NFPA No. 701

STANDARD

for

FLAMEPROOFED TEXTILES

Adopted by

NATIONAL FIRE PROTECTION ASSOCIATION
NATIONAL BOARD OF FIRE UNDERWRITERS

1951

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The National Fire Protection Association was organized in 1896 to promote the science and improve the methods of fire protection and prevention, to obtain and circulate information on these subjects and to secure the cooperation of its members in establishing proper safeguards against loss of life and property by fire. Its membership includes over a hundred and eighty national and regional societies and associations and more than thirteen thousand individuals, corporations, and organizations.

This pamphlet is one of a large number of publications on fire safety issued by the Association. The standards prepared by the technical committees of the National Fire Protection Association and adopted in the conventions of the Association, are intended to prescribe reasonable measures for minimizing fire losses. All interests concerned have opportunity through the National Fire Protection Association to participate in the development of the standards and to secure impartial consideration of matters affecting them.

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FLAMEPROOFED TEXTILES

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This standard, prepared by the Committee on Flameproofing and Preservative Treatments and adopted by the National Fire Protection Association at the 55th Annual Meeting on May 11, 1951, is a complete revision of "Recommended Requirements for Flameproofing Textiles" adopted in 1941 and reprinted in pamphlet form in 1948.

This standard contains changes in performance requirements under recommended test methods for flameproofed textiles (other than clothing) which are not resistant to dry cleaning, laundering or weather exposure as well as those which are resistant to such exposures. Several laboratories have conducted important research since the publication of the 1941 standard, the results being reflected in the present edition. The appendix of the standard also includes several suggested methods of flameproofing treatments and formulas not included in the 1941 edition.

Action by the NFPA in the adoption of this standard is recorded in the Proceedings of the 55th Annual Meeting.

NFPA COMMITTEE ON FLAMEPROOFING AND PRESERVATIVE TREATMENTS

R. E. DUFOUR, *Chairman*
Underwriters' Laboratories, Inc.
207 East Ohio Street, Chicago 11, Illinois

D. L. DAVIES,
American Wood-Preservers Assn.

THOMAS G. FISHER,*
Special Enforcement Officer, Office of the State Fire Marshal, California

E. W. FOWLER,
National Board of Fire Underwriters.

MALCOLM A. JENCKES,
Conference of Special Risk Underwriters.

DR. EDWARD J. KENNEY,
American Hotel Assn.

R. G. KIMBELL,
National Lumber Manufacturers Assn.

ROBERT W. LITTLE,*
Research Dept., Hercules Powder Co.

HAROLD E. MUIR,
Factory Insurance Assn.

DR. MARJORIE W. SANDHOLZER,
National Bureau of Standards

R. G. SHEPHERD,
Factory Mutual Engineering Division.

A. J. SMITH,†
Committee on Marine Fire Protection

W. F. STEFFENS,
Assn. of American Railroads, Fire Protection & Insurance Section.

A. J. STEINER,
Underwriters' Laboratories, Inc.

T. R. TRUAX,
Forest Products Laboratory.

WARREN C. HYER
(Alternate to Dr. Edward J. Kenney.)

* Serving in a personal capacity in accordance with Par. 11-b-2 of the regulations on Technical Committee Procedure.

† Deceased.

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INTRODUCTION

While it is not possible to make combustible textiles resistive to charring and decomposition when exposed to flame or high temperature, flameproofing and glowproofing treatments can be applied that will considerably reduce their flammability and tendency toward smoldering or flameless combustion. The potential fire hazards incidental to the use of combustible fabrics for decorative or utilitarian purposes may, therefore, often be reduced to a large extent by flameproofing treatments. These fire hazards are avoided by the use of noncombustible fabrics, and such fabrics are preferable when they are practical for the intended use.

The effects of chemical treatments in reducing the flammability of combustible fabrics are varied and complex, and all phases are not fully understood. Apparently different chemicals or mixtures react in different ways to retard spread of flame and afterglow.

The flameproofing of theater scenery, curtains, and draperies in places of public assembly is commonly required by law. Flameproofed fabrics are used in hotels, hospitals and other occupancies in the interest of preservation of lives and property from fire. Suitable flameproofed fabrics are also used for tents and awnings, tarpaulins, boat and truck covers, and other outdoor protective coverings.

