March 2019 Newsletter

Text and photos by Steve D’Antonio © 2019

Photo Essay: Shore Power, are Fuses OK?

Over-current protection is among the most important features of any vessel’s electrical system; in simple terms it involves the use of the correct fuses and/or circuit breakers, in the right capacity, and installed in the right location.

In many cases fuses or circuit breakers can be used interchangeably. While fuses are often used, autopilots, shift/throttle controls and engine electronic control units (all are DC) for instance, are better served by circuit breakers, because they can be reset in the event of a troubleshooting because scenario, where they trip multiple times before the fault is found. If these utilize fuses, and your spare supply is limited, you could find yourself in a difficult situation.

Where shore power is concerned, ABYC Guidelines clearly mandate the use of “simultaneous trip” circuit breakers for primary supplies used in both 120-volt AC and 240-volt AC systems. For 120-volt AC systems, like the one shown in the accompanying image, both the “hot” (black) and the “neutral” (white) conductors must be protected. In this case, however, while both legs are protected, fuses have been used, thereby violating the “simultaneous trip” requirement of the Standard, which can only be achieved by a two pole, interlinked circuit breaker.

If fuses are used, and just one blows, onboard equipment could be damaged or a fire could ensue. Ultimately, while some exceptions exist, there’s no good reason to use fuses in shore power applications. For more on over-current protection, see this article.

Ask Steve

Steve,

Thanks for your many informative articles. I have two issues which you might comment upon.

1. Sympathetic vibration. The drive line is more or less in line, in that the shaft is easily turned by hand (Yanmar 6by2 – 260 in a Ranger 29). There are noticeable vibrations from 2300 – 2900 rpm. The dealer tells me it is a result of the horsepower (?), the builder says to check the alignment; but perhaps it is hull flex, doubtful if it is prop related as the prop is new (Acme). So to me the vibration is a bit of a mystery.

And…

2. The boat has 6 – GP31 AGM batteries. The charge voltage would seem to be 14.1 to 14.4 v. A recent conversation with the manufacturer (Deka – Penn) suggests charging at 14.4 would improve battery performance. However, the alternator charges at 13.9 and the solar panel is about the same. The charger-inverter is now set to 14.4. So in cruise mode the batteries will be undercharged. Is there a simple solution to this problem? I've thought it would be very convenient if there was a device through which all charging sources were directed that provided the desired charge voltage. Is there such a device?

Thanks for any comments you might offer.

Richard Baker

Richard:

Identification of vibration sources can be very challenging indeed. In spite of good intentions, unless those who are carrying out the analysis are trained in the proper procedures, a great deal of time, and money, can be wasted.

Counterintuitively, while misalignment can lead to other issues, because of its constant nature it rarely causes a vibration. Areas you might check, however, include motor mount adjustment and loading (if diagonally opposed mounts are in compression, and their mirror pair are in tension, it can set up a vibration), shaft centering (ensure the shaft is centered in the coupling) and propeller balance. Fully 30% of the *new* propellers I have tested are out of balance or otherwise not true. It's possible that in some cases, at a given rpm, even if nothing is specifically wrong, a sympathetic vibration can be established. This can be identified or narrowed down by hanging lead weights over the top of the engine; if, when doing so, the rpm at which the vibration occurs, changes, then it points toward the engine as the source, again even if nothing is wrong per se.

Where battery charging is concerned, I'm afraid no universal charge device exists. However, your alternator and solar panel output seem low, bulk charging can't occur at anything under about 14.2 volts. The solar panel regulator should provide a bulk charge voltage, if it isn't something is awry, I would contact the manufacturer for guidance. In spite of what AGM manufacturers may say, stock alternators are simply ill-suited to charging this type of battery. They require specific charge profiles that simply aren't produced by a standard, internally regulated (and typically non-adjustable) alternator. The only reliable way to provide them with what they need is by using a proprietary high output alternator and external regulator.

Hi Steve,

I did a reasonably decent job on lightning protection some years ago; I put on a real lightning rod on top the main mast and ran a heavy down conductor inside the hollow wooden mast, through the cabin top and down to the top of a keel bolt (holding lead outside ballast) near the front of the boat. Additionally, I installed some lightning arrestors, Delta LA302DC to protect the wires going up the mast to the various mast lights from induced currents. I also put these units on the wires that supply the basic electrical panel back aft. I have no idea whether these units have worked. At least we haven't had lightning damage.

Since that time, the boat was re-powered, now with a lovely Yanmar 4JH5E. It is a wonderful engine but it can be disabled because it needs electricity to run the fuel pump and I suspect it uses electricity for lots of other things too.

So, I called up the Delta company and they recommended the same unit, LA302DC for lightning protection. I'll buy a new one, unless you have a better idea.

Here is my question… Where should I attach the new lightning arrestor to protect the engine?

You can see from the wiring diagram below that my boat has three electrical systems

1. The starting battery. Interstate 12 volt marine cranking battery. It does nothing but starts the engine. It is charged via an echo charger.
2. There are two banks under the forward berths, Trojan T105 wet cells, each bank has two, 6-volt batteries in series. These banks take care of lighting, pumps, navigation, auto-pilot, etc.
3. Two 6 volt AGMs in series for the refrigerator.

There is a Dynaplate on the hull for a single sideband radio (no longer on the boat). My understanding is that these are no longer recommended for lighting dissipation. Maybe I should put on some sort of a bronze plate as a supplementary ground?

