GKCL08 - Testing to Confirm Product Safety Compliance #2

In this article we shall begin to tackle some of the issues, problems and techniques involved with basic Product Safety Testing. This task is a mine-field that requires detailed, specialist and encyclopaedic knowledge. There are two basic reasons for this:

1- It will be our last chance to ensure that our well engineered product meets the wide-ranging and detailed safety requirements necessary

2- It is probable that no-one will check our task correctly.

This does not mean to imply that we are safe from scrutiny: it means that if our work is checked (e.g. following an accident or complaint) it WILL be checked thoroughly and professionally. If our work is subject to this kind of scrutiny we can be sure that our professionalism and 'due diligence' will be questioned if there are mistakes or wrong assumptions.

It is, therefore, essential that we reflect upon what we are about to do and how we intend to carry out our responsibilities in conducting this - perhaps the most awesome, yet rewarding, job in the design process.

Due Diligence and "The Golden Rules"

Remember that if we get any part of our work wrong then ***people may die*** - this is what our duty of "Due Diligence" is all about.

Be confident about your ability to undertake this task and be sure of your facts. Compliance with an appropriate Harmonised Standard is, generally, deemed to demonstrate compliance with the LVD. Be cautious of any article or product that presents itself as an easy or general solution to product safety compliance: there are no simple solutions or panaceas.

Similarly, there is no such thing as a simple checklist or generic method of verifying compliance for all electrical products. If there was then there would only be one electrical safety standard - the fact that there are many hundred standards clearly demonstrates that electrical safety verification is not such a simple task as it first appears. It requires exceptional knowledge and experience - if you have any doubt go to a test laboratory or contact your local EMC Club.

It is the duty and responsibility of every engineer to learn what is required for his particular product and to fulfil his (and her) duty of "Due Diligence" without compromise. A few of the "Golden Rules" from the last issue are repeated below: this is because these are extremely important and outline the attitude that we must have when reviewing or testing a product. A copy of them should be pinned up over every test-bench.

1. When we Review or Test we are trying to make the product FAIL! We are not trying to prove that it will PASS. - See the following section “The Right Mind-Set”.
2. Always have a copy of the relevant standard with you and use the many interpretative books or articles to aid your understanding of it.
3. Never review a product, or use a Product Safety Review Checklist unless you are confident of your understanding, competence and ability. (You could be placing yourself at considerable personal risk - physically and financially - if you make a mistake.)
4. If in doubt, always err on the side of caution - when standards are revised the changes are usually to make them clearer or the conditions more severe.
5. If you find part of the product is 'marginal' but the interpretation of the standard allows you to accept the design consider (and explain to your manager) the business implications if that marginal PASS becomes a marginal FAILURE!
6. Remember that critical parameters are usually specified as a MINIMUM or a MAXIMUM: if we specify these as NOMINAL design parameters we will automatically guarantee that 50% of all our products will be non-compliant and potentially illegal.
7. Never be pressurised into allowing a dubious product to be supplied to a customer - samples and refurbished items must meet the latest standards of safety - there are no exceptions.
8. Always correct a non-compliance. To place the CE Mark to a product knowing it to be non-compliant is a Criminal Offence. You may be prosecuted, fined, and imprisoned.
9. Always proceed methodically and record each step. This will allow others to follow your path - this will be essential when someone needs to answer a detailed question about the product or to re-specify a critical component.
10. Always get a copy of a safety certificate for each Safety Critical Item before you are committed to use that component.
11. NEVER ASSUME.
12. ALWAYS DEMAND PROOF.
13. NEVER ACCEPT VERBAL ASSURANCES.

The Right Mind-Set

As design engineers we expect our products to be right and to work correctly - if we thought that there was less than a 95% chance that they might not work then we most of us would simply not even start the design process. This expectation of ‘correct’ performance is the biggest single problem that we designers must overcome. It is our ‘culture’ to expect out products to function correctly - this is the wrong attitude for safety testing and safety reviews. We must try our best to make our product FAIL - we do that by analysing how it could create a hazard; then, with this knowledge, we add modifications and/or (where permissible) warnings.

Before we start - remember that someone, somewhere will do something that we thought would be unlikely, unreasonable or just plain stupid - and if they are injured then at the very least we will have to defend our product. At the other extreme we may be forced to recall every product from the entire European Economic Area.

Warning

PLEASE NOTE: The following tests are not authoritative they are intended to give an outline of some of the tests that are necessary - many of these tests are often overlooked during the design proving phase where, if they are performed and interpreted "correctly", they will usually result in substantial saving in time and money.

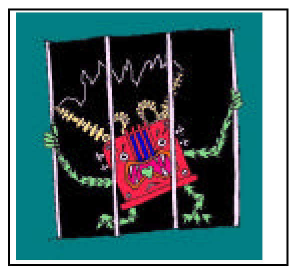
Please refer to the requirements detailed throughout the safety standard appropriate to your product to ensure that the tests carried out are appropriate - conducted under the right conditions and application, and that the acceptance criteria are known and correctly interpreted.
Some of the following tests will expose the test engineer to hazardous voltages and currents - others are by their nature 'hazardous operations'.

Electrical Tests

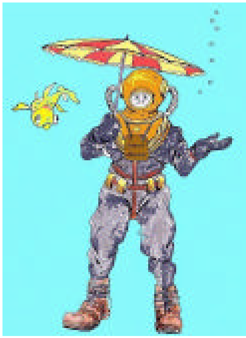
Before we even think about applying an electrical supply to the Unit Under Test (UTT) it makes good sense to ensure that there is a good electrical earth in place. Therefore we ALWAYS do this test first.