In selecting a flameproofing treatment, consideration should be given to the intended use of the treated fabric. Where the chemicals employed in flameproofing treatments are water soluble, the treatment is usually nullified by the leaching action of water encountered in laundering, washing, scrubbing or exposure to weather. Some special flameproofing treatments for fabrics used for specific purposes have been developed which may be expected to remain effective under ordinary conditions of exposure to water or weather for the useful life of the fabric. Flameproofing treatments which are not impaired by the leaching action of water may not necessarily resist the action of solvents commonly used in dry cleaning. Some flameproofing treatments may gradually lose their effectiveness under conditions of storage and use not involving dry cleaning, laundering or water leaching.

The painting or coating of an otherwise flameproofed or noncombustible fabric may impair the flame-retardant qualities of the material. Persons charged with the selection of noncombustible or flameproofed

fabrics should make certain that no such treatment has been applied which would impair the flame-retardant qualities of the fabric.

Certain flameproofing treatments may cause objectionable changes in the appearance, texture, or flexibility of textile fabrics. Some flameproofed fabrics may become tacky when subjected to high atmospheric temperatures, or may crease or crack when subjected to low temperatures. A few chemicals sometimes used in flameproofing treatments are very hygroscopic, and may absorb sufficient moisture from the atmosphere to make the treated fabric objectionably damp. Some other flameproofing chemicals become dusty or powdery, through loss of water of crystallization on exposure to the air, and may thus separate from fabrics to an extent that the flameproofing treatment loses its effectiveness.

Flameproofing treatments may reduce the strength of the fabrics treated, though in many uses of flameproofed fabrics this is not always an important factor. Some chemicals used in flameproofing treatments may tend to deteriorate wood or corrode metal with which the treated fabric is in contact.

It is important that flameproofing treatments should involve no chemicals which may cause adverse physiological reactions in persons handling or otherwise exposed to the treated fabrics.

Flameproofed fabrics intended for use as clothing demand special consideration and are outside the scope of the "Standard for Flameproofed Textiles."

PART I

TEXTILES FLAMEPROOFED BY TREATMENTS NOT RESISTANT TO DRY CLEANING, LAUNDERING, OR WEATHER EXPOSURE

Section 1. Scope

1-1 General

These requirements apply mainly to flameproofed fabrics used for decorative or other purposes on the inside of buildings or other structures. Since the flameproofing treatments may be completely nullified by dry cleaning, laundering, or the leaching action of water, the fabrics will require retreatment after every dry cleaning, and after every laundering, washing, scrubbing, exposure to weather, or other exposures where the flameproofing chemicals are subjected to leaching by water. Some flameproofing treatments gradually lose their effectiveness even though not subjected to dry cleaning, laundering, weathering, or exposure to water, and these will require appropriate renewal.

1-2 Small Scale Test

It is the intent of the requirements set forth in Section 2–1 to provide a test to determine that treated fabrics are not readily ignited by small sources of ignition such as matches, cigarette lighters, sparks, small coals, and smoldering cigars and cigarettes, and that the flaming or smoldering combustion which occurs on ignition does not spread on the fabric beyond the vicinity of the source of ignition. Flameproofing processes producing results which comply with the requirements may not protect a fabric against flaming or smoldering combustion under severe fire exposure or when hung in folds or parallel strips.

1-3 Larger Scale Test

It is the intent of the additional requirements set forth in Section 2–2 to provide a test on a somewhat larger scale to determine that treated fabrics are comparatively difficult to ignite and do not propagate flame, even when in drafts, beyond the area exposed to the source of ignition, when used in single sheets or in folds. Flameless or smoldering combustion which occurs on ignition may spread in folds, but in the case of single sheets, will not extend beyond the area exposed to ignition. Flameproofing processes producing results which comply with these requirements may not protect a fabric against flaming or smoldering combustion under severe fire exposure.

Section 2. Flameproofing Requirements

2-1 Performance Requirements — Small Scale Test

When subjected to the small scale test described in Section 3–1, a fabric shall not continue flaming for more than two seconds after the test flame is removed from contact with the specimen. The vertical spread of

flame and afterglow (smoldering combustion) on the fabric, as indicated by the length of char, shall not exceed the values shown in Table I.

