DIY-Boat.com

Issue #1 2008

DIY BOAT OWNER

THE MARINE MAINTENANCE MAGAZINE

THE BOTTOM LINE

Selecting Antifouling Paint

Spring Fitting Out Checklist
Non-Skid Deck Repairs
Diesel Injector Service
Bilge Pump Turn Ons
Software Showdown
Sterndrive Lube Job

vetus®

www.vetus.com

ELECTRIC AND HYDRAULIC
BOW THRUSTERS

Most boaters knows that bow and stern thrusters provide docking control and peace of mind in cross winds, cross currents and tight spots, but it's been a given that those professional and calm maneuvers are accompanied by a noise that sounds like a giant can-opener working on the hull. Not any more, as VETUS takes thrusters up several notches, with new six blade, super-quiet, propellers.

Working in close collaboration with the Maritime Institute of the Netherlands (MARIN), VETUS has optimized the performance of its new range of thruster props, for power output and low noise. Although it sounds mechanical, most of that noise is caused by cavitation, the formation and implosion of vacuum bubbles against the fast moving propeller blades. These new VETUS props have unique blade designs that greatly reduce that cavitation and the noise it creates.

NEW DESIGNS AND BENEFITS IN BOW AND STERN THRUSTERS

- Noise reduction by up to 50%
- More thrust per horse power of motor output
- Equal thrust, port and starboard
- Single props for short, easily-installed thruster tubes, and simple inspection, cleaning and maintenance.
- Six blade low noise props can be retrofitted to most existing VETUS thrusters.

VETUS AMERICA 7251 National Drive, Hanover MD 21076
Tel: 410-712-0740, Fax: 410-712-0985, email: sales-service@vetus.com
Web: WWW.VETUS.COM

vetus america - full ahead

DIY BOAT OWNER
THE MARINE MAINTENANCE MAGAZINE
#1 2008

COLUMNS

DEPARTMENTS

Edited by Jan Mundy

Salon or Saloon?

One of my pet peeves as editor of DIY is the use of "salon" and "saloon." Whenever I hear the word "saloon" I envision a drinking establishment in a classic Hollywood western. While a saloon ashore may be a Wild West bar, a boat's "salon" is the comfortable cabin amidships. Or is it?

A search on Google proves that these two words have gone amuck and are totally transposable. In support of "salon," I found descriptions from numerous builders that describe their boats. "Salon lounge converts into a double berth." "Spacious salon with enormous picture windows." "A canvas runner begins in the salon." "The salon and cabins are located aft of centerline, the most comfortable place in a boat." Even more definitive descriptions I found were, "On the port side of the salon, there is an honest-to-goodness sofa" and "Expansive salon/galley open to the aft cockpit."

Next, I typed in "saloon" and found just as many occurrences. "Combining the cockpit, saloon and galley on the same level." "On this boat, the saloon is shoved aft." "Spacious saloon area aft with the galley." "The galley is the central feature of the boat's main saloon. "Sail the boat from the comfort of the saloon." "Dinette in the saloon converts to a double bed at night."

Could it be that, over time, "salon" transgressed to the misnomer "saloon" to reflect the popular imbibing activity that occurs on many boats in the main cabin? Or perhaps the French word "salon" just seems too haughty?

Interesting to note that neither "salon" nor "saloon" is found in "The Oxford Companion to Ships and the Sea," which is my favorite reference for seafaring terms.

My vote is for "salon." Should you visit me, we'll likely have cocktails in the salon onboard the boat and may venture into a local "saloon" (drinking establishment) when ashore.

— Jan Mundy

Sourcing Responders

In the "View from the Stern," in DIY 2007-#4 issue, Roger Marshall says: "...then add suspenders to your safety belt by installing a radar responder." I'd be very interested in doing so but where do you purchase one and how much does it cost? It's not listed on West Marine, Defender, Consumers Marine, Furuno or Raymarine websites.

Roger Marshall replies: "There are two types of radar signal detectors. The C.A.R.D. (acronym for collision avoidance radar detector) is available at survivalsafety.com. This device sets off an alarm when painted with a radar signal up to 8 miles away and indicates the signal direction. The Ocean Sentry ARE from Pains Wessex (painswessex.com) provides an audible and visual warning that your boat is being painted by radar up to 12 miles away. It's equipped with an active radar enhancer, which amplifies an X-band radar pulse and transmits it back to the sender on the same frequency." [Ed: Both systems are described on page 133 of Roger's book, "Rough Weather Seamanship for Sail and Power," published by McGraw Hill.

Manifolds Revisited

In DIY 2007-#4 issue, there was a great DIY Projects article about manifolds (see "Buyer Alert: Manifolds, Risers and Elbows" on page 54) and a warning about the machined surfaces on new manifolds not being flat and true. I have had two boats with twin engines that both needed new manifold replacement.

The telltale sign that these manifolds needed attention was rust at the places where they connected to the risers and around the exhaust ports. These were freshwater boats so I was confident in the integrity of the core of the manifolds and risers. Instead of an expensive new replacement of both assemblies, I took them to a machine shop and had them "boiled" to debride the internal passages and then they were face milled about 1/16" on all machined surfaces. After a coat of paint, they were in perfect shape at a cost of $100 total. I replaced them with original gaskets and they worked great. That beats the daylights out of tons of cash for new ones that might leak.

Halsey Fields, Spring Lake, Michigan

Locking Nuts

On page 14 of DIY 2007-#4 issue, the top center photo caption reads: "The tension adjustment nut is not threaded tight to the fitting." This nut is a locknut having nothing to do with tensioning anything. I would agree that it should be locking the pelican hook but so should the nut in the second row left picture, which is also loose but according to the description is "well installed." Maybe next time you could make it a little clearer.

