

**Electrocution by Grounds [editor's note: use "Grounds for Electrocution" if you like.]**

Steve-

I arranged to have a diver scrape the hull of my boat, and was surprised when the diver got a severe electrical shock when getting close to the boat. I also have some problems with the electrical system on board, where some 120volt appliances behave erratically when other 120volt equipment is turned off and on. Could these problems be related?

Yes, the two problems are probably related. As a general rule, it's likely that two related symptoms are caused by the same root problem.

Your diver is getting shocked from current flowing from your underwater gear (propeller, through-hulls etc) into the water. Your underwater gear is normally connected together by a "bonding" system, which is just a group of green wires or copper straps that connects all the underwater gear and your zincs together. This allows the zincs to apply a small voltage to your expensive gear to protect it from electrolysis corrosion. For safety reasons, the bonding system is also connected to all metallic chassis and structures and to your power source's neutral wire at one point. This point should be as close as possible to the nearest isolated source. An "isolated" source is a transformer, genset or inverter.

Here's the safety plan with respect to the grounds: If a live conductor comes in contact with a chassis or metallic structure the current will travel through the bonding wires and return to the power source's neutral allowing enough current to flow to "pop" a breaker, and stop the power. This is a lot better than allowing a metallic object to become electrified and shocking someone. Your boat has two problems: something is causing current to flow to the bonding system and your bonding system is not carrying the current back to the power source.

A side note: I would be willing to bet that your boat doesn't have an isolation transformer, because this is one of many problems that isolation transformers solve very well.

Before we try to solve the problem without all the facts, let's consider the other problem; the erratic interaction of appliances. With long and heavily loaded shore power cords, most of us are used to lights dimming when an air conditioner comes on, so I will assume that you have more problems than that. If you find that some appliances appear to get an INCREASE in voltage when something is turned on then you probably have a neutral conductor problem with a 120/240-volt system.

A 120/240-volt power source is made up of three current carrying wires, plus a safety ground. Each of two "hot" wires carries 120 volts, a third white wire called the "neutral" or "common" is very much like the ground in a 12 volt system, in that it doesn't normally have much voltage on it, but it does conduct current back to the power source. The forth wire, the green safety ground, is there for emergencies only, it only car-

ries current when there is a problem. Equipment can be connected across the two "hot" wires and it receives 240 volts from the same wires. The "neutral" is only needed for the 120volt loads to divide the 240 volts into two equal 120-volt sources. If the neutral is disconnected, the division of the 240volts between to two lines will be out of control. You could turn on a air conditioner, which might get only 40volts and the 120volt appliance on the other line could be damaged by the remaining 200volts.

Considering both your problems at the same time, I suspect that your neutral and safety ground are inappropriately connected together. This is a common design problem that has probably been present for a long time, but you haven't noticed. The single event that happened recently, causing both symptoms is a bad connection of your common wire, probably in a shore power cord.

Post Script: This problem was investigated and the actual cause of the lost neutral was far from the boat in the shore-side power wiring. The inappropriate connection between the neutral and safety ground was caused the shore/genset transfer switch, which did not switch the neutral wires. The power panel wiring simply connected the shore neutral, the load's neutrals and the genset neutral together. Generator sets usually connect their output neutral and the chassis ground together, which of course is connected to the boat's bonding system. This caused a continuous tie of the shore power neutral to the boat's grounding system.

This shock hazard was caused by two problems with two types of grounds, the neutral and the safety ground. So, it is possible to cause an electrocution with grounds only and no faults in the "hot" side wiring!

A three-pole transfer switch was installed which solved the problem with the inappropriate neutral/safety ground tie. The power company fixed a broken neutral wire ashore.

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