Table I

PERMISSIBLE LENGTH OF CHAR — SMALL SCALE TEST

Weight of Treated Fabric Being Tested (Ounces per square yard)	Maximum Average Length of Char for Ten Specimens (Inches)	Maximum Length of Char for Any Specimen (Inches)
Over 6	3½	4½
Over 2 and not exceeding 6	4½	5½
Not exceeding 2	5½	6½

2-2 Performance Requirements — Larger Scale Test

When subjected to the larger scale test described in Section 3–2, a fabric in single sheets or in folds shall not continue flaming for more than two seconds after the test flame is removed from contact with the specimen. The vertical spread of flame and afterglow (smoldering combustion) on the fabric in single strips, as indicated by the length of char above the tip of the test flame, shall not exceed 10 in. The vertical spread of flame on the fabric in folds shall not exceed 10 in. above the tip of the test flame, but the afterglow may spread in the folds.

Section 3. Test Methods

3-1 Flame Test — Small Scale

(a) Five specimens of the fabric, 2¾ by 10 in., shall be cut with their long dimension in the direction of the warp and five in the direction of the filling. Each lot of five shall be cut from at least four places in the sample separated sufficiently to give indication as to the uniformity of the flameproofing treatment.

(b) The test specimens shall be suspended and heated in an oven having mechanical circulation of air, at temperatures of 140° to 145° F., for durations of not less than 1 hour nor more than 1½ hours before testing. Specimens shall be removed from the oven one at a time and immediately subjected to the flame test described in Section 3–1 (d).

(c) In conducting the flame test, the specimen shall be placed in a holder of metal which clamps each long edge of the fabric, leaving the ends free and exposing a strip 2 in. wide by 10 in. long. The holder and specimen shall be supported in vertical position within a shield 12 in. wide, 12 in. deep, and 30 in. high, open at the top, and provided with a door or sliding panel having an observation window of glass. Provision shall be made for moving the gas burner used in igniting the specimen into test position after the shield is closed. A rod attached to the base of the burner and extending through a slot near the bottom of one side of the shield will serve the purpose.

(d) The specimen shall be supported with its lower end ¾ in. above

the top of a Bunsen or Tirrill gas burner, having a tube of ⅜ in. inside diameter, and with the air supply completely shut off, adjusted to give a luminous flame 1½ in. long. The flame shall be applied vertically near the middle of the width of the lower end of the specimen for 12 seconds, then withdrawn, and the duration of flaming on the specimen noted.

(e) After all flaming and afterglow on the specimen has ceased, the length of char shall be determined. The length of char in this test is defined as the distance from the end of the specimen which was exposed to the flame to the end of the tear made lengthwise of the specimen through the center of the charred area in the following way: A hook is inserted in the specimen, on one side of the charred area ¼ in. in from the adjacent outside edge. A weight, which inclusive of the hook is equal to that specified for the fabric in Table II, is attached to the hook. 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 fabric strong enough to carry the load is reached.

Table II

TEARING WEIGHTS — SMALL SCALE TEST

Weight of Treated Fabric Being Tested (Ounces per square yard)	Total Tearing Weight for Determination of Length of Char (Pounds)
2 to 6 inclusive	0.25
Over 6 and not exceeding 15	0.5
Over 15	0.75

3-2. Flame Test — Larger Scale

(a) The following method for conducting flammability tests of treated fabrics employs a larger specimen and a larger test flame than are specified for the small scale test, Section 3–1. This method is also useful for investigating the flammability of treated fabrics when hung in folds.

(b) For conducting flammability tests of fabrics in single sheets, five specimens, 5 in. by 7 ft., shall be cut from the sample. For conducting flammability tests of fabrics hung in folds, a specimen 25 in. by 7 ft. shall be cut from the sample and folded longitudinally so as to form five folds each, 5 in. wide. Specimens shall be cut from places in the sample separated sufficiently to give indication as to the uniformity of the flameproofing treatment.

(c) The test specimens shall be suspended and heated in an oven, having mechanical circulation of air, at temperatures of 140° to 145° F. for durations of not less than 1 hour nor more than 1½ hours before testing. Specimens shall be removed from the oven one at a time and immediately subjected to the flame test described in Section 3–2(e).