Franklin Beveridge, Pocasset, Massachusetts

Pat Kearns replies: You are quite right in your observations and my face is humbly red with editorial embarrassment. The nut should have been described as the locking nut for the pelican hook. In the lower left photo on the same page, the nut is best snugged against the hook. Thanks for the course correction.

Merc Anodes Notes

I recently received my first issue of DIY and feel that, as a result of the "Freshwater Anode Advisory" submitted by K. Spano (see the 2007-#4 issue, page 3), my subscription has already paid for itself.

For the last 20 years I boated on Lake Ontario and each year I dutifully replaced the anodes on my Alpha I sterndrive. In spite of this precaution, I still experienced pitting on the sterndrive and always wondered why this was so. On one of my boats, I even installed the MerCathode electronic system and, while it helped somewhat, I still was not satisfied with the degree of protection. Unlike Spano, I never pursued the matter further.

Checking the Alpha sterndrive service manual, I can find no mention of utilizing magnesium or aluminum anodes in freshwater. You would think that Mercury would bring this situation to an owner's attention, especially when you consider (as I recently found out) that Mercury offers aluminum anode kits as stock items for most of its sterndrives. In short, having read numerous boating magazines, repair manuals and user manuals over the years, this is the first time I have ever read about zinc anodes not being effective in freshwater. Thanks to DIY, come springtime my sterndrive will be treated to a set of aluminum anodes.

Bob Gerol, Jackson Heights, New York

How can you do a professional job without being a professional?

The truth is you can't. Not on the first job, maybe on the second or third though. By then, you are a pro anyway. The biggest difference between an amateur and a pro is the simple fact that the pro has actually done the job before. An amateur usually only does a project once for his/her own satisfaction and personal quality standard be it slack, sleaze or fanatical perfection. The amateur, also being at the same time a very understanding final customer, can talk himself into cutting corners. The pro however must meet a paying customer's expectations and absolutely without fail the paying customer is extremely picky. (Doesn't everyone want an excuse not to pay?) This commercial reality tends to drive up the pro's quality levels by strict Darwinian principles alone. There are rare meticulous amateurs who achieve high quality on a first time project but they will log three times the man hours on a first time project than the experienced pro and spend a lot of time fretting over what do to do next.

— Just the facts as observed by opinionated DIY columnist Nick Bailey after more than 30 years in the boat repair business.

Chasing Horses

Q: We have a 1986 Sea Ray 270 with twin OMC Cobra 4.3 liter 175 hp engines, two-barrel carburetors and 15" by 17" aluminum propellers. The engines were rebuilt last year. The fuel economy and performance seems to be deficient based on side-by-side comparisons with a friend's identical boat powered with 4.3 Mercruisers with four-barrel carbs and stainless 15" by 19" props. This boat runs faster and at lower rpm and after a five-hour run at about 22 knots and 3,350 rpm used less fuel. Both boats are loaded approximately the same. Our boat's wide-open throttle is 4,200 rpm. We could purchase a four-barrel manifold, carburetor and camshaft to increase horsepower but what is the impact on fuel economy, performance and engine life span? Will stainless props have any effect on fuel economy? Any other suggestions to boost performance and/or fuel economy?

David Bryan, Thunder Bay, Ontario

Mercury Marine

Switching to a modern propeller can boosts fuel economy at cruising speed.

A: Although your engines and boat are similar to your friend's boat, there are many factors that can affect overall performance, such as gear ratio, propeller pitch, diameter, design and number of blades, the boat's center of gravity and overall weight. My information indicates that a two-barrel carb 4.3 175 hp consumes about 8.4 gallons per hour (31.8L) at 3,500 rpm and a 4.3 205-hp four-barrel model consumes about 7.2 gallons per hour (27.3L) at 3,500 rpm. You could add four-barrel carbs and intakes etc., to your existing engines at a cost of around $4,000 (equates to 1,000 gallons/3,785L of gasoline) but that does not guarantee an improvement in fuel economy. Your friend's boat has 60 more horses or 20% more power, which means it can turn higher pitch props, the reason why it's faster in miles per hour at the same rpm. Your boat is running close to spec except your wide-open throttle rpm is a little low. I would be looking at purchasing modern propellers that will likely give you better fuel economy at cruising speed at a much lower cost. Two propellers you could try are the Mercury Alpha Four and the Mercury Enertia. The Alpha Four is an aluminum four blade designed to keep a boat on plane at lower speeds than a conventional three-blade aluminum propeller. The Enertia is a stainless steel alloy three-blade prop that offers superior low speed planing and acceleration. There are also other propeller companies with similar style propellers and it's best to try a few to see which one works best for your boat. You may want to experiment with 15" and 16" props to get the maximum rpm closer to specification but reducing the pitch may hurt your top-end speed. There are also other processes and devices that can be used to tweak your boat's performance and fuel efficiency. A major tune up and bigger trim tabs often help fuel economy when running at slower speeds. Be sure that the engine compartment is getting lots of fresh air and check that the air inlet hoses are not plugged with seawater thus restricting the airflow to the engine. If you boat in freshwater, have your technician verify the jetting in the carburetor is correct for the altitude that your boat is normally operated. On long trips, try to keep extra gear as close as possible to the middle of the hull's centerline and balance the weight from side to side. Any of the above helps to raise the maximum rpm and that improves your fuel economy and overall speed.

