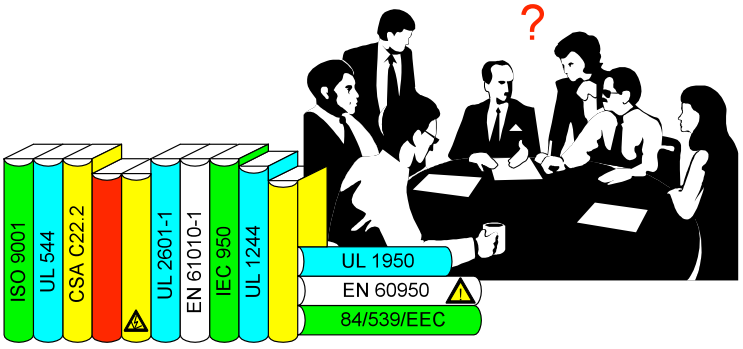
Why Perform Electrical Safety Testing?

Pose this question to a number of manufacturers and you will get a wide variety of answers. One answer that is all too common is "we perform EST because the standards require these tests". This should not be a common answer once you consider what can be achieved from EST and who is ultimately responsible for product safety from a liability standpoint. Let's take a look at the product safety standards, their development and their requirements. We'll find the answer to 'Why perform EST?' is not to increase production time but is simply to provide the safest product possible. It's not likely we want to discover post-production that a simple ground bond test could have prevented a major product recall. Do it right the first time and save the time, money and product that could potentially be wasted.

EST Standard Development

Most standards are developed by committees composed of individuals representing industry, academia, test laboratories, government and consumer groups. This process of standard development has advantages in that ideas and opinions from a wide variety of sources and backgrounds are used. This results in a standard that will be accepted by the manufacturers and a safer and more durable product for consumers. The standards also insure that similar products are tested to similar requirements.



On the negative side, the time required to develop or even update a standard can easily take years from start to finish. In addition, the development time for products covered under a standard, especially consumer electronic, can be much shorter. This can result in several generations of new products, with potentially unique technology, that were not considered when the standard was developed. Since the ultimate responsibility for product safety is the manufacturer each and every new product should be evaluated not just to see if it meets the standard but through sound engineering principles to ensure the product is reasonably safe. All too often products are recalled not because they did not meet the standard but because in normal use a potential safety issue has arisen. In some instances additional testing still would not have detected the potential safety issue however some recalls could have been prevented with minimal cost and effort.

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Test Equipment

Generally standards are written around test equipment that is available at the time the standard is written. Input from manufacturers plays a role because standards often reference equipment that manufacturers are using at that time. One example of equipment lagging behind technology is the requirement of a 500VA Tester for dielectric withstand (hipot) tests. When hipot testers first came out they were little more than a transformer and variac. The transformer was used to step up standard 115V AC line voltage to several thousand volts. The variac was then used to adjust this high voltage down to the required test voltage. There were drawbacks to this design in that if the 115V AC line voltage dropped so did the output voltage. To compensate for this most standards indicated that the test voltage could be as much as 20% higher than recommended to account for any drop in line voltage. As the leakage current in the device being testing varied so did the output voltage. One way to minimize the output voltage changing with each device tested was to use a hipot that could produce higher output power, i.e., 500VA. The higher the output power the less susceptible the output voltage was to change as the leakage current changed. This 500VA design was cost effective, worked well and was widely used for most electrical safety testing. Most standards referenced a 500VA hipot for electrical safety testing.

Today most hipot testers are digital and provide load and line regulation to insure that the test voltage remains constant. Most new standards do not specifically require a 500VA tester, however there are still standards currently in use that do require a hipot tester capable of producing an output power of 500VA. One concern with the use of a 500VA hipot is operator safety. A 500VA hipot can provide enough current to be extremely harmful should an operator come in contact with the output. The intent of any standard is to provide a guideline for manufactures to follow to produce safe products.

