



UL 94

STANDARD FOR SAFETY

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

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

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Summary of Topics

This Sixth Edition of ANSI/UL 94 is being issued as a routine update. There are no changes to the requirements from the previous pages of the Fifth Edition.

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

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Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <http://csds.ul.com>.

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INTRODUCTION

1 Scope

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

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

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

2 References

2.1 General

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

2.2 Referenced standards in this text

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

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

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

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

ASTM E 162-08, Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source

ASTM D 3195, Practice of Rotameter Calibration

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

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

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

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

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

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

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

2.3 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

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

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

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

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

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

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

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

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4 Significance of Tests

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

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

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

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

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

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

5.3 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 degrees 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 percent 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 7 only.)

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

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

5.12 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 $70 \pm 2^\circ\text{C}$.

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 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.)

5.19 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, 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 ± 2 hours at $70 \pm 2^\circ\text{C}$ and then cooled in the desiccator for at least 4 hours at room temperature, prior to testing.

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

6.4 All specimens are to be tested in a laboratory atmosphere of $15 - 35^\circ\text{C}$ and ≤ 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 or IEC 60695-11-10)

7.1 Test criteria

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

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

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