— Steve Auger

Flushing Needs

Q: I have an old Volvo Penta MD5A saildrive that ran great until recently. After 15 minutes of operating at a faster than normal speed, the temperature light came on. I've since checked the alarm wiring and changed the water pump impeller, which looked okay. Now, when running at high rpm, the alarm sounds after about 15 minutes. I shift into neutral and the alarm stops soon thereafter. The engine continues to run at low rpm without sounding the alarm. I suspect the water flow is restricted, reducing full cooling at higher rpm. The engine has been professionally tuned two of the last four years and I've been doing the basic maintenance, adopting the "don't mess with what is working" approach.

Graham Collins, Halifax, Nova Scotia

Jan Mundy

Add a laser pyrometer to your toolbox to check engine cooling systems and read surface temperatures before applying coatings.

A: Two problems come to mind: the point of union where seawater enters the exhaust elbow might be rust clogged; or the bypass thermostat may be sticking and/or malfunctioning. A good flushing is in order. There are many brands of cooling system cleaning fluids and most are dreadfully toxic. Isolate your cooling system by removing the seawater inlet and the exhaust union for seawater and make a "bucket" loop so the fluid goes through the engine and back into the bucket. Do not use a galvanized bucket as it can corrode during this process, carrying those residues with the water. During this process, you must supply the exhaust system with cooling water from a dependable source, typically, a water hose at low pressure, to put cooling water into the exhaust riser or elbow at the point where you removed the hose

to put flushing water into the bucket. This keeps the exhaust cool while you warm up and flush the engine. You have bypassed the riser/elbow but that can be visually inspected once off the engine. Let the cleaning fluid get very warm (170F/76.6C). This may take some time. When finished, seal the cooling system with a winterizing coolant. Do not leave out the engine drain plug or petcock for any period of time as the screw threads degrade very quickly and the petcock will not reseat. A very good tool to have for about $30 is an infrared laser pyrometer, available at auto parts stores (Princess Auto in Canada). Point the laser at various cooling system components and note the readings. Consistently even temperature readings are the clue to proper water blending.
— Randy Renn

The Bottom Line

Q: My sister has an aluminum houseboat on a freshwater lake. In addition to new bottom paint, the local marina wants to replace the barrier coat below the waterline to the tune of $10,000. What's the purpose of a barrier coat on an aluminum hull?
Darrell Gentry, Independence, Kansas

A: According to Jim Seidel, assistant marketing manager for Interlux, a barrier coat (anticorrosive primer) on aluminum hulls is applied to protect the metal from corrosion. There are several reasons to use anticorrosive primers on aluminum in freshwater. If the original primer is epoxy and in good shape and was applied properly initially, there's no need to replace it, although you may need to add to it or repair areas that were scraped or damaged. If the barrier coat was a single-part primer, such as zinc chromate or Primocon, and the marina is sandblasting the bottom then obviously, this demands replacing the barrier coat/primer. There are many reasons a yard recommends returning the hull to bare metal, including the need to make a bunch of money, but such yards usually don't stay in business for long. Below are some questions you might want to ask before she commits. Why is she replacing the bottom paint? Is it time for a new coat or is it peeling off? Can you see bare metal? Are there signs of corrosion? What paint was on the bottom? Is it compatible with the new paint the yard wants to apply?

Leak Enigma

Q: I have owned my 1986 17' center-console Aquasport for five years. After a full day of fishing and cruising there is a gallon or two of water in the bilge. I have caulked under the rubrail and removed the thru-hull fitting for the livewell and recaulked. With the boat on its trailer, I have looked at the hull for cracks and big gouges and there are a few but nothing that looks like a leak point. The 800-gph bilge pump can keep up with the leak but where do you think it's coming from?
Mike Mangham, "Snapperwhipper," Miami Shores, Florida

A: I presume that your Aquasport is outboard powered so that eliminates the possibility of a leak in the U-joint or shift cable bellows making its way through the sterndrive transom assem-

bly. I am also going to presume that the boat is high and dry on a trailer when not in use and that water does not get into the bilge when the boat is on the trailer. Otherwise, you could check to see if it leaks at the same rate whether sitting idle or running. This would help indicate if the leak is through the hull below the stationary waterline or a dynamic or "splash" related leak, such as you might get from a leaky rubrail. Presuming this is a constant leak the source is almost always related to some fitting below the waterline that penetrates the hull. You have already caulked the livewell thru-hull but you should look carefully at any other below-waterline fittings. The transom drain plug assembly is always a prime suspect as are any parts of the outboard mounting that are below the waterline or any fasteners on the transom for transducers or trim tabs etc. On a double skin, such as found at the transom, the leaks can be quite deceptive. Water enters at any penetration through the outer skin but seeps through the inner skin at a completely different location. This brings forward the question of water entering and saturating any core that may exist between the skins, especially in the transom. You would be wise to get a repair shop or surveyor to check the transom with a moisture meter for a wet core. The wet core (usually plywood) becomes a problem when the wood starts to deteriorate but that can take a long time to develop.
— Nick Bailey

Drying Timeline

Q: How long does it take a boat to dry out on the hard without heaters and fans?
Byron Rountree, Woodlands, Texas

A: Unfortunately, when it comes to the process of drying out a hull, every boat is different. It depends on the moisture content of the hull and laminate characteristics, such as thickness and resin type, as well as the laminate condition, i.e. the severity and extent of any hydrolysis etc. Whether or not the bottom coatings have been removed or the gelcoat has been peeled to expose the laminate, as is usually done at the beginning of an osmosis repair, also makes a big difference as does the temperature


Jan Mundy

Peeling off the gelcoat to expose the laminate helps to accelerate hull drying.

and relative humidity of the ambient air. Hotter and dryer is better.

