

UL 94

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Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

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UL Standard for Safety for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances,
UL 94

Fifth Edition, Dated October 29, 1996

Revisions: This Standard contains revisions through and including June 2, 2006.

Summary of Topics

The following changes in requirements are being adopted:

1. Miscellaneous Revisions to UL 94

2. Modification of UL 94 Scope to Express Relationship to UL 1694

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Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The revised requirements are substantially in accordance with UL's Proposal(s) on this subject dated October 14, 2005 and March 17, 2006.

The revisions dated June 2, 2006 include a reprinted title page (page1) for this Standard.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

As indicated on the title page (page1), this UL Standard for Safety has been adopted by the Department of Defense.

The UL Foreword is no longer located within the UL Standard. For information concerning the use and application of the requirements contained in this Standard, the current version of the UL Foreword is located on ULStandardsInfoNet at: <http://ulstandardsinfo.net.ul.com/ulforeword.html>

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Recognition, Classified and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

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This Standard consists of pages dated as shown in the following checklist:

Page	Date
1-2A	June 2, 2006
2B-3	June 8, 2000
4-18	June 2, 2006
19	June 10, 1997
20-21	June 2, 2006
22-22B	June 8, 2000
23	June 10, 1997
24	December 12, 2003
25-28B	June 2, 2006
29	July 10, 1998
30	June 10, 1997
31-32	July 29, 1997
33-34	October 29, 1996
SA1-SA3	October 29, 1996
SA4	June 8, 2000
SB1-SB2	June 8, 2000

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1

UL 94

Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

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Third Edition – January, 1980
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Fifth Edition

October 29, 1996

The most recent designation of ANSI/UL 94 as an American National Standard (ANSI) occurred on May 18, 2006.

This ANSI/UL Standard for Safety, which consists of the Fifth edition with revisions through June 2, 2006, is under continuous maintenance, whereby each revision is ANSI approved upon publication. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <http://csds.ul.com>.

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

The Department of Defense (DoD) has adopted UL 94 on September 16, 1988. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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CONTENTS

INTRODUCTION

1 Scope	5
2 References	6
2.1 General	6
2.2 Referenced standards in this text	6
2.3 Related standards	7
3 Definitions	7
4 Significance of Tests	8
5 Apparatus	8
6 Conditioning	8B

TESTS

7 Horizontal Burning Test; HB	9
7.1 Test criteria	9
7.2 Test apparatus	9
7.3 Test specimens	9
7.4 Conditioning	10
7.5 Procedure	10
7.6 Calculations	11
7.7 Results	12
8 50W (20 mm) Vertical Burning Test; V-0, V-1, or V-2	14
8.1 Test Criteria	14
8.2 Test apparatus	15
8.3 Test specimens	15
8.4 Conditioning	16
8.5 Procedure	16
8.6 Results	17
9 500 W (125 mm) Vertical Burning Test; 5VA or 5VB	18
9.1 Test criteria	18
9.2 Test apparatus	19
9.3 Test specimens	19
9.4 Conditioning	20
9.5 Bar specimens test procedure	20
9.6 Plaque specimens test procedure	21
10 Radiant Panel Flame Spread Test	21
10.1 Test criteria	21
10.2 Test specimens	23
11 Thin Material Vertical Burning Test; VTM-0, VTM-1, or VTM-2... ..	24
11.1 Test criteria	24
11.2 Test apparatus	25
11.3 Test specimens	25
11.4 Conditioning	26
11.5 Procedure	26
11.6 Test results	27
12 Horizontal Burning Foamed Material Test; HBF, HF-1, or HF-2... ..	27
12.1 Test criteria	27

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12.2 Test apparatus	29
12.3 Test specimens	29
12.4 Conditioning	29
12.5 Procedure	30
12.6 Test results	31

MARKING

13 General	33
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SUPPLEMENT SA - FOLLOW-UP INSPECTION INSTRUCTIONS

INTRODUCTION

SA1 Scope	SA1
SA2 Glossary	SA1
SA3 Responsibility of the Manufacturer	SA2
SA4 Responsibility of the Field Representative	SA2
SA5 Selection of Samples for Follow-Up Testing	SA3
SA6 Follow-Up Test Program	SA3

SUPPLEMENT SB - GUIDANCE FOR ACCEPTING ALTERNATE MANUFACTURING LOCATIONS

Supplement SB added June 8, 2000

INTRODUCTION

SB1 Scope	SB1
SB2 Guidelines	SB1

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INTRODUCTION

1 Scope

1.1 These requirements cover tests for flammability of polymeric materials used for parts in devices and appliances. They are intended to serve as a preliminary indication of their acceptability with respect to flammability for a particular application.

1.1 revised June 2, 2006

1.2 The methods described in this Standard involve standard size specimens and are intended to be used solely to measure and describe the flammability properties of materials, used in devices and appliances, in response to a small open flame or radiant heat source under controlled laboratory conditions.

1.2 revised June 2, 2006

1.2.1 The tests in the Standard for Tests for Flammability of Small Polymeric Component Materials should be used to evaluate small components which contain materials that can not be fabricated into standardized specimens in the minimum use thickness and subjected to applicable preselection tests in UL 94. Test procedures in UL 1694 are applicable to small components with an overall volume of less than 2500 mm³(0.15 in³). UL 1694 is generally not applicable to small components with an overall volume greater than 2500 mm³(0.15 in³).

1.2.1 added June 2, 2006

1.3 The final acceptance of the material is dependent upon its use in complete equipment that conforms with the standards applicable to such equipment. The flammability classification required of a material is dependent upon the equipment or device involved and the particular use of the material. The performance level of a material determined by these methods shall not be assumed to correlate with its performance in end-use application. The actual response to heat and flame of materials depends upon the size and form, and also on the end-use of the product using the material. Assessment of other important characteristics in the end-use application includes, but is not limited to, factors such as ease of ignition, burning rate, flame spread, fuel contribution, intensity of burning, and products of combustion.

1.3 revised June 2, 2006

1.4 If found to be appropriate, the requirements are applied to other nonmetallic materials.

1.4 revised June 10, 1997

1.5 These tests, with the exception of the Radiant Panel Test in Section 10, are not applicable to the evaluation of parts where the thickness exceeds 13.0 mm or where the surface area exceeds 1 m². These requirements do not cover polymeric materials when used for building construction, finishing, or contents such as wall and floor coverings, furnishings, decorative objects and so forth. In addition, the fire resistance (in terms of an hourly rating), flame spread, smoke characterization, and heat release rate is not evaluated. Other fire tests exist and shall be used to evaluate the flammability of materials in the intended end-use-product configuration.

1.5 revised June 2, 2006

1.6 Deleted June 2, 2006

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2 References

2.1 General

2.1.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

2.2 Referenced standards in this text

2.2.1 If a designation for a test method is followed by an alternate or equivalent designation, in parenthesis, the latter method is considered technically equivalent, though not necessarily identical, and might yield somewhat different numerical test results than those obtained with the original test method.

ISO 13943, Fire Safety – Vocabulary (ASTM E 176, Standard Terminology of Fire Standards)

ISO 291 : Standard Atmospheres for Conditioning and Testing (ASTM D 618, Practice for Conditioning Plastics for Testing)

ASTM D 789, Test Method for Determination of Relative Viscosity of Polyamide

ASTM E 162, Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source

ASTM D 3195, Practice of Rotameter Calibration

IEC TS60695-11-4, Test Flames 50 W Flames - Apparatus and Confirmational Test Methods; Method A and IEC TS60695-11-3, Test Flames 500 W Flames - Apparatus and Confirmational Test Methods; Method A (ASTM D 5025, Specification for a Laboratory Burner Used for Small-Scale Burning Tests on Plastic Materials; ASTM D 5207, Practice for Confirmation of 20 mm (50 W) Test Flames for Small-Scale Burning Tests on Plastic Materials)

ASTM 2016, Standard Specification for Industrial Woven Wire Cloth, Appendix X3

HB: ASTM D 635, Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position (IEC 60695-11-10, Fire hazard testing Part 11-10; Test flames 50 W horizontal and vertical flame test methods)

V: ASTM D 3801, Test Method for Measuring the Comparative Burning Characteristics of Solid Plastics in a Vertical Position (IEC 60695-11-10, Fire hazard testing Part 11-10: Test flames 50 W horizontal and vertical flame test methods)

VTM: ASTM D 4804, Test Method for Determining the Flammability Characteristics of Nonrigid Solid Plastics (ISO 9773, Plastics – Determination of Burning Behavior of Flexible Vertical Specimens in Contact with a Small Flame Ignition Source)

5V: ASTM D 5048, Test Method for Measuring the Comparative Burning Characteristics and Resistance to Burn-Through of Solid Plastics Using a 125 mm Flame (IEC 60695-11-20, Fire hazard testing Part 11-20: Test flames 500 W flame test methods)

HBf: ASTM D 4986, Test Method for Horizontal Burning Characteristics of Cellular Polymeric Materials (ISO 9772, Cellular Plastics – Determination of Horizontal Burning Characteristics of Small Specimens Subjected to a Small Flame)

2.2.1 revised June 2, 2006

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2.3 Related standards

2.3.1 The Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, contains short-term test procedures to be used for the evaluation of materials used for parts intended for specific applications in electrical end products. The Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B, contains long-term test procedures to be used for the evaluation of materials used for parts intended for specific applications in end products. Test procedures are provided in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C, for the evaluation of polymeric materials in specific applications in end products. The test procedures include reference to the data obtained from the standard property tests in UL 746A, as well as other practical means of evaluation. The Standard for Polymeric Materials – Fabricated Parts, UL 746D, contains requirements for traceability and performance of parts molded and fabricated from polymeric materials.

2.3.2 Requirements for materials that have been modified to match the requirements of a specific application, including - but not limited to - the use of recycled and regrind materials, the use of additives and colorants, and the blending of two or more materials, are described in the Standard for Polymeric Materials – Fabricated Parts, UL 746D.

2.3.2 revised June 2, 2006

3 Definitions

For the purpose of this Standard, the following definitions apply (See ISO 13943):

3.1 Afterflame – Flame which persists after the ignition source has been removed.

3.1 revised June 2, 2006

3.2 Afterflame Time – The length of time during which an afterflame persists under specified conditions.

3.2 revised June 2, 2006

3.3 Afterglow – Persistence of glowing combustion after both removal of the ignition source and the cessation of any flaming.

3.3 revised June 2, 2006

3.4 Afterglow Time – The length of time during which an afterglow persists under specified conditions.

3.4 revised June 2, 2006

3.5 Flame – To undergo combustion in the gaseous phase with emission of light.

3.5 added June 2, 2006

3.6 Glowing Combustion – Combustion of a material in the solid phase without flame but with emission of light from the combustion zone.

3.6 added June 2, 2006

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4 Significance of Tests

4.1 Tests conducted on a material under the conditions specified are intended to provide information when: comparing the relative burning characteristics of different materials, or assessing any change in burning characteristics prior to, or during, use. This method is not intended to provide correlation with performance under actual service conditions.

4.1 revised June 10, 1997

4.2 Assessment for risk of fire shall take into account such factors as fuel contribution, intensity of burning (rate of heat release), products of combustion and environmental factors such as the intensity of source, orientation of exposed material and ventilation conditions.

4.2 revised June 10, 1997

4.3 Burning characteristics, as measured by these test procedures, are affected by such factors as: density, color, any anisotropy of the material molding conditions and the thickness of the specimen.

4.4 When a specimen of a thin material shrinks from the flame without igniting, the test results shall be deemed invalid and additional specimens shall be tested. If all test specimens shrink from the applied flame without igniting, these materials cannot be evaluated by the test procedure and an alternate test procedure in this Standard shall be conducted.