These tests are usually designed to support the detailed physical review by testing characteristics that cannot simply be assessed. Like the physical review they are intended to verify that there are no electrical hazards for "Operator" or "Service Personnel". The tests will usually consider two possibilities:-
* a hazard escaping from the unit
* the operator or "Service personnel" gaining access to hazardous parts of the unit
Before we apply any electrical supply to the Unit Under Test (UUT) it makes good sense to ensure that there is a good electrical earth in place. So (for Class I equipment) this is ALWAYS the first test we carry out.

Earth Bond Test - Hazardous Test (Current Hazard)



Purpose: To ensure Adequacy of Safety Earth Ground
Method: Connect a suitable Earth Bond Tester between Primary Earth Ground (and ALL metalwork that is insulated by only BASIC Insulation from hazardous voltages or that 'could' be contacted by Basic insulation, circuits in Extra Low Voltage under normal and Single Fault conditions). For pluggable equipment we use the earth pin of the inlet connector: for permanently connected equipment connect to the Primary Earth Ground.
Set the current to the level required by the relevant standard and verify that the resistance is <u>less</u> than the specified maximum. In most cases our result will be significantly less than the maximum permitted - therefore our manufacturing process should reflect this may ensuring that any deviation from our expected 'norm' is investigated - it will probably indicate an earth bond failure.
This test must be conducted on ALL Class I products - because any failure will be potentially lethal.
The OPERATOR must always be given two levels of protection.



HiPot Test - Hazardous Test (Electric Shock Hazard)

Purpose: To ensure that there is adequate insulation in place between Hazardous Voltages and Operator Contactable parts.
Method: First we must analyse what levels of insulation are required. This analysis will have been carried out during the Physical Review and will define where BASIC INSULATION and where REINFORCED INSULATION are required.
Between all Earthed parts and Hazardous Voltage there MUST be BASIC INSULATION: between all OPERATOR ACCESSIBLE Unearthed parts and Hazardous Voltages there must be Reinforced Insulation.
The areas that are frequently overlooked are where BASIC INSULATION can touch unearthed conductive parts (where there needs to be REINFORCED INSULATION) and where SELV supplies are floating and also require REINFORCED INSULATION.
This test must be conducted on ALL products powered from a hazardous supply - because any failure will be potentially lethal.

Input Current/Power

Purpose: To ensure that the Rating Information is correct.
Method: Using a suitable Break-Out box connect an ammeter and voltmeter (or true rms reading power meter) and exercise the PUT to determine the MAXIMUM input current/power drawn. This will depend upon the duty-cycle, clock speed and will be load dependant; it will also vary on any internal or external parts or systems that can ‘reasonably’ be connected, fitted or installed.

Earth Leakage Current - Hazardous Test (Electric Shock Hazard)

Purpose: To ensure that the Earth Leakage Current is not hazardous.
Method: There are generally two methods of measuring Earth Leakage - one methods requires an isolation transformer. This equipment can be expensive because high power isolation transformers tend to be heavy and costly.
The other method involves breaking the earth connection and then measuring the current flowing through the Earth conductor. The second method uses relatively cheap and portable equipment but leaves the UUT without a Safety Earth Ground.
Both methods will generally require a special measuring circuit using high precision components - it is worth remembering that the network specified by the standard MUST be used.
The maximum Earth Leakage allowable for a Type A (domestic) plug is usually specified as 3.5 mA - if we measure current approaching this level then it is a good idea to do

something about it now rather then risk component tolerances causing production units to fall outside the legal maximum.
Higher currents are usually allowable if Type B (Industrial grade connectors - IEC 309 - are used,: but there will be maximum limits specified in the standards).

Temperature Rise - Normal Conditions

Purpose: To ensure that Maximum Ratings of Components are not exceeded under normal operating conditions.
Method: The equipment is run under worst case loading and duty cycle at minimum, nominal and maximum input voltages and the steady-state temperature of ALL Critical Components is measured.
Critical Components will include Operator Accessible covers and also plastic parts that might deform and create a hazard. (e.g. where push-fit connectors fit into plastic.) It will also include wires that are heated by components.

Temperature Rise - Abnormal Conditions

Purpose: To ensure that specific maximum temperatures are not exceeded and there are no hazards under abnormal and single fault conditions.
Method: The unit will usually be run at nominal voltage input with worst case loads and duty cycle, single faults will be introduced to simulate “Reasonable Use” and “Foreseeable Misuse”.
This will include blocking air vents; stalling fans, short-circuiting components in both primary and secondary circuits, etc. Only one fault is introduced at a time.

Operator Accessible Outputs

Purpose: To ensure that any electrical output is SELV and within the Energy Limited Limits
Method: Measure all output voltages accessible to the Operator - a surprisingly high number of manufactures fail to recognise the importance of this test or incorrectly assume that it is not applicable to their products.
All output supplies are review (and tested) to ensure that they comply with SELV requirements. (The review will (obviously) consider failures of adjacent insulation, connections and joints.)
The Open Circuit and Short Circuit currents (and if necessary the Power) are measured and compared to the Limited Energy limited of the relevant standard. Some of the limits typically quoted are 240VA, 30VA, and 8A.

Stored Charge - Hazardous Test (Electric Shock Hazard)

Purpose: To ensure that the mains power cord does not expose the Operator to a stored charge or hazardous energy during disconnection.
Method: A specialist test box or a storage ‘scope with a 10M? probe are connected to a suitable “Break-Out” box - the UUT is turned “ON” and the power cord disconnected. The residual voltage on the lead is measured and must fall below 60V within (typically) 1 or 5 seconds - depending upon the standard and the type of connected fitted. This test is

repeated (usually MANY times) to ensure that the disconnection occurs during the mains peak half cycle; and then with the switch in the “OFF” position.