PRACTICAL SOLUTIONS

Protecting Aluminum Appendages

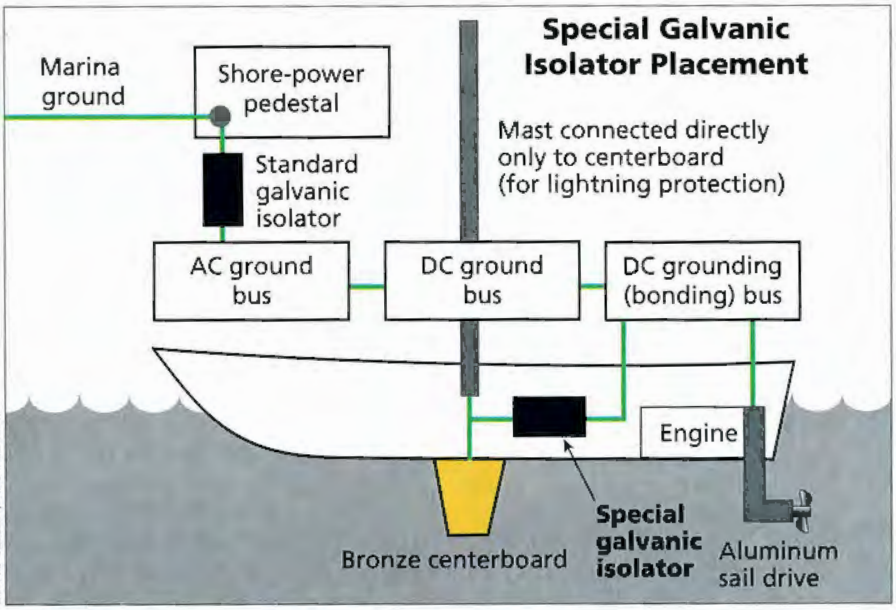
How to guard against galvanic corrosion between bonded components of dissimilar metals on the same hull.

Text by David Rifkin
Photographs by Dwight Escalera

Above—*A J/95 (31.2') in slings. Note the bronze centerboard and aluminum sail drive. Installing a special isolator can break the low-voltage "galvanic" circuit between the large cathodic centerboard and the small anodic sail drive.*

Most marine professionals are aware of the risks of plugging into AC shore power without some form of isolation between the marina and the boat's grounding system. Nowadays a galvanic isolator is installed in the grounding conductor ahead of its connection to the onboard AC grounding bus. The isolator breaks the low-voltage "galvanic" circuit that contributes to excessive deterioration of the sacrificial anode, which can leave a boat's underwater metals unprotected from corrosion. *[See* Professional BoatBuilder *No. 41, page 27, and No. 100, page 56—Ed.]*

While working on a case involving corrosion of an aluminum sail drive, I thought about the galvanic isolator's ability to provide protection not just for the whole boat from a marina grounding system, but also for components *within* the bonding system of the boat itself. This concept can apply to boats that have an aluminum appendage such as a sterndrive or swim platform bonded to more-cathodic metals such as an exposed lead keel.



DAVID RIFKIN, PBB REDRAW

A schematic showing how a special galvanic isolator might be inserted into a boat's grounding system. It's important that the DC ground bus not be connected directly to the mast, and that the centerboard and sail drive be kept electrically isolated—by the galvanic isolator.

In actuality, the application that prompted further development of the concept was a sailboat fitted with a bronze centerboard (think: large cathode) and an aluminum sail drive (think: relatively tiny sacrificial anode). Connecting these components together in a bonding system raises galvanic corrosion concerns, because bronze and aluminum are, after all, dissimilar metals making electrical contact in the same saltwater electrolyte.

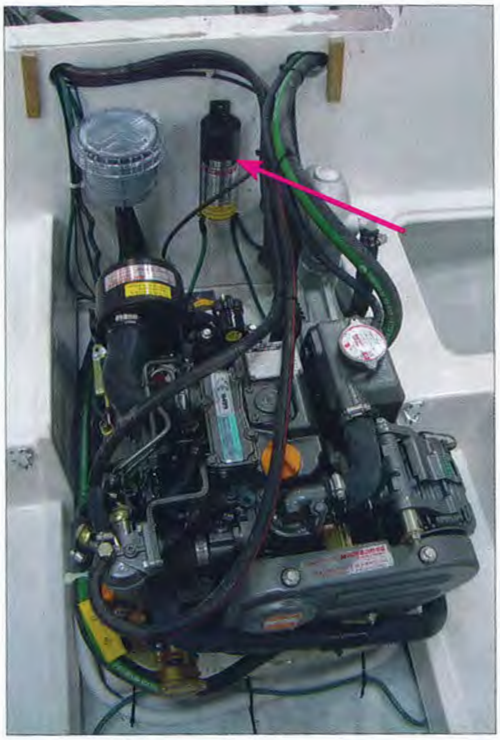
Although there are those in the industry who still contest the point, let's presume, for the purposes of our discussion, that it's a good idea to bond all of the boat's underwater metals together. The benefits of complete bonding include: *improved electrical safety*, by keeping the boat's metals at the same potential; *improved lightning safety*, by providing as many paths as possible to the water to minimize side flashes; and *reduced risk of stray-current corrosion*, by keeping all metals at the same potential, eliminating the water-path current essential to that phenomenon.