4.4 revised June 10, 1997

5 Apparatus

5.1 Laboratory Fume Hood – The laboratory fume hood chamber shall have an inside volume of at least 0.5 m³. The chamber shall permit observation of tests in progress and shall be draft free, while allowing a normal thermal circulation of air past the test specimen during burning. The inside surfaces of the chamber shall be of a dark color. When a light meter, facing towards the rear of the chamber, is positioned in place of the test specimen, the recorded light level shall be less than 20 lx. For safety and convenience, it is desirable that the enclosure (which can be completely closed) be fitted with an extraction device, such as an exhaust fan, to remove products of combustion which may be toxic. The extraction device shall be turned off during the test and turned on immediately after the test to remove the fire effluents. A positive closing damper may be needed.

Note 1: The amount of oxygen available to support combustion is important for the conduct of these flame tests. For tests conducted by this method when burning times are prolonged, chamber sizes less than 1 m³ do not consistently provide accurate results.

Note 2: Placing a mirror in the chamber, which provides a rear view of the test specimen, has been found useful.

5.1 revised June 2, 2006

5.2 Laboratory Burner – A laboratory type burner having a tube with a length of 100 ±10 mm and an inside diameter of 9.5 ±0.3 mm. The barrel is not to be equipped with an end attachment, such as a stabilizer. The burner shall be in compliance with ASTM D5025.

Note: Method A of IEC TS60695-11-4 and Ignition Source P/PF2 of ISO 10093 are technically equivalent to ASTM D 5025

5.2 revised June 2, 2006

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5.3 Burner Wing Tip – A wing tip with dimensions of slit 48 ± 1 mm in length by 1.3 ± 0.05 mm in width, for the burner. (Used for the test procedure in Horizontal Burning Foamed Material Test; HBF, HF-1, or HF-2... Section 12 only.)

5.3 revised July 29, 1997

5.4 Burner Mounting Fixture – Capable of positioning the burner at an angle of 20 degrees from the vertical axis. (Used for the test procedure in 500w Vertical Burning Test; 5VA or 5VB Section 9 only.)

5.4 revised July 29, 1997

5.5 Ring Stands – Laboratory ring stands with clamps or the equivalent, for horizontal or vertical positioning of the specimen and/or the wire gauze. Laboratory ring stands with clamps adjustable to the desired angles and heights, or a support gauze holder constructed from aluminum or steel, or equivalent equipment.

5.6 Timing Devices – Accurate to 0.5 second.

5.7 Measuring Scale – Graduated in mm.

5.8 Gas Supply A supply of technical grade methane gas (min. 98 percent pure) with regulator and meter for uniform gas flow.

Note: Natural gas having a heat content of approximately 37 ± 1 MJ/m³ at 25°C has been found to provide similar results. However, technical grade methane shall be used in case of dispute.

5.8 revised June 2, 2006

5.9 Wire Gauze – Having approximately 20 openings per 25 mm, made with 0.43 ± 0.03 mm diameter iron or steel wire and cut to approximately 125 mm squares. (Used for the test procedure in Horizontal Burning Test; HB Section 7 only.)

5.9 revised June 2, 2006

5.10 Conditioning Room or Chamber – Capable of being maintained at $23 \pm 2^\circ\text{C}$ and a relative humidity of 50 ± 5 percent.

5.11 HB Support Fixture – A metal support fixture for testing specimens that are not self-supporting. See Figure 7.2 (Used for the test procedure in Horizontal Burning Test; HB Section 7 only.)

5.11 revised July 29, 1997

5.12 Micrometer – Capable of being read to 0.01 mm.

5.13 Cotton – A supply of absorbent 100 percent cotton.

5.14 Desiccator – A desiccator containing anhydrous calcium chloride, or other drying agent, maintained at a relative humidity not exceeding 20 percent at $23 \pm 2^\circ\text{C}$.

5.15 Conditioning Oven – A full draft air-circulating oven, minimum of 5 air changes per hour, capable of being maintained at $70 \pm 1^\circ\text{C}$.

5.15 revised July 10, 1998

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5.16 Specimen Mandrel Form – Made from 12.7 ± 0.5 mm diameter rod with a minimum 250 mm length. (Used for the test procedure in Thin Material Burning Test; VTM-0, VTM-1, VTM-2... Section 11 only.)

5.16 revised June 2, 2006

5.17 Tape – Pressure-Sensitive Adhesive. (Used for the test procedure in Thin Material Burning Test; VTM-0, VTM-1, VTM-2... Section 11 only.)

5.17 revised July 29, 1997

5.18 Support-Gauze – A wire cloth of plain weave, low carbon, plain steel or stainless steel, approximately 215 mm long by 75 mm wide having 13 mm of its length bent to form a right angle at one end. It is to consist of 6.4 mm mesh gauze constructed of 0.88 ± 0.05 mm diameter steel wire. The cloth mesh and wire diameter are to be determined as described in ASTM E437. (Used for the test procedure in Horizontal Burning Foamed Material Test; HBF, HF-1, or HF-2... Section 12 only.)

5.18 revised July 29, 1997

5.19 Foam Support Fixture – A metal support fixture capable of holding the support gauze in 5.18 including height adjustment to allow for burner height variations. See Figure 12.1. (Used for the test procedure in Horizontal Burning Foamed Material Test; HBF, HF-1, or HF-2... Section 12 only.)

5.19 revised July 29, 1997

5.20 Manometer/Pressure Gage – A gage capable of measuring to 200 mm of water, with increments of 5 mm.

5.21 Flow Meter – A rotameter calibrated in accordance with the Practice of Rotameter Calibration, D 3195, with correlation curves appropriate for the gas, or a mass flow meter with ± 2 percent accuracy.

6 Conditioning

6.1 Specimens are to be preconditioned in accordance with ASTM D 618 (ISO 291) at $23 \pm 2^\circ\text{C}$ and 50 ± 5 percent relative humidity for a minimum of 48 hours.

6.2 Specimens for certain tests are to be preconditioned in an air-circulating oven for 168 hours at $70 \pm 1^\circ\text{C}$ and then cooled in the desiccator for at least 4 hours at room temperature, prior to testing.

6.3 Once removed from the pre-conditioning environment, specimens shall be tested within 30 minutes.

6.3 revised June 2, 2006

6.4 All specimens are to be tested in a laboratory atmosphere of $15 - 35^\circ\text{C}$ and 45 – 75 percent relative humidity.

6.5 Cotton shall be conditioned in the desiccator for at least 24 hours prior to use.

6.6 Once removed from the desiccator, the cotton shall be used within 30 minutes.

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TESTS

7 Horizontal Burning Test; HB

(ASTM D 635 or IEC 60695-11-10)

7.1 Test criteria

7.1.1 A material shall be classified HB when tested as described in 7.2.1 – 7.5.10.

7.1.2 A material classed HB shall (also see 7.1.4):

- a) Not have a burning rate exceeding 40 mm per minute over a 75 mm span for specimens having a thickness of 3.0 to 13 mm, or
- b) Not have a burning rate exceeding 75 mm per minute over a 75 mm span for specimens having a thickness less than 3.0 mm, or
- c) Cease to burn before the 100 mm reference mark. See 7.5.1 and 7.5.9.

7.1.2 revised June 2, 2006

7.1.3 A material classified HB in the 3.0 +0.2 mm thickness shall automatically be classed HB down to a 1.5 mm minimum thickness without additional testing.

7.1.3 revised July 29, 1997

7.1.4 If only one specimen from a set of three specimens does not comply with the requirements, another set of three specimens is to be tested. All specimens from this second set shall comply with the requirements in order for the material in that thickness to be classified HB.

7.1.4 revised July 29, 1997

7.2 Test apparatus

7.2.1 See 5.1, 5.2, 5.5– 5.12, 5.20 and 5.21.

7.3 Test specimens

7.3.1 All specimens shall be cut from sheet material, or shall be cast or injection, compression transfer or pultrusion molded to the necessary form. After any cutting operation, care is to be taken to remove all dust and any particles from the surface; cut edges are to have a smooth finish. Fabrication of test specimens shall be in accordance with current ASTM Practices.

7.3.2 Standard bar specimens are to be 125 ±5 mm long by 13.0 ±0.5 mm wide, and provided in the minimum thickness and 3.0 (-0.0 +0.2) mm thick. The 3.0 mm thick specimens are not necessary if the minimum thickness is greater than 3.0 mm, or the maximum thickness is less than 3.0 mm. The maximum thickness is not to exceed 13 mm. The maximum width is not to exceed 13.5 mm, the edges are to be smooth, and the radius on the corners is not to exceed 1.3 mm.

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7.3.3 Material Ranges – If a material is to be considered in a range of colors, densities, melt flows, or reinforcement, specimens representing these ranges are also to be provided.

7.3.4 Specimens in the natural and in the most heavily pigmented light and dark colors are to be provided and considered representative of the color range, if the test results are essentially the same. In addition, a set of specimens is to be provided in the heaviest organic pigment loading, unless the most heavily pigmented light and dark colors include the highest organic pigment level. When certain color pigments (for example, red, yellow, or the like) are known to affect flammability characteristics, they are also to be provided.

7.3.4 revised June 10, 1997

7.3.5 Specimens in the extremes of the densities, melt flows and reinforcement contents are to be provided and considered representative of the range, if the test results are essentially the same. If the burning characteristics are not essentially the same for all specimens representing the range, evaluation is to be limited only to the materials in the densities, melt flows, and reinforcement contents tested, or additional specimens in intermediate densities, melt flows, and reinforcement contents are to be provided for tests.

7.4 Conditioning

7.4.1 Two sets of three specimens are to be preconditioned as in 6.1.

7.5 Procedure

7.5.1 Three specimens are to be tested. Each specimen is to be marked with two lines perpendicular to the longitudinal axis of the bar, 25 ± 1 mm and 100 ± 1 mm from the end that is to be ignited.

7.5.1 revised April 30, 1997

7.5.2 Clamp the specimen at the end farthest from the 25 mm mark, with its longitudinal axis horizontal and its transverse axis inclined at 45 ± 2 degrees. The wire gauze (see 5.9) is to be clamped horizontally beneath the specimen, with a distance of 10 ± 1 mm between the lowest edge of the specimen and the gauze with the free end of the specimen even with the edge of the gauze. See Figure 7.1.

7.5.2 revised June 2, 2006

7.5.3 The methane gas supply to the burner shall be arranged as in Figure 7.3 and adjusted to produce a gas flow rate of 105 ml/min with a back pressure less than 10 mm water. See ASTM D 5207.

7.5.4 The burner is to be placed remote from the specimen and ignited. Adjust the burner to produce a blue flame 20 ± 1 mm high. The flame is to be obtained by adjusting the gas supply and the air ports of the burner until an approximate 20 ± 1 mm yellow-tipped blue flame is produced. Increase the air supply until the yellow tip disappears. Measure the height of the flame again and adjust it if necessary.

7.5.5 The test flame shall be confirmed in accordance with ASTM D 5207 at least once a month and when the gas supply is changed, test equipment is replaced, or when data is questioned.

7.5.5 revised June 2, 2006

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7.5.6 If the specimen sags at its free end during the initial set up, the support fixture illustrated in Figure 7.2 is to be positioned under the specimen with the small extending portion of the support fixture at least 20 mm from the free end of the specimen. Enough clearance is to be provided at the clamped end of the specimen so that the support fixture is capable of being freely moved sideways. As the combustion front progresses along the specimen, the support fixture is to be withdrawn at the same approximate rate.

