June 2021 Newsletter “AC Ground Wire Sizing”

From the Masthead

Let me begin by apologizing to Marine Systems Excellence readers for our hiatus. As most boat owners, and virtually anyone who is buying, selling, building or repairing vessels knows, the industry has been super-charged during COVID. As a result, I’ve been traveling extensively for the past 12 months, and even more so in the past three months, from Seattle, Boston and San Diego to Fort Lauderdale, Taiwan, Italy and Turkey, it’s been frenetic to say the least. I’m writing this column from Roche Harbor in the San Juan Islands, Washington, after completing a three day inspection on a newly refit 60 foot trawler.

While low inventory can be depressing for those searching for the perfect boat, I remain amazed at how many good examples continue to come on the market; they just don’t remain there for long. Therefore, if you are a buyer, while there are few bargains, don’t be discouraged. If you are selling, your timing is good.

Having said all that, if you are a buyer don’t let the frantic

market push you into buying the wrong vessel, and don’t let the time table or seller pressure you into cutting your due diligence corners. Lining up hull and engine surveyors (and consultants) can be challenging in these schedule-crunched times, however, they are necessary steps in avoiding post-signing surprises. Remember, every purchase should get a thorough review, including a 2-3 hour sea trial, as well as fluid analysis, which includes crankcase oil, transmission and hydraulic fluid, along with all coolant. You can find more on this subject in the following articles:

- The Art of the Engine Survey
- Trial by Water
- Selecting and Working with a Surveyor
- For Sale by Owner; Buyer Beware

We’ll be back next month with a feature article on the subject of engine room checks, until then I hope you find the Ask Steve and Photo Essay columns useful.

Photo Essay: AC Ground Wire Sizing


4AWG
ELECTRIC

The vast majority of onboard AC power circuits include at least three wires, a “hot”, sometimes referred to as “ungrounded”, which is usually black or red, a “neutral”, or “grounded” wire, which is white, and a safety ground, which green, and is more accurately referred to as a “grounding wire” because it normally carries no current, unless it is

actually *grounding* a fault.

In order for a grounding wire to be able to safely resolve or clear a fault (fault "clearing" occurs when the short safely causes a circuit breaker to trip), and to comply with ABYC Standards, it must be properly sized to carry the fault current. In the example shown here, which shows wiring associated with a generator, the largest hot or ungrounded wire is a #4, while the green safety ground is a #8; *two* sizes smaller than the ungrounded wire, which means it's under-sized and thus non-compliant. This wire should be the same size as the hot wire, or no more than one size smaller. The wire travels from the genset all the way to the main AC panel, a long and expensive run to replace.

In this case, the electrician undertaking the repair work later asked me if he could, "take a short cut", he'd found a more easily accessible route between the genset and the panel. I explained, unfortunately, yet another ABYC guideline requires that grounding and current-carrying wires, hots and neutrals, must all be run together, in the same bundle or sheath, for their entire length with the exception of short segments at the terminating ends.

Ask Steve

Steve,

After a lifetime of sailing, my wife and I purchased a trawler three years ago. It is a 1987 President 41, with twin turbocharged Lehmans. I discovered that the port fuel tank (200 gal. "black iron") is leaking. Can you suggest a contractor or boatyard that does fuel tank replacement? I believe that the job would involve cutting the tank up to remove and using multiple smaller tanks, but may require

engine removal as well.

The boat is in Newport News, VA so I would probably be limited to somewhere in the lower bay in looking for the right boatyard.

Thanks,

Ray Keffer

Dear Ray:

While I can't make specific recommendations for yards and contractors , I can offer some guidance on a project of this sort. Among other things, you should thoroughly vet any yard with careful research and questions.

- The yard you select should be a member of the American Boat and Yacht Council, and ideally have at least one certified member on staff (a "Systems" certification would be ideal). You can check membership status and certifications here.
- The yard should agree that the work they do will be ABYC compliant. This would include ABYC H-33 Diesel Fuel Systems, as well as any other systems and related standards that require disassembly and replacement, including P-1 Exhaust Systems, and E-11 AC and DC Electrical Systems.
- The yard should be willing to quote the project, or at the very least offer a firm estimate, with a range. Quotes and estimates should include all expenses, parts, shipping, taxes, fees etc.
- The material from which the tanks are fabricated, and its thickness, should comply with ABYC H-33.
- Tanks should include inspection ports into every baffled chamber.
- Metallic tanks should be elevated above the shelves on which they rest and tops should be sloped inboard to shed water.

You might find these articles useful…

- Working with the marine industry part I and part II
- Fuel Tank Installations
- Fuel System Plumbing

Hi Steve,

As an older guy who has been around aluminum commercial fishing vessels in Alaska since the early 60's, I cannot help but be impressed by the longevity of aluminum gillnetters built in the late 50's and 60's. So many are still around and very much a part of commercial fishing up here. I also spent time working at Bay Weld Boats in Homer Alaska and watched quite a number of new rugged aluminum boats go out the door with that wonderful unpainted shine along the hull.

The topic invariably comes up – why can't the industry figure out some way to restore some of that initial shine to hull plating without destroying the natural anti-oxidation properties that marine aluminum has? We all sort of understand why it hasn't happened – yet – but surely Alcoa and other industry players must have thought about this. It has generally been my experience that people who end up painting aluminum boats also end up regretting it – and the vinyls that grace some boats become graceless with a few scratches – and certainly not an option for work boats that bump things.