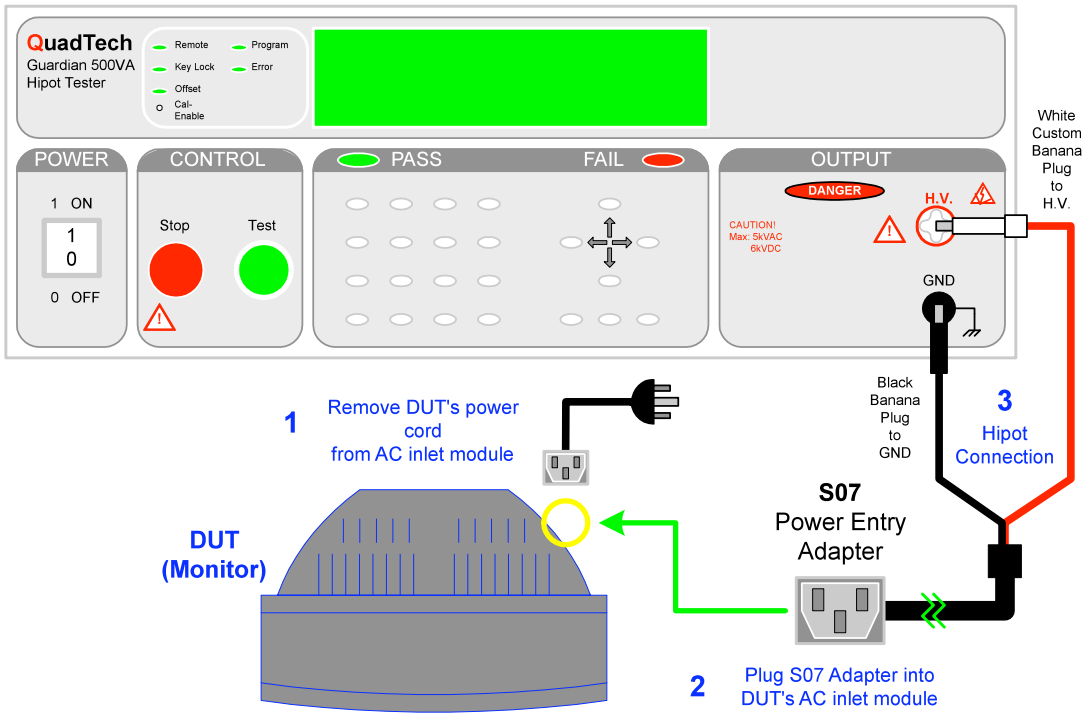

Figure 1: Guardian 500VA Hipot Tester

Standard Requirements

Another consideration when performing electrical safety testing is what is in the standard. The content of a standard can be broken up into the following sections: Introduction, Construction, Performance, Manufacturing & Production Tests, Markings and Appendix. For electrical safety testing the two main sections are performance and production tests. The section on performance covers all of the various tests that need to be performed during initial product evaluation. This section will focus on the four types of safety requirements: shock, fire, energy and mechanical hazards as it pertains to the safety of an operator of the product. Performance tests verify that the manufacturer has followed the requirements laid out in the section on construction. Performance tests are generally extensive and cover operation of the product under normal **and** fault conditions.

The tests that must be performed on all products on an on-going basis are outlined in the production tests section. Production tests frequently include a dielectric withstand test, polarization and ground continuity or ground bond tests. Medical products will also include a line leakage test. The required production test voltages and limits are outlined or referenced back to a performance test requirement. To ensure continued compliance regular surveillance is required through periodic factory inspections of Listed (certified) products.

Performance tests per the standards are done on a sample product. An authorized test laboratory normally does the Performance Testing of a product to certify that the product meets the requirements set forth in the standard. Production tests, on the other hand, are required on all products and these are the tests most manufactures are involved with on a day-to-day basis. The manufacturing tests are a subset of the production tests and are tailored for ease and speed of testing. There are three main issues to consider when determining what equipment will be required for production testing.

The requirements in the standards represent a set of test requirements to provide an acceptable level of product safety. The development process of the standard requires a consensus of a wide variety of individuals each with different points of view. To accommodate the various points of view the test requirements are written in broad general terms. The requirements in the standard are adequate to insure an acceptable level of safety, however some manufacturers will test beyond what is required in the standard. This can provide an added level of safety. This is often referred to as a safety margin or safety factor. The safety factor takes into account variations in test procedures, accuracy of test equipment and unanticipated variables. The application of the product also needs to be considered when determining acceptable safety limits. Products being used by a trained operator may only be tested for a modest safety factor. Consumer products on the other hand, may be tested beyond the requirements given in the standard to yield a much higher safety factor. It is important to emphasize that products need to be at least tested to the standard and that should go without saying.

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More on Standard Requirements

The ultimate responsibility for product safety is the manufacturer's not the standard's. The requirements set forth in the standards are based upon sound engineering principles, research and experience in the field. Armed with this information the standard is written with the intent of providing a guideline that will protect the user of the product. Compliance with the standard does not fully protect the manufacturer from liability. As well, compliance with the text of the standard does not mean the product will comply with the standard should the product have a design that compromises safety. On the other hand, a product's failure to conform to the product safety standard could be damning evidence in a product liability case.

