UL 94

STANDARD FOR SAFETY

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

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

Seventh Edition, Dated February 28, 2023

Summary of Topics

This revision of ANSI/UL 94 dated January 5, 2024 includes the correct terminology regarding radiant panel index; 1.6, 10.1.1, 10.1.2, and Table 10.1.

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated December 1, 2023.

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FEBRUARY 28, 2023
(Title Page Reprinted: January 5, 2024)

ANSI/UL 94-2024

UL 94

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

First Edition – September, 1972
Second Edition – September, 1973
Third Edition – January, 1980
Fourth Edition – June, 1991
Fifth Edition – October, 1996
Sixth Edition – March, 2013

Seventh Edition

February 28, 2023

This ANSI/UL Standard for Safety consists of the Seventh Edition including revisions through January 5, 2024.

The most recent designation of ANSI/UL 94 as an American National Standard (ANSI) occurred on January 5, 2024. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page. Any other portions of this ANSI/UL standard that were not processed in accordance with ANSI/UL requirements are noted at the beginning of the impacted sections.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

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.

1.2 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.

1.3 The tests in the Standard for Tests for Flammability of Small Polymeric Component Materials, UL 1694, 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 mm^3 (0.15 in^3). UL 1694 is generally not applicable to small components with an overall volume greater than 2500 mm^3 (0.15 in^3).

1.4 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.

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

1.6 These tests, with the exception of the Radiant Panel Index Test, Section 10, are not applicable to the evaluation of parts where the thickness exceeds 13.0 mm or where the surface area exceeds 1 m^2. 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.

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 E176, Standard Terminology of Fire Standards)

ISO 291, Standard Atmospheres for Conditioning and Testing (ASTM D618, Practice for Conditioning Plastics for Testing)

ASTM D789, Test Method for Determination of Relative Viscosity of Polyamide

ASTM E162-08, Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source

ASTM D3195, 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 D5025, Specification for a Laboratory Burner Used for Small-Scale Burning Tests on Plastic Materials; ASTM D5207, 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 D635, 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 D3801, 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 D4804, 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 D5048, 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 D4986, 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)

2.3 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.

3 Definitions

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

3.2 AFTERFLAME – Flame which persists after the ignition source has been removed.

3.3 AFTERFLAME TIME – The length of time during which an afterflame persists under specified conditions.

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

3.5 AFTERGLOW TIME – The length of time during which an afterglow persists under specified conditions.

3.6 FLAME – To undergo combustion in the gaseous phase with emission of light.

3.7 GLOWING COMBUSTION – Combustion of a material in the solid phase without flame but with emission of light from the combustion zone.

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.

4.2 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.

4.3 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.

5 Apparatus

5.1 Laboratory Fume Hood – The laboratory fume hood chamber shall have an inside volume of at least 0.5 m^3. 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 m^3 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.

5.2 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 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.)

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

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 0.1 second.

5.7 Measuring Scale – Graduated in mm.

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

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 6.2 only.)

5.10 Conditioning Room or Chamber – Capable of being maintained at 23 ±2 °C and a relative humidity of 50 ±10 %.

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.)

5.12 Micrometer – Capable of being read to 0.01 mm.

5.13 Cotton – A supply of absorbent 100 % cotton.

5.14 Desiccator – A desiccator containing anhydrous calcium chloride, or other drying agent, maintained at a relative humidity not exceeding 20 % at 23 ±2 °C.

5.15 Conditioning Oven – A full draft air-circulating oven, minimum of 5 air changes per hour, capable of being maintained at 70±2 °C.

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.)

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

5.18 Support-Gauze – A wire cloth of plain weave, low carbon, plain steel or stainless steel, approximately 215 mm long by 75 mm wide . 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 the Standard Specification for Industrial Woven Wire Cloth, ASTM E2016. (Used for the test procedure in Horizontal Burning Foamed Material Test; HBF, HF-1, or HF-2..., Section 12 only.)

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.)

5.20 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, ASTM D3195, with correlation curves appropriate for the gas, or a mass flow meter with ±2 % accuracy.

6 Conditioning

6.1 Specimens are to be preconditioned in accordance with ASTM D618 (ISO 291) at 23 ±2 °C and 50 ±10 % 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 ±2 hours at 70 ±2 °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.

6.4 All specimens are to be tested in a laboratory atmosphere of 15 – 35 °C and ≤ 75 % 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 D635 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 7.1.5):

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.

7.1.3 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.

7.1.4 A material not exceeding the 75 mm/min burning rate or if the burning cannot be determined when tested at any thickness less than 3.0 mm is to be classed HB at the thickness tested (the minimum thickness) and up to a maximum of 2.99 mm without testing additional specimens within this range.

