UL 1694

STANDARD FOR SAFETY

Tests for Flammability of Small Polymeric Component Materials

UL Standard for Safety for Flammability of Small Polymeric Component Materials, UL 1694

Third Edition, Dated February 18, 2002

SUMMARY OF TOPICS

This revision of ANSI/UL 1694 dated November 25, 2019 is being issued to update the title page to reflect the most recent designation as a Reaffirmed American National Standard (ANS). No technical changes have been made.

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

The requirements are substantially in accordance with Proposal(s) on this subject dated September 6, 2019.

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UL 1694

Standard for Tests for Flammability of Small Polymeric Component Materials

First Edition – May, 1995
Second Edition – July, 1997

Third Edition

February 18, 2002

This ANSI/UL Standard for Safety consists of the Third Edition including revisions through November 25, 2019.

The most recent designation of ANSI/UL 1694 as an American National Standard (ANSI) occurred on November 25, 2019. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

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 https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements specify a needle-flame test to simulate the effect of small flames which may result from fault conditions within equipment in order to assess the fire hazard by a simulation technique.

1.2 This test is applicable to small components which contain materials that can not be fabricated into standardized specimens in the minimum use thickness and subjected to applicable preselection tests, such as UL 94. Test procedures specified have been determined to be applicable to small components with an overall volume of less than 2500 mm^3 (0.15 in^3). Test procedures may not be applicable to small components with an overall volume greater than 2500 mm^3 (0.15 in^3).

Test results may vary between small components which are similar in construction. Consideration should be given to the individual component construction to determine the suitability of extending results obtained for one component to other similar components.

1.3 The test is applied to ensure:

– that, under defined conditions, the test flame does not cause ignition of the small component, or

– that a combustible small component ignited by the test flame under defined conditions has a limited extent of burning and burning time, or

– that a combustible small component ignited by the test flame under defined conditions which is totally consumed has a limited burning time.

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

2 Glossary

2.1 RISK OF FIRE – A risk of fire is considered to exist at any two points in a circuit where:

a) The open circuit voltage is more than 42.4 V peak and the energy available to the circuit under any condition of load, including short circuit, results in a current of 8 A or more after 1 minute of operation, or

b) A power of more than 15 W can be delivered into an external resistor connected between the two points.

2.2 FLAME CONFIRMATION – The time for the temperature of the copper block, described in Figure 5.1 to increase from 100°C to 700°C shall be 23.5 s ±1.0 s, when the flame test arrangement of Figure 5.2 is used.

2.3 EXTENT OF BURNING – The extent of burning is measured after the specimen has been allowed to cool down to approximately room temperature and has been cleaned by means of a clean dry cloth. Extent of burning denotes the distance measured between the center of the area where the test flame is applied and the most distance trace of burning.

2.4 EXTENT OF BURNING TIME – The extent of burning time is the time of burning immediately following the application of the test flame until the flaming of the specimen ceases.

2.5 TRACE OF BURNING – Trace of burning denotes the destroyed area of the surface of the specimen affected by burning including charred areas. When determining the trace of burning, changes in color, soot formation, distortion of shape due to heat, melting and scorching of the surface should be ignored.

3 Units of Measurement

3.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

4 References

4.1 General

4.1.1 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.

4.2 Referenced standards in this text

4.2.1 If a designation for a test method is followed by an alternate or equivalent designation, in parenthesis, the latter method can be considered technically equivalent, though not necessarily identical, and might yield somewhat different numerical test results.

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

ASTM D 3195, Practice of Rotameter Calibration

IEC 60695-11-5 , Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance (formerly IEC 60695-2-2).

