

From The Lab



BY BOB NEVES



The UL Survival Guide (Part 1)

Do terms like “Yellow Card,” “Follow Up Services” and “Long Term Thermal Aging” send shivers down your spine? If so, you have had the experience of dealing with Underwriters Laboratories (UL). Most of the printed wiring products manufactured in the world today carry the “UL” mark. The word “UL” (pronounced “ool”) has roots in archaic Hebrew, meaning “All-Powerful Eternal” and was sometimes used as an adjective to describe God. Although our modern day UL may seem all-powerful to many, I’m reasonably sure that the relationship to this ancient Hebrew word must be purely coincidental. As with any organization which governs our lives (DSCC, IRS, EEOC), the difficulties people experience tend to become legendary long before any of the successes. This “UL Survival Guide” series will attempt to remove some of the mysticism surrounding UL, and hopefully aid in making your UL experience a little more bearable.

Underwriters Laboratory was founded in the late 1800s as a not-for-profit organization. Its primary stated goal is to determine and assess the hazards to life and property of systems and materials, as well as the publication of standards specifications and classifications for materials and products that affect such hazards. In a nutshell, its goal is to assure the safety of electronic products. It currently has five U.S. offices and over ten international subsidiaries and liaison offices which handle tens of thousands of company files.

In the electronics interconnection industry, the UL safety program is broken up into two parts: printed wiring materials and printed wiring boards. I will start the discussion with printed wiring boards and work my way into materials.

Your File

If your company has ever dealt with UL, then you have a “file.” The first step in deal-

ing with UL is to know your file. Look in the upper-right hand corner of any of the correspondence you have gotten from UL, and you will see a file number (E123456, etc.). This is your company’s UL “social security number,” and acts as a tracking number. The way your file is currently set up will determine the steps necessary to update or change the information about your products that UL maintains. Your file contains information about material and process limitations which may or may not reflect what you are currently using or doing today. When making changes or additions to your file, it is important to review all of the material and process information within your facility to assure that current processing and materials are reflected. A typical UL file is broken out into sections, each of which contains separate product descriptions. In each description, there can be several types of products identified.

The Specs

UL does not treat revisions to standards and specifications as we are accustomed to seeing with military or IPC documents. The letter found after the UL specification number is part of the specification number and not a revision level (i.e., UL 746B does not supersede UL 746A). Revision pages are released to a UL document by date and the revised pages are then substituted into the document to replace the superseded pages. Below is a list of the UL documents which are pertinent to our industry along with a brief description of what is contained in each specification. I have also placed the current revision date next to the document name.

UL 746A—Polymeric Materials—Short Term Properties (4th edition 3/14/97); UL 746A contains the details for test methods used to determine mechanical, electrical and physical properties of polymeric materials.

This document is referenced by both UL 746E and UL 796.

UL 746B—Polymeric Materials – Long Term Properties (3rd edition 7/21/97); UL 746B contains the details for determination of the relative thermal index of polymeric materials as well as a supplement on follow-up inspection instructions.

UL 746E—Polymeric Materials—Industrial Laminates, Filament Wound Tubing, Vulcanized Fibre, and Materials Used in Printed Wiring (8/30/96); UL 746E covers the requirements and follow-up service procedures for metal clad laminates, metal clad flexible films, and prefabricated multi-layer laminates. It also contains the information on which generic classes like FR-4, CEM-3, XXXPC and GPY material were formed.

UL 796—Printed Wiring Boards (7/23/96); UL 796 covers the requirements and follow-up service procedures for both rigid and flexible printed wiring boards.

UL 94—Test for Flammability of Plastic Materials for Parts in Devices and Appliances (5th edition 7/29/97); UL 94 contains the requirements and follow-up services for the flammability testing of plastic materials used in parts and devices.

NEMA LI 1—Industrial Laminated Thermosetting Products (Rev. 89; Reaffirmed 1995); NEMA LI 1 contains information concerning the manufacture, testing, and performance of laminated thermosetting products.

The Color of the Card

The listing of your approval information can be found on your UL yellow card (it really is yellow), and the compilation of everyone’s listing can be found in UL’s yellow book(s), although the pages in this book are

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not yellow like the cards, nor are the listings found in it like the Yellow Pages we have at home. I have often wondered, why yellow? In soccer, a yellow card is given to a player by a referee for a foul or other offense. Stinging bees and Post-it™ Notes are typically yellow. Yellow has been used to describe cowardice or a state of gastronomical distress or relief. Large flowers and alien blood often come in yellow. The signal indicating a hazard, turn, danger or forthcoming halt is usually yellow. Snow found in that color is best avoided. Yellow vehicles typically get the most speeding tickets. The flame that burns your samples “to the clamp” is yellow. In other words, not a lot of really positive things are yellow. I know there are some pleasant things about the color (the sun, sunflowers, etc.) but by and large, yellow does not give the most positive of feelings. Why not Sky Blue or Forest Green to make us feel better?