If the hull has a thick laminate that is pegging the moisture meter, drying can take many months leading into a year or even two. You eventually reach a point of diminishing returns where the rate of drying becomes very slow. In my professional experience, I have never waited long enough to see exactly the same moisture meter reading above and below the waterline. Talk to a surveyor or repair shop to see what moisture levels they would consider acceptable for your boat. The only really effective method I know of to force the drying process is the HotVac system (hotvac.com) of heated vacuum blankets. This method can dry most hulls in a few weeks but it is expensive to hire the equipment.
— Nick Bailey

Awlgrip Overhaul

Q: My 20' (6m) Limestone was in freshwater for nine weeks this past summer. On hauling the boat, I discovered tiny white lumps on various sections below the waterline but not on any vertical areas, such as the transom. Initially, these lumps, about 1/32" (.08mm) high, seemed as if they were part of the Awlgrip paint system but they disappeared after one week on the trailer so I assume they were residues left from zebra mussels. Also, the in-water surfaces of the Awlgrip finish have a faint yellow discoloration, more pronounced on the transom. Is there any way to remove this? There are also some chips that need repair.
Rod Sumner, Niagara Falls, Ontario

A: It is possible that you have moisture below the gelcoat (osmosis); suggest

DIY BOAT OWNER
THE MARINE MAINTENANCE MAGAZINE

DIY Boat Owner™
The Marine Maintenance Magazine™
P.O. Box 22473
Alexandria, VA 22304

Publisher: Michael G. Sciulla

Executive Editor: Elaine Dickinson

Editor: Jan Mundy

Associate Publisher: Steve Kalman

Technical Editor: Patricia Kearns

Circulation: Susan Clark

Designer & Illustrator: Joe VanVeenen

Cover Photo by: Jan Mundy

Contributors:
David and Zora Aiken, Steve Auger, Nick Bailey, Garrett Lambert, Roger Marshall, John Meskauskas, John Payne, Zuzana Prochazka, Randy Renn, Paul and Sheryl Shard.

Director of Advertising:
Steve Kalman
888/658-BOAT (2628)
e-mail: stevek@diy-boat.com

REQUEST A MEDIA KIT
www.diy-boat.com

Subscription Inquiries:
Call 888/658-BOAT (2628)
weekdays 8am to 6pm EST or log onto DIY ONLINE @ www.diy-boat.com

Subscription Rates:

1 year (4 issues)	$25
Canadian residents	add $5
Foreign residents	add $25
EZINE (web version) 1 year	$15

Payable in U.S. Funds only

DIY Boat Owner™ and The Marine Maintenance Magazine™ are registered trademarks. DIY Boat Owner is published quarterly. ISSN 1201-5598

Periodicals pending postage paid at Alexandria, VA, and additional mailing offices. POSTMASTER: Send change of address to DIY Boat Owner, P.O. Box 22473, Alexandria, VA 22304.
PRINTED IN USA

MEMBER ABYC Setting Standards for Safer Boating
WE FOLLOW BWI'S ETHICS GUIDELINES

Jan Mundy

Handy Prevail sprayer, available from many home and hardware stores, is ideal for paint or gelcoat spray touch-ups.

that you have the hull metered with a moisture meter. To remove the discoloration apply 3M Finesse-it-II or other very mild compound using a yellow wool pad on a dual-action polisher/sander (buffer) running at 1,500 rpm. To repair the paint chips, grind the chips using a rotary tool (Dremel) and a grinding bit. Feather the edges. Fill with a two-part polyester or vinylester filler (e.g., 3M Premium filler). Don't use automotive filler or other single part filler. Purchase a quart kit of the matching Awlgrip paint and apply using a Prevail sprayer. See awlgrip.com for mixing instructions. After full cure, wet sand with 1,500-grit paper and buff out.

— Jan Mundy

Pumping Action

Q: The accumulator tank on the domestic water system of my 42' (12.8m) Carver boat has failed. The boat has seven water fixtures. I am looking at the new variable speed water pumps. Can you tell me if they actually maintain even water pressure and temperature or is it possible that I need to replace the accumulator tank.

Dave Torelli, West Grove, Pennsylvania

A: I see no reason to disbelieve Jabsco's claims about its new Sensor Max variable speed pumps. When the old style diaphragm pumps were used, the accumulator was designed to damp out pulsation as well as preserve the extra pressure needed in a multifixture system. These new multilobe pumps are, by nature, much smoother and the variable speed units are capable of picking up the pressure in a multifixture water system as needed without resorting to accumulators. I have never seen any claims about maintaining even water temperature, however. That is more a function of the faucet or mixer design, such as the anti-temperature shock system used in most Moen shower mixers.

— Nick Bailey

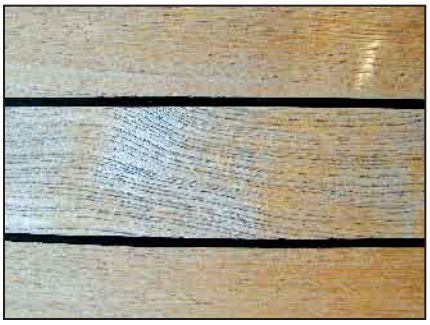
Jan Mundy

Quiet running variable speed water pressure pump ramps up to meet the water demand so you can shower and do dishes concurrently.

Renewing Teak

Q: My trawler's teak deck has grayed. I would like to refinish it without sanding. On the aft hatch, I used chemical cleaner and then teak oil. It looked very nice for a couple of weeks now it looks like the rest of my deck, which has prompted many questions. Are chemical cleaners worth using or do I need to sand? Can I apply Cetol or does it cause slippery decks? If I use teak oil, is the secret to apply it frequently, perhaps monthly? Or should I overcoat the teak with a deck coating like Durabak?

