Weekly Whitepaper
Week #37

The 6 Hazards of Product Safety & Battery Operated Products

The "Designing for Compliance" Series

Our "Designing for Compliance" series of whitepapers will help educate you on the intent of the standards and provide guidance on how to design your product for compliance to UL/CSA/EN/IEC safety product standards.

Battery Operated Products:

Most people assume a battery operated product is safe and does not need certification. That would be a big mistake. If we review the 6 Hazards of Product Safety as they apply to battery operated products, we find that although the risks may be reduced, they are not eliminated. And in the case of Risk of Fire, the risk may actually be higher with a battery operated product.

The 6 Hazards & Battery Operated Products:

1) Risk of Shock: Shock hazards are unlikely to exist in battery operated products as the voltages are usually below shock hazard level (24V or less). Battery operated products have no direct mains connection meaning that shock hazard circuit isolation/insulation is not required. For these reasons, circuit accessibility requirements also do not apply.
   - NOTE: Many battery operated products are rechargeable, and the charger is considered part of the product. When your product is charging, the charger provides all of the shock hazard protection to the user. So it behooves you to know the Risk of Shock requirements and to insure that the charger you select provides adequate Risk of Shock protection. You need to be sure to source a certified charger that has a Class II output rating (for use with appliances) and/or a SELV output rating (for use with information technology products, lab equipment, & test equipment).

2) Risk of Energy: This hazard is unlikely to apply unless using an automotive type battery, in which case you would almost certainly want to fuse accessible circuits to limit them below 240VA even if this is not defined as a hazard in your product's safety standards.

3) Risk of Fire: This hazard remains a potential concern with most battery types, and is especially a concern with lithium batteries. Since many of today's battery operated products are powered by lithium batteries, which present a serious risk of fire, a detailed review of this potential hazard is provided on the next page.

4) Risk of Injury: This hazard has limited application with battery operated products other than sharp edges and pinch points. Battery powered moving parts usually do not have the available energy necessary to cause injury, nor are the products large enough to have tip-over concerns. However, the weight of some battery operated hand-held products can be a concern, making design aspects that affect user grip very important.

5) Risk of Radiation: Radiation hazards in battery operated products are typically limited to LED optic limits for EU-CE photobiological concerns. Lasers can also present a real concern such as with a laser pointer. Battery powered products usually do not have the necessary power for microwave and UV products.

6) Risk of Chemicals: This hazard is not directly related to the means of power for the product. However, for battery operated products, the chemicals contained within the batteries can add a chemical hazard risk. For battery operated products intended for Europe, the CE-RoHS & CE-WEEE requirements may be an unanticipated requirement that can present a major obstacle. In addition, component and material content concerns become critical for battery operated products that are considered toys.

Risk of Fire & Battery Operated Products:

Just about everyone has seen or heard the dramatic news events showing electronic products on fire – cell phones, hover boards, e-cigarettes – what's next? These products have one design feature in common that has caused all of their fires = a lithium battery. While other types of batteries can cause a fire, lithium batteries themselves can explode or ignite. In our opinion, the problems related to fires with lithium battery powered products are primarily due to:

a) Using cells that are certified to the lithium cell standards (i.e. UL1642) however, failing to have the overall "battery pack" tested (UL2054, UL62133). Testing on the cell is not enough to properly evaluate the safety of multi-cell battery applications. Short-circuiting a battery pack that has not been tested as a "pack" can result in disastrous consequences.

b) Failing to understand that lithium batteries can become extremely hot when used *within their ratings*. The more current drawn from the battery, the hotter the battery operating temperature. Without proper design considerations, the batteries can even overheat during normal operation. We have seen certified component batteries that were permitted to get to 150°C during component certification testing! We have also seen LED lighting cause high current draw from lithium batteries making the cells extremely hot. Product manufacturers need expert compliance guidance when integrating a lithium battery into a product design.

c) Exposing the cells to moisture – the lithium compounds used in lithium batteries can be very volatile and explode or ignite when exposed to water. These compounds can also ignite if exposed to air, making damage to any lithium battery a serious concern. This helps explain why many electronic product fires are so violent and difficult to extinguish = a lithium battery fire. Note that handheld products are much more likely to be subjected to impacts or other abuse that could damage the battery cells.

d) Failing to test the cells and battery packs after subjecting the product to real life conditions such as shock, vibration, repeated drop impacts, etc. Excessive shock, vibration, impact forces and product flex can damage the lithium battery cells. These environmental conditions can also cause damage to the product to the extent that the lithium batteries are then exposed to environmental conditions causing dire consequences.

e) Recognizing that lithium battery fires are extremely hard to contain and almost impossible to extinguish. One of the critical elements of Risk of Fire protection is insuring that the product enclosure can prevent any internal fires from escaping. But few product enclosures can contain a lithium battery fire – the requirements in the safety standards simply do not anticipate this event occurring. The expectation is that certified batteries and battery packs will prevent a battery fire. This simply is not enough.

Determining if the product safety certification test program is adequate for the application is critical. Remember that the battery certification is limited to the requirements in the safety standard. Quite often a battery operated product can be subjected to user abuse that far exceeds the testing requirements in the safety standard. Considering the very extreme consequences we have seen from lithium battery product fires, can you afford not to conduct additional "ruggedness" tests? In the case of the hoverboards, was testing done simulating the repeated dropping of the product on a hard surface, followed by a heavy person jumping onto the product = shock, vibration, flex, heat, cold = how do the lithium cells respond to repeated charging/discharging while also being subjected to these harsh environmental conditions? Did the manufacturer check? The results suggest that some did not.

So often a product manufacturer does the minimum or only what is specified in the standard. With the viral nature of social media, can you afford to find on the internet that your product has a Risk of Fire problem? Of the "6 Hazards of Product Safety", Risk of Fire can certainly be viewed as one of the most important. The potential for a single product to risk many lives by causing a structural fire must be considered in the Risk Analysis of electronic products. Compounded by the fact that product fires are dramatic and, in today's social media era, the results of a single event can be shared with millions of potential customers. Yet there are no 100% fault free components meaning there are no 100% fault free products. As such, it is important that you consider environmental simulation testing as part of your lithium battery product test program.