(d) The apparatus for conducting the flame test shall consist of a sheet-iron stack 12 in. square transversely, 7 ft. high, and supported 1 ft. above the floor on legs. The stack shall be open at top and bottom, and shall be provided with an observation window of wired glass extending the full length of the front.

(e) The specimen, either a single sheet or folded, shall be suspended vertically from a bar at the top of the stack so that the bottom of the specimen is 4 in. above the top of a Bunsen burner having ⅜-in. diameter tube and placed on the floor below the stack. The gas supply to the burner shall be natural gas or a mixture of natural and manufactured gases having a heat of combustion of approximately 800 to 1000 Btu per cubic foot. With a gas pressure of 4¼ in. (108 mm) of water, the burner shall be adjusted to produce an oxidizing flame 11 in. high. The flame shall be applied vertically near the middle of the width of the lower end of the specimen in a single sheet, or to the middle of the width of the lower end of the middle fold of the specimen in folds. The position of the specimen relative to the test flame shall be maintained by guide wires attached to the outer edges of the specimen.

(f) The test flame shall be applied to the specimen for two minutes, then withdrawn, and the duration of flaming combustion on the specimen recorded. 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 tip of the test flame to the top of the charred area resulting from spread of flame and afterglow.

PART II

TEXTILES FLAMEPROOFED BY TREATMENTS RESISTANT TO DRY CLEANING, LAUNDERING, OR WEATHER EXPOSURE

Section 4. Scope

4-1. General

(a) These requirements apply to flameproofed fabrics subject to dry cleaning, laundering, weathering, or to exposures where the fabrics may come in contact with water.

(b) The intent of the requirements set forth in Section 5–1 and the additional requirements set forth in Section 5–2 is the same as discussed in Section 1, "Textiles Flameproofed by Treatments Not Resistant to Dry Cleaning, Laundering or Weather Exposure."

(c) Since the flameproofing treatments are expected to remain effective for the useful life of the fabric, accelerated exposure tests relating to dry cleaning, laundering, washing, scrubbing, weathering, and leaching by water are described in Sections 6–3, 6–4, 6–5 or 6–6. It is to be noted that some flameproofing treatments which are unimpaired by dry cleaning may not withstand laundering, weathering, or water leaching and vice versa. In many applications of flameproofed fabrics it is not necessary that the flameproofing treatment be equally resistant to dry cleaning, laundering, weathering or water leaching since some of the exposures may not be encountered. In applying the accelerated exposure tests described in Sections 6–3, 6–4, 6–5 or 6–6, consideration should be given to the intended use of the treated fabric. Additional requirements relative to exposure tests should be included if deemed necessary.

Section 5. Flameproofing Requirements

5-1. Performance Requirements — Small Scale Test

The treated fabric, after being subjected to the applicable accelerated exposure tests described in Sections 6–3, 6–4, 6–5 or 6–6 shall be tested as described in Section 6–1. When subjected to the flame test described in Section 6–1, a fabric shall not continue flaming for more than two seconds after the test flame is removed from contact with the specimen. The vertical spread of flame and afterglow (smoldering combustion) on the fabric, as indicated by the length of char, shall not exceed the values shown in Table III.

Table III

PERMISSIBLE LENGTH OF CHAR — SMALL SCALE TEST

Weight of Treated Fabric Being Tested (Ounces per square yard)	Maximum Average Length of Char for Ten Specimens (Inches)	Maximum Length of Char for Any Specimen (Inches)
Over 10	3½	4½
Over 6 and not exceeding 10	4½	5½
Not exceeding 6	5½	6½

5-2. Performance Requirements — Larger Scale Test

The treated fabric, after being subjected to the applicable accelerated exposure tests described under "Test Methods" following, shall comply with Section 2–2 "Flameproofing Requirements — Larger Scale Tests for "Textiles Flameproofed by Treatments Not Resistant to Dry Cleaning, Laundering or Weather Exposure."

Section 6. Test Methods

6-1. Flame Test — Small Scale

This test shall be conducted as described in Section 3–1, Test Methods for Textiles Flameproofed by Treatments Not Resistant to Dry Cleaning, Laundering or Weather Exposure.

