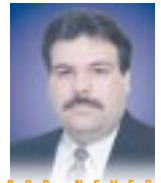


From The Lab



BY BOB NEVES



UL Survival Guide (Part 3)

I am not really a superstitious person, although I do my best to avoid black cats, walking under ladders, and opening umbrellas indoors. I do also occasionally read fortune cookies and horoscopes (not that I am tempted to stay in bed when a bad day is predicted). That being said, I find it peculiar (X-File-ish) that the PWB Construction test program tables in UL 796 are located in unlucky section 13.

There are not a lot of positive things associated with the number 13. Hotels and Office Buildings usually don't have a 13th floor; Fridays that land on the 13th are considered worse than Mondays; hangmen were paid 13 pence; and airplanes typically don't have a 13th row. Practitioners of witchcraft and voodoo are some of the only people that hold the number 13 in the highest regard (please note that no implication or comparison to UL is intended).

Of the tests listed in section 13 of UL 796, the most common for the Printed Wiring Board Manufacturer are Thermal Shock, Bond Strength, and Flammability. These tests form the heart of what is contained on the magical UL card. I covered the Flammability requirements in Part 1 of this glorious series (look back if your interested), and in this third installment of "As UL turns," I will focus on the mechanics of the Thermal Shock and Bond Strength tests.

The Thermal Shock Test consists of a pre-bake at 121°C for 1.5 hours unless the PWB manufacturer uses higher/longer parameters in manufacturing. The sample is then exposed to a "soldering operation" at a temperature and duration set by the manufacturer. This means that the manufacturer must set up the limits for Soldering time/temperature (i.e., 288°C/10 sec.). It is typically a good practice to submit for, and test both aggressive and conservative soldering temperature and time limits. This

will allow a "fallback" value in case the aggressive temp./time samples fail subsequent testing.

Following this thermal shock test, the samples are tested for Bond Strength. The Bond Strength test is broken into two categories: as received & after oven conditioning. Keep in mind that these bond strength tests are both done after the thermal shock test, and that both the aggressive and conservative thermal shock test samples should be subjected to the bond strength test.

The "as received" bond strength test is basically a peel strength test of the circuits that were etched onto the test board. The bond strength test is performed on a 1/16 inch line—the smallest line on the sample—and on an "edge conductor." When peeling minimum conductors in the 2–4 mil range, the two pound per inch minimum equates to approximately 2–3 grams of force. This range is a just a little out of the typical tensile testers capability. In order to feel comfortable with measurement accuracy, we had to have some special five gram load cells manufactured for our machine so that we could adequately measure this minuscule force.

The "after oven conditioning" bond strength tests are what has been historically known as the "10 & 56 day" tests. To get an "assigned temperature rating" for a PWB, the test samples must pass a bond strength test at a force of one pound per inch of

width (1–2 grams for a 2–4 mil line) after oven conditioning. In addition to this, the PWB cannot have evidence of wrinkling, cracking, blistering (sounds like an advertisement for hand lotion), conductor loosening or delamination. Why 10 & 56 days, you ask? Well the 10-day test is at a higher temperature than the 56-day test. The only reason for running the 10-day test (other than it is the default) is time savings, and I always suggest to people that if time is critical, the 10 & 56 day ovens should be started together. The formulas for calculating the actual 10 & 56 day oven temperature(s) for a given "desired rating" are:

$$\text{10 Day Oven Temp.} = 1.076 \text{ ("Desired Rating" + 288)} - 273$$

$$\text{56 Day Oven Temp.} = 1.02 \text{ ("Desired Rating" + 288)} - 273$$

For example, if you desired a 120°C rating for your PWBs, the 10-day oven temperature would be 166°C while the 56-day temperature would be a cool 143°C. If the 10-day samples pass the tests, turn the 56-day oven off, and use the extra samples as coasters, earrings or key-chains. If the 10-day samples fail, you are 10 or more days closer to finishing the 56-day test, and you also come away with some interesting looking charcoal briquettes (10-day samples).

Management of different solder limits (times/temps.) and multiple desired operating temperatures can be complicated. A thorough, well implemented plan can get you the maximum rating possible in the minimum amount of time. Getting a solid UL program is not witchcraft or voodoo, it just takes understanding, patience and a good relationship with your UL engineer. As I've heard Agent Scully of the X-Files say, "witchcraft is just science not yet understood."



Bob Neves is the president for Microtek Laboratories, an independent test facility. Prior to his tenure at Microtek, Bob worked in quality management and engineering in PWB manufacturing. He currently serves as the IPC's Rigid Board General Committee chairman, Rigid Board Test Method Task Group chairman, Laboratory Qualifications (IPC-QL-653) Committee chairman, member of DESC's Tiger Team for MIL-P-RRRRR (MIL-PRF-31032), member of Blue Ribbon Committee for MIL-S-XXXXX (MIL-PRF-5X) and convener of IEC TC52 Working Group 10 Printed Wiring Test Methods. You can reach him by e-mail at BobNeves@thetestlab.com or at the company web site: <http://www.thetestlab.com>.