David Hart, Pulaski, New York



Jan Mundy

Using acid cleaners and harsh scrubbing has raised the soft grain in this one-year old teak deck. The only remedy is to sand.

A: The use of chemical cleaners depends on the condition of the teak. If the soft grain has been raised and formed deep grooves in the boards, then you'll need to sand. Use a belt sander or do it by hand with 100-grit wet sandpaper. Sand only until the gray in the little grooves becomes visible. This way you remove as little wood as possible. If this lower grain is still black from pollutants instead of light gray, a light bleaching with oxalic acid should return the wood to an even light tan color. Avoid the use of harsh acid cleaners, which overtime softens the polysulfide seam caulking. I prefer the single part to the two-part products. One of the most effective cleaners with the added benefit of ease-of-use and non-toxic so it doesn't harm other surfaces is Interlux Premium Teak Restorer. Soak the teak, apply the restorer, wait 10 to 15 minutes, scrub across the grain with a soft bristle brush and rinse off. Another excellent product is Amazon Teak Prep.

Just oil the decks or you'll have a skating rink. Interlux Teak Oil is easy to apply using a sponge or cloth. As a rule, oils require reapplication about every six weeks in Florida, two to three months in northern areas, and more frequently depending on the product used. Never apply an oil that darkens the deck and makes it too hot in summer.

If you're in saltwater, leave the decks bare and a weekly soaking with saltwater maintains the teak. The all-around most satisfactory way of maintaining bare teak if you don't mind some graying is a scrubbing with warm salt water, some dish soap and a pot scrubber. Scrub in a circular or across the grain motion. Try to minimize scrubbing with the grain as the pot scrubber can also press into the softer wood fibers and scratch it out a little. With this method, you should be able to go five years with only slight grooves developing in your edge grain deck or brightwork.

The regular use of saltwater is critical to the maintenance of scrubbed decks. The salt left on the wood attracts moisture and holds it there. Wet or damp wood resists checking and cracking because it doesn't shrink and swell as much. The salt soaks into the soft grain, dries and toughens the wood so that regular wear is kept to an absolute minimum. Finally, salt is a preservative that preserves wood. The best time to wash down with saltwater is just before dark so the decks and bare wood can absorb moisture all night long. Try to wash the boat with saltwater at least once a week.

Durabak (durabakcompany.com) is a premixed polyurethane coating containing specially treated rubber granules that offer excellent slip protection and great traction. It bonds to properly prepared surfaces; typically, a heavy sanding followed by a xylene clean-up. The problem painting teak decks is the flexible bedding/seam compound so overcoating is not recommended.

— Jan Mundy

Appraising Tank Materials

Q: I am refitting my trawler with new diesel fuel tanks and need an opinion on the merits of aluminum versus poly tanks.

Pete Butorac, Peterborough, Ontario

A: In my opinion "xpoly" (a.k.a. cross-linked polyethylene) is by far the best tank material to choose. Such tanks are very durable but most important they are immune to corrosion. Stock

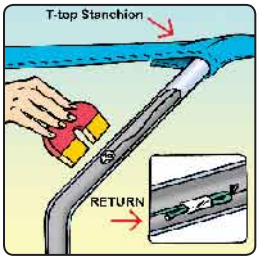
tanks are available in a wide array of shapes and sizes from any marine service yard with a good parts department. They are a special order item so you may have to wait several weeks for delivery. Gasoline fuel tanks, metal or poly, produced for recreational marine applications must be certified as meeting the USCG requirements for fuel tanks so this rules out custom-made, one-off tanks. Diesel fuel is much less volatile so U.S. and Canadian law does not require diesel tanks to be certified. It is legal (perhaps not prudent) to custom make a one-off diesel tank in aluminum, stainless steel or xpoly. The custom option may be preferred if you can't find the perfect size in a stock tank but make sure your custom tank, regardless of material, is built and installed to comply with ABYC recommendations.

— Nick Bailey

Ideal Attraction

Q: I am installing electronics in a new 29 Hydra-Sport CC and need to snake wires through the aluminum T-top stanchions for the GPS and radar; however, getting the metal snake to make two turns is impossible. I was considering using magnets to snake a line instead of using the steel 1/8" (3mm) wide snake. I do not want to drill any holes into the stanchions. Is there is an easier way?