Exception: If the burning rate cannot be determined when tested at a thickness < 1.5 mm as a result of the material ceasing to burn before the 100 mm reference mark, the HB rating shall be restricted to only the tested thickness.

7.1.5 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.

7.2 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 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 color (often white) and dark color (often black/including carbon black) 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 (not carbon black), 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.

7.3.5 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.

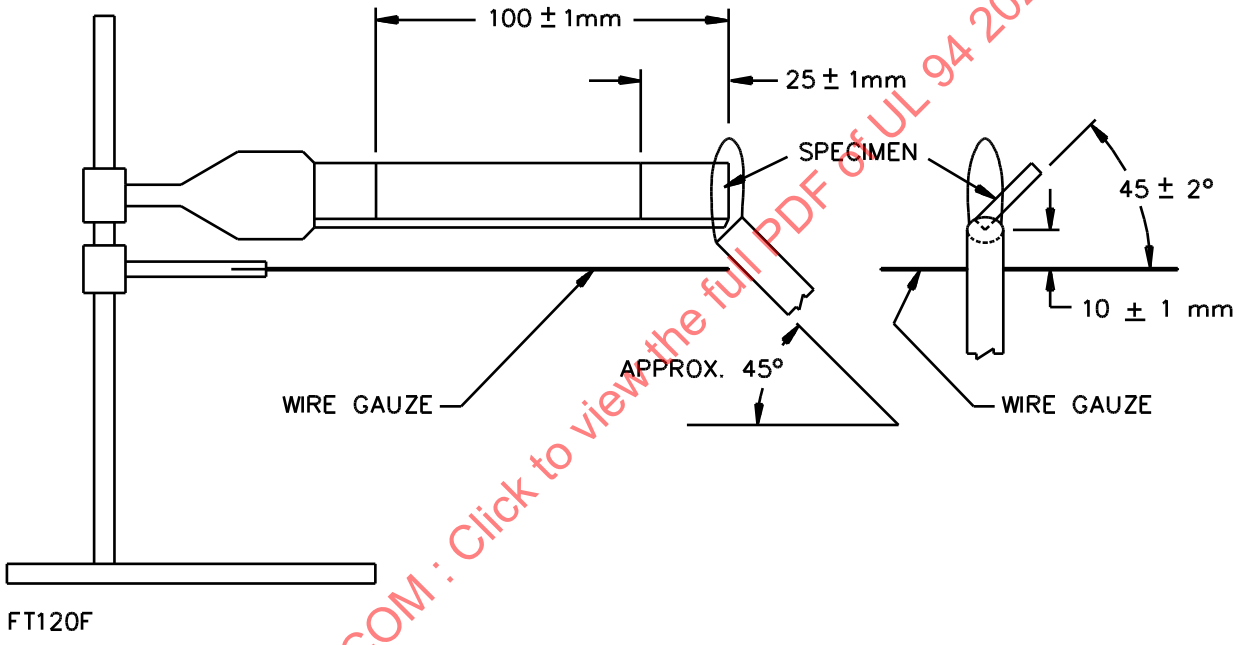
7.5 Procedure

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.

7.5.2 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°. 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.

Figure 7.1

Horizontal Burning Test for HB Classification



7.5.3 To produce the nominal 50 W test flame, the methane gas supply to the burner shall be adjusted to produce a gas flow rate of 105 ±5 ml/min with a back pressure less than 10 mm water and arranged as in Figure 7.3. See ASTM D5207.

Note: A mass flow meter is the preferred means of controlling accurately the input flow rate of gas to the burner. Other methods may be used if they can show equivalent accuracy and demonstrate that the final gas flow rate remains in the range of 105 ±5 ml/m following the test flame adjustment procedure specified in 7.5.4.

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 nominal 50 W test flame shall be confirmed in accordance with ASTM D5207 at least once a month and when the gas supply is changed, test equipment is replaced, or when data is questioned. The

confirmed test flame shall meet the requirements of ASTM D5207 while using a gas flow rate of 105 ±5 ml/m and both the gas flow rate and back pressure shall be recorded in the calibration record.

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 sidewards. As the combustion front progresses along the specimen, the support fixture is to be withdrawn at the same approximate rate.