Consider reviewing other standards that reference your product or similar products. Industry organizations frequently publish standards that set minimum requirements for products being sold by its members. Industry standards are often referred to as **"Non-Mandatory Standards"** and need to be considered when it comes to liability. Non-mandatory standards are generally written and reviewed by members of the organization. Frequently these members are leaders in the industry that provides additional credibility to what is considered acceptable for tests and test limits. It is important to remember that failure to comply with a non-mandatory standard does not mean that a product is unsafe. However non-compliance can be used as evidence to build a case that the product may not be safe. Knowing what tests are recommended by both mandatory and non-mandatory standards related to your product can save both time and money.

It is also advisable to look at the tests that are being required in recent standards. Significant emphasis has been placed on worldwide harmonization of product safety standards with the hope of establishing truly uniform global specifications. One certainty at present is that the harmonization of standards will continue throughout the world. One of the key reasons why harmonization of the standards will continue is reduced cost to manufacturers. In today's global market place where manufacturers are selling the same product to multiple countries it is expensive to test in accordance with each country's agency requirement. The benefit in testing to a harmonized standard is in reduced testing costs to manufactures and hopefully reduced costs to consumers. Understanding where the standards are going can provide insight as to what the requirements maybe in the future. Currently most standards are following along with international standards such as those from ISO and IEC.

Consider One More Thing…

One other consideration is that the cost of electrical safety test equipment has come down dramatically. Tests that were in the past only performed during performance testing on one product are now cost effective done as a production test. One such test is ground bond (high current ground continuity). A ground bond test verifies the integrity of the ground connection under a simulated fault condition. This verifies how the product would perform under an actual fault condition where the hot lead from the power cord was to come in contact with the metal case of the product. In this type of fault condition the internal ground of the product needs to function long enough so the circuit breaker or fuse in the building's wiring trips.

Currently most standards require a ground continuity test on all products with a three-prong power cord not a ground bond test. A ground continuity test checks that there is connection between the ground blade on the power cord and any exposed metal on the product. The ground continuity test does not test the product under a simulated fault condition. The ground continuity test is adequate as long as an assumption is made. The assumption is that if the sample product passed the ground bond test during initial performance testing so as long as there is continuity between the ground blade and any exposed metal, then each production unit should also pass a ground bond test. For the most part this is a valid assumption as long as nothing has changed in production or at one of your suppliers. If the assumption is wrong however the results could be shocking if not extremely costly.

So what does EST achieve beyond safety?

One by-product of EST is the capability of analysis of the data to improve product reliability and quality. Electrical safety testing is just like every other test. The data can be analyzed and limits placed around nominal values. Taking advantage of EST data allows manufacturers to screen out units with too high a deviation in leakage current, insulation resistance or ground resistance that can be an indication of some change in the manufacturing processes or materials used in manufacture. This can provide a manufacturer with an additional final check of product quality without any additional costs or manufacturing steps.

For example, one manufacturer was able to determine that the pressure in the high-pressure air lines was fluctuating based upon analysis of ground resistance tests. The ground resistance of the product was normally in the 50mΩ range (which is well within the 100mΩ limit of the standard). This resistance however changed throughout the day and an occasional failure was detected. The change was eventually traced to how tight the nut was on the ground stud that connects the ground on the power cord to the case of the product. An air gun is used to tighten the nut and as the air pressure changed so did how tight the nut was put on the ground stud. Stabilization of the pressure resulted in a more consistent ground resistance well within acceptable limits by a larger safety margin. Though a small change, each and every step taken, when it comes to electrical safety, is an advantage with potential benefits in quality and reliability.

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Summary

Standards do **not** distinguish between good and bad product designs. Standards are however guidelines, for manufacturers to follow representing acceptable set tests and limits required which ensure a reasonably safe product. It is up to the manufacturer to use good engineering techniques and principles in both the design and testing of a product. Good engineering techniques and testing beyond the requirements set in the standards benefits both manufacturers and consumers.

The process of updating the standards is never-ending. We must be aware that the standards can lag behind current technology and take this into account when reviewing new product designs and test equipment. As a side note, one area that is currently being worked on at UL is the standardization of appliance standards. This task is still in a preliminary stage. It is expected that in the near future the UL standards will be updated to bring them more in line with IEC335 that is the international standard for household and similar electronic devices. Updating the standards should result in the standards reflecting more modern technology in both the products being testing and the test equipment.

It is the manufacturer who is ultimately liable for product safety **not** the standard. Reviewing both mandatory and non-mandatory standards as well as taking an **active** role in industry organizations can provide manufacturers with valuable information.

Electrical safety testing is much more than just a requirement in a standard. Analysis of data from electrical safety testing can be used to detect variations in components and in the manufacturing process. Early detection of problems, improved quality and reliability are all benefits from tests we already perform. We all need to look at ways of improving electrical safety testing for the benefit of both manufactures and consumers. After all, if we take the time to concern ourselves with safety now the vast majority of people will never be concerned with why we perform electrical safety testing in the first place.

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