Ten Deadly Conditions to Check for in Your Boat's Electrical System - Part 1

Blue Sea Systems' engineering department has identified 10 conditions that, when present in your boat's electrical system, can cause serious problems. Five of these conditions are presented here. The second five will be presented in the October newsletter.

1. Incorrectly sized wire

There are several problems that occur when sizing wire for a boat's electrical system using the ABYC 105°C tables:

- Using wire with less than 105°C insulation.
- Bundling wires together or burying them in thermal insulation.

However, usually wire size isn't a problem because:

- Most DC large loads are short term.
- Most DC wire is chosen for voltage drop and is therefore larger than the minimum recommendations from the ABYC tables.

- Wire is sold with different insulation temperature ratings. The highest rating in general use for shore side wiring is rated for 90°C and there are numerous common wire materials rated at 75°C, 80°C and 90°C. The ABYC 105°C table should only be used with wire that is rated at 105°C.
- Heat is produced in wire by resistance to current flow. Wire temperature is a function of the heat produced by the losses in the wire and how effective the installation is at removing that heat. This heat escapes into the air or into heat sinks such as busbars made of solid copper bars. Efforts to neatly "dress" wire by tying it together or concealing them between hull and liner actually make the situation worse. The better job we do of providing physical protection for wire with conduits and installing between hull and liner, the harder it is for the heat to get out. The efforts to make neater installations can result in a potential hazard if the wire size is not increased to compensate.

The greatest concern here is with AC circuits that feed recepticles that can be readily overloaded.

Even when using 105°C rated wire at its maximum current rating, the wire may be too hot to touch without burning yourself. At these high temperatures, corrosion at terminals will be accelerated and the system may have shortened life.

2. Running fuses continuously at full ratings

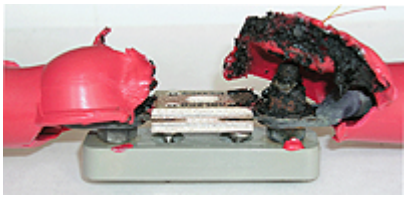
When matching circuit protection to the wire it protects, two facts contribute to the complexity of this task:

- The amperage at which fuses actually blow, and circuit breakers actually trip, is considerably higher than their nominal ratings, the rating usually marked on the unit.
- Wire and circuit protection devices heat up dramatically when they carry 100% of their rated value for several minutes or more.

SEA, Maxi, ATO and AGC fuses, and most circuit breakers, blow or trip at about 130% of their rating. ANL fuses blow from 140% to as high as 266% of their rating. When fuses carry 100% of their rated current value, they generate excessive heat. When wires carry 100% of their rated current value, they also generate excessive heat. In combination, the heat produced by fuses and wires carrying high current can melt wire insulation and fuse blocks. This heat generation may become critical when loads run for a considerable time. Large diameter wires take a long time to heat up, so short term operations like bow thrusters, windlasses, and macerator pumps seldom run long enough for this kind of heating to occur. For example, a 2/0 wire may take 25 minutes to approach its maximum temperature. In contrast, small diameter wires reach near peak temperature in less than 10 minutes.

For loads and appliances that run continuously for 10 to 30 minutes, choose circuit protection and wire so that current does not exceed 80% of their rating.

For more information in this topic, refer to Technical Brief: Choosing Circuit Protection.



3. Not using the shore power cord locking ring

The shore power cord locking ring maintains a solid connection between the power cord plug and hull receptacle. When this connection isn’t secure, motion can cause the plug to wiggle back and forth in the receptacle, compromise the electrical connection, and result in dangerous heating.

Shore power connectors can have both electrical and mechanical stresses applied. The locking ring keeps the plug from backing out and fixes the two elements together so that the connection is not moved by normal motions. The constant working of the connection between shore power cord plug and receptacle with the boat's motion can loosen the connection, increase corrosion

and weaken spring contact tension.

The shore power cable and connection is the most easily overloaded point of wiring on the boat because it feeds all of the AC system including receptacle circuits. Every new appliance brought onboard can add a new load, and devices like electric grills, hair driers, air conditioners and space heaters are designed to use about 12 Amps each. It is easy to turn on more than the rated capacity of your system, and the circuit breaker system will not trip until your overload is at about 130% or more. In this condition, a weak connection between plug and receptacle can become a fire source.

