Attn: Doug Aiers
1-320-252-8611

Underwriters Laboratories

Go directly to a UL Service: Global Locations Search UL.com Search

UL 94 flammability testing

There are two types of pre-selection test programs conducted on plastic materials to measure flammability characteristics. The first determines the material's tendency either to extinguish or to spread the flame once the specimen has been ignited. The first program is described in UL 94, The Standard for Flammability of Plastic Materials for Parts in Devices and Appliances, which is now harmonized with IEC 60707, 60695-11-10 and 60695-11-20 and ISO 9772 and 9773.

The second test program measures the ignition resistance of the plastic to electrical ignition sources. The material's resistance to ignition and surface tracking characteristics is described in UL 746A, which is similar to the test procedures described in IEC 60112, 60695 and 60950.

UL 94 flame classifications

There are 12 flame classifications specified in UL 94 that are assigned to materials based on the results of these small-scale flame tests. These classifications, listed below in descending order of flammability, are used to distinguish a material's burning characteristics after test specimens have been exposed to a specified test flame under controlled laboratory conditions.

- Six of the classifications relate to materials commonly used in manufacturing enclosures, structural parts and insulators found in consumer electronic products (5VA, 5VB, V-0, V-1, V-2, HB).
- Three of the remaining six classifications relate to low-density foam materials commonly used in fabricating speaker grills and sound-deadening material (HF-1, HF-2, HBF).
- The last three classifications are assigned to very thin films, generally not capable of supporting themselves in a horizontal position (VTM-0, VTM-1, VTM-2). These are usually assigned to substrates on flexible printed circuit boards.

Horizontal versus vertical positioning

Specimens molded from the plastic material are oriented in either a horizontal or vertical position, depending on the specifications of the relevant test method, and are subjected to a defined flame ignition source for a specified period of time. In some tests, the test flame is only applied once, as is the case of the horizontal burning (HB) test, while in other tests the flame is applied twice or more.

A HB flame rating indicates that the material was tested in a horizontal position and found to burn at a rate less than a specified maximum.

The three vertical ratings, V2, V1 and V0 indicate that the material was tested in a vertical position and self-extinguished within a specified time after the ignition source was removed. The vertical ratings also indicate whether the test specimen dripped flaming particles that ignited a cotton indicator located below the sample. UL 94 also describes a method in which the test flame is applied for up to five applications, in testing for a 5VA or 5VB classification. These small-scale tests measure the propensity of a material to extinguish or spread flames once it becomes ignited.

Difference in test methods and criteria

When looking at the flame ratings for plastic materials commonly molded to fabricate enclosures, structural parts and insulators found in consumer electronic products (5VA, 5VB, V-0, V-1, V-2 and HB), a material classified as 5VA or 5VB is subjected to a flame ignition source that is approximately five times more severe than that used in the HB, V-0, V-1 and V-2 tests, and the specimens may not drip any flaming particles. The three remaining six classifications specified in UL 94 relate to low-density foam materials commonly used in fabricating speaker grills and sound-deadening material (HF-1, HF-2, HBF). The remaining three classifications are assigned to very thin films, generally not capable of supporting themselves in a horizontal position (VTM-0, VTM-1, VTM-2).

UL 746A ignition tests

In addition to flammability considerations, a material's ability to resist ignition from electrical sources is another important factor that must be considered in the selection and evaluation of a material for use in electrical equipment. Possible electrical ignition sources in equipment are: overloaded (overheated) electrical conductors and components; arcing parts, such as the open contacts of switches and relays; and arcing at broken or loose connections, e.g., splices or terminals. Polymeric materials in direct contact with or in close proximity to overloaded or arcing electrical parts could ignite.

The three basic tests used to evaluate a material's ability to resist ignition are the Hot-Wire Ignition (HWI) High-Current (or High-Amp) Arc Ignition (HAI); and High-Voltage Arc Tracking Rate (HVTR). Details of the test criteria can be found in UL 746A, The Standard for Polymeric Materials - Short-Term Evaluations. The *Recognized Component Directory* tabulates the results of the small-scale tests conducted on the materials.

The HWI test indicates a material's resistance to ignition when exposed to abnormally high temperatures resulting from a component failure, such as a conductor carrying far more than its rated current. HWI performance is expressed as the mean number of seconds required to ignite a specimen when wrapped with an energized ni-chrome resistive wire that dissipates a specified level of energy.

The HAI test determines the material's ability to withstand electrical arcing either directly on or just above the surface of the plastic material. This can occur in the presence of open switch contacts or in the event of the failure of an electrical connection. HAI performance is expressed as the number of arc rupture exposures -- using standardized electrode materials, geometry and electrical supply circuit -- required to ignite a specimen when the arc occurs directly on the surface or a specified distance above the test specimen.

The HVTR for a material is expressed as the rate (in inches per minute) that a tracking path can be produced on the surface of the material under standardized test conditions. This test relates to establishment of an electrically conductive path on the surface of a solid, insulated material as a result of electrical stress.

Another ignition test can be applied to measure a material's resistance to ignition property. This test is the Glow-Wire Ignitability Test and is also described in UL 746A and 746C, Polymeric Materials - Use in Electrical Equipment Evaluations. The method is based on a test procedure that is documented in IEC 60695 and specified in numerous IEC end-product specifications, including IEC 60335-1. The test is somewhat similar to the HWI test in that it measures a material's resistance to ignition on application of a heated non-flaming source.

Resources for more information

Other resources for UL 94 and flammability testing include:

- *Scope of UL 94*
- *Flammability Training Video*

Attn: Doug Arts
1-320-252-8611

QMFZ2 Component - Plastics **E146584**

NOVA CHEMICALS CORP
TECHNICAL CENTRE, 3620 32ND ST NE, CALGARY AB T1Y 6G7 CA

TR-0338-UI, TR-0338-UIG

Polyethylene (PE), "Novapol", furnished as pellets, powder

Color	Min Thk (mm)	Flame Class	HWI	HAI	RTI Elec	RTI Imp	RTI Str
NC	1.5	HB	-	-	50	50	50

Comparative Tracking Index (CTI): -
Dimensional Stability (%): -
High-Voltage Arc Tracking Rate (HVTR): -
High Volt, Low Current Arc Resis (D495): -
Dielectric Strength (kV/mm): -
Volume Resistivity (10xohm-cm): -

UL94 small-scale test data does not pertain to building materials, furnishings and related contents. UL94 small-scale test data is intended solely for determining the flammability of plastic materials used in the components and parts of end-product devices and appliances, where the acceptability of the combination is determined by ULI.

Report Date: 9/8/1995 **Underwriters Laboratories Inc®** **Component Plastics**

IEC and ISO Test Methods

Test Name	Test Method	Units	Thickness Tested (mm)	Value
IEC Flammability	IEC 60695-11-10	Class	1.5	HB75 (NC)
Glow-Wire Flammability (GWFI)	IEC 60695-2-12	C	-	-
Glow-Wire Ignition (GWIT)	IEC 60695-2-13	C	-	-
IEC Comparative Tracking Index	IEC 60112	Volts (Max)	-	-
IEC Ball Pressure	IEC 60695-10-2	C	-	-
ISO Heat Deflection (1.80 MPa)	ISO 75-2	C	-	-
ISO Tensile Strength	ISO 527-2	MPa	-	-
ISO Flexural Strength	ISO 178	MPa	-	-
ISO Tensile Impact	ISO 8256	kJ/m2	-	-
ISO Izod Impact	ISO 180	kJ/m2	-	-
ISO Charpy Impact	ISO 179-2	kJ/m2	-	-

Underwriters Laboratories Inc®