7.5.6 revised June 10, 1997

7.5.7 Apply the flame to the free end at the lower edge of the specimen. The central axis of the burner tube is to be in the same vertical plane as the longitudinal bottom edge of the specimen and inclined toward the end of the specimen at an angle of $45 \pm 2^\circ$ to the horizontal. See Figure 7.1.

7.5.7 revised June 2, 2006

7.5.8 Position the burner so that the flame impinges on the free end of the specimen to a depth of 6 ± 1 mm. Apply the test flame for 30 ± 1 seconds without changing its position; remove the burner after 30 ± 1 seconds, or as soon as the combustion front of the specimen reaches the 25 mm mark (if less than 30 seconds). Start the timing device when the combustion front reaches the 25 mm mark.

7.5.9 If the specimen continues to burn after removal of the test flame, record the time in seconds, for the combustion front to travel from the 25 mm mark up to the 100 mm mark and record the damaged length, L ($L = 75$). If the combustion front passes the 25 mm mark but does not pass the 100 mm mark, record the elapsed time in seconds and the damaged length, L . The damaged length, L , is measured from the 25 mm mark to the point where the combustion front stops (maximum distance = 75).

7.5.9 revised June 2, 2006

7.5.10 The test procedure is to be conducted on at least three specimens. The laboratory fume hood shall be evacuated after each specimen.

7.5.10 revised June 2, 2006

7.6 Calculations

7.6.1 Calculate the linear burning rate, V , in millimeters per minute, for each specimen using the equation:

$$V = 60 L/t$$

in which:

V is the linear burning rate in mm/minute

L is the damaged length, in millimeters

t is time, in seconds

7.6.1 revised June 2, 2006

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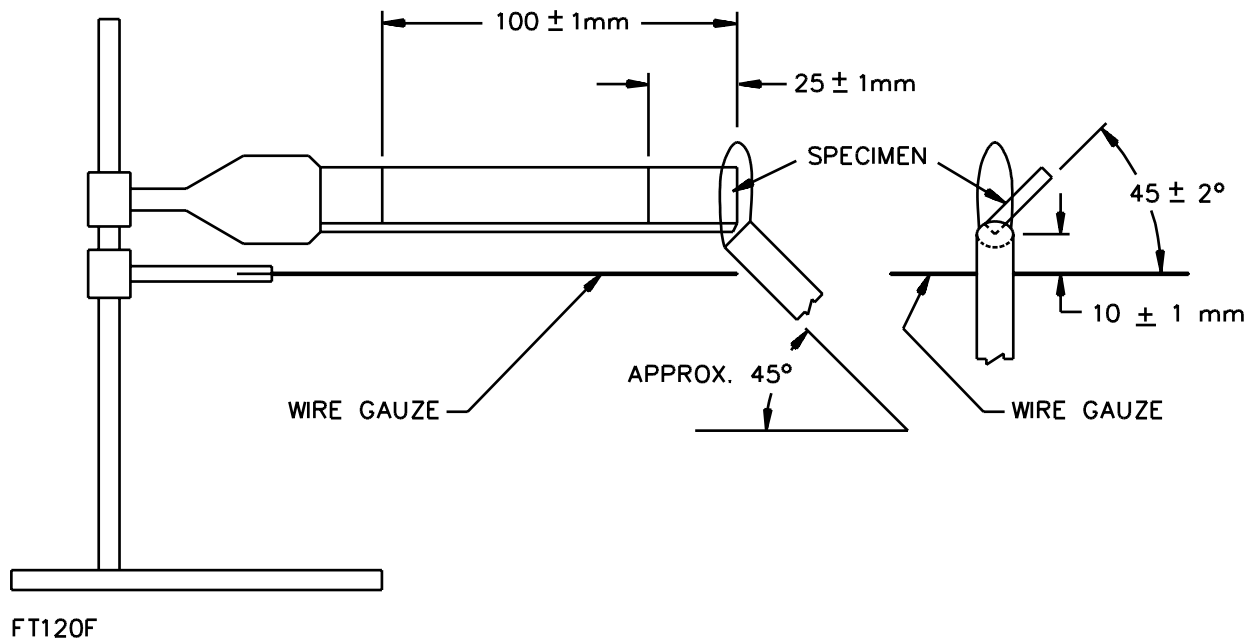
7.7 Results

7.7.1 The following are to be recorded for each specimen:

- Whether or not the flame front passed the 25 mm and 100 mm marks.
- If the flame front passed the 25 mm mark but ceased before the 100 mm mark, the damaged length, L and elapsed time, t .
- If the flame front passed the 100 mm mark, the elapsed time t between the 25 mm and 100 mm marks.
- The calculated linear burning rate.

Figure 7.1
Horizontal burning test for HB classification

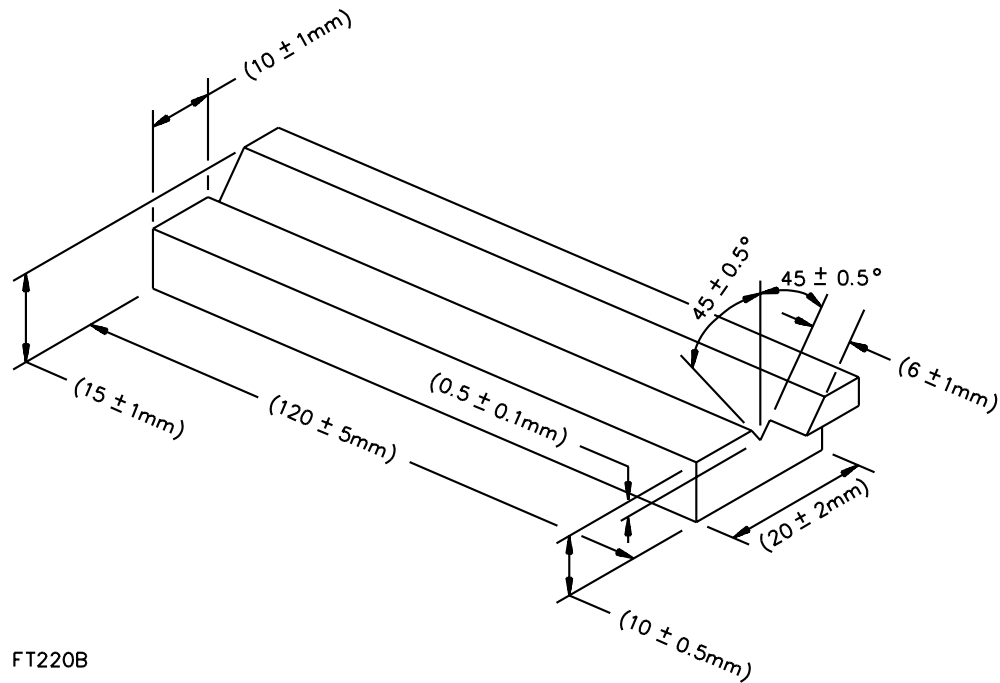
Figure 7.1 revised July 10, 1998



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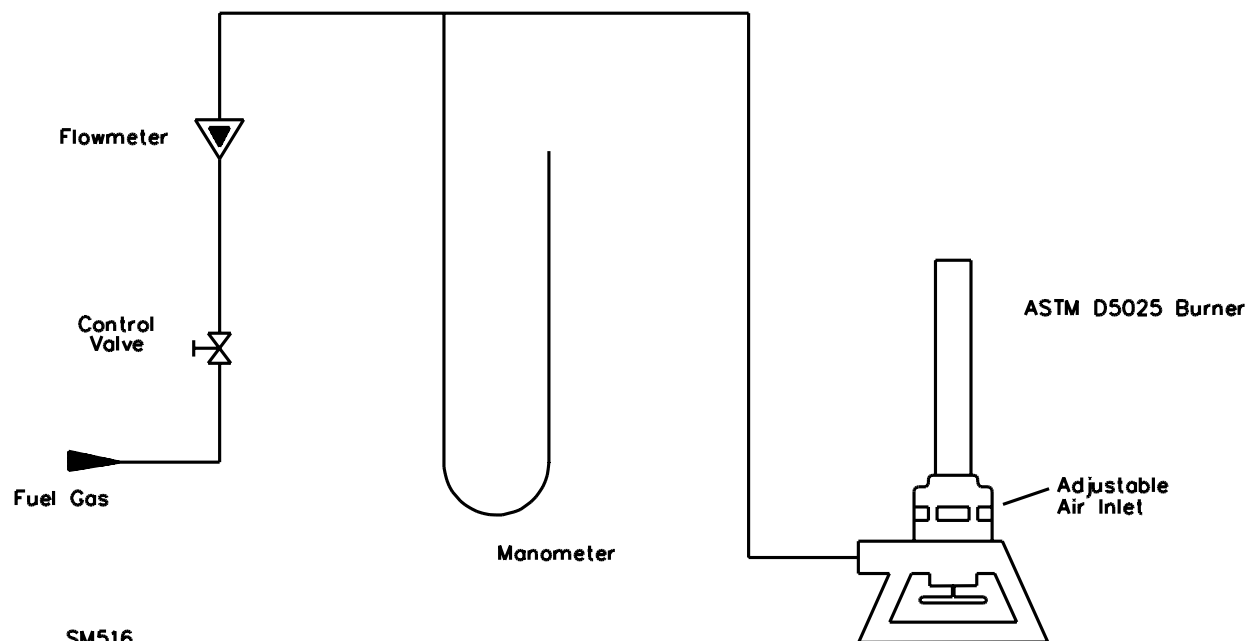
Figure 7.2
Flexible specimen support fixture

Figure 7.2 revised April 30, 1997



FT220B

Figure 7.3
Burner supply arrangement



SM516

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8 50W (20 mm) Vertical Burning Test; V-0, V-1, or V-2

(ASTM D 3801 or IEC 60695-11-10)

8.1 Test Criteria

8.1.1 Materials shall be classified V-0, V-1, or V-2 on the basis of results obtained on small bar specimens when tested as described in (8.2.1 – 8.5.6).

8.1.1 revised July 29, 1997

8.1.2 Some materials, due to their thinness, distort, shrink, or are consumed up to the holding clamp when subjected to this test. These materials may be tested in accordance with the test procedure in Thin Material Burning Test; VTM-0, VTM-1, VTM-2... Section 11, provided specimens can be properly formed.

8.1.2 revised July 29, 1997

8.1.2.1 Materials with a density less than 250 kg/m³ may optionally be tested in accordance with the Horizontal Burning Foamed Materials Test; HBF, HF-1, or HF-2 in Section 12.

8.1.2.1 added June 2, 2006

8.1.3 Table 8.1 specifies the material classifications.

Table 8.1
Materials classifications

Table 8.1 revised July 29, 1997

Criteria conditions	V-0	V-1	V-2
Afterflame time for each individual specimen t_1 or t_2	≤10s	≤30s	≤30s
Total afterflame time for any condition set (t_1 plus t_2 for the 5 specimens)	≤50s	≤250s	≤250s
Afterflame plus afterglow time for each individual specimen after the second flame application (t_2+t_3)	≤30s	≤60s	≤60s
Afterflame or afterglow of any specimen up to the holding clamp	No	No	No
Cotton indicator ignited by flaming particles or drops	No	No	Yes

8.1.4 If only one specimen from a set of five specimens does not comply with the requirements, another set of five specimens is to be tested. In the case of the total number of seconds of flaming, an additional set of five specimens is to be tested if the totals are in the range of 51– 55 seconds for V-0 and 251 – 255 seconds for V-1 and V-2. All specimens from this second set shall comply with the appropriate requirements in order for the material in that thickness to be classified V-0, V-1, or V-2.

