

UL 94

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

Underwriters Laboratories Inc. (UL)
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UL Standard for Safety
for
Test 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 July 10, 1998.

A change is indicated by a note following the affected item. The note is preceded and followed by an asterisk.

The revised requirements are substantially in accordance with UL's Bulletin on this subject dated December 26, 1997.

The revisions dated July 10, 1998 include a reprinted title page (page 1) for this Standard.

As indicated on the title page (page 1), this UL Standard for Safety has been adopted by the Department of Defense.

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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that have been revised and that have a future effective date are located after the Standard, and are preceded by a "SUPERSEDED REQUIREMENTS" notice.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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UL 94

Standard for

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

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Fifth Edition

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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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FOREWORD

A. This Standard contains a description of the basic test method(s) for evaluating products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. This test method(s) is based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. It is subject to revision as further experience and investigation may show is necessary or desirable.

B. The consistent and uniform production of the product so that it will perform in the manner indicated by the coverage is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which performs in a specified manner will not necessarily be judged to be eligible for coverage if, when examined and tested, it is found to have other features which impair the significance associated with such performance.

D. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

E. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 These requirements cover tests for flammability of plastic 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.

1.2 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 heat and flame under controlled laboratory conditions. 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 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.

1.3 revised July 10, 1998

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

1.4 revised June 10, 1997

1.5 These requirements do not cover plastics when used as materials for building construction or finishing.

1.6 A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this Standard, and that involves a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the acceptable level of safety as originally anticipated by the intent of this Standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this Standard cannot be judged to comply with this Standard. Where considered appropriate, revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this Standard.

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.

ASTM D 618, Method for Conditioning Plastics and Electrical Insulating Materials for Testing (ISO 291: Plastics – Standard Atmospheres for Conditioning and Testing)

ASTM D 789, Test Method for Determination of Relative Viscosity, Melting Point, and Moisture Content of Polyamide (PA)

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

ASTM D 3195, Practice of Rotameter Calibration

ASTM D 5025, Specification for a Laboratory Burner Used for Small-Scale Burning Tests on Plastic Materials

ASTM D 5207, Standard Practice for Calibration of 20 mm and 125 mm Test Flames for Small-Scale Burning Tests on Plastic Materials

ASTM E 437, Specification for Industrial Wire Cloth and Screens (Square Opening Series), Appendix X3

94HB: 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 707, Methods of Test for the Determination of the Flammability of Solid Electrical Insulating Materials When Exposed to an Igniting Source, ISO 1210, Plastics – Determination of the Burning Behavior of Horizontal and Vertical Specimens in Contact with a Small Flame Ignition Source)

94V: ASTM D 3801, Method for Measuring the Comparative Extinguishing Characteristics of Solid Plastics in a Vertical Position (IEC 707, ISO 1210)

94VTM: 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)

94-5V: ASTM D 5048, Standard Test Method for Measuring the Comparative Burning Characteristics and Resistance to Burn-Through of Solid Plastics Using a 125 mm Flame (ISO 10351, Plastics – Method of Test for the Determination of Combustibility of Specimens Using a 125 mm Flame Source)

94HBF: ASTM D 4986, Standard Test Method for Horizontal Burning Characteristics of Cellular Polymeric Materials (ISO/DIS 9772.3, Cellular Plastics – Determination of Horizontal Burning Characteristics of Small Specimens Subjected to a Small Flame)

2.2.1 revised June 10, 1997

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 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.

3 Definitions

For the purpose of this Standard, the following definitions apply (See ISO/IEC Guide 52):

3.1 Afterflame – Persistence of flaming of a material, after the ignition source has been removed.

3.2 Afterflame Time – The length of time for which a material continues to flame, under specified conditions, after the ignition source has been removed.

3.3 Afterglow – Persistence of glowing of a material, after cessation of flaming or, if no flaming occurs, after removal of the ignition source.

3.4 Afterglow Time – The length of time for which a material continues to glow under specified test conditions, after the ignition source has been removed and/or cessation of flaming.

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 – having an inside volume of at least 0.5 m^3 , is to be used when testing the specimens. The chamber is to permit observation and is to be draft free while permitting normal thermal circulation of air past the specimen during burning. For safety and convenience, it is desirable that this

enclosure (which can be completely closed) be fitted with an evacuation device, such as an exhaust fan, to remove products of combustion which may be toxic. However, it is important to note that the device shall be turned off during the actual test and started again immediately after the test to remove the products of combustion.