Michael Bentivegna, Iselin, New Jersey



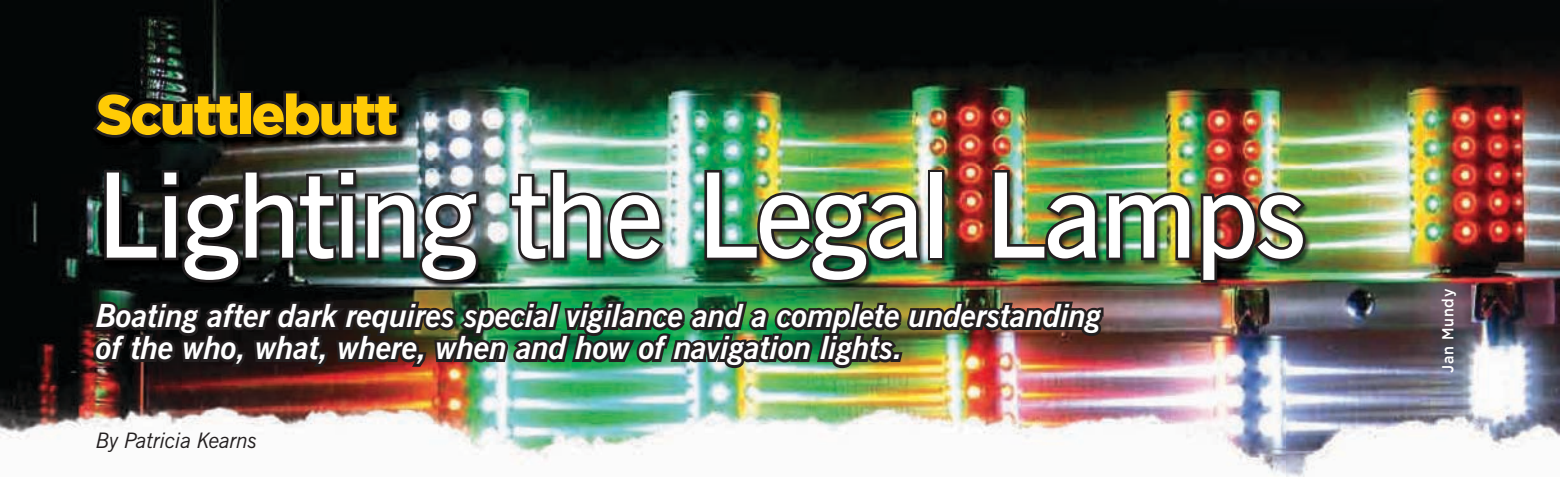
Sacha

A: Fishing wires through inaccessible locations is what makes boat-wiring jobs so much fun. The magnet idea is unconventional but it may work. Tie a heavy thread or monofilament line to the largest mild steel nut that will easily slide through the tubing. Use the biggest magnet you can find to drag it through. To finish, tie the monofilament to a heavier messenger line and use that to drag the wire back through again. Another method is to use two snakes coming from each end so that they meet in the middle at that insurmountable second bend. The first snake should have a hooked end; the second should carry the messenger line. With some luck and perseverance you should be able to snag the messenger line and using the first snake pull the slack tail of the line forward, past the second snake it is attached to and out the other end.

— Nick Bailey

Sacha

Lighting the Legal Lamps



Jan Mundy

Boating after dark requires special vigilance and a complete understanding of the who, what, where, when and how of navigation lights.

By Patricia Kearns

My reaction to a statement that I recently read in a marine surveyor's report was close to that of the bull in the ring when the red cape is waved in his face. "Found: No navigation lights. Recommend: Install navigation lights as required by the USCG." Good idea? Absolutely. Requirement? Only for boat operators, not builders.

It's a common misconception and even some of my surveyor colleagues state it incorrectly in their well-intentioned zeal for the importance of having and using navigation lights. The recommendation is a good directive but the author anchored his opinion by citing a federal boat building requirement that doesn't exist. The U.S. Coast Guard (USCG) doesn't require that a boat be built with navigation lights, but if your boat doesn't have them, don't be caught operating the boat during the hours from dusk to dawn (and other periods of limited visibility).

The bottom line is that the boat operator has the burden of responsibility to ensure the installation, proper display and illumination of navigation lights on any vessel operated during the times lighting is required. The fault for not having lights on a boat does not fall to the boat builder. If you don't have lights on your boat and you don't operate it during those times when they are mandated, you're home free without any lights. Have a nighttime accident and it's all your fault unless you have an extremely clever lawyer defending you for missing, misplaced or inoperative navigation lights.

(Visit uscgboating.org/safety/fedreqs/equ_nav.htm for navigation light descriptions and graphics per the Federal Requirements for Recreational Boats.)

Fiction and the Facts

Typically, navigation lights are installed on boats that are likely to be operated between sunset and sunrise and other periods of reduced visibility. They are installed because boat builders know that most boaters want them and, in fact, expect them to be installed.

If nav lights are not a federal boat construction requirement, where is the rule you must use them? For recreational boats, it all began with the Motorboat Act of 1940 that required boaters carry certain items onboard vessels operating on U.S. navigable waters and these include lights, bells and whistles, flame arrestors, fire-fighting equipment and other safety gear. From 1940 until 1971, all rules and the responsibility for their observance were imposed on boat operators, not boat builders. Things changed in the U.S. when the Federal Boat Safety Act of 1971 handed the USCG the authority to regulate the boat manufacturer.

Rules Not Made to be Broken

USCG Navigation Rules, International-Inland, specify lighting requirements for every description of watercraft measuring less than 65.5' (20m) in length. These rules are further defined for power-driven vessels and sailing vessels. Remember that a sailing vessel becomes a power-driven vessel as soon as it is propelled in whole or part by an engine (inboard or outboard). Even a "vessel under oars" is addressed in the Rules, along with other requirements for all boats at anchor or with restricted maneuverability or engaged in diving or fishing operations.

If your boat has manufacturer-installed lights, should you presume that they comply? Most builder-installed lights meet the standard but no matter what the builder has done, you, the boat's operator, are still the person who is required to display complying lights, although the builder would probably be in the line of liability if the issue of compliance came under legal scrutiny.

Since the onus of compliance is on the boat's operator, it's wise to personally affirm that your boat's light arrangement, installation and fixtures meet the applicable requirements and always remember that these requirements are the minimum for compliance. You can go bigger and brighter in the pursuit of good, better, best.

The Right Stuff

When installing new or replacement lights, you must select light fixtures that are certified as an approved type. As of November 1, 2003, boat builders must use certified lights if factory installed. Such navigation lights are now labeled as meeting the requirements of ABYC Standard A-16 or an equivalent standard. The current standards apply only to electric lights and today's fixtures and lamps are manufactured to precise visibility specifications. Most simply have a label that says "USCG 1 nm" or "USCG 2 nm," meaning they are visible at 1 nautical mile or 2 nautical miles.