8.1.4 revised July 29, 1997

8.1.5 Type 66 nylon materials classed V-2 shall have a relative viscosity (RV) of less than 120 in the supplied form, as determined by the method specified in 8.1.6, or if the relative viscosity is 120 or greater, the relative viscosity of the molded specimen shall not be less than 70 percent of the relative viscosity in the supplied form.

8.1.5 revised July 29, 1997

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8.1.6 The relative viscosity is to be determined by the solution method in ASTM D789, using either a pipet or Brookfield viscometer. The pipet viscometer shall be used if a referee determination is needed.

8.1.6 revised June 2, 2006

8.2 Test apparatus

8.2.1 See 5.1, 5.2, 5.5– 5.8, 5.10, 5.12 – 5.15, 5.20 and 5.21.

8.3 Test specimens

8.3.1 All specimens are to be cut from sheet material, or are to be cast or injection, compression, transfer or pultrusion molded to the necessary form. After any cutting operation, care is to be taken to remove all dust and any particles from the surface; cut edges are to have a smooth finish. Fabrication of test specimens shall be in accordance with current ASTM Practices.

8.3.2 Standard bar specimens are to be 125 ± 5 mm long by 13.0 ± 0.5 mm wide, and provided in the minimum and maximum thicknesses. The maximum thickness is not to exceed 13 mm. Specimens in intermediate thicknesses are also to be provided and shall be tested if the results obtained on the minimum or maximum thickness indicate inconsistent test results. Intermediate thicknesses are not to exceed increments of 3.2 mm. Also, the edges are to be smooth, and the radius on the corners is not to exceed 1.3 mm.

8.3.2 revised June 10, 1997

8.3.3 Material Ranges – If a material is to be considered in a range of colors, densities, melt flows, or reinforcement, specimens representing these ranges are also to be provided.

8.3.4 Specimens in the natural and in the most heavily pigmented light and dark colors are to be provided and considered representative of the color range, if the test results are essentially the same. In addition, a set of specimens is to be provided in the heaviest organic pigment loading, unless the most heavily pigmented light and dark colors include the highest organic pigment level. When certain color pigments (for example, red, yellow, or the like) are known to affect flammability characteristics, they are also to be provided.

8.3.4 revised June 10, 1997

8.3.5 Specimens in the extremes of the densities, melt flows and reinforcement contents are to be provided and considered representative of the range, if the test results are essentially the same. If the burning characteristics are not essentially the same for all specimens representing the range, evaluation is to be limited only to the materials in the densities, melt flows, and reinforcement contents tested, or additional specimens in intermediate densities, melt flows, and reinforcement contents are to be provided for tests.

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8.4 Conditioning

8.4.1 Two sets of five specimens are to be preconditioned as in 6.1.

8.4.2 Two sets of five specimens each are to be preconditioned as in 6.2.

8.4.2 revised June 2, 2006

8.5 Procedure

8.5.1 Clamp the specimen from the upper 6 mm of the specimen, with the longitudinal axis vertical, so that the lower end of the specimen is 300 ± 10 mm above a horizontal layer of not more than 0.08 g of absorbent 100 percent cotton thinned to approximately 50 x 50 mm and a maximum thickness of 6 mm (See Figure 8.1).

8.5.2 The methane gas supply to the burner shall be arranged as in Figure 7.3 and adjusted to produce a gas flow rate of 105 ml/min with a back pressure less than 10 mm of water. See ASTM D 5207.

8.5.3 Adjust the burner to produce a blue flame 20 ± 1 mm high. The flame is obtained by adjusting the gas supply and air ports of the burner until a 20 ± 1 mm yellow-tipped blue flame is produced. Increase the air supply until the yellow tip just disappears. Measure the height of the flame again and readjust it if necessary. The wide edge of the specimen is to face the burner.

8.5.3 revised June 2, 2006

8.5.4 The test flame shall be confirmed in accordance with ASTM D 5207 at least once a month and when the gas supply is changed, test equipment is replaced, or when data is questioned.

8.5.4 revised June 2, 2006

8.5.5 The burner shall approach the specimen horizontally from the wide face at a rate of approximately 300 mm/sec. Apply the flame centrally to the middle point of the bottom edge of the specimen so that the top of the burner is 10 ± 1 mm below that point of the lower end of the specimen, and maintain it at that distance for 10 ± 0.5 seconds starting when the flame is fully positioned under the specimen, moving the burner as necessary in response to any changes in the length or position of the specimen. If the specimen shrinks, distorts, or melts, the point of application shall remain in contact with the major portion of the specimen.

8.5.5 revised June 2, 2006

8.5.5.1 If the specimen drips material during the flame application, tilt the burner to an angle of $45 \pm 5^\circ$ perpendicular to the wide face of the specimen and withdraw it just sufficiently from beneath the specimen to prevent material from dropping into the barrel of the burner while maintaining the 10 ± 1 mm spacing between the center of the top of the burner and the remaining major portion of the damaged specimen, ignoring any strings of molten material.

8.5.5.1 added June 2, 2006

8.5.5.2 After the application of the flame to the specimen for 10 ± 0.5 seconds, immediately withdraw the burner at a rate of approximately 300 mm/sec, to a distance at least 150 mm away from the specimen and simultaneously commence measurement of the afterflame time t_1 to the nearest half second.

8.5.5.2 added June 2, 2006

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8.5.6 As soon as afterflaming of the specimen ceases, even if the burner has not been withdrawn to the full 150 mm distance from the specimen, immediately place the burner again under the specimen and maintain the burner at a distance of 10 ± 1 mm from the remaining major portion of the specimen for an additional 10 ± 0.5 seconds, while moving the burner clear of dropping material as necessary as indicated in 8.5.5.1. After this application of the flame to the specimen, immediately remove the burner at a rate of approximately 300 mm/sec to a distance of at least 150 mm from the specimen and simultaneously commence measurement of the afterflame time, t_2 , and the afterglow time, t_3 to the nearest half second. Record t_2 and t_3 . The laboratory fume hood shall be evacuated after each specimen.

Note 1: If it is difficult to visually distinguish between flaming and glowing, a small piece of cotton, approximately 50 mm square as described in 5.13, is to be brought into contact with the area in question by holding with tweezers. Ignition of the cotton will be indicative of flaming.

Note 2: If the test flame is extinguished during either flame application the test specimen is to be disregarded and another specimen is to be tested. The only exception is in the case where the test flame is extinguished as a direct result of out-gassing from the specimen. In this case, the burner shall be reignited immediately and reapplied to the specimen so that the total time of application is 10 ± 0.5 seconds.

8.5.6 revised June 2, 2006

8.6 Results

8.6.1 The following are to be observed and recorded for each specimen:

- a) Afterflame time after first flame application, t_1 .
- b) Afterflame time after second flame application, t_2 .
- c) Afterflame time plus afterglow time after second flame application, $t_2 + t_3$.
- d) Whether or not specimens burn up to the holding clamp.

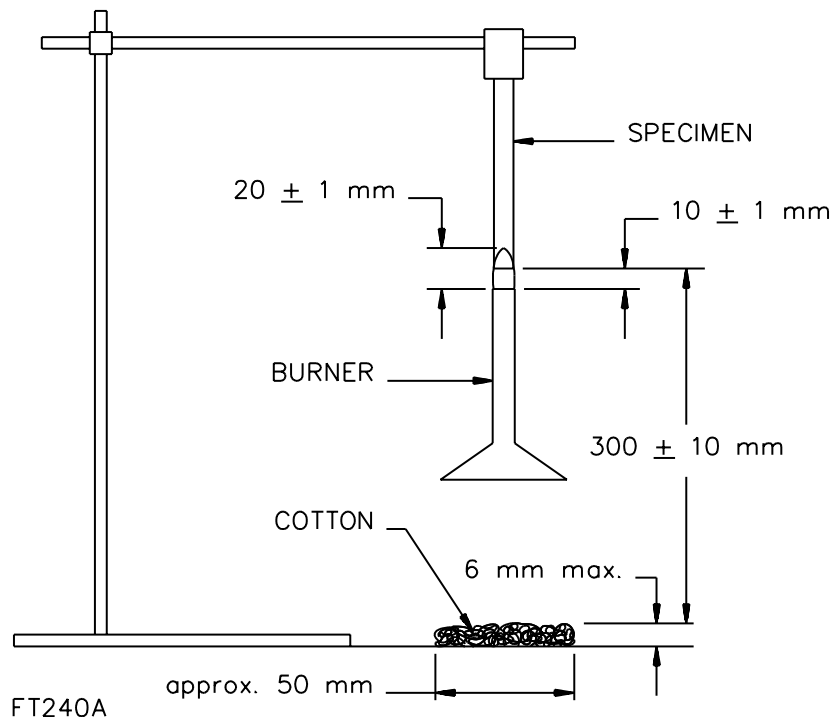
Note: Burned to the clamp – After allowing the sample to cool, use a soft, dry cloth to wipe away soot and effluent residue and examine the sample 2 mm below the clamp line for signs of combustion or pyrolysis. Any thermal damage, such as melting or distortion, on the sample below the clamp, shall be neglected.

- e) Whether or not specimens drip flaming particles and whether the particles ignited the cotton indicator.

8.6.1 revised June 2, 2006

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Figure 8.1
Vertical burning test for V-0, V-1, V-2 classification



9 500 W (125 mm) Vertical Burning Test; 5VA or 5VB

(ASTM D 5048 or IEC 60695-11-20)

9.1 Test criteria

9.1.1 Material shall be classified 5VA or 5VB on the basis of test results obtained on small bar and plaque specimens when tested as described in (9.2.1 – 9.6.5).

Exception: For materials that are submitted for a 5VB rating only (i.e., the manufacturer does not seek the 5VA rating), plaque specimens do not need to be tested.

9.1.1 revised May 22, 2001

9.1.2 Materials classified 5VA or 5VB shall also comply with the requirements described in 8.1.1– 8.6.1 for materials classified V-0 or V-1.

9.1.2 revised June 2, 2006

9.1.3 Table 9.1 specifies the material classifications.

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Table 9.1
Material Classifications

Criteria	94-5VA	94-5VB
Afterflame time plus afterglow time after fifth flame application for each individual bar specimen	≤60s	≤60s
Cotton indicator ignited by flaming particles or drops from any bar specimen	No	No
Burn-through (hole) of any plaque specimen	No	Yes

9.1.4 If only one specimen from a set of five bar specimens or one specimen from a set of three plaque specimens does not comply with the requirements, another set of specimens are to be tested. All specimens from this second set are to comply with the requirements in order for the material in that thickness to be considered acceptable.

9.2 Test apparatus

9.2.1 See 5.1, 5.2, 5.4, 5.5, 5.6 – 5.8, 5.10, 5.12– 5.15, 5.20 and 5.21.

9.3 Test specimens

9.3.1 All specimens are to be cut from sheet material, or are to be cast or injection, compression, transfer or pultrusion molded to the necessary form. After any cutting operation, care is to be taken to remove all dust and any particles from the surface; cut edges are to have a smooth finish. Fabrication of test specimens shall be in accordance with current ASTM Practices.

9.3.2 Bar specimens are to be 125 ±5 mm long by 13.0 ±0.5 mm wide, and provided in the minimum thickness. Plaque specimens are to be 150 ±5 mm by 150 ±5 mm and provided in the minimum thickness. Thicker specimens may also be provided and shall be tested if the results obtained on the minimum thickness indicate inconsistent test results. The maximum thickness is not to exceed 13 mm. Edges are to be smooth, and the radius on the corners is not to exceed 1.3 mm.