4. No "Green Wire" or poor-quality connection between DC negative and AC safety ground

Without a good connection between DC negative and AC safety ground, stray AC current may enter the DC ground system. When this happens, AC current may enter the water around a boat and injure or kill swimmers near the boat.

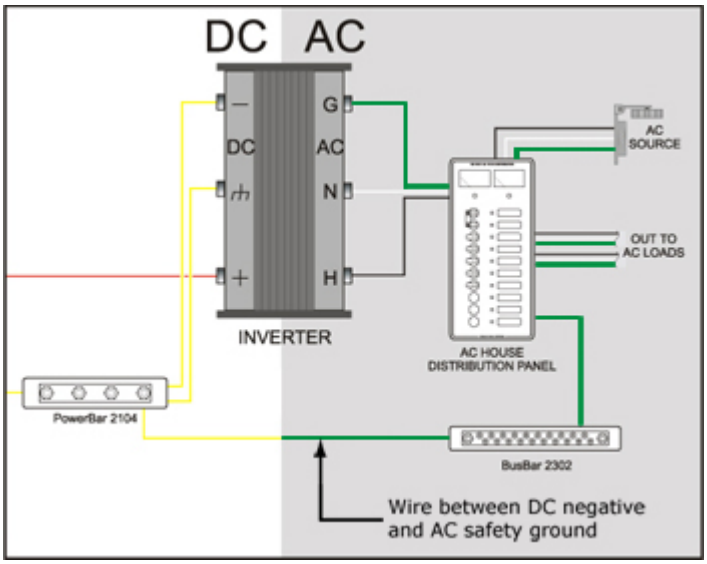
The green wire is the safety ground wire that connects the DC negative ground block to the AC safety ground bus. The purpose of this wire is to provide a lowest-resistance path to ground for any stray AC current that finds its way onto the DC ground system. There have been cases of AC current entering the water around a boat through the engine shaft and killing swimmers near the boat.

There is a down side to this green wire connection. This safety ground can also provide a path for galvanic current if the boat is not adequately protected with galvanic isolators. However, most marine industry organizations and professionals now consider it standard practice to install this wire. Safety requires providing the grounding wire, either directly or through a galvanic isolator, or using a properly installed marine isolation transformer. Some people have left off the ground wire in a mistaken notion that they are providing galvanic protection, but forget that they are compromising safety for those on the boat, on the dock, and in the water. Electrically induced drowning is now recognized as a previously undocumented cause of death. The Coast Guard is funding a study to isolate and investigate this hazard.

The green wire can be tested and indicate continuity but be unable to safely carry enough current to trip a circuit breaker during a fault. There are ways to check the quality of the connection.

An Ohm meter test may show very little resistance in a green wire installation, yet the wire may be incapable of carrying 30 amperes or the higher currents needed to trip a circuit breaker during a fault. The minimum resistance reading of an Ohm meter will not necessarily indicate if a connection is compromised, such as a connection making to only a single strand of wire. There are specialized ground resistance testers that apply significant current, but they are uncommon. Careful visual inspection of the grounding connections helps, but even a careful surveyor may have a hard time finding all connections and tracing the wiring path.

One way to test the green wire connection quality is to connect a spot light or other heavy 12V load, positive to the boat's battery, and the negative to the safety ground pin of the shore cord. In a properly wired boat, the safety ground pin should return to the battery negative after first connecting at the AC panel. If the light burns bright and steady, there probably is a good grounding system. This is a good check to perform if a boat has an unknown maintenance history, has been rewired, or is being repaired after damage.



5. Using ordinary plug-in AC receptacle testers to check ground integrity

Ordinary plug-in AC receptacle testers are so sensitive that they will indicate a good ground even if the only connection is through a prop shaft or thru-hull fitting to water. A better way to test for ground integrity is to connect the shore cord to the boat and bring the shore plug back to a position near the electrical panel. With all on-board AC sources turned off, use an Ohm meter to check that the ground prong is solidly connected to the boat’s safety ground system. Check to the “U” ground at each receptacle by dragging around the shore cord end and meter to test at each receptacle.

Summary

Avoiding these deadly conditions will make your boating experience far more safe and pleasurable. Take time to check your boat’s electrical system and look for these conditions. Contact your local ABYC electrician.