6-2. Flame Test — Larger Scale

This test shall be conducted as described in Section 3–2 Test Methods for Textiles Flameproofed by Treatments Not Resistant to Dry Cleaning, Laundering or Weather Exposure.

6-3. Accelerated Dry Cleaning Test

(a) A sample of the treated fabric shall be agitated for 25 minutes in a suitable dry-cleaning apparatus containing a solution of 1000 parts carbon tetrachloride and six parts of dry cleaning soap. The volume of solution employed shall be in excess of that required to saturate the sample. The sample shall then be rinsed three times in pure carbon tetrachloride for periods of 5 minutes each, centrifuged and allowed to dry at room tem-

perature on a horizontal screen. When dry the sample shall be pressed or steamed. The above procedure shall be repeated a total of ten times.

(b) In order to simulate the wet cleaning sometimes encountered in dry-cleaning practice, the sample of treated fabric shall be agitated in carbon tetrachloride base solution, rinsed, centrifuged, and dried as described in the foregoing procedure. The sample shall then be placed on a porcelain, marble, or slate slab and treated with water containing 0.1 per cent neutral soap at temperature of 90° to 100° F. The fabric shall be kept thoroughly wet for 15 minutes. The sample shall then be rinsed for five minutes in water at 90° to 100° F., centrifuged, and allowed to dry at room temperature on a horizontal ventilated screen. When dry the sample shall be pressed or steamed. The above procedure shall be repeated a total of ten times

6-4. Accelerated Laundering Test

A sample of the treated fabric shall be washed in a 0.25 per cent solution of tallow soap of low titer dissolved in water not exceeding 50 parts per million hardness. A suitable automatic machine with a fixed operating cycle of approximately 28 minutes shall be used. The cycle shall consist approximately of a 12-minute washing in the soap solution at 125° F., three 2½-minute rinsing periods, and a 3-minute extraction period, the remaining time to be allotted to inlet or outlet of the water in the machine. The sample shall be allowed to dry at room temperature on a horizontal ventilated screen, moistened, and pressed with a flat iron at a temperature of 275° to 300° F. The above procedure shall be repeated a total of ten times.

NOTE: **Commercial Laundering.** The above test procedure simulates ordinary home laundering practice. Some commercial laundering methods may completely nullify flameproofing treatments. Commercial laundering practices vary considerably with respect to features which may reduce the effectiveness of flameproofing treatments, including the soaps or other detergents used, the temperatures which may be encountered, and the amount of mechanical wear imposed on the fabric. Sometimes bleaching compounds or very dilute solutions of weak acids are used which may impair flameproofing treatments. Where instructions with respect to laundering of flameproofed fabrics are provided by manufacturers or treaters of the fabrics, these instructions should be followed. When the effects of laundering on a flameproofing treatment are unknown, representative specimens of the treated fabric should be subjected to flame tests after repeated laundering by the specific methods selected or proposed.

Scrubbing. Certain articles of flameproofed fabric not ordinarily washed by home or commercial laundering methods are sometimes scrubbed vigorously on one or both sides, applying laundry soap (or other detergent) and water with a stiff bristle brush. The fabric is then thoroughly rinsed with water and dried. Where treated fabrics are likely to be cleaned in this manner during their use, test specimens should be subjected to flame tests after repeated cycles of scrubbing as outlined.

6-5. Accelerated Water Leaching Test

A sample of the treated fabric shall be totally submerged in a vessel containing tap water at room temperature for a period of 72 hours. The vessel shall have a capacity of at least 4 gallons of water. The water shall be drained from the tank and replenished at 24-hr. intervals during the immersion period. At the conclusion of the immersion period, the sample shall be removed from the test vessel and dried at room temperature.