Figure 7.2

Flexible Specimen Support Fixture

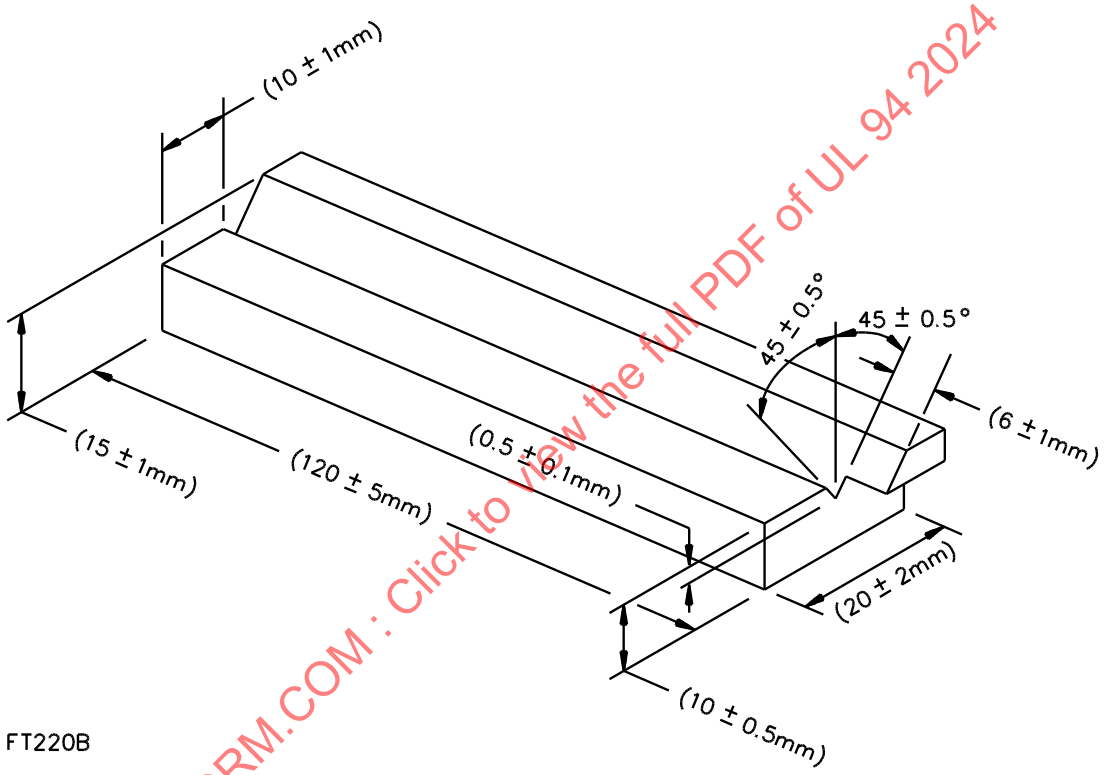
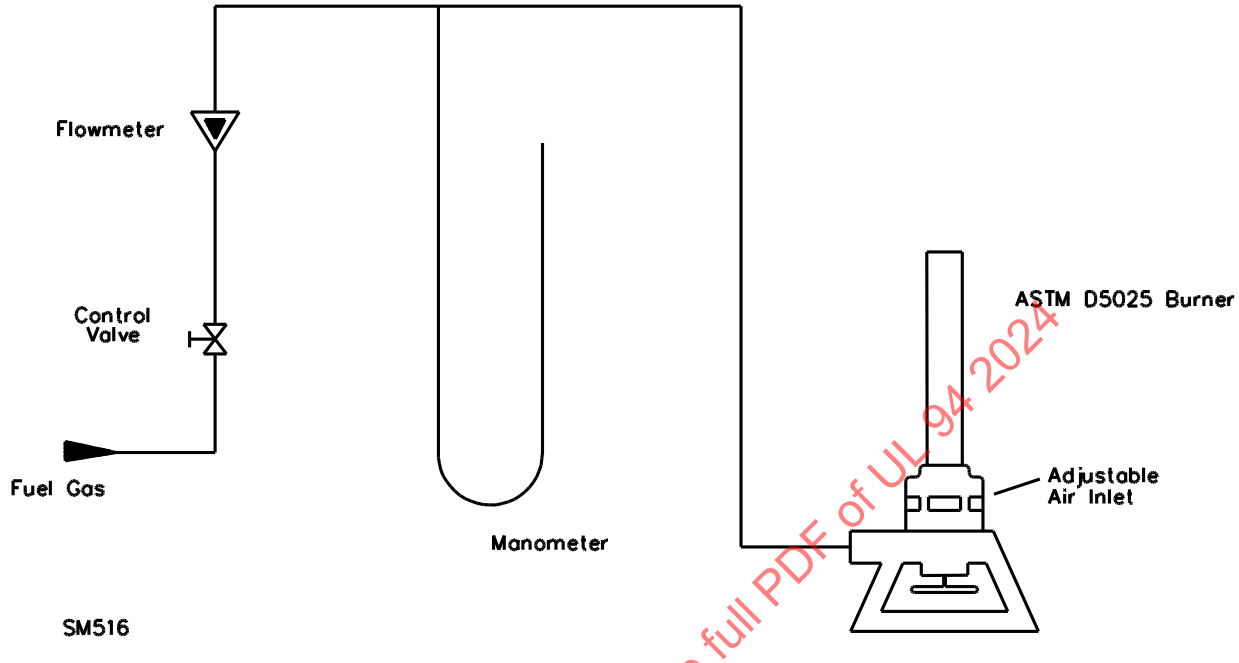