9.3.2 revised June 10, 1997

9.3.3 Material Ranges – If a material is to be considered in a range of colors, densities, melt flows, or reinforcement, specimens representing these ranges are also to be provided.

9.3.4 Bar Specimens – Specimens in the natural (if used in this color) and in the most heavily pigmented light and dark colors are to be provided and considered representative of the color range, if the test results are essentially the same. In addition, a set of specimens is to be provided in the heaviest organic pigment loading, unless the most heavily pigmented light and dark colors include the highest organic pigment level. When certain color pigments (for example, red, yellow, or the like) are known to affect flammability characteristics, they are also to be provided.

9.3.4 revised June 10, 1997

9.3.5 Plaque Specimens – Specimens in the natural or normally supplied color are to be provided, and are to be considered representative of the color range.

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9.3.6 Specimens in the extremes of the densities, melt flows and reinforcement contents are to be provided and considered representative of the range, if the test results are essentially the same. If the burning characteristics are not essentially the same for all specimens representing the range, evaluation is to be limited only to the materials in the densities, melt flows, and reinforcement contents tested, or additional specimens in intermediate densities, melt flows, and reinforcement contents are to be provided for tests.

9.4 Conditioning

9.4.1 Two sets of five bar and three plaque specimens are to be preconditioned as in 6.1.

9.4.2 Two sets of five bar and three plaque specimens are to be preconditioned as in 6.2.

9.5 Bar specimens test procedure

9.5.1 Clamp the specimen from the upper 6 mm of the specimen, with the longitudinal axis vertical, so that the lower end of the specimen is 300 ± 10 mm above a horizontal layer of not more than 0.08 g of absorbent cotton thinned to approximately 50 x 50 mm and a maximum thickness of 6 mm. See Figure 9.1.

9.5.2 The methane gas supply to the burner shall be arranged as in Figure 7.3 and adjusted to produce a gas flow rate of 965 ml/min with a back pressure of 125 ± 25 mm water.

9.5.3 Place the burner remote from the specimen, ignite, and in a darkened room < 20 lux at unlit burner, adjust the gas flow. With the burner in a vertical position, adjust the overall height of the flame to approximately 125 ± 10 mm and the height of the inner blue cone to 40 ± 2 mm. Support the burner on the burner fixture so that the burner tube is positioned at $20 \pm 5^\circ$ from the vertical. The narrow edge of the specimen is to face the burner. See Figure 9.1.

9.5.3 revised June 2, 2006

9.5.4 The test flame shall be calibrated in accordance with ASTM D 5207 at least once a month and when the gas supply is changed, test equipment is replaced, or when data is questioned.

9.5.4 revised July 10, 1998

9.5.5 The flame is then to be applied to one of the lower corners of the specimen at an angle of $20 \pm 5^\circ$ from the vertical, so that the tip of the blue cone is within 0 to 3 mm of the specimen edge - without impinging into the specimen.

9.5.5 revised June 2, 2006

9.5.6 Apply the flame for 5 ± 0.5 seconds and then remove for 5 ± 0.5 seconds. Repeat the operation until the specimen has been subjected to five applications of the test flame. If the specimen drips particles, shrinks, or elongates during the test, adjust the burner so that the tip of the inner blue cone is in contact with the major portion remaining on the specimen corner.

Note: When necessary, hand-hold the burner and fixture to complete the test.

9.5.6 revised June 10, 1997

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9.5.7 After the fifth application of the test flame for each specimen, observe and record the following:

- a) Afterflame time and afterglow time.
- b) Whether or not specimens drip particles and whether the particles ignited the cotton indicator.

9.5.7 revised June 2, 2006

9.6 Plaque specimens test procedure

9.6.1 Support the plaque specimen by a clamp on the ring stand in the horizontal plane. See Figure 9.2.

9.6.2 Adjust and calibrate the burner as in 9.5.2 – 9.5.4.

9.6.3 The flame is then to be applied to the center of the bottom surface of the plaque at an angle of $20 \pm 5^\circ$ from the vertical, so that the tip of the blue cone is within 0 to 3 mm of the plaque surface - without impinging into the specimen.

9.6.3 revised June 2, 2006

9.6.4 Apply the flame for 5 ± 0.5 seconds and then remove for 5 ± 0.5 seconds. Repeat the operation until the plaque specimen has been subjected to five applications of the test flame. When necessary, to complete the test, hand hold the burner and fixture so that the tip of the inner blue cone maintains the required distance.

9.6.4 revised June 2, 2006

9.6.5 After the fifth application of the test flame, and after all flaming or glowing combustion has ceased, it is to be observed and recorded whether or not the flame penetrated (burned through) the plaque material. Flame penetration shall be defined as any visible flame observed during the test on the surface of the plaque opposite to the surface to the test flame applied. In addition, no opening greater than 3 mm shall appear after the test and the sample has cooled for 30 seconds.

9.6.5 revised June 2, 2006

10 Radiant Panel Flame Spread Test

(ASTM E 162)

10.1 Test criteria

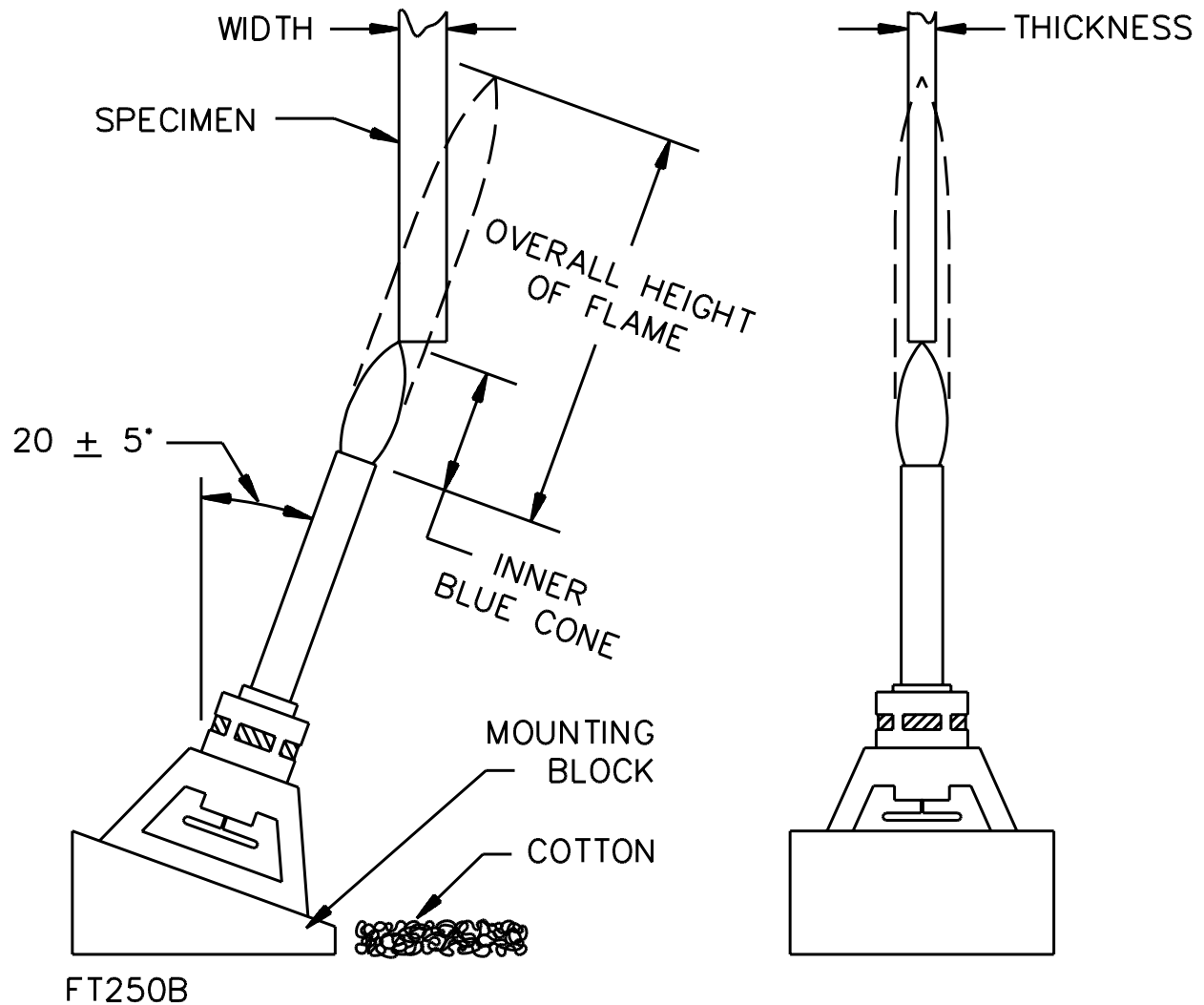
10.1.1 The flame spread index of a material shall be determined in accordance with ASTM E162, Test for Surface Flammability of Materials Using a Radiant Heat Energy Source.

10.1.2 The flame spread index is to be assigned based upon the average flame spread of 4 specimens, or 6 if the average is less than 50, in accordance with the ranges specified in Table 10.1.

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Figure 9.1
Vertical burning test for 5VA, 5VB classification— bar specimens

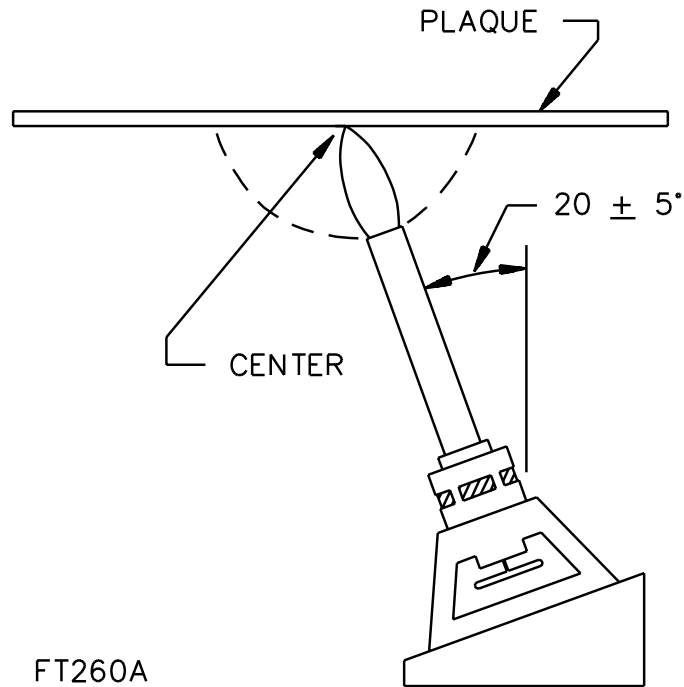
Figure 9.1 title revised July 29, 1997



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Figure 9.2
Vertical burning test for 5VA, 5VB classification– plaque specimens

Figure 9.2 title revised July 29, 1997



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Table 10.1
Radiant panel flame spread classes

Average flame spread of four specimens	Flame spread class
15 maximum	RP15
25 maximum	RP25
50 maximum	RP50
75 maximum	RP75
100 maximum	RP100
150 maximum	RP150
200 maximum	RP200

10.1.3 This method provides a laboratory test procedure for measuring and comparing the surface flammability of materials when exposed to a prescribed level of radiant heat energy. This method is intended to measure surface burning characteristics when exposed to fire.

10.1.3 revised June 10, 1997

10.2 Test specimens

10.2.1 Test specimens, 460 ± 3 mm in length by 150 ± 3 mm in width, in the minimum and maximum thicknesses, are to be tested covering the thickness range to be considered. Specimens in intermediate thicknesses are also to be provided and shall be tested if the results obtained on the minimum or maximum thicknesses indicate inconsistent test results.