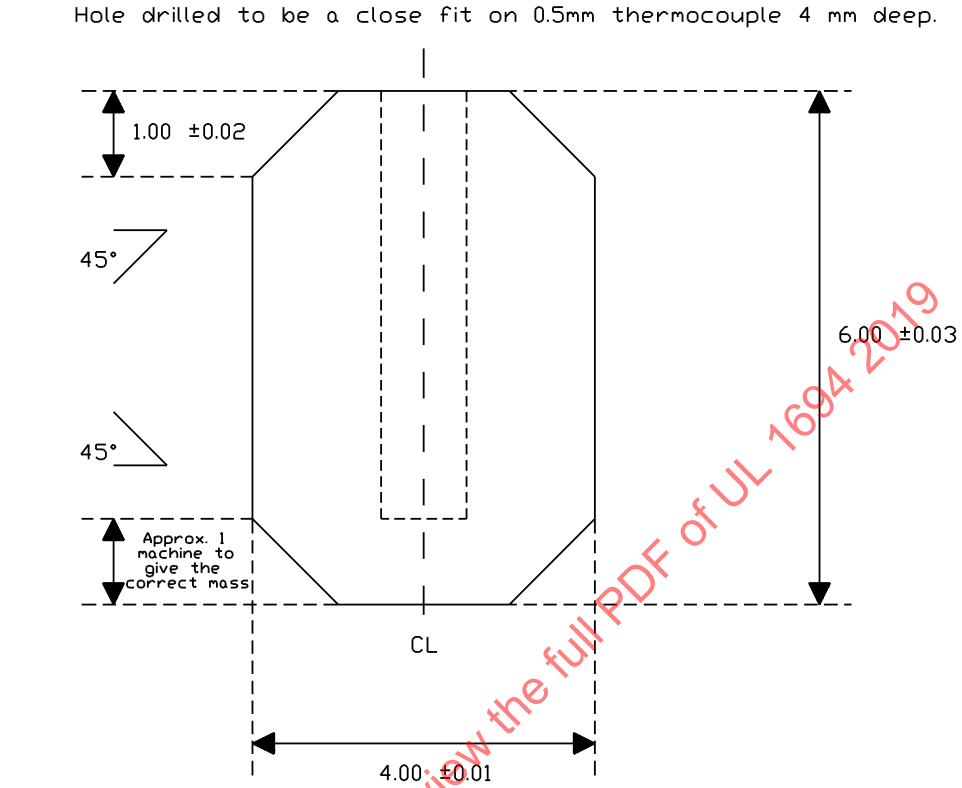
5 Apparatus

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 naturally 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 may not provide accurate results.