6-6. Accelerated Weathering Tests

One of the two test procedures described below should be followed:

(a) The apparatus shall consist of a vertical carbon arc with solid electrodes 0.5 in. in diameter (1 cored electrode is used if the arc operates on alternating current) and uniform in composition throughout, mounted at the center of a vertical metal cylinder. The arc shall be surrounded by a clear globe of No. 9200 PX Pyrex glass 0.0625 in. thick or other enclosure having equivalent absorbing and transmitting properties. The electrodes shall be renewed at intervals sufficiently frequent to insure full operative conditions of the lamp. The globe shall be cleaned when carbons are removed or at least once in each 36 hours of operation. The arc shall be operated on 13 amperes direct or 17 amperes, 60-cycles alternating current with the voltage at the arc 140 volts. The specimens for test shall be mounted on the inside of the cylinder facing the arc. The diameter of the cylinder shall be such that the distance of the face of the specimen holder from the center of the arc is 14¾ in. The cylinder shall rotate about the arc at a uniform speed of approximately three revolutions per hour. A water spray discharging about 0.7 gallons per minute shall strike each specimen in turn for about 1 minute during each revolution of the cylinder. Specimens shall be subjected to this exposure for 360 hours. They shall then be allowed to dry thoroughly at a temperature between 70° and 100° F.

(b) The apparatus shall consist of a vertical carbon arc mounted at the center of a vertical cylinder. The arc is designed to accommodate two pairs of carbons, No. 22, upper carbons, and No. 13 lower carbons; however, the arc burns between only one pair of carbons at a time. The arc shall be operated on 60 amperes and 50 volts across the arc for alternating current or 50 amperes and 60 volts across the arc for direct current. The specimens for test shall be mounted on a rotating rack inside the cylinder and facing the arc. The diameter of the rotating rack shall be such that the distance from the center of the arc to the face of the specimen is 18¾ in. The rack shall rotate about the arc at a uniform speed of about 1 revolution in 2 hours. No filters, or enclosures, shall be used between the arc and the specimens. Spray nozzles shall be mounted in the cylinder so that the specimens shall be exposed to wetting once during each revolution of the rack. Specimens shall be subjected to this exposure for 100 hours. They shall then be allowed to dry thoroughly at a temperature between 70° and 100°F.

PART III

FIELD TESTS FOR FLAMEPROOFED TEXTILES

Section 7. Clamp Test

7-1. General

The following method for conducting flame tests of textiles such as curtains in place uses a vertical clamp with attachment for supporting the candle that enables the test to be conducted with convenience and a minimum of incidental variation in the test results due to the method of testing. The clamp is inserted at a horizontal edge or slit in the fabric or at a vertical edge or slit that can be placed in horizontal position for testing. The clamping of the material in the device will prevent spread of fire to portions of the material beyond the area exposed in the clamp. Due care must, however, be taken in any use of open flame in the presence of combustible materials.

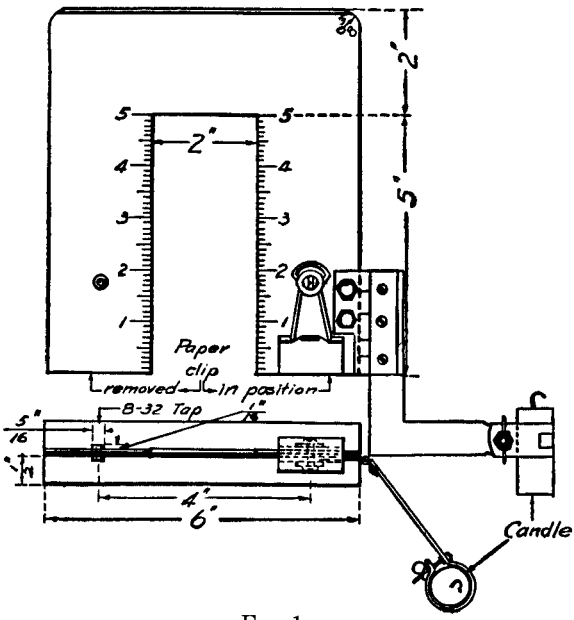


FIG. 1

TEST CLAMP FOR MAKING FLAME TESTS OF TEXTILES IN PLACE

The clamp is made of No. 14 gauge rolled brass (0.065-in.) and is made of two pieces in duplicate as shown, with graduations to 1/10-in. on one side of one piece. The clamp is chromium plated with outside surfaces polished.

7-2. Scope

These requirements supplement those provided in Part I and Part II. This field test is intended to accomplish the same result as that achieved by flame tests described in Sections 3–1 and 6–1, and the same general requirements apply.