Note: 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.

5.1 revised June 10, 1997

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.

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 500 w 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 has been found to provide similar results. However, technical grade methane shall be used in case of dispute.

5.8 revised April 30, 1997

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

5.9 revised July 29, 1997

5.10 Conditioning Room or Chamber – Capable of being maintained at 23 ±2EC 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

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

5.16 revised July 29, 1997

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 desiccator, specimens shall be tested within 30 minutes.

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.

TESTS

7 Horizontal Burning Test; HB

(ASTM D 635, D 4804, IEC 707, or ISO 1210)

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 – 13 mm, or
- b) Not have a burning rate exceeding 75 mm per minute over a 75 mm 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 July 29, 1997

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.

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 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 April 30, 1997

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 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.

7.5.5 revised July 10, 1998

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 approximately 45 degrees to the horizontal. See Figure 7.1.

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 . 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 , in millimeters between the 25 mm mark and where the combustion front stops.

7.5.10 The test procedure is to be conducted on at least three specimens.

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

Note: If the flame front passed the 100 mm mark, $L = 75$ mm.

7.7 Results

7.7.1 The following are to be recorded for each specimen:

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

Figure 7.1
Horizontal burning test for HB classification

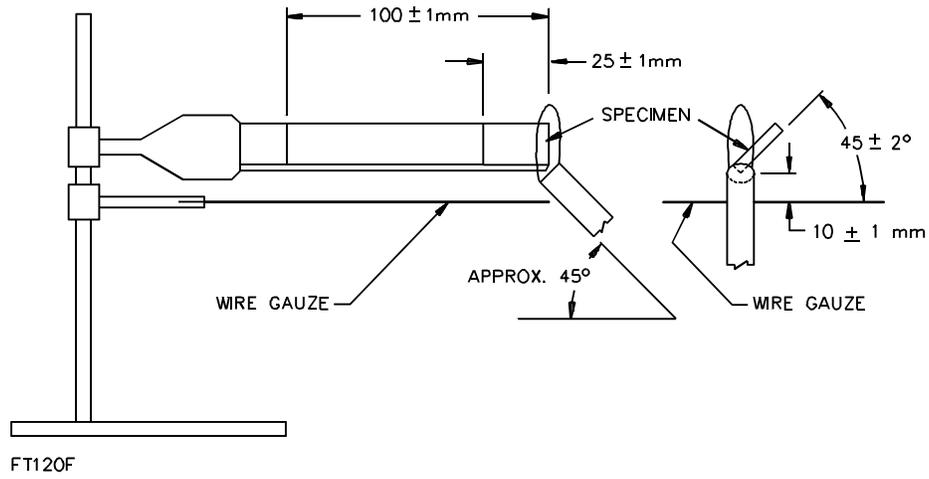


Figure 7.1 revised July 10, 1998

Figure 7.2
Flexible specimen support fixture

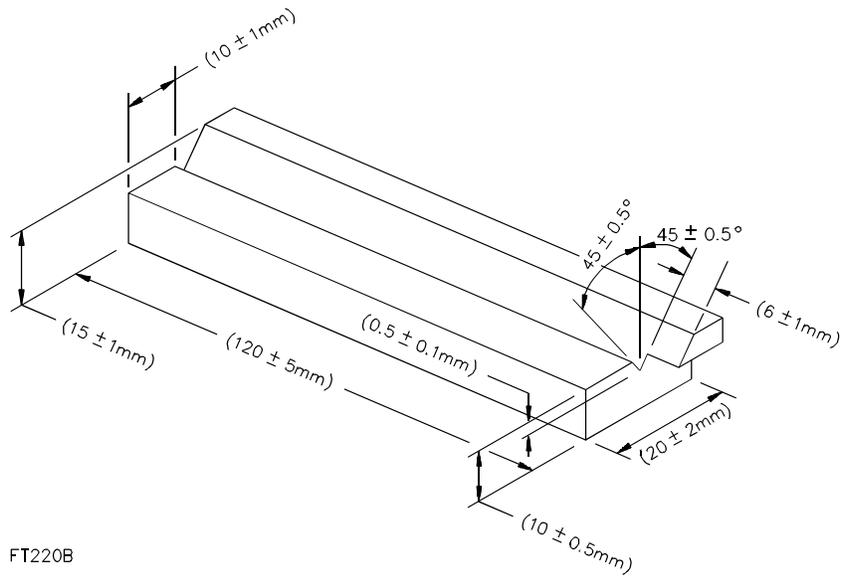
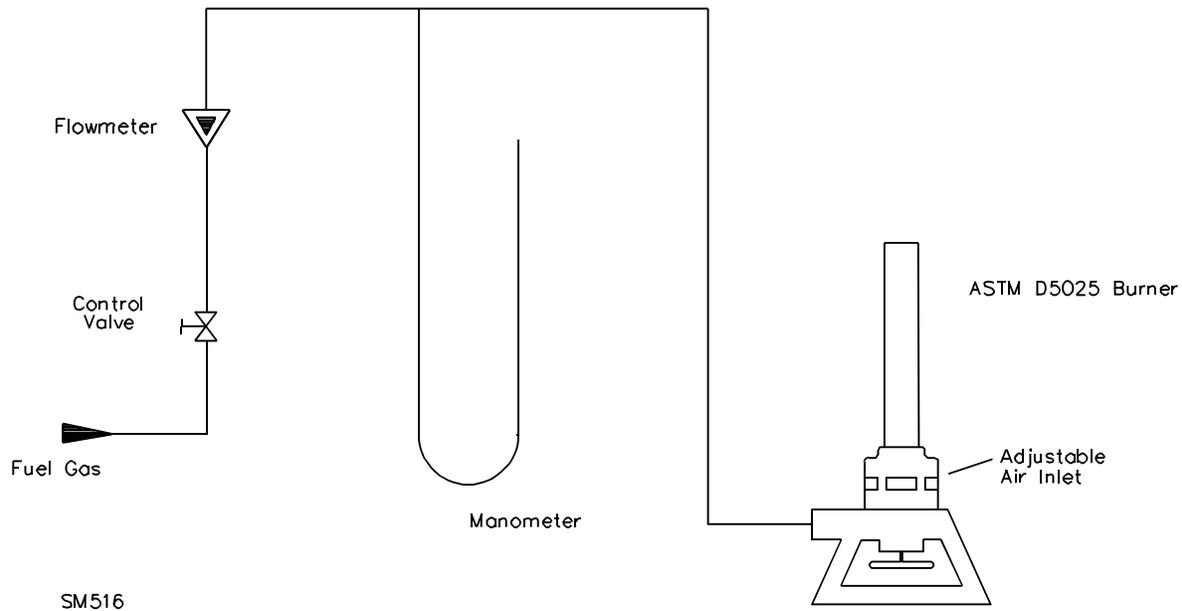


Figure 7.2 revised April 30, 1997

Figure 7.3
Burner supply arrangement



8 20 mm Vertical Burning Test; V-0, V-1, or V-2 (ASTM D 3801, IEC 707, or ISO 1210)

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

8.1.3 Table 8.1 specifies the material classifications.

Table 8.1
Materials classifications

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

Table 8.1 revised July 29, 1997

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

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

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.

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.

Exception: As an alternative, industrial laminates are to be conditioned for 24 hours at 125 ±1EC.

8.4.2 revised June 10, 1997

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.

8.5.4 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.

8.5.4 revised July 10, 1998

8.5.5 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, moving the burner as necessary in response to any changes in the length or position of the specimen. If the specimen drips molten or flaming material during the flame application, tilt the burner at an angle of up to 45 degrees 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. 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 in seconds. Record t_1 .

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 portion of the specimen for an additional 10 ± 0.5 seconds, while moving the burner clear of dropping material as necessary. 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 . Record t_2 and t_3 .

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.

8.6 Results

8.6.1 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 holding clamp.
- e) Whether or not specimens drip flaming particles that ignited the cotton indicator.