Figure 7.3

Burner Supply Arrangement



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 ±2° 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 (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).

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

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

7.7 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 only in case where the flame front passed the 100 mm mark.

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

(ASTM D3801 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. The final classification shall be the lower classification from both conditions as described in 8.4.

8.1.2 Some materials, due to their thinness distort and/or shrink and/or are consumed up to the holding clamp when subjected to this test. The test specimens used in this test method shall be limited to a minimum thickness of 0.025 mm. Test specimens with a thickness less than 0.025 mm shall be tested in accordance with the test procedure in the Thin Material Burning Test; VTM-0, VTM-1, or VTM-2, Section 11.

Exception No. 1: Test specimens with a thickness less than 0.025 mm may be subjected to the 20 mm Vertical Burning Test; V-0, V-1, or V-2 if the specimens cannot be properly formed for the Thin Material Burning Test; VTM-0, VTM-1, or VTM-2 , as indicated in 11.3.2 and 11.3.3.

Exception No. 2: A test specimen with a thickness less than or equal to 0.250 mm, but greater than or equal to 0.025 mm that is capable of meeting the physical property requirements of both the 20-mm Vertical Burning Test and the Thin Material Burning Test; VTM-0, VTM-1, or VTM-2 test (Section 11) shall be evaluated by the test of choice.

8.1.3 Materials with a density less than 250 kg/m^3 may optionally be tested in accordance with the Horizontal Burning Foamed Materials Test; HBF, HF-1, or HF-2, Section 12.

8.1.4 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 and 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

8.1.5 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.

8.2 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 minimum thickness shall be limited to 0.025 mm, except as indicated in 8.1.2. 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.

8.3.3 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 color (often white) and dark color (often black/including carbon black) 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 (not carbon black), 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.

8.3.5 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.

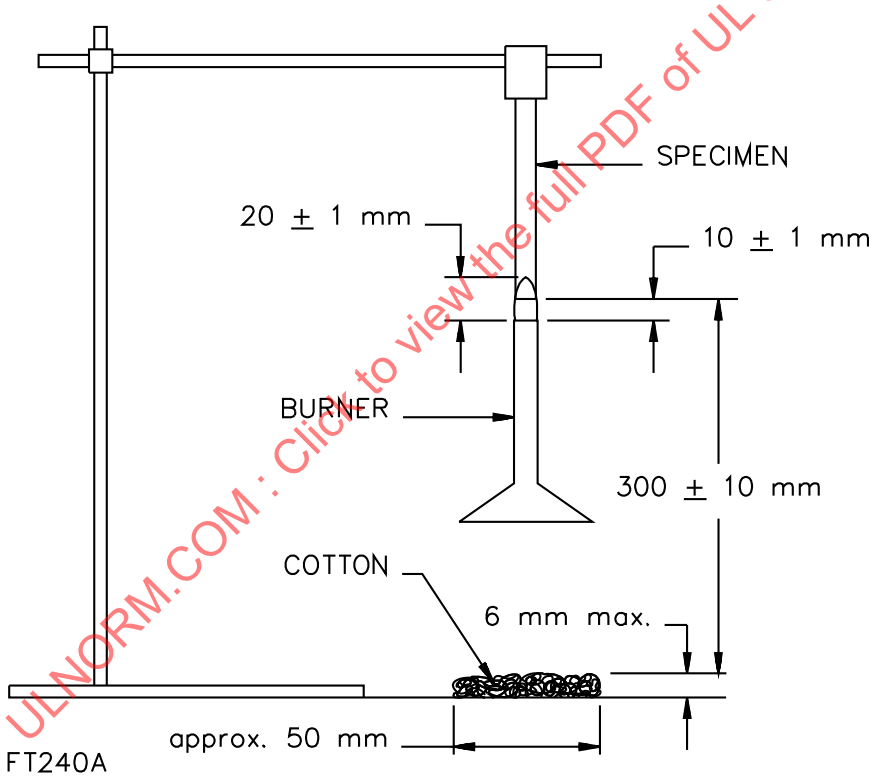
8.4.2 Two sets of five specimens each are to be preconditioned as in 6.2.