10.2.1 revised June 10, 1997

10.2.2 Material Ranges – If a material is to be considered in a range of colors, densities, melt flows, or reinforcement, specimens representing these ranges are also to be provided.

10.2.3 Specimens in the natural and in the most heavily pigmented dark color are to be provided and considered representative of the color range, if the burning characteristics are essentially the same. In addition, a set of specimens is to be provided in the heaviest organic pigment loading, unless the most heavily pigmented dark color includes the highest organic pigment level. When certain color pigments (for example, red, yellow, or the like) are known to affect flammability characteristics, they are also to be provided.

10.2.3 revised June 10, 1997

10.2.4 Specimens in the extremes of the densities, melt flows and reinforcement contents are to be provided and considered representative of the range, if the burning characteristics are essentially the same. If the burning characteristics are not essentially the same for all specimens representing the range, evaluation is to be limited only to the material in the densities, melt flows, and reinforcement contents tested, or additional specimens in intermediate densities, melt flows, and reinforcement contents are to be provided for tests.

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11 Thin Material Vertical Burning Test; VTM-0, VTM-1, or VTM-2...

(ASTM D 4804 or ISO 9773)

11.1 Test criteria

11.1.1 This test is intended to be performed on materials that, due to their thinness, distort, shrink, or are consumed up to the holding clamp when tested using the test described in 20 mm Vertical Burning Test; V-0, V-1, or V-2, Section 8. This test shall only be performed after it has been determined that the samples cannot meet the requirements of the 20-mm Vertical Burning Test in Section 8. The materials shall also possess physical properties that will allow a 200 ± 5 mm long by 50 ± 1 mm wide specimen to be wrapped longitudinally around a 13 mm diameter mandrel (see 11.3.2).

11.1.1 revised December 12, 2003

11.1.2 Materials shall be classified VTM-0, VTM-1, VTM-2 on the basis of results obtained on wrapped cylindrical specimens when tested as described in 11.2.1 – 11.5.6.

11.1.2 revised July 29, 1997

11.1.3 Table 11.1 specifies the material classifications.

Table 11.1
Material classifications

Table 11.1 revised July 29, 1997

Criteria conditions	VTM-0	VTM-1	VTM-2
Afterflame time for each individual specimen t_1 or t_2	$\leq 10s$	$\leq 30s$	$\leq 30s$
Total afterflame time for any condition set (t_1 plus t_2 for the 5 specimens)	$\leq 50s$	$\leq 250s$	$\leq 250s$
Afterflame plus afterglow time for each individual specimen after the second flame application ($t_2 + t_3$)	$\leq 30s$	$\leq 60s$	$\leq 60s$
Afterflame or afterglow of any specimen up to the 125 mm mark	No	No	No
Cotton indicator ignited by flaming particles or drops	No	No	Yes

11.1.4 If only one specimen from a set of 5 specimens fails to comply with the requirements of 11.1.3 or the total number of seconds of flaming is in the range of 51 – 55 seconds for VTM-0 or 251 – 255 seconds for VTM-1 or VTM-2, an additional set of 5 specimens shall be tested. All specimens from this second set shall comply with the appropriate requirements in order for the material in that thickness to be classified VTM-0, VTM-1, or VTM-2.

11.1.4 revised July 29, 1997

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11.2 Test apparatus

11.2.1 See 5.1, 5.2, 5.5– 5.8, 5.10, 5.12 – 5.17, 5.20 and 5.21.

11.3 Test specimens

11.3.1 Test specimens are to be cut from sheet material or film to a size 200 ± 5 mm in length by 50 ± 1 mm in width, in the minimum and maximum thicknesses that are to be tested covering the thickness range under consideration. Specimens in intermediate thicknesses are also to be provided and shall be tested if the results obtained on the minimum and/or maximum thicknesses indicated inconsistent test results.

11.3.1 revised July 10, 1998

11.3.1.1 Test specimens are to be cut from sheet material or film to a size 200 ± 5 mm in length by 50 ± 1 mm in width, in the minimum and maximum thicknesses that are to be tested covering the thickness range under consideration. Specimens in intermediate thicknesses are also to be provided and shall be tested if the results obtained on the minimum and/or maximum thicknesses indicated inconsistent test results.

11.3.1.1 added June 2, 2006

11.3.2 Test specimens are to be prepared by marking a line across the specimen width 125 mm from one end (bottom) of the cut specimen. The longitudinal axis of the specimen is to be wrapped tightly around the longitudinal axis of a 12.7 ± 0.5 mm diameter mandrel to form a lapped cylinder 200 mm long with the 125 mm line exposed. The overlapping ends of the specimen are to be secured within the 75 mm portion above the 125 mm mark (upper tube section) by means of pressure sensitive tape. The mandrel is then to be removed.

Note: If the material is prone to developing static charges which make the formation of a cylinder difficult, the unformed specimen is to be deionized by a device or material intended for that purpose.

11.3.3 When a material's characteristics do not allow the specimen to remain a lapped cylinder along its entire length after securing of one end (resulting in varying degrees of flaring out of the untaped end), it is acceptable provided the upper end is capable of being formed into the cylinder and the specimen remains lapped at the 125 mm gauge mark; however, a fully lapped cylinder shall be used whenever the material permits. See Figure 11.1.

Exception: When testing stiff specimens, reinforce or replace the pressure-sensitive tape by wrapping nichrome wire around the top 75 mm of the specimen. See Figure 11.1.

11.3.3 revised June 2, 2006

11.3.4 Material Ranges – If a material is to be considered in a range of colors, densities, melt flows, or reinforcement, specimens representing these ranges are also to be provided.

11.3.5 Specimens in the natural and in the most heavily pigmented light and dark colors are to be provided and considered representative of the color range, if the test results are essentially the same. In addition a set of specimens is to be provided in the heaviest organic pigment loading, unless the most heavily pigmented light and dark colors include the highest organic pigment level. When certain color pigments (for example, red, yellow, or the like) are known to affect flammability characteristics, they are also to be provided.

11.3.5 revised June 10, 1997

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11.3.6 Specimens in the extremes of the densities, melt flows and reinforcement contents are to be provided and considered representative of the range, if the test results are essentially the same. If the burning characteristics are not essentially the same for all specimens representing the range, evaluation is to be limited only to the materials in the densities, melt flows, and reinforcement contents tested, or additional specimens in intermediate densities, melt flows, and reinforcement contents are to be provided for tests.

11.4 Conditioning

11.4.1 Two sets of 5 specimens are to be preconditioned as in 6.1.

11.4.2 Two sets of 5 specimens are to be preconditioned as in 6.2.

11.4.2 revised June 2, 2006

11.4.3 Cylindrical specimens are to be prepared before conditioning.

11.4.3 added June 2, 2006

11.5 Procedure

11.5.1 Clamp the specimen from the upper 6 mm of its length with the longitudinal axis vertical, by a heavy spring clamp, so that the upper end of the tube is closed to prevent any chimney effects during the test. The lower end of the specimen is to be 300 ± 10 mm above a horizontal layer of not more than 0.08 g of absorbent 100 percent cotton thinned to approximately 50 x 50 mm and a maximum thickness of 6 mm. See Figure 11.1.

11.5.2 The methane gas supply to the burner shall be arranged as in Figure 7.3 and adjusted to produce a gas flow rate of 105 ml/min with a back pressure less than 10 mm water. See ASTM D 5207.

11.5.3 Adjust the burner to produce a blue flame 20 ± 1 mm high. The flame is obtained by adjusting the gas supply and air ports of the burner until a 20 ± 1 mm yellow-tipped blue flame is produced. Increase the air supply until the yellow tip just disappears. Measure the height of the flame again and readjust it if necessary.

11.5.4 The test flame shall be calibrated in accordance with ASTM D 5207 at least once a month and when the gas supply is changed, test equipment is replaced, or when data is questioned.

11.5.4 revised December 12, 2003

11.5.5 Apply the flame centrally to the middle point of the bottom edge of the specimen, on the cylindrical edge opposite the lapped edges, so that the top of the burner is 10 ± 1 mm below that point of the lower end of the specimen, and maintain it at that distance for 3 ± 0.5 seconds, moving the burner as necessary in response to any changes in the length or position of the specimen (see the Note to 11.5.5.2).

11.5.5 revised June 2, 2006

11.5.5.1 If the specimen drips molten or flaming material during the flame application, tilt the burner at an angle of $45 \pm 5^\circ$ and withdraw it just sufficiently from beneath the specimen to prevent material from dropping into the barrel of the burner while maintaining the 10 ± 1 mm spacing between the center of the top of the burner and the remaining portion of the specimen, ignoring any strings of molten material.

11.5.5.1 added June 2, 2006

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11.5.5.2 After the application of the flame to the specimen for 3 ± 0.5 seconds, immediately withdraw the burner at a rate of approximately 300 mm/sec to a distance at least 150 mm away from the specimen and simultaneously use the timing device to commence measurement of the afterflame time t_1 in seconds. Record t_1 .

Note – For specimens that are not lapped at their lower end when suspended from the secured upper end, the flame is to be applied in line with the longitudinal axis of the specimen.

11.5.5.2 added June 2, 2006

11.5.6 As soon as afterflaming of the specimen ceases, even if the burner has not been withdrawn to the full 150 mm distance from the specimen, immediately place the burner under the specimen and maintain the burner at a distance of 10 ± 1 mm from the remaining portion of the specimen, while moving the burner clear of dropping material as necessary. After this application of the flame to the specimen for 3 ± 0.5 seconds, immediately remove the burner at a rate of approximately 300 mm/sec to a distance of at least 150 mm from the specimen and simultaneously commence measurement of the afterflame time, t_2 , and the afterglow time, t_3 , of the specimen. Record t_2 and t_3 to the nearest half second.

11.5.6 revised June 2, 2006

11.6 Test results

11.6.1 The following are to be observed and recorded:

- a) Afterflame time after first flame application, t_1 .
- b) Afterflame time after second flame application, t_2 .
- c) Afterglow time after second flame application, t_3 .
- d) Whether or not specimens burn up to the 125 mm mark.
- e) Whether or not specimens drip flaming particles which ignite the cotton indicator.

12 Horizontal Burning Foamed Material Test; HBF, HF-1, or HF-2...

(ASTM D 4986 or ISO 9772)

12.1 Test criteria

12.1.1 This test is intended to be performed on foamed plastic materials used for parts in devices and appliances in non-structural applications.