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

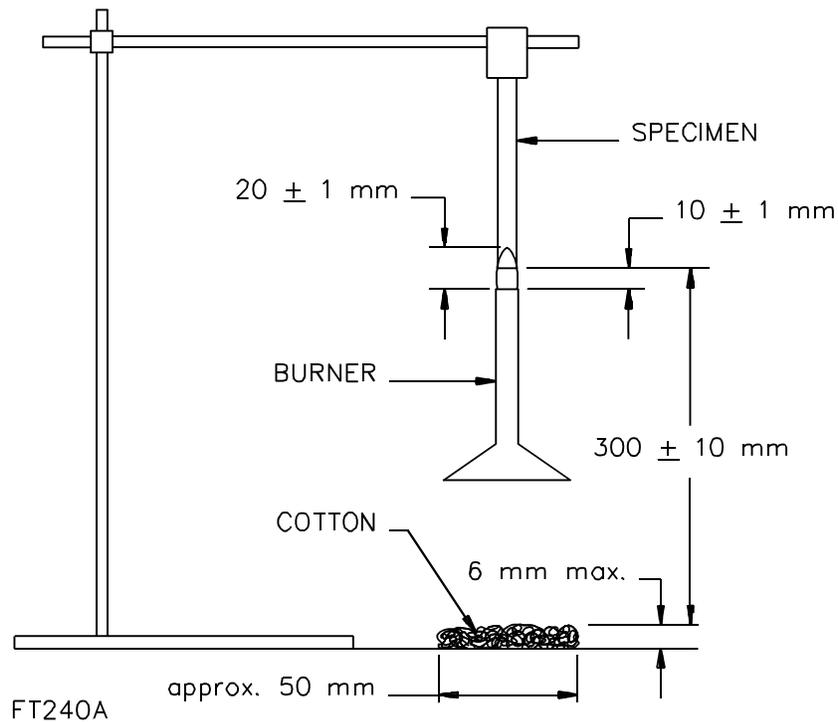


Figure 8.1 title revised July 29, 1997

9 500 w (125 mm) Vertical Burning Test; 5VA or 5VB (ASTM D 5048 or ISO 10351)

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).

9.1.1 revised July 29, 1997

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, V-1 and V-2.

9.1.2 revised July 29, 1997

9.1.3 Table 9.1 specifies the material classifications.

**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.

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, 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 10, 1997

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 degrees from the vertical, so that the tip of the blue cone just touches the specimen.

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

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 flaming particles ignited the cotton.

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 just touches the specimen.

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 contact with the surface of the plaque.

9.6.4 revised June 10, 1997

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.

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

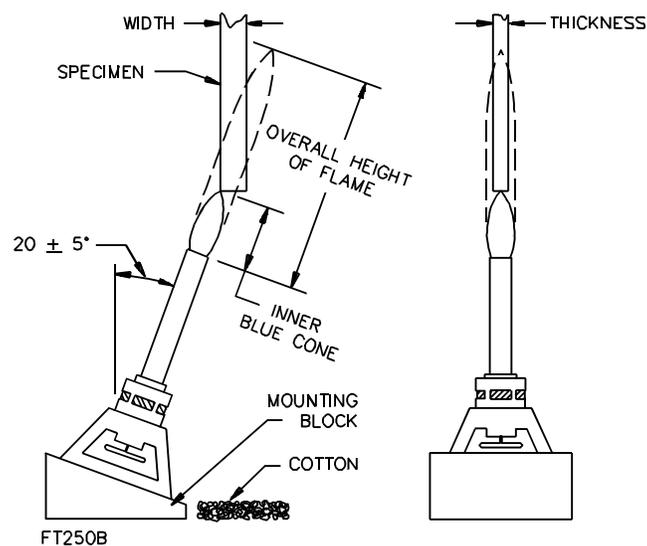


Figure 9.1 title revised July 29, 1997

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

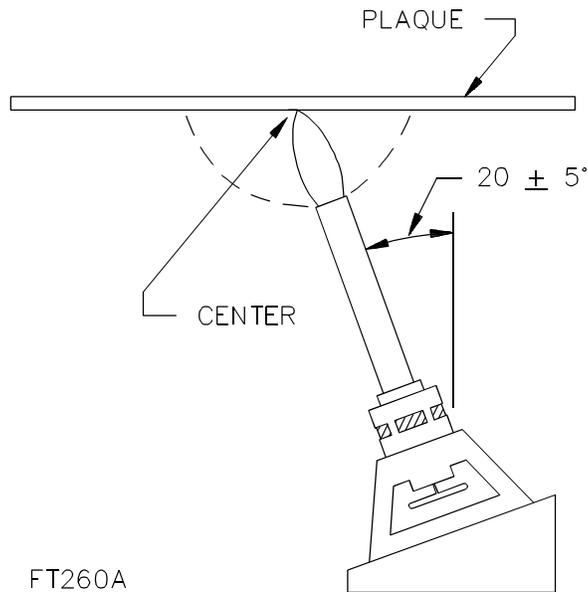


Figure 9.2 title revised July 29, 1997

10 Radiant Panel Flame Spread Test

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.