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 % cotton thinned to approximately 50 x 50 mm and a maximum thickness of 6 mm (See Figure 8.1).

Figure 8.1

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



8.5.2 Adjust the burner and confirm the nominal 50 W test flame as specified in 7.5.3 – 7.5.5.

8.5.3 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.

8.5.4 If the specimen drips material during the flame application, tilt the burner to an angle of 45 ±5° 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 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 second.

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 8.5.4. 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 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.

8.6 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.

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

(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 plate test specimens when tested as described in 9.2.1 – 9.6.5. The final classification shall be the lower classification from both conditions as described in 9.4.

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

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 at the thickness under consideration.

9.1.3 Table 9.1 specifies the 5V classifications.

Table 9.1
5V Burning Classifications

Criteria	5VA	5VB
Afterflame time plus afterglow time after the fifth flame application (t1 + t2) for each individual bar specimen[a]	≤60 s	≤60 s
The cotton pad indicator (see 5.13) ignited by flaming particles or drops from any bar test specimen?	No	No
Classified as V-0 or V-1?	Yes	Yes
Either • burn-through occurs with any of the individual plate test specimens • no plate test specimens have been tested	No	Yes

[a] Full consumption of bar specimens or burning up to the holding clamp during the test is acceptable for the bar specimen criteria.

9.1.4 If only one specimen from a set of five bar specimens or one specimen from a set of three plate 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. Plate 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. The edges of the specimens are to be smooth. For bar specimens only, the radius on the corners is not to exceed 1.3 mm.

Exception: Plate specimens smaller than 150 ±5 mm by 150 ±5 mm are acceptable provided that no undesirable influence of heat or combustion around the edge of the specimen exists. This is verified by allowing the tested sample to cool and then using a soft and dry cloth, wipe away soot and/or effluent residue to examine the sample 2 mm away from the edges. Any visual sign of combustion or pyrolysis, or any visual thermal damage such as melting or distortion around the edge of the plate specimen is judged as "burn overflow" and a retest is necessary with bigger plate specimens.

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 color (often white) and dark colors (often black/including carbon black) 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 (not carbon black), 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.

9.3.5 Plate 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 plate specimens are to be preconditioned as in 6.1.

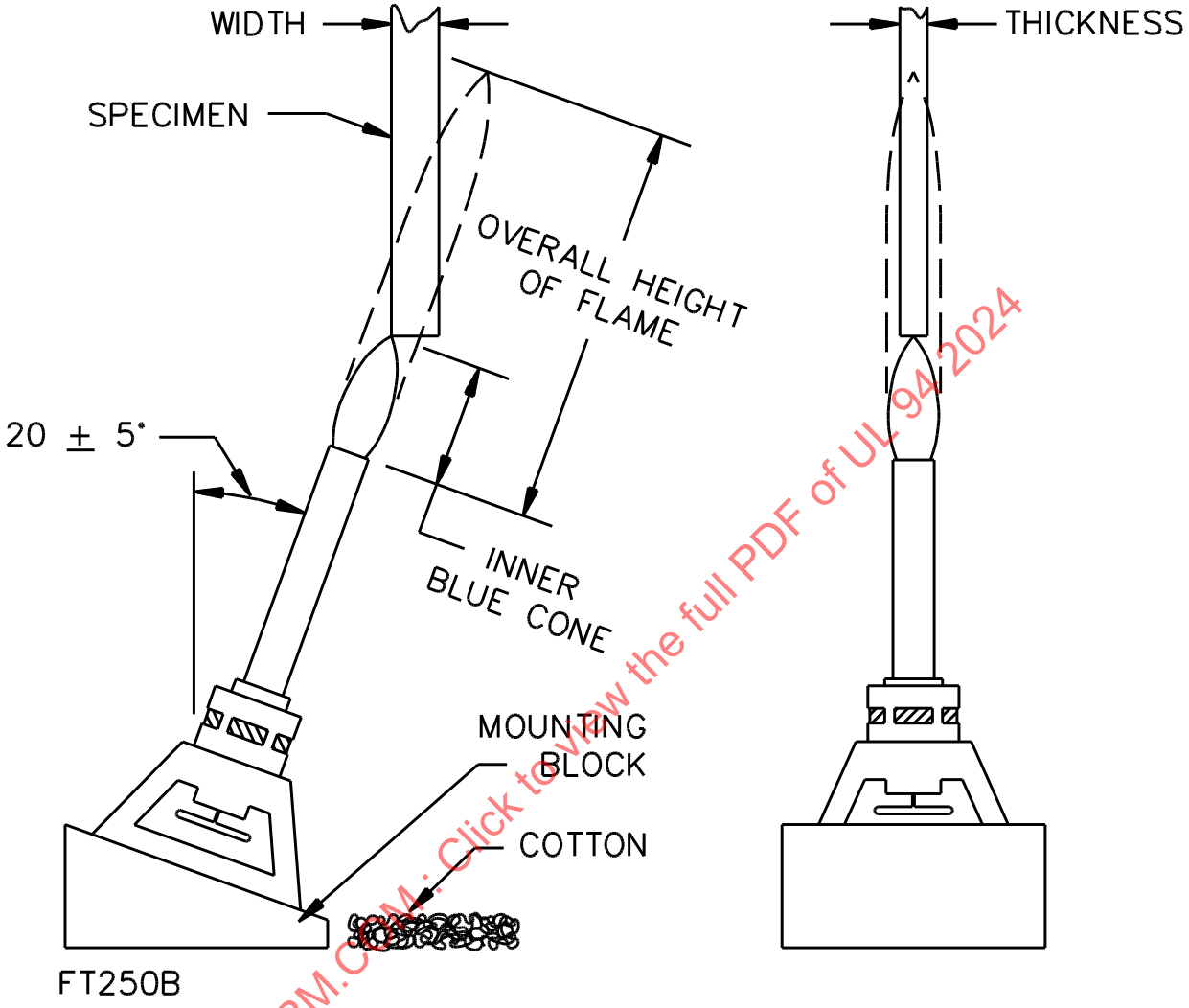
9.4.2 Two sets of five bar and three plate specimens are to be preconditioned as in 6.2.