Figure 5.1

Copper block



All dimensions in mm

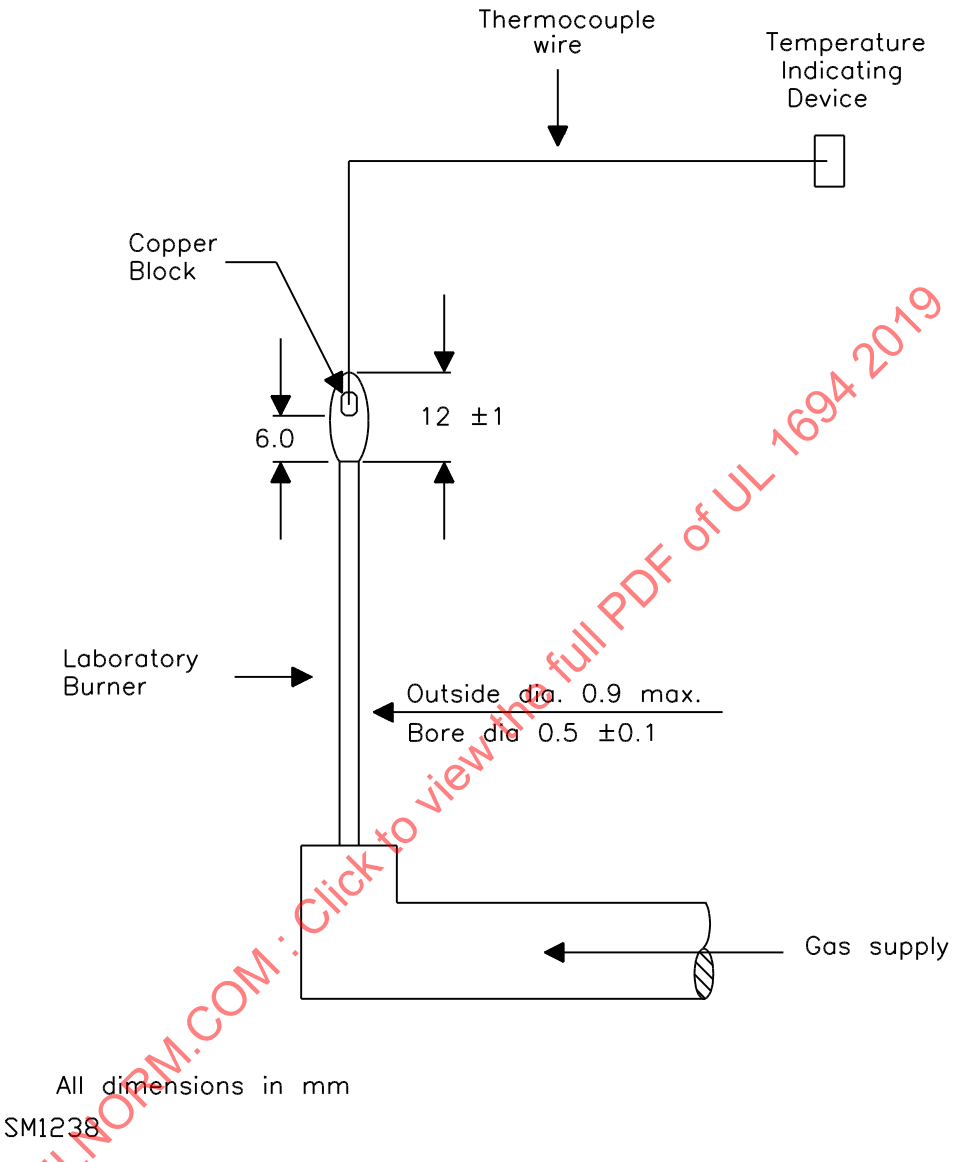
MATERIAL – HIGH CONDUCTIVITY (ELECTROLYTIC) COPPER
POLISH ALL EXTERNAL SURFACES

Mass before drilling 0.58 ±0.01 g

SM1237

Figure 5.2

Confirmatory test arrangement



5.2 Laboratory Burner – A laboratory type burner having a tube with a length of at least 35 mm and an inside diameter of 0.5 ±0.1 mm. The outside diameter shall not exceed 0.9 mm. The burner shall be in accordance with IEC 60695-11-5.

NOTE: A hypodermic needle with the tapered end removed has been found acceptable for the test.

5.3 Ring Stands – Laboratory ring stands with clamps or the equivalent, for positioning of the specimen. Laboratory ring stands with clamps adjustable to the desired angles and heights.

5.4 Timing Devices – Accurate to 0.1 second.

5.5 Measuring Scale – Graduated to mm.

5.6 Gas Supply – A supply of butane gas with a minimum purity of 95 percent with regulator and meter for uniform gas flow, in accordance with IEC 60695-11-5.

5.7 Micrometer / Caliper – Capable of being read to 0.1 mm.

5.8 Cotton – A supply of absorbent 100 percent cotton.

5.9 Desiccator Chamber – containing anhydrous calcium chloride or other drying agent, capable of being maintained at 23°C ±2°C and relative humidity not exceeding 20 percent.

5.10 Air-Circulating Oven – To provide a conditioning temperature of 70°C ±1°C, while not providing less than five air changes per hour.

5.11 Control Valve – One control valve is required to set the gas flow rate, in accordance with IEC 60695-11-5.

5.12 Copper Block – 4 mm diameter, of mass 0.58 g ±0.01 g in the fully machined but undrilled state, in accordance with IEC 60695-11-5.

5.13 Thermocouple – Sheathed fine wire type K (NiCr/NiAl) outer sheath diameter 0.5 mm, suitable for long term operation at ≥ 1050°C, in accordance with IEC 60695-11-5.

NOTE: Preferred method of fastening thermocouple to block is by compressing the copper around the thermocouple.

5.14 Temperature Indicating/Recording and Timing Devices – Appropriate for the measurement of the time for the block to heat up from 100° C ±3° C to 700° C ±2° C with a time uncertainty of 0.1 s, in accordance with IEC 60695-11-5.

PERFORMANCE

6 Flammability Test for Small Components

6.1 Test criteria

6.1.1 A small component shall be classified SC-0, SC-1, SC-2, SC-TC 0, SC-TC 1, or SC-TC 2 on the basis of results obtained on parts or specimens when tested as described in 6.4.

6.1.2 Table 6.1 specifies the material classifications.

Exception: Small components that are molded from materials that are classed as 5VA, 5VB, V-0, V-1, or V-2 in the minimum use thickness by the vertical burning test described in the requirements for standard for tests for flammability of plastic materials for parts in devices and appliances, UL 94, need not be subjected to the flammability test described in 6.4.