7-3. Performance Requirements — Clamp Test

When tested by the method described in Section 7–4, a fabric shall not continue flaming for more than two seconds after the test flame is removed from contact with the specimen. The average length of char in three tests shall not be more than 2½ in. for heavy ducks and drapery material, and not more than 4½ in. for any fabric. By length of char is meant the length from the zero point on the scale to the point on the scale opposite the end of a tear through the charred area. This is to be made by hand with enough force to tear through the charred or scorched portion but not sufficient to break undamaged threads.

7-4. Test Method

(a) The test clamp, as illustrated, holds the portion of the curtain or other fabric to be tested at any convenient edge or slit. The candle is of paraffin and of ¾-in. nominal diameter. It is swung away from the fabric and the tapered portion allowed to burn away until a normal constant flame is reached. The wick should bend to near the outer boundary of the flame and burn to a length that remains constant at about ⅝ in. The candle is then adjusted in its holder until the top of the wick is 1/10 in. below the bottom edge of the fabric or zero point on the graduated scale. The candle flame is applied to the exposed edge of the fabric for 12 seconds. The tear is to be made by applying pressure by hand against the side of the specimen as mounted in the clamp.

(b) The clamp is made of duplicate pieces of sheet metal about $\frac{1}{16}$ in. thick, held with spring type paper clamps 1¼-in wide. The candle holder can be made of a ¾-in. hose clamp bolted to a window screen corner angle and hinged to the front clamp member with a 2 by ½-in. brass hinge, the lower portion of one leaf of which is cut away to clear the paper clamp. The hinge and clamp support are mounted in such a manner that the candle will swing against a stop when its center is directly under the middle of the 2-in. wide exposed lower edge of the specimen.

Section 8. Match Flame Test

8-1. Test Method

In conducting this test, a sample of the material is taken to a location where the test may be conducted safely. The sample is held in a position favorable to burning and tested by application of a flame from a common paper match held in a horizontal position, ½-in. under the sample; and at a constant location for a minimum of 15 seconds. Observations are made to determine that the textile sample does not ignite and spread flame over its surface.

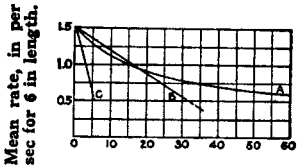
APPENDIX

FLAMEPROOFING TREATMENTS

I. Decorative Textiles

Hundreds of different chemicals have been used or tested for flameproofing fabrics. Many proved reasonably effective flameproofings, but only a few are in general use. Many chemicals are not suitable because of objectionable characteristics such as moisture absorption, change in color or deterioration of the fabric, deterioration under high-temperature drying or pressing, corrosion of metal in contact with the fabric, toxicity, requiring an excessively heavy weighting of the fabric to be effective, requiring difficult techniques in application, or being unduly expensive.

Mixtures of two or more chemicals are usually more effective than the same chemicals used alone. Figure 2 shows that borax and boric acid together are far more effective than the same weight of either chemical alone.



A—Boric Acid.
B—Borax.
C—Boric Acid and Borax (50:50).

FIG. 2. RATE OF FLAME PROPAGATION

There are many proprietary flameproofing preparations† which vary greatly in effectiveness, cost and other factors such as tendency to absorb moisture. The purchaser should consult responsible testing authorities prior to purchase and use.

Many concerns specialize in the effective flameproofing treatment of theater scenery, draperies and other fabrics, using standard flameproofing chemicals. It is advisable to deal only with concerns of known reliability, or if dealing with an unknown concern, to have treated fabrics tested for adequacy of treatment.

Most of the treatments used are not resistive to water since the chemicals are water-soluble. A few have been developed that resist leaching action from exposure to weather, laundering, or dry cleaning.

Most of the treatments in use cause very little reduction in the strength of the fabric, but when subjected to higher than normal temperature and sunlight, some of the treatments cause decided loss in strength.

† Information on a number of proprietary preparations is given in Research Report No. 8, "Textile Flameproofing Compounds," published by American Hotel Association, 221 W. 57th St., New York, New York, 1947.

It is often important that change in color and texture shall not be caused by the flameproofing treatment of fabrics, and there are a number of treatments that will meet this requirement. Few of the treatments used contain chemicals that would cause poisoning or injury from handling of the treated fabric.