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.

Figure 9.1

Vertical Burning Test for 5VA, 5VB Classification – Bar Specimens



9.5.2 To produce the nominal 500 W test flame, the methane gas supply to the burner shall be adjusted to produce a gas flow rate of 965 ±30 ml/min with a back pressure of 125 ±25 mm water and arranged as in Figure 7.3. A manometer shall be used in conjunction with a mass flow meter in order to maintain the required back pressure. See ASTM D5207.

Note: A mass flow meter is the preferred means of controlling accurately the input flow rate of gas to the burner. Other methods may be used if they can show equivalent accuracy and demonstrate that the final gas flow rate remains in the range of 965 ±30 ml/m following the test flame adjustment procedure specified in 9.5.3.

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 ±5° from the vertical. The narrow edge of the specimen is to face the burner. See Figure 9.1.

9.5.4 The nominal 500 W test flame shall be calibrated in accordance with ASTM D5207 at least once a month and when the gas supply is changed, test equipment is replaced, or when data is questioned. The confirmed test flame shall meet the requirements of ASTM D5207 while using a gas flow rate of 965 ±30 ml/m and a back pressure of 125 ±25 mm water. Both the gas flow rate and back pressure shall be recorded in the calibration record.

9.5.5 The flame is then to be applied to one of the lower corners of the specimen at an angle of 20 ±5° 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.

9.5.6 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 within 0 mm to 3 mm of the corner of the bar test specimen nearest to the burner, ignoring any strings of molten material. Refer to Figure 5 and Annex A of IEC 60695-11-20 for guidance on the flame application point on the deformed flame test specimen.

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

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 to the nearest second.

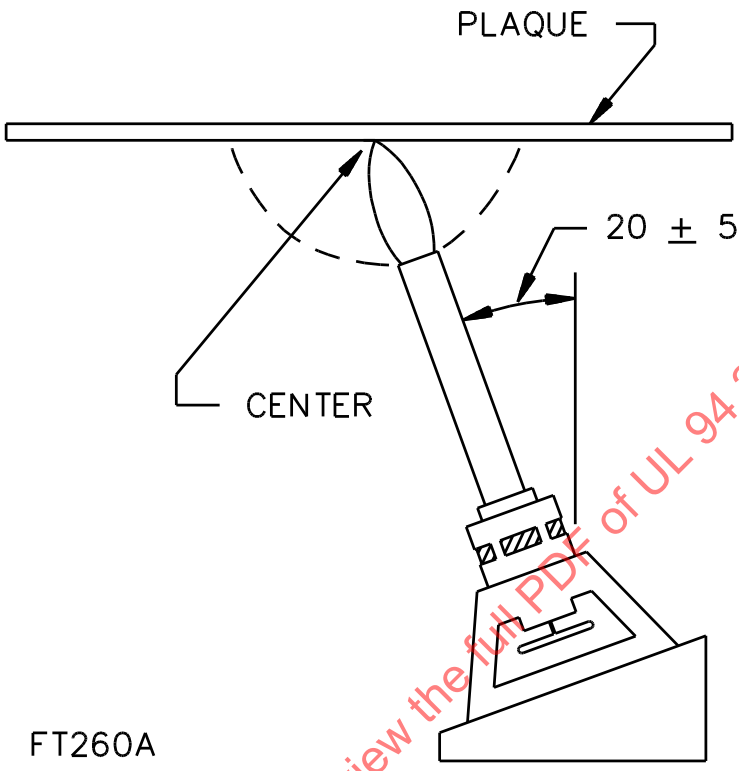
b) Whether or not specimens drip particles and whether the particles ignited the cotton indicator.