One time, I did take some 3D buffing compound and 7 inch polisher to an older (40 year) aluminum hull. It looked beautiful for about 24 hours. Then the luster faded quickly and I never knew why. I enjoy reading what you write on the net – and thought I would drop you this question.

Regards,

Mike Heimbuch

Mike:

Aluminum is in many ways an enigmatic alloy. It's among the least noble, only zinc and magnesium are more corrosion-prone. And yet, when uncoated it remains mostly corrosion-free year after year.

The phenomenon you experienced, the fading and surface "dusting" is in fact an aspect of what enables aluminum to resist corroding. As soon as aluminum is exposed to air it develops an extremely hard aluminum oxide coating, which stabilizes the surface. How hard is this coating? It's used to make sandpaper. If you clean it off as you did, it will quickly reacquire this "skin" as long as it's exposed to air. Polishing and waxing it will stave off this process for some time as polishing removes microscopic surface pits and leaves a hard, smooth surface, and the wax seals the aluminum, preventing the oxide from forming. As the wax wears away the aluminum will begin to lose its luster.

Aluminum runs into trouble when coated with paint. If, or when, water makes its way beneath the paint the aluminum remains wet, however, not having any access to air it cannot develop its tough oxide skin, at which point it begins suffer from what's known as poultice corrosion. It is for this reason that other than for cosmetic, or anti-fouling, purposes, aluminum is best left uncoated. More on aluminum corrosion here and on painting aluminum here.

Hi Steve,

We are starting to see marinas in our area install pedestals with quick tripping GFI's under NEC 555. It's going to be a hassle, I understand, for any boat operating an Inverter. So…

1) Am I correct in assuming that we needs 2 ELCI's for both fore and aft shore power receptacles (46 Ft apart; 20 Ft from

main panel)?

2) Would not a single *Isolation Transformer* do the job better and in lieu of an ELCI? If so, is installing it near the most often used shore power inlet sufficient?

Thanks.

Jon Peterson

Jon:

Many vessels are facing issues with use of dockside ground fault circuit breakers, not just those with inverters.

While there are a number of details, along with some exceptions, included in the ABYC E-11 Standard on this subject, generally speaking, in order to be compliant, you would need an ELCI to protect the vessel's shore power system. Here's what the standard says…

ABYC E-11.11.1: An Equipment Leakage Circuit Interrupter (ELCI) or Type A Residual Current Device (RCD) shall be installed with or in addition to the main shore power disconnect circuit breaker(s) or at the additional overcurrent protection [see below SDA] *as required by E-11.10.2.8.3 whichever is closer to the shore power connection.*

EXCEPTION: Installations where an isolation transformer is installed within 10 feet (3 m) of the shore power inlet or the electrical attachment point of a permanently installed shore power cord and supported according to 11.14.4.1.3

11.10.2.8.3 Additional Overcurrent Protection – If the location of the main shore power disconnect circuit breaker is in excess of 10 feet (three meters) from the shore power inlet or the electrical attachment point of a permanently installed shore power cord, additional fuses or circuit breakers shall be provided within 10 feet (three meters) of the inlet or attachment point to the electrical system of the boat.

Measurement is made along the conductors.

Thus, you would need an ELCI within 10 feet of each shore power inlet. Conversely, you could rely on a transformer, however, it too would need to be within 10 feet of each inlet in order to negate the need for an ELCI. But, if it had an ELCI it would be safer and very unlikely to trip unless there was a genuine fault.

If the transformer is in excess of 10 feet from the inlet, a circuit breaker and ELCI (or combined unit) is required within 10 feet (closer is better) of the shore power inlet. A single transformer can be used in the case where there are two inlets, assuming they cannot be used simultaneously. In that case the transformer is often centrally located, near the electrical panel, but that's not mandatory, and not necessarily an issue as voltage drop is not a serious problem with AC power. Power from the shore inlet would pass through a forward or aft ELCI. Using a transformer nearly always reduces the likelihood of dock or vessel RCD or ELCI tripping. However, a transformer should not be installed to mask a genuine onboard AC fault. Therefore, shore power leakage should be measured before a transformer is installed to determine if there is an issue, which should be corrected before a transformer is installed.

You might find these articles on the subject of transformers and electric shock drowning useful

- https://stevedmarineconsulting.com/wp-content/uploads/2019/12/ShorePowerTransformers181-04.pdf
- http://stevedmarineconsulting.com/wp-content/uploads/2014/03/DAntonio_WaterwayExplorerMag18.pdf

Hi Steve,

I plan to replace the raw water impeller on a Yanmar 4JH3,

after reading your Service Article about lubricating the impeller vanes, the O-ring, and shaft. Why not use a small amount of Marine Wheel Bearing Grease on all three components rather than Teflon for the 0-ring and soap for the impeller vanes?

Thank you,

Scott Thomas

Scott:

Generally speaking, it is frowned upon to use petroleum-based lubricants on rubber impellers and O rings, because of a potential for incompatibility, and resultant deterioration to those components. Having said that, if you lubed the impeller alone with wheel bearing grease, and then started and ran the engine immediately afterward, it’s probably not a technical issue, other than the fact that you might create a bit of an oil slick around the boat, and in the process incur the wrath of surrounding boat owners, marina operators or the Coast Guard/law enforcement folks.

Superlube Teflon is food-grade approved, so there’s no issues with it being pumped overboard in small amounts. You could use Superlube for all of these items, however, it is a bit messy, while the liquid dish soap is cleaner thanks to its water solubility.