Table 6.1
Material classifications

Criteria conditions	SC[a]-0	SC-1	SC-2	SC[b]-TC 0	SC-TC 1	SC-TC 2
Afterflame time for each individual component or specimen t_{b1} or t_{b2}	≤ 10s	≤ 30s	≤ 30s	≤ 10s	≤ 30s	≤ 30s
Total afterflame time for any conditioned set of components or specimens (t_{b1} plus t_{b2} for the five components or specimens)	≤ 50s	≤ 250s	≤ 250s	≤ 50s	≤ 250s	≤ 250s
Afterflame plus afterglow time for each individual component or specimen (t_{b2} plus t_{b3} for each component or specimen)	≤ 30s	≤ 60s	≤ 60s	≤ 30s	≤ 60s	≤ 60s
Cotton indicator ignited by flaming particles or drops	No	No	Yes	No	No	Yes
Complete consumption of component or specimen	No	No	No	Yes	Yes	Yes

[a] SC – Small Component

[b] TC – Total Consumption

6.2 Test specimens

6.2.1 If possible, the specimen should be a complete component or sub-assembly. If it is necessary to cut off a suitable part to perform the test, care must be taken to ensure that the test conditions are not significantly different from those occurring in normal use with regard to shape, ventilation, effect of thermal stresses and possible flames occurring or burning or glowing particles falling in the vicinity of the specimen.

6.2.2 If the test cannot be made on the complete specimen, a suitable part may be cut from it. If the specimen is a part cut from a larger unit, care must be taken to ensure that in this particular case, the test flame is not applied incorrectly, for example, to an edge created by cutting.

6.3 Conditioning

6.3.1 Five samples of the small component shall be tested as described in this Standard following preconditioning for a minimum of 48 h at 23±2°C and 50±10% Relative Humidity in accordance with ASTM D 618 (ISO 291).

6.3.2 Another five samples of the small component are to be placed in a forced draft air-circulating oven and maintained at a temperature of 70°C (158°F). The samples are to remain in the oven for a minimum of 24 hours and then cooled in the desiccator for a minimum of 2 hours. The samples are to be tested as described in this Standard within 30 minutes following removal from the desiccator.

6.3.3 Cotton shall be conditioned in a desiccator for at least 24 hours prior to use.

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

6.3.5 All specimens shall be tested in a laboratory atmosphere at 15°C to 35°C and 45 percent to 75 percent relative humidity.

6.4 Procedure

6.4.1 Five samples of the small component are to be subjected to the flame test described in 6.4.3 – 6.4.5. In the performance of the test, the specimen shall be arranged in its most unfavorable position of normal use. The means to fix the specimen shall not influence the effect of the test flame or the propagation of flames in a way other than that occurring under normal conditions of use. For example of typical test positions, see Figure 6.1.

6.4.2 The bottom edge of the small component shall be located 200 ±5 mm above a horizontal layer of absorbent 100 percent cotton thinned to approximately 50 mm by 50 mm having a maximum thickness of 6 mm. The weight of the cotton shall not exceed 0.08 g.

6.4.3 With the central axis of the burner tube vertical, place the burner remote from the specimen and set the burner to produce a standardized test flame with a height of 12 mm ±1 mm – when viewed in subdued light against a dark background and using the test jig shown in Figure 6.4 that conforms with IEC 60695-11-5. Wait a period of at least 5 minutes to allow the burner conditions to reach equilibrium.

6.4.4 The test flame shall be calibrated in accordance with IEC 60695-11-5 , using the copper block, thermocouple, temperature indicator, and timing devices, as shown in Figure 5.1 and Figure 5.2, at least bi-monthly and when the gas supply is changed, test equipment replaced, or when data is questioned. The mean time for the temperature of the block to increase from 100°C ±2°C to 700°C ±3°C shall be within the range of 23.5 ±1.0 seconds after three determinations. The block shall be allowed to cool naturally in air to below 50°C between determinations.