References

Detailed information on the history, techniques of treatment and testing of flameproofed textiles may be found in the following references:

Flameproofing and Preservative Treatments, Chapter 31, Tenth Edition (1948), Handbook of Fire Protection, NFPA.

Flameproofing Textiles, Circular C455, National Bureau of Standards, 1946.

Report of Fabrics Coordinating Research Committee, British Dept. of Scientific and Industrial Research, 1930, Reviewed by A. H. Nuckolls, NFPA Quarterly Vol. 24, No. 2, page 184.

The Fireproofing of Fabrics, British Dept. of Scientific and Industrial Research, 1947.

Flameproofing Textile Fabrics, by Robert W. Little, Reinhold Publishing Co., New York, N. Y., 1947.

Symposium on Flame Retarding of Textiles, Industrial and Engineering Chemistry, Vol. 43, No. 3, March, 1950, pages 414–445.

Methods of Application

Water soluble flameproofing chemicals may be applied by immersion of the fabric in a solution, by spraying, or by brushing. The objective is to deposit in the fabric the desired amount of the flameproofing chemicals, measured in terms of percentage increase in weight of the fabric after treatment and drying, as compared with the original weight. As long as uniform treatment and the desired increase in weight are obtained, the particular method of application and the proportion of water used in the solution are unimportant. Good results may be obtained by dipping, spraying or brushing; the method selected is dictated by convenience and the character of the fabric to be treated.

Effective flameproofing treatments may be obtained by the use of nonproprietary solutions of flameproofing chemicals in water, without professional assistance, after some experience and testing of the results. The chemicals should be dissolved in clean water. Warm water and stirring will dissolve chemicals more quickly.

It is desirable to wash new fabrics containing sizing prior to treatment so as to secure proper absorption of flameproofing chemicals. Commercial wetting agents may be added to the treating solution to increase penetration of flameproofing ingredients.

When a piece of fabric is immersed, usually at room temperature, in a flameproofing solution, the container must be large enough so that all the fabric is thoroughly wet and there are no folds which the solution does not penetrate, if too small tubs or tanks were used.

Care must be used in the wringing of the immersed material. If a mechanical wringer is used, more of the solution is likely to be extracted and a more concentrated solution may be necessary to obtain the desired weighting. Best results will be obtained if the articles can be dried in a horizontal position. Drying in a vertical position permits a certain amount of drainage of the solution, depending upon the wetness of the wrung articles. It is advisable to increase the weighting if horizontal drying is not feasible.

Where solutions are applied by brushing or spraying some skill is required for uniform application; repeated application may be necessary to secure the desired weighting.

It is difficult to flameproof cellulose acetate fabrics. Flameproofing of fabrics made from proprietary synthetic fibers requires separate consideration, taking into account the effectiveness and suitability of the treatment for the given fabric.

Formulas

The nonproprietary flameproofing formulations described in the following are applied mainly to fabrics used for decorative or other purposes inside buildings. They are intended to provide protection against small sources of ignition such as matches, cigarette lighters, sparks, small coals, and smoldering cigars and cigarettes, and do not necessarily protect a fabric against flaming combustion under severe fire exposure, or when hung in folds or parallel strips. Renewal of the treatment is required after a certain time, and after every laundering, dry cleaning, or exposure to weather where the flameproofing chemicals are subject to leaching by water. Where flameproofing is required by law, it is common practice to require renewal of treatments at least annually.

Formulas Nos. 1 to 5 are published by the National Bureau of Standards; Nos. 6 and 7 by the American Hotel Association.

Formula No. 1:

Borax, $Na_2B_4O_7.10H_2O$	6 parts	6 lb.
Boric acid. H_3BO_3	5 parts	5 lb.
Water	100 parts	12 gal.

The fabric is steeped in a cool solution until thoroughly impregnated, then dried. Heavy applications by spray or brush are usually reasonably effective. Such applications may have to be repeated two or three times with drying between applications to obtain the desired degree of flameproofing. The treatment has been used for many kinds of fabrics, including theater scenery. It is recommended for rayon. As in the case of most of the other formulas listed, care must be taken in ironing the fabric to avoid discoloration by heat.

The treatment is effective in weighting from 8 to 12 per cent, depending upon the type of fabric. Hand-wringing the above solution from a fabric leaves a weighting of 10 to 12 per cent after drying.