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.

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. The materials shall also possess physical properties that will allow a 200 mm long by 50 mm wide specimen to be wrapped longitudinally around a 13 mm diameter mandrel (see 11.3.2).

11.1.1 revised July 29, 1997

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

Criteria conditions	VTM-0	VTM-1	VTM-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 125 mm mark	No	No	No
Cotton indicator ignited by flaming particles or drops	No	No	Yes

Table 11.1 revised July 29, 1997

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

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

11.3.2 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 required to test different generic materials, although capable of being wrapped and taped around the mandrel, there are varying degrees of flaring out of the untaped end, some of which results in a unlapped "U" type specimen. These various forms are considered acceptable to test if the upper end is capable of being formed into the cylinder. 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 10, 1997

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

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.

Note: The cylindrical specimens are to be prepared either before or after conditioning.

11.4.2 revised June 10, 1997

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 July 10, 1998

11.5.5 Apply the flame centrally to the middle point of the bottom edge of the unlapped 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 3 ± 0.5 seconds, moving the burner as necessary in response to any changes in the length or position of the specimen (see Note 1). If the specimen drips molten or flaming material during the flame application, tilt the burner at an angle of up to 45 degrees 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. 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 1: For specimens that are not lapped at their lower end when suspended from the pinched upper end, the flame is to be applied in line with the longitudinal axis of the specimen.

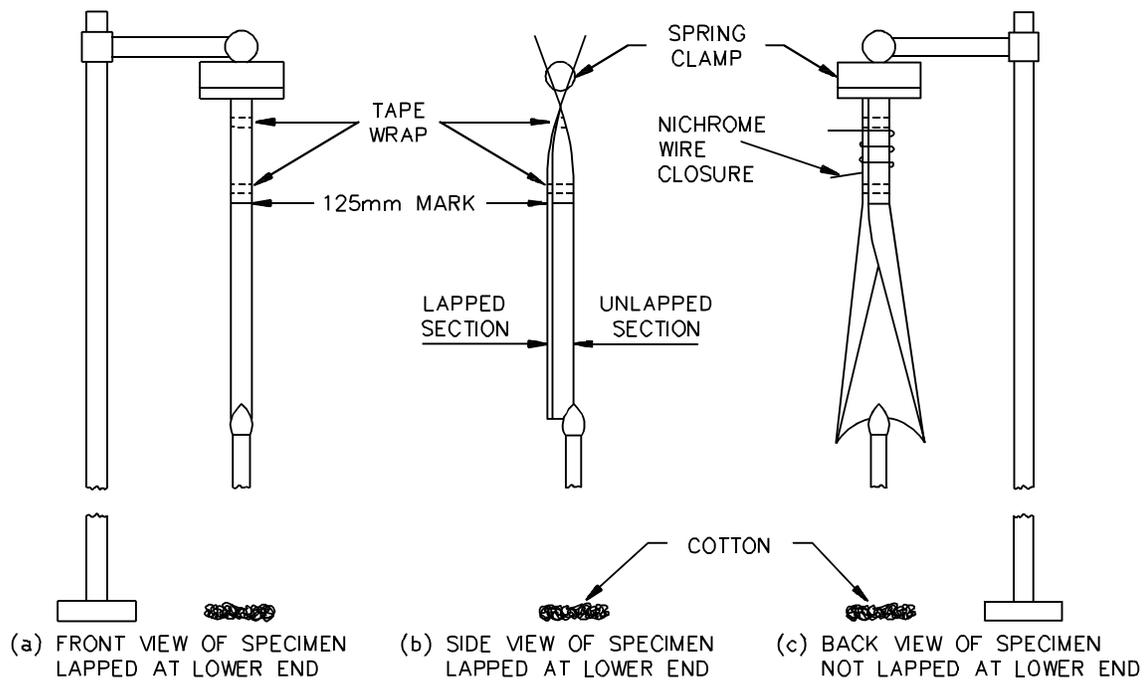
11.5.6 As soon as afterflaming of the specimen ceases, even if the burner has not been withdrawn to the full 150 mm distance from the specimen, immediately place the burner under the specimen and maintain the burner at a distance of 10 ± 1 mm from the remaining portion of the specimen, while moving the 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 .