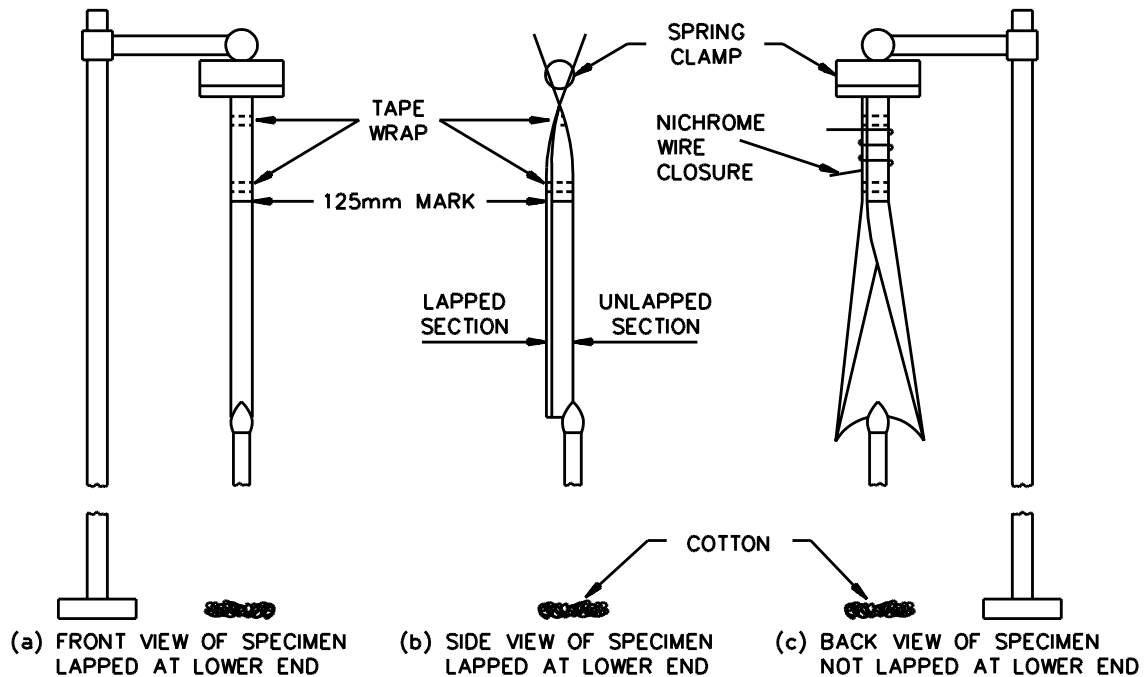
12.1.2 This test does not cover foamed plastics for use as materials for building construction or finishing.

12.1.3 Materials shall be classed HBF, HF-1, or HF-2, on the basis of test results obtained on small specimens when tested as described in 12.2.1 – 12.6.2.

12.1.3 revised July 29, 1997

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Figure 11.1
Specimen orientation



FT270

12.1.4 MATERIALS CLASSIFIED HBF – Materials classified HBF shall:

- a) Not have any specimens with a burning rate exceeding 40 mm per minute over a 100 mm span, or
- b) Have each specimen cease to burn before flaming or glowing reaches the 125 mm gauge mark.

12.1.4 revised July 29, 1997

12.1.5 If only one specimen from a set of five specimens does not comply with the requirements in 12.1.4, another set of five specimens, subjected to the same conditioning, shall be tested. All specimens from this second set of specimens shall comply with the requirements in 12.1.4 for the material in that thickness and density to be classed HBF.

12.1.5 revised July 29, 1997

12.1.6 MATERIALS CLASSIFIED HF-1 and HF-2 – Materials classified HF-1 and HF-2 shall be in compliance with Table 12.1.

12.1.6 revised July 29, 1997

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Table 12.1
Material classifications

Table 12.1 revised July 29, 1997

Criteria Conditions	HF-1	HF-2
Afterflame time	4/5 is ≤ 2 s 1/5 is ≤ 10 s	4/5 is ≤ 2 s 1/5 is ≤ 10 s
Afterglow time for each individual specimen	≤ 30 s	≤ 30 s
Cotton indicator ignited by flaming particles or drops	No	Yes
Damaged length for each individual specimen	< 60 mm	< 60 mm
Notes: 4/5 – Four out of a set of five specimens. 1/5 – One out of a set of five specimens.		

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12.1.7 If a set of five specimens does not comply with the requirements in 12.1.6 because of one of the following situations, another set of five specimens subjected to the same conditioning shall be tested:

- a) A single specimen flames for more than 10 seconds; or
- b) Two specimens flame for more than 2 seconds but less than 10 seconds; or
- c) One specimen flames for more than 2 seconds but less than 10 seconds, and a second specimen flames for more than 10 seconds; or
- d) One specimen does not comply with the additional criteria in 12.1.6.

12.1.8 All specimens from this second set shall comply with the requirements in 12.1.6 in order for the foamed plastic material in that thickness and density to be classed HF-1 or HF-2.

12.1.8 revised July 29, 1997

12.2 Test apparatus

12.2.1 See 5.1 – 5.3, 5.5 – 5.8, 5.10, 5.12 – 5.15, 5.18 and 5.19.

12.3 Test specimens

12.3.1 Test specimens are to be cut from a representative sample of the material. Care is to be taken to remove all dust and any particles from the surface.

12.3.2 Standard test specimens are to be 150 ± 5 mm long by 50 ± 1 mm wide, in the minimum and maximum thicknesses covering the thickness range to be considered. Specimens tested by this method are limited to a maximum thickness of 13 mm. Specimens in intermediate thicknesses are also to be provided and shall be tested if the results obtained on the minimum and/or maximum thickness indicate inconsistent test results. Intermediate thicknesses are not to exceed increments of 6 mm. The maximum width is not to exceed 50 mm. The edges are to be smooth and the radius on the corners is not to exceed 2 mm.

12.3.2 revised July 10, 1998

12.3.3 Material Ranges – If the material is to be considered in a range of densities or colors, specimens representing the extremes of the range are to be provided and considered representative of the range if the test results are essentially the same. When certain color pigments (for example, red, yellow, and the like) are known by experience to affect flammability characteristics, they are also to be provided.

12.3.3 revised June 10, 1997

12.3.4 If consideration is to be given to foamed material having a high density exterior on one or both sides, representative specimens are to be provided. If a range of exterior densities are to be considered, the specimens representing the ranges are to be provided.

12.3.5 If consideration is to be given to foamed material having adhesive on a surface, specimens having adhesive on one side are to be provided.

12.4 Conditioning

12.4.1 Two sets of five specimens are to be preconditioned as in 6.1.

12.4.2 Two sets of five specimens are to be preconditioned as in 6.2.

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12.5 Procedure

12.5.1 The specimen support gauze is to be held in a support fixture similar to Figure 12.1 such that the major section is horizontal and 13 ± 1 mm above the tip of the burner wing tip, and 175 ± 25 mm above a horizontal layer of absorbent 100 percent cotton, thinned to approximately 50 x 50 mm and a maximum thickness of 6 mm. The cotton is to be located under the front upturned portion of the wire cloth.

12.5.2 Each specimen is to be marked across its width with three lines, 25 mm, 60 mm, and 125 mm from one end, referred to as gauge marks.

12.5.3 The test specimen is to be placed flat on the wire cloth with the gauge marks facing up. The end closer to the 60 mm mark is to be placed in contact with the upturned end of the wire cloth.

Note 1: Specimens with a high density exterior on one side are to be tested with that side facing down. Specimens with adhesive on one side are to be tested with that side facing up.

Note 2: If a new wire cloth is not used for each test, any material remaining on the cloth from previous tests is to be burned off, and the cloth is to cool before conducting the test.

12.5.4 The burner with wing tip is then to be placed remote from the specimen, ignited, and adjusted to provide a blue flame 38 ± 2 mm high, when measured in subdued light. The flame is to be obtained by adjusting the gas supply and the air port of the burner until a 38 ± 2 mm yellow-tipped blue flame is produced. The air supply is increased until the yellow tip disappears. The height of the flame is to be measured again and readjusted, if necessary. The flame height measurement should be made from the outside edges of the curved wingtip.

12.5.5 The burner is then to be quickly placed in position beneath the wire gauze under the upturned end of the specimen support so that one edge of the flame is in line with the upturned end of the wire gauze and the other edge of the flame extends into the front end of the specimen. See Figure 12.2.

Note: The center of the width of the wing tip is to be in line with the longitudinal axis of the specimen.

12.5.6 The flame is to be applied for 60 ± 1 seconds and then removed from the specimen a distance of 100 mm or greater. Simultaneously start a timing device with the removal of the test flame.

12.5.7 Start another timing device when the flame reaches the 25 mm gauge mark, whether the flame is on the bottom, top or edge of the specimen.

Note: Always start the second timing device when the flame reaches the 25 mm gauge mark, regardless of whether the 60 second flame is still being applied.

12.5.7 revised June 10, 1997

12.5.8 Record the time when:

- a) The flaming ceases (afterflame).
- b) The flaming and glowing ceases (afterglow).
- c) The flaming or glowing front reaches the 125 mm gauge mark, or when the specimen ceases to burn or glow before the 125 mm gauge mark.

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12.6 Test results

12.6.1 For specimens considered for Class HBF, the following are to be observed and recorded:

- a) The duration of burning (t_b) (sec), between the 25 mm until flaming or glowing stops or passes the 125 mm gauge mark, as recorded by the third timing device.
- b) The distance the specimen burned (L_b) (mm), between the 25 mm gauge mark and where flaming or glowing stops, or up to the 125 mm mark, and if the 125 mm mark was reached.
- c) The calculated Burning Rate from the formula:

$$BR = 60 \left(\frac{L_b}{t_b} \right)$$

in which:

BR = burning rate expressed in mm/min

12.6.1 revised July 29, 1997

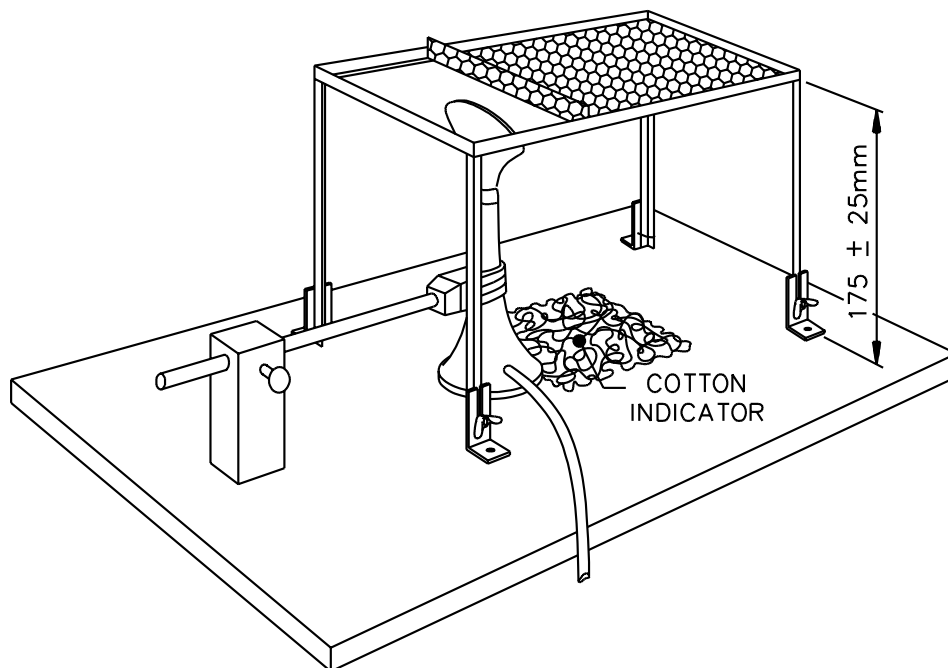
12.6.2 For specimens considered for Class HF-1 or HF-2, the following are to be observed and recorded:

- a) The time recorded in 12.5.8.
- b) The distance the specimen burned up to the 60 mm mark, or if the 60 mm mark was passed.
- c) Whether or not the dry absorbent surgical cotton placed below the test specimen was ignited by flaming particles.