9.6 Plate specimens test procedure

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

Figure 9.2

Vertical Burning Test for 5VA, 5VB Classification – Plate Specimens



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 plate at an angle of 20 ±5° from the vertical, so that the tip of the blue cone is within 0 to 3 mm of the plate surface – without impinging into 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 plate 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.

9.6.5 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 plate material. Flame penetration shall be defined as any visible flame observed during the test on the surface of the plate 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.

10 Radiant Panel Index Test

(ASTM E162-08)

10.1 Test criteria

10.1.1 The radiant panel index of a material shall be determined in accordance with ASTM E162-08, Test for Surface Flammability of Materials Using a Radiant Heat Energy Source.

10.1.2 The radiant panel index is to be assigned based upon the average radiant panel index results of testing 4 specimens, or 6 if the average is less than 50, in accordance with the ranges specified in Table 10.1. The calculated average shall be rounded to the nearest multiple of five to determine the radiant panel index class.

Table 10.1
Radiant Panel Index Classes

Average radiant panel index	Radiant panel index
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.

10.2 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.

10.2.2 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 (often black/including carbon black) 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 (not carbon black), 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.

10.2.4 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 D4804 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 and/or shrink and/or are consumed up to the holding clamp when tested using the test described in the 20 mm Vertical Burning Test; V-0, V-1, or V-2, Section 8. The test specimens used in this test method shall be limited to a maximum thickness of 0.250 mm. 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).

Exception No. 1: A test specimen with a thickness less than 0.025 mm shall not be subjected to the 20 mm Vertical Burning Test; V-0, V-1, or V-2, Section 8 prior to conducting the Thin Material Burning Test; VTM-0, VTM-1, or VTM-2, Section 11.

Exception No. 2: A test specimen with a thickness less than or equal to 0.250 mm, but greater than or equal to 0.025 mm, that is capable of meeting the physical and performance requirements of both the 20-mm Vertical Burning Test; V-0, V-1, or V-2 (Section 8) and the Thin Material Burning Test; VTM-0, VTM-1, or VTM-2 (Section 11) shall be evaluated by the test of choice.

Exception No. 3: A test specimen with a thickness greater than 0.250 mm may be subjected to the Thin Material Burning Test; VTM-0, VTM-1, or VTM-2, Section 11 only if the specimen distorts and/or shrinks and/or is consumed up to the holding clamp when tested according to the 20 mm Vertical Burning Test; V-0, V-1 or V-2, Section 8.

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. The final classification shall be the lower classification from both conditions as described in 11.4.

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 and t_2	≤10 s	≤30 s	≤30 s
Total afterflame time for any condition set (t_1 plus t_2 for the 5 specimens)	≤50 s	≤250 s	≤250 s
Afterflame plus afterglow time for each individual specimen after the second flame application ($t_2 + t_3$)	≤30 s	≤60 s	≤60 s
Did the afterflame or afterglow of any specimen progress up to the 125 mm mark?	No	No	No
Was the 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.

11.2 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.

11.3.2 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 by means of pressure sensitive tape applied immediately above the 125 mm mark as well as the upper end of the tube or throughout the 75 mm portion above the 125 mm mark. The mandrel is then to be removed.