While bonding dissimilar metals together in a boat's electrical system is a commonly accepted practice, some problems become evident when you compare the materials and surface areas of all metals that need protection, to the size of the sacrificial anode(s) installed.

For instance, consider a sailboat with an aluminum sail drive. Let's say this boat also has an exposed lead keel, and that the coating on the lead is not complete, due to improper coating or grounding abrasion. Now take a look at the sacrificial protection provided for all these bonded underwater metals. For the type of sailboat in question it's usually a single ring anode that attaches to the sail drive forward of the propeller. That small anode is designed and installed to provide protection for the sail drive only. It is not sized to protect the lead keel, or any other underwater metal in the bonding system. It is predictably overwhelmed by the large galvanic load and quickly corrodes away, leaving the aluminum sail drive unprotected. Ultimately, the sail drive casing becomes the sacrificial anode for any other cathodic underwater metals connected to the bonding system—in this case, the lead keel.

A second real-life situation is a sailboat with an uncoated bronze retractable centerboard and an aluminum sail drive. The builder understands the safety advantages of bonding all the underwater metals, along with

A closer look at the uncoated centerboard and the sail drive on the J/95. The centerboard will be protected with its own sacrificial anode, so the sail drive's anode won't be burdened with the additional load of the centerboard.

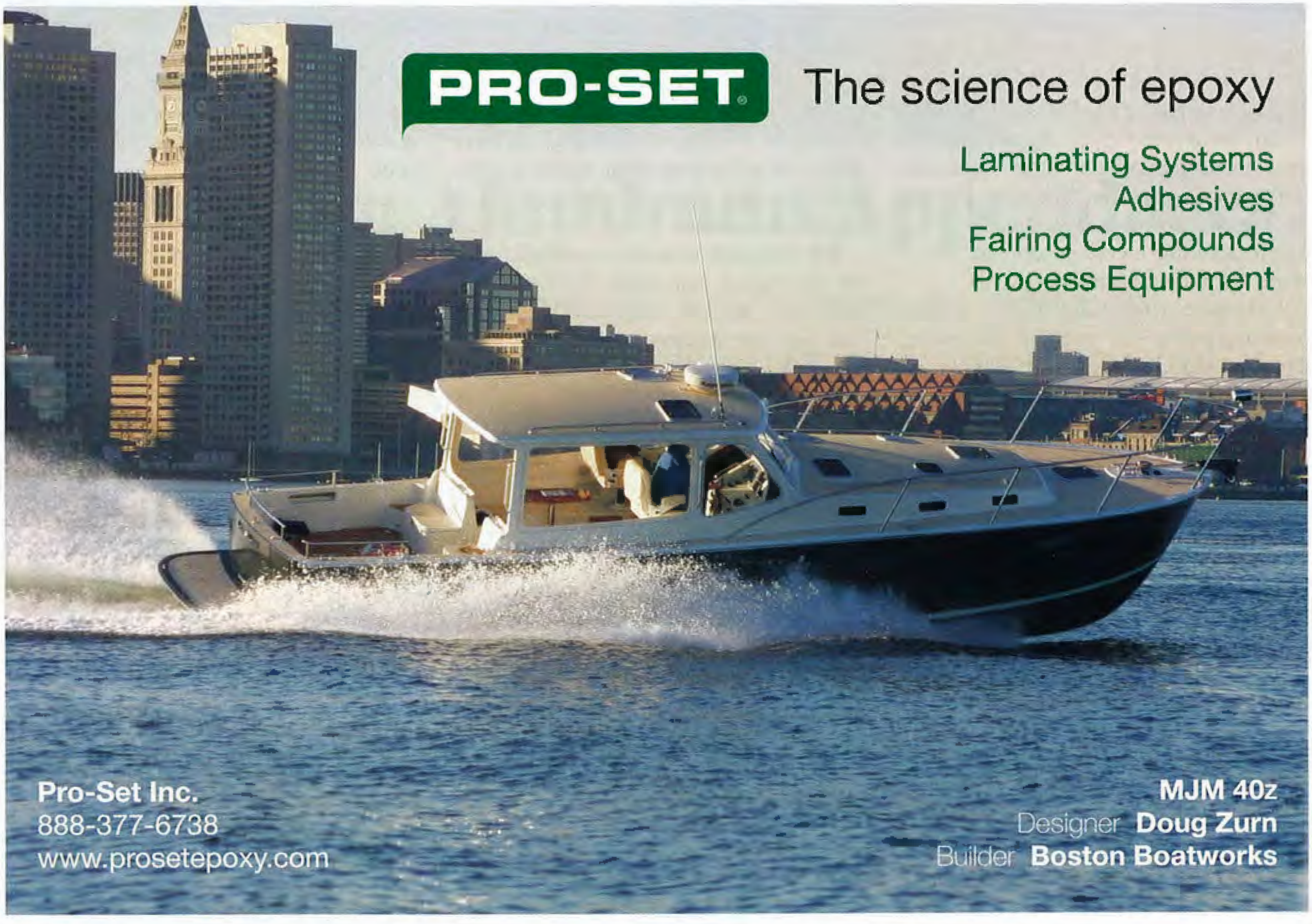


The boat's builder (C&C Fiberglass Components, Bristol, Rhode Island) mounted a standard fail-safe isolator (from Dairyland Electric, Stoughton, Wisconsin) in the engine compartment, where it is easily accessible for necessary periodic testing.

proper galvanic isolation from the shore grounding system. But again we find an unfavorable ratio between a large cathode and small anode. The solution is to break the galvanic bond between the centerboard and the sail drive on the boat itself. Simply install a properly rated galvanic isolator, preferably one that is considered "fail safe" by American Boat & Yacht Council standards, and has been tested to a commercial lightning standard. (Although not required under ABYC standards, some isolators *are* tested for lightning performance.)

This "special" galvanic isolator should be inserted electrically between the bonded components to isolate one from another. In the sailboat it would be installed in series with the bonding conductor, connecting the centerboard to the saildrive housing *(see illustration on the previous page)*.