11.6 Test results

11.6.1 The following are to be observed and recorded:

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

Figure 11.1
Specimen orientation



FT270

12 Horizontal Burning Foamed Material Test; HBF, HF-1, or HF-2... (ASTM D 4986 or ISO/DIS 9772.3)

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

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

Table 12.1
Material classifications

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

Table 12.1 revised July 29, 1997

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.

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 50×50 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.

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

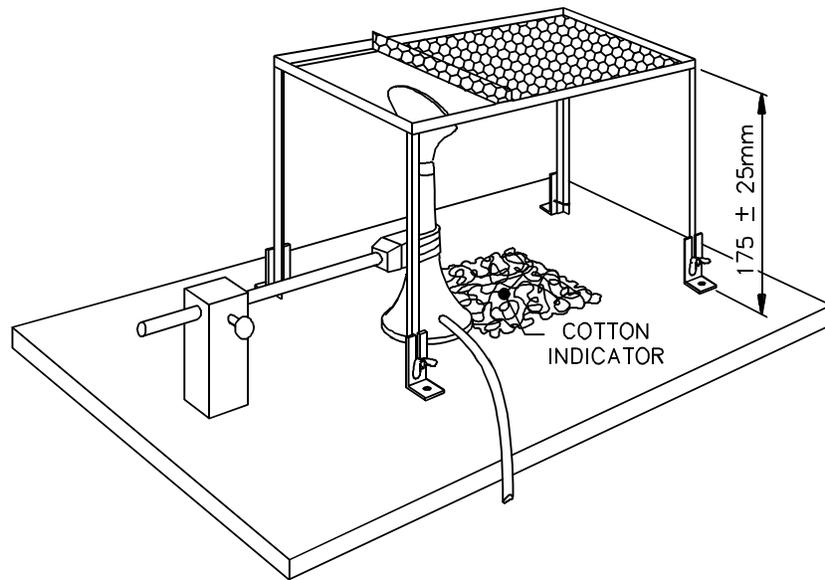
12.6.1 revised July 29, 1997

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.

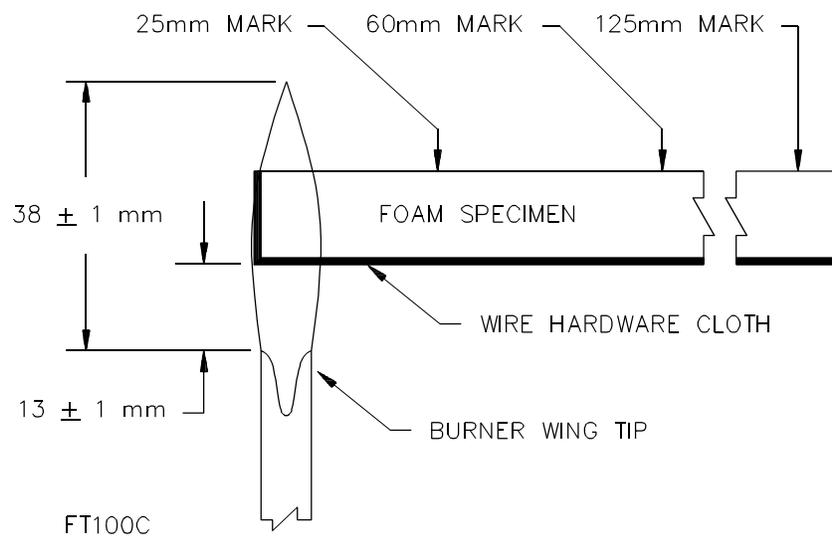
12.6.2 revised July 29, 1997

Figure 12.1
Foam support fixture



FT280

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



FT100C

Figure 12.2 title revised July 29, 1997

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.

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.

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.

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.