6.4.5 Apply the flame to that part of the surface of the specimen which is likely to be affected by flames resulting from normal use or from fault conditions, or from any source of ignition accidentally applied. The flame should be applied so that the top of the burner is 12±1 mm below the surface being contacted and maintained in that position for a time period, t_a as specified in Table 6.2, moving the burner as necessary in response to any changes in the length or position of the specimen. It may be necessary to tilt the burner to an angle of 45 degrees to apply the flame to the proper surface. If it is necessary to tilt the burner to apply the test flame to a vertical surface, the positioning shall be in accordance with Figure 6.2.

Figure 6.1

Typical flame test arrangement

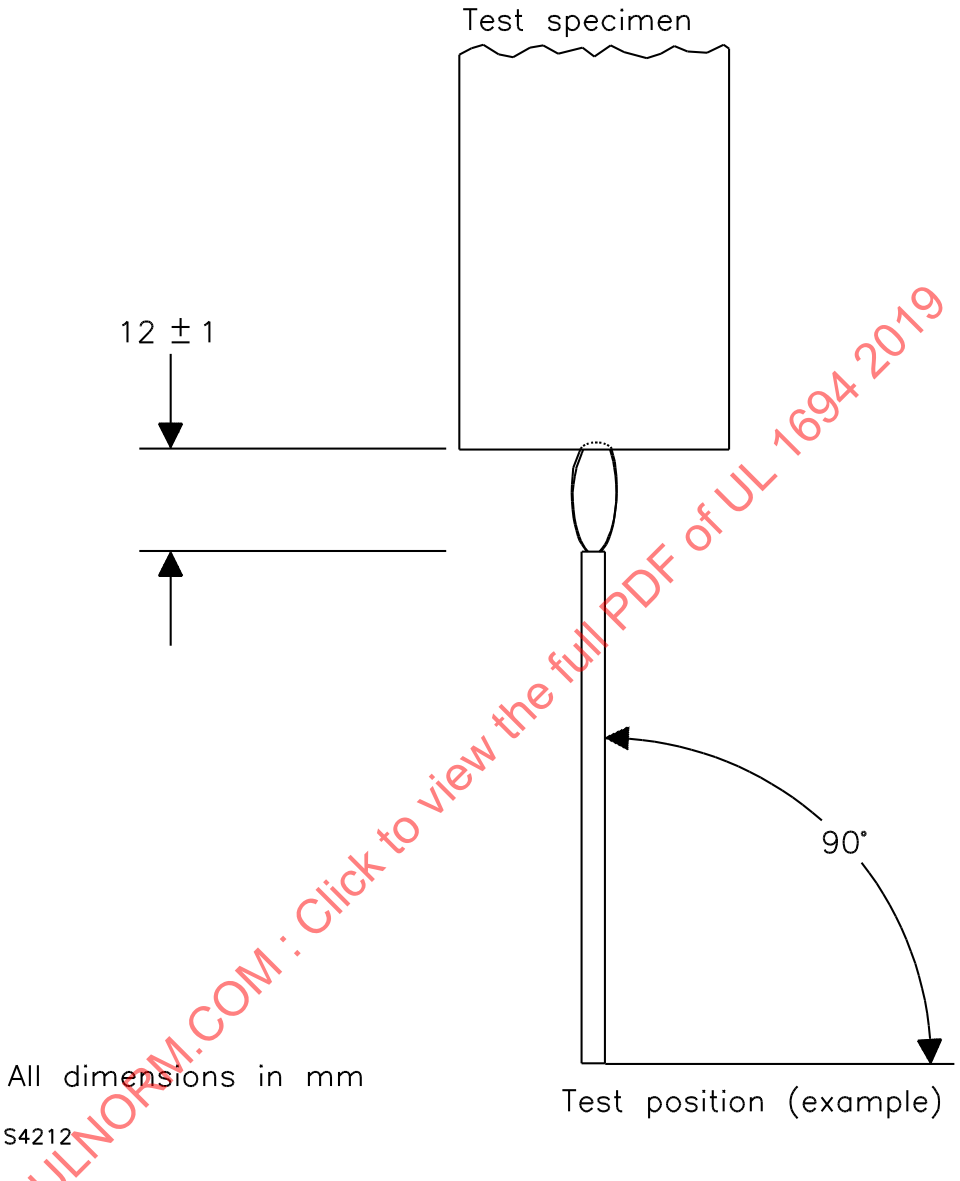


Figure 6.2

Typical flame test arrangement – vertical surfaces