The 6 Hazards of Product Safety – Risk of Shock

The “Designing for Compliance” Series

Hazard #1 – Preventing electrical shock to the user

“Designing for Compliance” is critical to getting your product certified on the first try. Designing for Compliance requires owning, knowing, and applying the standard(s) while designing your product. However, in order to successfully read and understand the standard, you have to know the intent of the requirements. Our “Designing for Compliance” series of whitepapers will educate you on “The 6 Hazards of Product Safety”. The intent of the requirements in all UL/CSA/EN/IEC safety standards is to protect the user from the “6 Hazards of Product Safety”. This whitepaper covers Hazard #1 – Risk of Shock.

Risk of Shock Definition: A “Risk of Shock” is considered to exist within a product if the user can access a hazardous voltage circuit (typically >30VAC). Due to the potential for severe injury or death from an electrical shock, two levels of protection are required from circuits presenting a shock hazard. Two levels of protection means that even when one protection method goes bad (referred to as a single fault condition) the user still cannot be shocked.

Risk of Shock – Level of Importance: The most important requirement in the product safety standards is to protect the user from receiving an electric shock. And, because the outcome from an electric shock can be so severe (potential for death), the product safety standards require that you provide “2 Levels” of protection from a potential shock hazard. And it’s that “2nd level” that results in much of the difficulty in understanding how to design for shock hazard compliance. It is also part of the reason that Risk of Shock protection accounts for more than 50% of the requirements and tests in most UL standards. So if you learn Risk of Shock, you have learned a large part of the standard.

Risk of Shock – Accessibility: The first element of learning Risk of Shock protection is to understand the term “accessibility”. In order for the user to get “shocked”, the user must touch an electrical circuit. Ability to touch an electrical circuit is typically referred to as “accessibility”. This is critical to understanding Risk of Shock and it provides us with the first set of important compliance design questions:

1) Can the user access the circuit? And,
2) Do you need the user to access the circuit?

To answer these questions we need the product safety standards. Product safety is not intended to be a subjective process. Determining whether the user can access the circuit should not be dependent on whose finger is used. Rather, the product safety standards specify “accessibility probes” that are used to determine what circuits are considered to be user accessible. There are different accessibility probes in different standards.

Many compliance professionals are familiar with the “International Finger” which is based on an adult male hand size. There is also a “UL Finger” that is much smaller as it is based on the hand size of a women and, a set of “Child Finger Probes” representing two different age groups of children, with the probe including a child’s arm. In addition, some standards include probes that represent a basic tool that is typically found in the product’s user environment (paper clip, screw driver, etc.). There is even a test chain that simulates a user’s jewelry drooping into a product vent to see if it can “access” a hazardous circuit. Be sure to check your product safety standards to identify what accessibility probes and conditions of use apply to your products (i.e. force limitations, limited use guidelines, etc.).
It should be noted that most safety standards require opening and removing all parts that can be removed or opened without tools before applying the accessibility probes. This can include using a Finger Nail probe to try and pry open snapped together parts. And for products with electrical connectors for communication or accessories (USB, headphones, etc.), these connectors are assumed to be accessible regardless of the type of connector. This is very important – all circuits connected to external connectors are usually considered user accessible (other than certified power receptacles).

Risk of Shock – Shock Hazard Levels: Once you identify all circuits that can be “accessed” by the probes, the next step is for you to answer the question “do you need for the user to access the circuit”? If the answer is no, you should design means into the product to prevent the accessibility probes from accessing the circuit (locking door, screw down a panel, replace thumbscrews, change a vent size or location, etc.). However, you may need the user to be able to access the circuit (usb port, headphone jack, change battery, plug-in options, etc.). Circuits which are accessible must not be a “Shock Hazard”. For an accessible circuit, the first step in verifying compliance is to determine if the accessible circuit is at a “Shock Hazard Level”.

Each product safety standard defines a Shock Hazard level circuit. This definition always begins with a definition for “hazardous voltage level”. In many standards, voltages above 30 Vrms are considered a shock hazard. Some standards expand that definition to 30Vrms, 42.4 Vpk or 60VDC. These numbers can vary by standard, so be sure of the limits in your standard. Also be aware that for some standards such as the standard for electrical medical products, the accessible voltage limit is lower (25 Vrms).

Risk of Shock – 2 Levels of Protection: Once you know which circuits are user accessible, and you have verified they are not at shock hazard voltage level, you must verify that the accessible circuit is properly protected during fault conditions. The product safety standards require that you must protect the user from all potential shock hazards with 2 levels of protection (“2 levels”, not “2 layers”). Two levels of protection means that if the user is touching the circuit, and a fault occurs, the user still will not be shocked (the voltage in the accessible circuit will not increase above the hazardous voltage limits). The standards accomplish this by requiring “Double” or “Reinforced Insulation” between accessible circuits and all hazardous voltage circuits. For double and reinforced insulation, a single fault will not eliminate the insulation.

Double or reinforced insulation can only be achieved through the use of an isolation device = meaning that you must have an isolation transformer or opto-isolator between the accessible circuit and all mains/hazardous voltage circuits. This can be a very complex process, insuring that each isolation device has 2 “levels” of insulation, and that each of the 2 levels protects in the event that 1 fails. Which is the reason Risk of Shock is such a large part of the product safety standards.

Risk of Shock – Summary: In summary, “accessible circuits” are those circuits that can be contacted by the accessibility probes. Users must be protected from a Risk of Shock. To do this, all accessible circuits must be verified to have 2 levels of protection from shock hazards. Shock hazard circuits include all interconnected circuits that contain a hazardous voltage (30Vrms, 42.4Vpk, 60VDC). Accessible circuits must be “isolated” from all hazardous voltage circuits by 2 levels of protection = double or reinforced insulation. Primarily, shock hazard protection involves verifying the product has 2 levels of protection between all accessible parts/circuits and all hazardous voltage circuits, and that each level of protection meets the requirements within the standard.

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