

## There are no short cuts to safety!

The following article should give you cause for thought as you prepare for another season of safe boating here at Raystown Lake.

While enjoying the Memorial Day weather on the sundeck of their moored houseboat on a lake in the Southeast, a mother and her adult daughter decided to go for a brief swim to cool off. Aside from a couple splashes and a shout that the water was cold, neither woman gave any indication that anything was wrong, but as a second daughter prepared to follow them a short time later, she looked down and saw her mother floating face down near the swim ladder; her sister was nowhere to be seen.

The subsequent frantic efforts to resuscitate the mother were to no avail. Despite administering CPR, a witness was unable to save her. Rescuers found the daughter several minutes later more than 50 feet below the surface of the water, but it was too late to save her. The post mortem suggested both had drowned because neither body had suffered any physical trauma, but the surviving daughter reported that they were both good swimmers. What could have possibly happened?

As the investigation into their deaths continued, it became increasingly evident that the women were the victims of a phenomenon that has become known as electric shock drowning.



### Dangerous currents.

Electric shock drowning is often the result of a situation similar to a hair dryer falling into a bathtub; in these cases the hair dryer is a boat and the bathtub is a lake. The cause is often an undetected ground fault that energizes the hull and causes a low-level current to flow through the swimmers, thereby disabling muscle function. It's referred to as electric shock drowning and not electrocution because there is no physical injury. The victims either lose muscle control if the current level is in the 0.01A to 0.02A

range or suffer ventricular fibrillation at 0.05A to 0.06A current levels. Because victims typically show no sign of injury, many electric shock drownings are mislabeled as deaths attributable to alcohol intoxication or heart attack. Oftentimes those drownings that are attributed to electric shock are classified that way because of circumstantial evidence like great distress, multiple deaths, and a tingling sensation reported by the survivors.

How does the hull become energized? What happens to the safety bonding system? American Boat and Yacht Council (ABYC) recommended practices require that the AC shore cord's green bonding wire be joined on a boat to the DC negative bus and the underwater gear bonding system. Should a fault develop on the boat, the fault current in the ground wire will initiate a breaker trip or at least prevent a potential (voltage) rise on the hull or underwater gear. However, there's no way for the marina to know if the ground wire on the boat is OK under normal operating conditions.

Current takes all paths back to the source, so even with a good ground system there still may be a small voltage rise on the hull as a fault establishes a parallel current path in the water. The boat may become lethal, however, if the ground return is damaged and located in fresh water.



Regardless of the size of the AC fault, the potential may rise to lethal levels as low as 15VAC. Even with a poor ground, a boat in salt water won't develop enough potential to cause a problem for a swimmer, making this an unheard of phenomenon with boats in the ocean.

### **Lakes are a different story.**

Fresh water is a very poor conductor by comparison, so an ungrounded fault will raise the potential on the hull as it attempts to enter the water. A swimmer represents a much lower resistance fault path, even if only in the electric field and not touching anything.

The common elements in all of the accidents for which information is available always include a fault

to ground below the breaker trip point, a high resistance or open ground, fresh water, and a swimmer near the faulted boat. Possibilities include:

- Neutral ground connections, open ground, reverse polarity
- Motor or heating element insulation failure and open ground
- Metal conduit on dock, not bonded and water soaked



### **A preventable disaster.**

**The investigation revealed that the boat owner failed to connect the grounding (bonding) wire to the female plug, which ultimately led to an ineffective ground-fault return path.**

As more evidence was uncovered, the investigation into the deaths of the two women began to focus on the electrical system. On the day of the incident, the resort at which the boat was docked had put into service new power pedestals that required boat owners to use new shore power cords. The owner of the boat in question — and the husband and father of the two victims — had been working that morning on

converting his existing Type SOW 600V power cord, which required nothing more than discarding the pig-tail adapter that had been used for the old service and plugging the cord into the new pedestal.

However, in making the conversion, he also altered the female plug connector at the boat. In doing so, he miswired the ground and hot wire, thus energizing the boat's aluminum hull, railing, and ladder. In addition, the wiring within the boat had been altered. Additional circuits had been added, and the incoming power had been changed from 125V (as designed) to 125/250V, which had exceeded the listed rating of the houseboat's female receptacle.

Without complete GFCI or isolation transformer protection, the safety grounding system had to be intact to protect the boat.



**The boat owner connected a hot conductor to the ground connection.**

The underwater metal hull of every boat in a marina is electrically connected through the shore power grounding system while moored. So while most of these accidents occur when both the fault and missing ground are on the boat, as was the case in this incident, the marina operator must ensure that his dock power system is in good condition.

We are committed to your safety here at Seven Points Marina but we ask you to be committed to your own safety and those around you. Never alter the manufacturers electrical configuration on your vessel without consulting a qualified marine electrician. Should you have any concerns, please

ask the marina office for assistance.

Since most of the problems that cause these drownings originate on the boat and many are generated by nonqualified workmanship, it may be necessary to implement around-the-clock monitoring of the marina shore power system to detect ground faults.

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