12.6.2 revised July 29, 1997

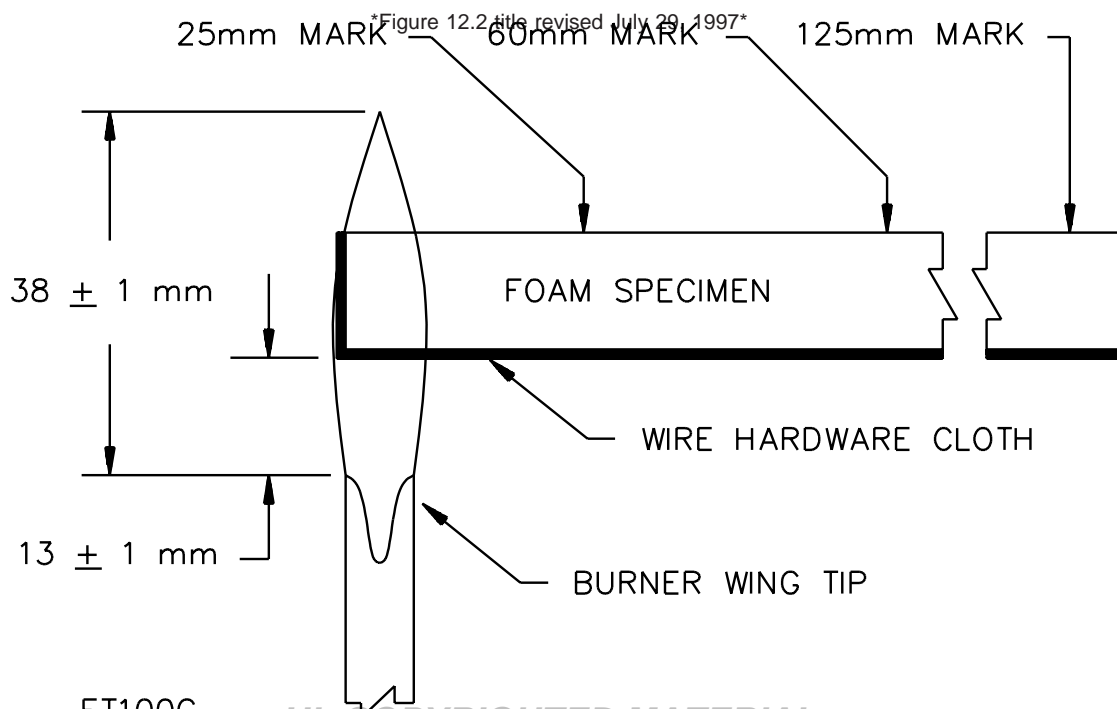
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Figure 12.1
Foam support fixture



FT280

Figure 12.2
Horizontal burning test for HBF, HF-1, OR HF-2 classification



FT100C

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MARKING

13 General

13.1 Material containers shall be marked with the following:

- a) The manufacturer's or private labeler's name or identifying symbol.
- b) A distinctive material designation.

13.2 If a manufacturer produces the material at more than one factory, each material container shall have a distinctive marking to identify it as the product of a particular factory.

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SUPPLEMENT SA - FOLLOW-UP INSPECTION INSTRUCTIONS

INTRODUCTION

SA1 Scope

SA1.1 This Supplement describes the manufacturer's production program necessary to verify that the product continues to be in compliance with the requirements in this Standard.

SA1.2 This Supplement also describes the duties and responsibilities of the field representative of the certification organization.

SA1.3 Recognizing that manufacturers are required to have quality assurance systems in place for the control of their production processes and products, this Supplement only covers the sampling inspections, tests, and other measures taken by the manufacturer and considered to be the minimum requirements of the certification organization. Such inspections, tests, and measures are supplemented by the certification organization as an audit of the means that the manufacturer exercises to determine conformance of products with the certification organization's requirements.

SA1.4 The certification organization shall have additional authority specified in legally binding agreements, signed by both the certification organization and manufacturer, to control the use and application of the certification organization's registered mark(s) for product, packaging, advertising, and associated literature. The legal agreements shall cover the control methods to be used by the certification organization and the manufacturer's options for appeal. Any additional inspections, tests, or other measures deemed necessary by the certification organization but to be taken by the manufacturer are to be applied in order to control the use and application of the certification organization's registered Mark(s).

SA2 Glossary

SA2.1 For the purposes of this Supplement, the following definitions apply.

SA2.2 **CERTIFICATION ORGANIZATION** – A third party organization independent of the manufacturer who, under a legally binding contract with the manufacturer, evaluates a product for compliance with requirements specified in the Standard, and who maintains periodic inspection of production of these products to verify compliance with the specifications in the Procedure and this Supplement.

SA2.3 **FIELD REPRESENTATIVE** – An authorized representative of the certification organization who makes periodic unannounced visits to the manufacturer's facilities for purposes of conducting inspections and monitoring the manufacturer's production program.

SA2.4 **INSPECTION REPORT** – The report generated by the field representative summarizing the results of the inspection visit.

SA2.5 **MANUFACTURER** – The authorized party who maintains and operates the facilities where a Recognized Component is produced or stored and where the product is inspected and/or tested as described in this Supplement.

SA2.6 **PROCEDURE** – The document issued by the certification organization, upon determination that a product is eligible for Recognition, for use by the manufacturer and the field representative. The document contains requirements and other provisions and conditions regarding the Recognized product and provides the authorization for the manufacturer to use the Recognition Marking on products fulfilling these requirements.

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SA2.7 RECOGNIZED COMPONENT – A part or subassembly intended for use in other equipment and that has been investigated for certain construction or performance, or both, characteristics. A Recognized Component is incomplete in construction features or is restricted in performance capabilities so as not to warrant its acceptability as a field-installed component. It is intended solely as a factory-installed component of other equipment where its acceptability is determined by the certification organization.

SA2.8 RECOGNITION MARKING – A distinctive Mark of the certification organization that the manufacturer is authorized to apply to Recognized Components as the manufacturer's declaration that they conform to the requirements of the Standard.

SA2.9 VARIATION NOTICE (VN) – A document used to record observed differences between a product or manufacturing process and the description of the product or process in the Procedure and/or Standard.

SA3 Responsibility of the Manufacturer

SA3.1 It is the manufacturer's responsibility to restrict the use of the Recognition Marking to those products specifically authorized by the certification organization that are found by the manufacturer's own quality assurance program to comply with the Procedure description.

SA3.2 The manufacturer shall confine all Recognition Markings to the location or locations authorized in the Procedure.

SA3.3 During hours in which the manufacturer's facilities are in operation, the manufacturer shall permit the field representative free access to any portion of the premises where the plastic material is being produced, stored or tested.

SA3.4 The Field Representative shall be permitted to select a sufficient quantity of material, representative of current production. The manufacturer shall mold this material into test specimens, of a size and quantity, as indicated in the Procedure, for the purposes of the Follow-Up Test Program at the Certification Organization. The packaging and shipment of these samples is the responsibility of the manufacturer.

SA3.5 A material that is found to no longer be in compliance with the requirements of the certification organization shall be corrected by the manufacturer if the Recognition Mark is to be used on the product. If the noncompliance was the result of a manufacturing process, the manufacturer shall check subsequent production until it is certain that the process has been corrected and the noncompliance will not reoccur.

SA4 Responsibility of the Field Representative

SA4.1 At each visit to the manufacturer's facility, the Field Representative shall review a representative sampling of plastic production which bears the Recognition Marking, to assure that the Recognition Marking has been applied in accordance with this supplement, and the Procedure description. An inspection report shall be completed after each visit.

SA4.2 Any observed differences between the product marking and the description of the marking in the Procedure and/or Standard shall immediately be called to the attention of the manufacturer. Any observed differences shall be confirmed in a Variation Notice.

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SA4.3 Production that is found to no longer be in compliance with the requirements of the certification organization shall be brought into compliance by the manufacturer if the Recognition Marking is to be used on the product's packaging. If the non-compliance was the result of a manufacturing process, the manufacturer shall check subsequent production until it is certain that the process has been corrected and the noncompliance will not recur. The Field Representative shall verify that the product marking continues to be in compliance with the requirements of the certification organization.

SA4.4 Production that does not comply with the provisions of these follow-up inspection instructions shall have the Recognition Marking removed or obliterated. The manufacturer shall satisfy the field representative that all Recognition markings are removed or obliterated from rejected material. Those Recognition markings not destroyed during the removal from the product packaging shall be turned over to the field representative for destruction. If rejection of production is questioned by the manufacturer, the manufacturer may hold the material at the point of inspection, typically at the factory, pending an appeal.

SA5 Selection of Samples for Follow-Up Testing

SA5.1 The Field Representative shall randomly select representative samples of production for the purposes of follow-up testing at the Certification organization. The sample selection interval shall be specified by the Certification organization, and the Field Representative shall assure that all selected samples are properly identified through the use of sample identification tags provided by the Certification organization. The follow-up tests performed at the Certification organization are described in the "Follow-Up Test Program" Section of this Supplement.

SA6 Follow-Up Test Program

SA6.1 The following tests are to be performed by the Certification organization on samples received from the Field Representative.

SA6.1.1 **FLAMMABILITY TEST** – Test specimens are to be subjected to the appropriate burning tests, indicated in the Procedure, in accordance with the methods described in UL 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances. The classifications obtained in the Follow-Up Tests are to be the same as those indicated in the Procedure.

SA6.1.2 **QUALITATIVE INFRARED ANALYSIS** – An infrared spectrum of the material is to be obtained by means of an infrared spectrophotometer in accordance with the methods described in Infrared Spectroscopy, Section 43 of UL 746A, Polymeric Materials – Short Term Property Evaluation. Instrument settings used in obtaining the spectrum shall be identical to those used in obtaining the original spectrum of the material referenced in the procedure. The spectrum obtained shall indicate the same composition as that recorded in the spectrum obtained under the original investigation.

SA6.1.3 **THERMOGRAVIMETRY** – A thermogram of the material is to be obtained by means of a thermal analyzer with a thermogravimetric module in accordance with the methods described in Thermogravimetry, Section 46 of UL746A, Polymeric Materials – Short Term Property Evaluations. Instrument settings used in obtaining the thermogram shall be identical to those used in obtaining the original thermogram of the material referenced in the procedure. The thermogram obtained shall indicate the same characteristic weight loss over the programmed temperature range as that recorded in the thermogram obtained under the original investigation.

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SA6.1.4 A thermogram of the material is to be obtained by means of a thermal analyzer with a DSC (Differential Scanning Calorimetry) module in accordance with the methods described in Differential Scanning Calorimetry, Section 47 of UL746A, Polymeric Materials – Short Term Property Evaluations. Instrument settings used in obtaining the thermogram shall be identical to those used in the original thermogram of the material referenced in this procedure. The thermogram obtained shall indicate the same general thermal response over the programmed temperature range as that recorded in the thermogram obtained under the original investigation.

SA6.2 Upon completion of follow-up testing, the Certification organization shall report the results to the manufacturer.

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SUPPLEMENT SB - GUIDANCE FOR ACCEPTING ALTERNATE MANUFACTURING LOCATIONS

Supplement SB added June 8, 2000

INTRODUCTION**SB1 Scope**

SB1.1 The following guidelines have been developed by UL to assist manufacturers in understanding what additional testing is necessary when a manufacturer wants to change or add to the existing production sites.

SB2 Guidelines

SB2.1 A UL Recognized product may be produced at alternate manufacturing locations without additional testing if:

1. The new location (manufacturer) of the product is accountable to and initially audited by the UL Applicant.
2. The same raw material specifications are used.
3. The same product formulation is followed.
4. The same product name and product specifications are used.
5. Verification of the product is determined by UL Follow-Up testing.

SB2.2 These products may be produced at the same company, affiliate and/or contractor locations as long as the above requirements are met. The published ratings must be identical in all cases.

SB2.3 The applicant must provide a summary to UL of the initial audit with all relevant test data demonstrating that the new manufacturing location produces an identical product.

SB2.4 If any of the above requirements are not met, an appropriate test program would be conducted by UL.

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