

# Underwriters Laboratory Guide (UL)

A short guide to understanding UL for plastics

UL ratings are encountered in almost any application or device that uses or is exposed to an electrical current. Conventus Polymers and its vendor network boast over 200 UL cards with particular expertise in Nylon and Polycarbonate products. The following is a guide to common UL ratings on a standard Yellow Card

## UL 94

UL (Underwriters Laboratories) performs tests, such as UL 94 on products to measure the resistance of plastics to a flame source. The test will normally result in a mark of V-0, V-1, V-2, 5VA, or 5VB. UL approval is then given for a particular product based on the measured thickness as determined by the rating.

Criteria Conditions	V-0	V-1	V-2
After flame time for each individual specimen $t_1$ or $t_2$	10 sec	30 sec	30 sec
Total after flame time for any condition set ( $t_1 + t_2$ ) for the 5 specimens	50 sec	250 sec	250 sec
Burn through (hole) of any plaque specimen	30 sec	60 sec	60 sec
After flame or after glow of any specimen up to the holding clamp	No	No	No
Cotton indicator ignited by flaming particles or drops	No	No	Yes

Criteria	94-5VA	94-5VB
After flame time plus after glow time after 5th flame application for each individual bar specimen	60 sec	60 sec
Cotton indicator ignited by flaming particles or drops from any bar specimen	No	No
Burn-through (hole) of any plaque specimen	No	Yes

## RTI

The temperature below which a class of critical property will not be unacceptably compromised through chemical thermal degradation, over the reasonable life of an electrical product is defined as the Relative Thermal Index (RTI).

**RTI Elec** – Electrical RTI, associated with critical insulating properties.

**RTI Mech Imp** – Mechanical Impact RTI, associated with critical impact resistance, toughness, elongation and flexibility properties.

**RTI Mech Str** – Mechanical Strength (Mechanical without Impact) RTI, associated with critical mechanical strength and structural integrity where impact resistance, resilience and flexibility may not be essential.

## Outdoor suitability (f1 & f2)

Materials considered suitable for outdoor use have been subjected to ultraviolet (UV) light exposure and/or water immersion. UV exposure is performed by using either a twin-enclosed carbon weatherometer for 720 hours, or a xenon-arc weatherometer for 1000 hours. Water immersion testing is performed for 7 days at 70°C.

Specimens are tested before and after exposure for flammability, mechanical impact and mechanical strength. Materials whose properties are not significantly degraded after both UV and water immersion are rated f1.

## Resistance to Ignition and Tracking Properties

Performance may be investigated with respect to electrical track resistance, ability to resist ignition from electrical sources, and other electrical properties. In order to avoid an excessive level of implied precision and bias, material performances for several tests are recorded as Performance Level Categories (PLC), based on the mean test results (rather than recording the exact numerical results), as indicated in the table following the test description.

### Hot-wire Ignition (HWI; ASTM D3874, IEC 60695-2-20):

Performance is expressed as the mean number of seconds needed to either ignite standard specimens or to burn through the specimen without ignition.

HWI Range Mean Ignition Time (s)	Assigned PLC
120 and longer	0
60 through 119	1
30 through 59	2
15 through 29	3
7 through 14	4
Less than 7	5

### High-voltage, Low-current-arc Resistance (D495; ASTM D495):

Expressed as the number of seconds that a material resists the formation of a surface-conducting path when subjected to an intermittently occurring arc of high-voltage, low-current characteristics. The results of testing the nominal 3 mm thickness are considered representative of the material's performance in any thickness.

D495 Range Mean Time of Arc Resistance (s)	Assigned PLC
420 and longer	0
360 through 419	1
300 through 359	2
240 through 299	3
180 through 239	4
120 through 179	5
60 through 119	6
Less than 60	7

### Comparative Tracking Index (CTI; ASTM D3638):

Expressed as that voltage which causes tracking after 50 drops of 0.1% ammonium chloride solution have fallen on the material. The results of testing the nominal 3 mm thickness are considered representative of the material's performance in any thickness.

### High-voltage-arc Tracking Rate (HVTR; ANSI/UL 746A):

Denoted as the rate, in mm/min, that a tracking path can be produced on the surface of the material under standardized test conditions. A notation is made if ignition on the material takes place. The results of testing the nominal 3 mm thickness are considered representative of the material's performance in any thickness.

HVTR Range (in mm/min)	Assigned PLC
0 through 10	0
10.1 through 25.4	1
25.5 through 80	2
80.1 through 150	3
Greater than 150	4

### High-current-arc Ignition (HAI; ANSI/UL 746A):

Performance is expressed as the number of arc-rupture exposures (standardized as to electrode type and shape and electric circuit) that are necessary to ignite a material when they are applied at a standard rate on the surface of the material.

HAI Range Mean Number of Arcs to Cause Ignition	Assigned PLC
120 and longer	0
60 through 119	1
30 through 59	2
15 through 29	3
Less than 15	4

CTI Range Tracking Index (Volt)	Assigned PLC
600 and greater	0
400 through 599	1
250 through 399	2
175 through 249	3
100 through 174	4
Less than 100	5