattle, WA 02255

Representing (Please indicate organization, company or self) Fire Marshals Assn. of North America

1. a) Document Title: Protective Signaling Systems NFPA No. & Year NFPA 72D

   b) Section/Paragraph: 2-7.1 (Exception)

2. Proposal recommends: (Check one) ☐ new text
   ☐ revised text
   ☒ deleted text.

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted):

   Delete exception.

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   A properly installed and maintained system should be free of ground faults. The occurrence of one or more ground faults should be required to cause a "trouble" signal because it indicates a condition that could contribute to future malfunction of the system. Ground fault protection has been widely available on these systems for years and its cost is negligible. Requiring it on all systems will promote better installations, maintenance and reliability.

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