Ben Stavis

Ben:

I'm afraid I have no first-hand experience with the Delta surge protection products so I can't comment on their effectiveness. I did write an article on the subject of lightning protection for Professional BoatBuilder magazine , in which I detail the components of a lightning protection system, including the hull ground plate, you can access it on their website https://www.proboat.com/2016/04/3530/. Here's what I can say, lightning is unpredictable, there's no guarantee that any surge protector will work. However, in my experience, properly bonded vessels, those that comply, or mostly comply with ABYC chapter TE-4 Lightning Protection, tend to suffer less damage in the event of a direct or nearby strike, when compared with those that lack such a bonding systems.

Remember, the bonding wire attached to the engine, if present (and it should be) must be capable of carrying full short-circuit current, which means it must to be as large as the largest positive cable, i.e. the one connected to the starter. Therefore, the engine block has two paths to ground, one via the starting circuit and one via the block bond, and there may be another if the alternator uses an isolated ground. If the Delta product is designed to encompass this, you may need two or three of them.

Hi Steve,

Thanks again for your TrawlerForum issue response.

If you are interested, here is my scenario. I have a 44' ferro-cement trawler moored in fresh water at a yacht club with a galvanic isolator. The yacht club has a policy of "no swimming" and has been conducting AC leakage surveys on every boat in the moorage on an annual basis. This year they flagged my boat because I showed zero leakage, and that's because (drumroll) I don't have a bonding system, and I have no ties between the AC and DC grounds. FWIW, when I acquired the boat 15 years ago it came with an electrical analysis of the boat that had a schematic with bonding and measurements, so it was bonded at one time and then removed. Everything has been peachy since and I am reluctant to make major changes.

So, my analysis of this is that my boat – in its current state – does not present an AC hazard to a swimmer but could present a lethal hazard to someone on board **at the dock** if there was an AC fault and they short circuited between that piece of equipment and a grounded part of the boat (since it's essentially a metal boat, that's a very large ground). Am I correct?

Second, I acquired a number of years ago a 12KVA Charles Isolation Transformer that I <cough> never put into service. It's designed for 50A/240V, but can also function at 120V (obviously at 30A). My assumption is that if I install this piece of equipment I will eliminate the potential of that AC to DC short circuit **at the dock**. Am I correct?

Thank you,

Keith Pleas

Keith:

While your vessel is slightly out of the ordinary, ferro-cement hulls aren't terribly common, the bonding and grounding issues remain essentially the same as those found aboard a fiberglass vessel, with perhaps some exceptions, see below. In order to be ABYC compliant (these standards are, while highly desirable, voluntary) your DC negative, DC bonding, AC safety ground and bonding (if present, it’s optional as far as the voluntary Standards are concerned) systems must all be connected and remain at the same potential, and it sounds as if that’s not the case where your vessel is concerned.

There are several possible dangers when they are not common, the first being electrocution. If, for instance, a piece of hardware that’s not bonded, a fuel tank for instance, comes into contact with an energized shore power “hot” conductor, the black wire, it too will become energized, and will remain that way until the power is turned off or a path to ground is completed. In the latter case if that “path” is a person, who touches the energized component and something that is grounded, like the engine block or a seacock (since you say there is no connection between AC safety ground and DC negative aboard your boat, these are, or may be grounded via a water path), then that person may be shocked or electrocuted. Where bonding is present, this scenario is eliminated because the moment the hot wire makes contact with the tank or seacock, a path to its source is completed and the circuit breaker trips. Your non-bonded scenario also increases the likelihood of in-water electrocution, because AC current leaking into the water through a seacock or engine block that has become energized with AC power, will have a return path through the water. Furthermore, bonding systems mitigate both galvanic and stray current corrosion, a phenomenon I’ve explained in several articles on bonding systems, many of which are on my website, and sites of the magazines for which I’ve written, here’s one.

Isolating the AC safety ground and the vessel’s DC negative systems, and forgoing a bonding system all together, is risky at best, primarily because of the electrocution risk (especially in fresh water), and secondarily because of the potential for stray current and galvanic corrosion, not to mention lightning strike mitigation, a subject I recently covered in a column on Professional BoatBuilder's website.

Having said all that, I have very little familiarity with ferro-cement construction; there may be a reason why the bonding system was removed, again it's optional, while the DC negative to AC safety ground connection is not, if ABYC compliance is your goal. The reinforcement within the hull is presumably steel "rebar", and my assumption is you would want galvanic protection for it where it may be inadvertently exposed to water, but once again I have no experience with this construction method, so you may wish to consult with someone who does, before replacing the bonding system. Regardless, for safety sake, the DC negative and AC safety ground should be common. The AC safety ground and AC neutral conductors, on the other hand, must, with a few exceptions, never be connected aboard, I've written about that subject on several occasions as well, one article can be accessed on ProBoat's website here.

Finally, there's no reason not to use a high quality, ABYC compliant transformer such as the Charles unit you mentioned. If wired as an isolation transformer, it will safely sever the connection between shore and vessel ground, both AC and DC negative (the latter two must still be connected aboard), reducing the likelihood of in water electrocution as well as galvanic and externally induced stray current corrosion, and reverse polarity.

Ultimately, all of the vessel's wiring must be ABYC compliant. If you are unsure of how to go about this, if you are not an ABYC member and therefore have no access to the ABYC Standards, then I strongly recommend you either become a member and obtain access provided you have the skills to understand and implement the guidelines, or seek the assistance of an ABYC certified marine electrician. You can find one by searching here .