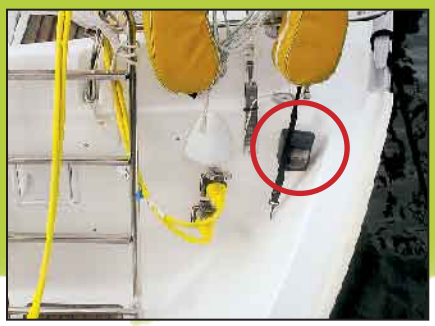
Modern LED technology has reached navigation lamps on a parallel with automotive trends and these are fast becoming the lamp of choice.

Properly displayed lights tell us which direction the boat is traveling, whether it is under power or sail and its angle of approach in a meeting situation.

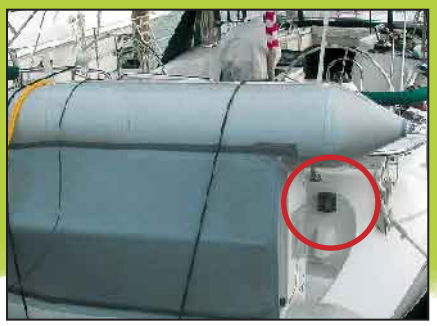
The most common violation concerning navigation lights is improper positioning of the lights. These are lights that are obscured by the boat's structure or by other gear onboard. All-around white lights or the individual bow and stern facing white lights must be visible for the full 360-degree arc surrounding the boat and require a vertical separation between the sidelights and masthead or all-around white lights. This means the all-around white light or the single fixture white forward facing light must be at least 39.3" (1m) higher than the sidelights. Make sure the sidelights are installed with red on left (port) and green on right (starboard).

Sailors have a propensity to illuminate both the tri-color masthead light and the

Photos by Pat Kearns



This modern sailboat stern integrates lots of handy features but the stern light placement hasn't been given its due respect and can easily be obscured.



Unless the dinghy is always towed between dusk and dawn, there's a good chance the stern light will never be seen. The boat's name and hailport markings are invisible as well.

Light locations don't comply with the rules for the required minimum vertical separation of sidelights (center) from the forward facing white light (left of center). The white light must be at least 39.3" (1m) above the sidelights.

side, bow and stern lights when underway under sail alone. It's a one or the other choice; displaying both is never a legal option. Displaying the tri-color when a sailboat is underway under auxiliary power (or power and sails) is just as much a lawbreaker.

Important to note as well, the navigation rules also say it is illegal for any light to create glare that diminishes the safe operation of the vessel. While this is difficult to enforce, glare is the cause of numerous nighttime collisions, according to insurance records. The all-around white light particularly should have shields to prevent glare for the helmsman.

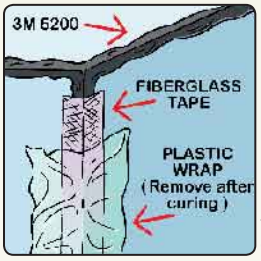
Your assignment now is to visit your boat some evening or early morning, light the lamps and make sure you are being seen out there as you should be and that the light arrangement and fixtures on your boat are in compliance with the requirements for navigation lights. The cause for preventing collisions at sea is a global quest and your navigation lights play an important role in that effort. The lights speak volumes to those who see them and who want their lights to be seen.

About the author: DIY's technical editor, Patricia Kearns, is a NAMS certified marine surveyor and operates Recreational Marine Experts Group, a marine surveying and consulting firm based in Naples, Florida.

Tech Tips

Homemade Fuel Catcher: Capturing spilled fuel from the fuel tank vent fitting during an accidental tank overfill could keep you from suffering a big fine and causing environmental damage. To make a fuel spill catcher (a.k.a. a fine and pollution avoider), take a large plastic jug, cut as shown in the photo so it "hooks" under the vent, use sealant to attach a large suction cup to the jug's inside surface and attach a short line to the jug handle.
Warren Milberg, "CrewZen," Annandale, Virginia

Low-cost Tank Patch: When both 25-year-old, 150-gallon (568L) forward and aft stainless-steel water tanks experienced leaks 10 years ago, I drained the tanks and removed them from their mounts to gain access to all seams. I spread 3M 5200, at least 1/16" (1.5mm) thick and 2" (50mm) wide, on all exterior tank seams, followed by clean and dry 4" (101mm) wide fiberglass tape and covered the tape with plastic wrap. Using a small roller or just pressing by hand, I worked the adhesive sealant through the fiberglass tape and let cure, then removed the wrap. This created a permanent watertight patch and leak-free tanks. [Ed: An acceptable fix for water tanks, never consider it as adequate for fuel or sewage.]



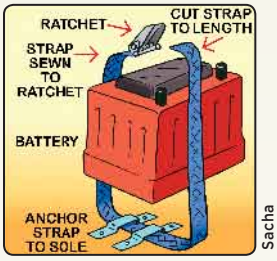
Tom Luke, "Bella Nova", Sturgeon Bay, WI

Protective Band-Aids: To prevent snagging skin or apparel dab a blob of clear silicone on all exposed screw tips, overlong bolts and cotter pin ends.

Stocking Dusters: To remove fiberglass grinding or drilling dust from bare skin, wipe with a nylon stocking, and then rinse with cold water, never hot, which opens up the pores.

Sourcing Leaks Ashore: If your boat takes on water while on the trailer, it is likely that rainwater or washdown water is leaking from either a deteriorated hose connected to a drain fitting in the deck or a leaking deck fitting or an ungasketed or poorly sealed deck hatch.
Patricia Kearns, Naples, Florida

Beefy Battery Bands: Replace a common battery box tie-down with one that is easy to adjust and release. Purchase a $3 ratchet tie-down strap (e.g., Harbor Freight item 47708-5 VGA or Princess Auto item 8002102), cut the short strap off the ratchet, cut the hook off the long strap, sew or tie the long strap to the ratchet, wrap it around the battery, cut to length and secure.