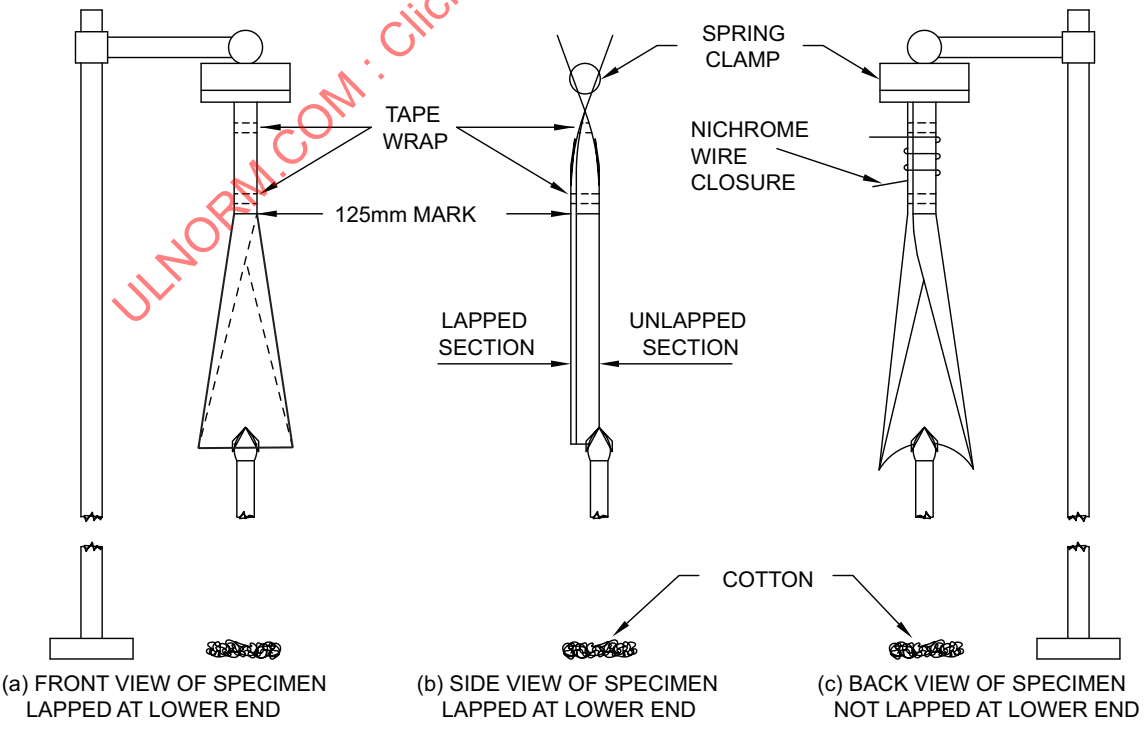
Note: If the material is prone to developing static charges which make the formation of a cylinder difficult, the unformed specimen is to be deionized by a device or material intended for that purpose.

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.

Figure 11.1

Specimen Orientation



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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 color (often white) and dark colors (often black/including carbon black) 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 (not carbon black), 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.

11.3.6 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.

11.4.3 Cylindrical specimens are to be prepared either before or after conditioning.

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 % cotton thinned to approximately 50 x 50 mm and a maximum thickness of 6 mm. See Figure 11.1.

11.5.2 Adjust the burner and confirm the nominal 50 W test flame as specified in 7.5.3 – 7.5.5.

11.5.3 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).

11.5.4 If the specimen drips molten or flaming material during the flame application, tilt the burner at an angle of 45 ±5° 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 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.

11.5.6 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 second.

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 the afterflame and/or afterglow progressed 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 D4986 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 This test method is used to determine the relative rate of burning and the extent and time of burning of horizontally oriented cellular polymeric materials having a density less than 250 kg/m^3.

12.1.4 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. The final classification shall be the lower classification from both conditions as described in 12.4.

12.1.5 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.

12.1.6 If only one specimen from a set of five specimens does not comply with the requirements in 12.1.5, 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 12.1.5 for the material in that thickness and density to be classed HBF.

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

Table 12.1
Material Classifications

Criteria Conditions	HF-1	HF-2
Afterflame time, t_1	4/5 is ≤2 s	4/5 is ≤2 s
	1/5 is ≤10 s	1/5 is ≤10 s
Afterflame time plus afterglow time for each individual specimen, $t_1 + t_2$	≤30 s	≤30 s
Cotton indicator ignited by flaming particles or drops	No	Yes
Damaged length for each individual specimen[a]	< 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.		
[a] In cases where upper and lower side of the specimen shows different extent of damage, the side (face) with the higher extent of damaged length shall be considered for the classification rating.		

12.1.8 If a set of five specimens does not comply with the requirements in 12.1.7 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 or equal to 10 seconds; or

c) One specimen flames for more than 2 seconds but less than or equal to 10 seconds, and a second specimen flames for more than 10 seconds; or

d) One specimen does not comply with the additional criteria in 12.1.7.

12.1.9 All specimens from this second set shall comply with the requirements in 12.1.7 in order for the foamed plastic material in that thickness and density to be classed HF-1 or HF-2.

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 edges are to be smooth and the radius on the corners is not to exceed 2 mm.

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.

12.3.4 Specimens in the natural and in the most heavily pigmented light color (often white) and dark color (often black/including carbon black) 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