That bit of philosophy aside, I wanted to give a description of what is actually contained on a typical Printed Wiring Yellow Card.

1 Company Information. The information on the listed manufacturer’s name and location.

2 File Number. This is the UL File number for the manufacturer.

3 UL Office Handling Manufacturer’s File. S = Santa Clara, CA; M = Melville, NY; N = Northbrook, IL; R = Research Triangle Park, NC; C = Camus, WA.

4 Type. The Type Designation the manufacturer has given to distinguish the product listed from other products.

5 Conductor Definition. The minimum conductor width listing is broken into two categories: conductors within 0.015” of the board edge, and all other conductors found on the board. To get these ratings, conductors are peeled off a test board after exposure to extreme temperatures (10 or 56 days) and have to meet a minimum peel strength. The minimum conductor thickness on the test

board is also measured and reported as a separate listing on the card.

6 Single- or Double-Sided. This one is reasonably self explanatory. Copper on one side or two. Double-sided listings cover single-sided printed boards.

7 Maximum Area Diameter. This portion of the listing gives the diameter of the largest un-pierced copper area that withstood a solder shock (as given by the listed “Solder Limits”) followed by exposure to extreme temperatures (10 or 56 days) without delamination.

8 Solder Limits. The solder temperature and time requested for the samples to pass the requirements of the “Maximum Area Diameter” testing.

9 Maximum Operating Temperature. The maximum continuous use temperature that the printed board may be exposed to under normal operating procedures.

10 UL94 Flammability Classification. This Designation (94V-0, 94V-1, 94V-2, 94VTM-0, 94VTM-1, 94VTM-2) describes the burning classification (as described in UL94; see below for definition) of the finished Printed Boards manufactured by the company.

11 UL796 Direct Support. Designates a Printed Board that meets minimum requirements set forth in UL 796 for support of current carrying parts. The requirements detail minimum values for “High Current Arc Ignition,” “Hot Wire Ignition,” “Volume Resistivity,” “Dielectric Strength,” “Comparative Tracking Index,” and “Heat Deflection” (thermoplastics only). These test attributes may not mean much to you right now, but being tests they are near and dear to my heart. I will explain them further in future “UL Survival” columns.

12 Comparative Tracking Index. CTI is expressed as the voltage that causes

tracking after 50 drops of a 0.1 percent ammonium chloride solution have fallen between two electrodes. The rating uses reference designators 0-5 where 5 = less than 100V, 4 = 100V up to 175V, 3 = 175V up to 250V, 2 = 250V up to 400V, 1 = 400V up to 600V, 0 = 600V and greater. In this case, lower is better!

Burn, Baby, Burn

By far, the most talked about UL listing category is UL94 Flammability. Our UL Flammability Test Technician has earned his reputation as a pyromaniac. He takes great pride in his fire-making abilities. UL94 has become the manifesto for flammability or the lack thereof, and has several different ratings associated with it (94V-0, 94V-1, 94V-2, 94VTM-0, 94VTM-1, 94VTM-2). The difference between the “V” and “VTM” in the ratings is that the VTM is a test for thin materials, and is tested slightly different from the standard “V rated” thick material.

In general, the samples are exposed to the prescribed flame for 10 seconds (for V rating), or 3 seconds (for VTM ratings) after which the flame is removed. The time the sample burns before extinguishing after this first flame exposure is called “T1.” The flame is then re-applied a second time for 10 or 3 seconds as applicable, after which flame time “T2” is counted. Once the flame “T2” goes out, any afterglow in the material is counted as “T3.” Here is a brief description of how each of the “V” ratings relates to the “T” times—no golf pun intended (see Table 1).

More on this fascinating subject to come. With the advance of new materials and technology, solid interaction with UL has become a necessity. I will continue with this survival guide until I have thoroughly covered the subject, answered all of your questions, or have been banned from writing about it. If a particular UL issue has come up for you and you would like me to address it, please e-mail me. If you could care less about UL and its affect on you, well then consider yourself blessed.

Table 1.

UL 94 Rating	T1 & T2 for 1 Specimen (s)	T1 & T2 for 5 Specimens (s)	T2 & T3 for 1 Specimen (s)	Burned To Clamp	Burned To 125mm	Cotton Indicator
94V-0	10	50	30	NO	N/A	NO
94V-1	30	250	60	NO	N/A	NO
94V-2	30	250	60	NO	N/A	YES
94VTM-0	10	30	30	N/A	NO	NO
94VTM-1	30	250	60	N/A	NO	NO
94VTM-2	30	250	60	N/A	NO	YES