Take care to ensure there are no other bonding conductors in parallel with the new isolator, since those would bypass the isolator and render it useless. To test for this possible failure, break the bonding system where you want to install the galvanic isolator. Then, if the boat is *out of the water*, measure for continuity between the two electrical connection points for the isolator. The meter should read "OL" (open circuit). If there *is* continuity, then the bonding



system must be modified to eliminate the parallel paths. Such troubleshooting can be avoided in a new-build. How? By giving thought to the bonding system design where this installation is an option.

For a boat *in the water*, the continuity test above may not be valid, since the water might carry enough current to show continuity. Instead, just measure DC voltage across the same gap. If there is a parallel bonding path, then the voltage will be 0.0VDC. If there is only a water path, the meter will read the voltage resulting from the actual galvanic potential difference of the metals connected to each side of the test points. For example, between a bronze centerboard and an aluminum sail drive, the voltage might be approximately 0.5VDC–0.7VDC, depending on several conditions, including: area of metal exposed, alloy composition, and condition of sacrificial anodes.

Some builders know, too, that adding sacrificial anodes to the hull will provide "help" for a sail drive anode. Another preventive option is to install a small impressed-current system to assist the small anodes on the aluminum drive. I recommend a hull potential monitor in any application where there's an aluminum appendage; it will warn the operator when an expensive drive system gets into what I call "the corrosion zone."

When corrosion protection is still needed for an item that is now galvanically isolated, consider local protection for that item. In the example cited above, the builder is installing a sacrificial anode directly to the bronze centerboard for its exclusive protection.

The fail-safe galvanic isolator (preferably rated and tested for lightning current) can be installed in locations other than the traditional ones, in order to improve protection against galvanic corrosion between bonded components of dissimilar metals on the same hull. Plan the design carefully to ensure that the bonding system wiring can support its use.

And don't forget to test all galvanic isolators: when they're installed; whenever lightning strikes close by; or at least once a year.

While there may be relatively few applications for the isolator I've described, you should consider installing it to minimize the likelihood of corrosion damage to expensive aluminum-housed equipment. PBB

About the Author: *Retired U.S. Navy captain David Rifkin is a marine corrosion/electrical consultant, and an instructor in corrosion and electrical certification courses for the American Boat & Yacht Council. He thanks Dwight Escalera for his photographic and technical contributions to this article.*