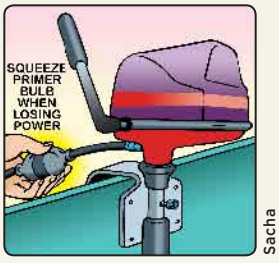


Tim Nye, "Sea Rose," Hamilton, Ontario

Aesthetically Bronze: To remove the green patinas on weathered bronze hardware, first polish with your favorite metal polish and then apply a clear coat to maintain a shiny finish.

Metal Draw: When drilling through metal apply wheel-bearing grease to the bit or holesaw and surrounding surfaces to catch most of the metal fillings as well as act as a cooling lubricant for the bit.

Stalling Engine Check: When fuel starvation is suspect on an outboard engine, run the engine until it starts to lose power and then immediately have a helper squeeze the fuel primer bulb. If the engine revs back up, the fuel pump is defective. If not, the problem might be carburetion or ignition.



Engine Service Vigilance: When degreasing your boat's engine, use a "green," non-toxic cleaner that you can safely pump overboard with the bilge water. Using a solvent-based cleaner (e.g., Spray 9) means that you need to plan how to recapture the cleaner and the solvent-permeated dirt and grease that ends up in the bilge because you can't pump it overboard.

Sourcing Leaks Ashore: If your boat takes on water while on the trailer, it is likely that rainwater or washdown water is leaking from either a deteriorated hose connected to a drain fitting in the deck or a leaking deck fitting or an ungasketed or poorly sealed deck hatch.
Patricia Kearns, Naples, Florida

Identifying Offenders: To identify sources of onboard interference, turn on all lights, pumps, electronics and other powered equipment, tune your VHF radio to a channel that has a lot of interference, then turn each piece of equipment off at a circuit breaker or the equipment's on/off button.

TECH TIPS WANTED

Published tips receive a special issue travel cooler. Great for carrying small snacks, lunches, and drinks.

Just send us a description of your boat-tested tip or technique, along with a photo (if available), your name, boat name and homeport to:

DIY TECH TIPS
P.O. Box 22473, Alexandria, VA 22304
or E-mail to: *tech@diy-boat.com*

Although reader tips are accepted as submitted in good faith, DIY has not tested or proven those tips. DIY offers no guarantee or warranty as related to their fitness or suitability for service or application as reported.

Star brite®

Solutions

Simple, Easy And Effective Solutions To Boaters Most Common Problems

Problem: Leaky Bimini Tops, T-Tops, Boat Covers, etc

The Cause: Over time, Bimini tops, T-tops and boat covers lose their water repelling ability.

The Result: T-Tops and Bimini Tops leak, fabric boat cushions get soggy, and boat covers no longer protect against rain or snow.

Solution: Apply Star brite Waterproofing with PTEF® to all fabrics. It provides a waterproof barrier to moisture, while the PTEF® coating protects against stains, bird droppings and grime. It is also ideal for protecting new fabric against UV rays and weathering. This means tops and covers will last longer than ever. Simply spray on to clean, dry fabric and allow to dry for six hours. Also ideal for waterproofing foul weather gear, sleeping bags, gear bags and more.

PTEF® is Star brite's registered trademark name for polytetraflouroethylene.

Problem: Mildew Stains

The Cause: Mildew stains form on vinyl cushions, boat covers and in the head or other unvented areas of the boat.

The Result: Unsightly mildew stains make even the nicest boat look bad.

Solution: Spray Star brite Mildew Stain Remover directly on stains, watch as they disappear and rinse well with fresh water. In most cases, just one application will whisk away mildew stains on contact.

Visit www.starbrite.com to view our Star brite Solutions How To Videos and find a dealer near you. Any questions? Call (800) 327-8583

BILGE PUMP TURN ONS

Considering the hostile environment and scarce maintenance the lowly bilge pump switch receives, it is no wonder it frequently fails. Here's a close look at switch types, construction and reliability.

Story by Nick Bailey

Nick Bailey

(Top) The popular ITT Rule Super Switch and Rule-A-Matic mechanical float switches. (Bottom) Older models like these contain mercury and should be properly disposed of when replaced.

After years of repairing boats, I have concluded that the ideal bilge, one that is clean and dry, is an abstract concept that exists only as pure theory. My experience also leads me to conclude that physicists have some explaining to do about the strange gravitational vortex found under the floorboards of every boat ever made. Even new boats, straight from the factory will, within a few hours, have construction debris, dust, lost fasteners and Doritos emigrating to the bilge. Can this be explained by standard model physics? I understand a bit about "black holes," "dark matter" and "dark energy" and that sure sounds like bilges I have seen.

In many older boats, the bilge environment is hostile at best and unspeakably vile at worst, presenting a challenge to the manufacturers of bilge pumps and automatic switches. Past experience with boat repair puts bilge pump switches at or near the top of the "Frequent Failure" list. Since it is a fact that many boats are actually in a constant state of slowly sinking, (far more boats sink at the dock than underway) those same pumps and switches are also at the top of the "Most Important Equipment" list. The respective top of the hit list positions don't bode well to keeping your boat dry and afloat.

Manufacturers are fully aware that the perverse nature of boats requires that vital bilge pumps and their switches operate reliably but they have too much faith the boating public will keep their bilges free of oily sludge, decomposed organic matter and corrosive saltwater.

The pump switches on the shelves today range from "improved" versions of the traditional mechanical float switch to the latest electronic sensor switches. Despite over 30 models to choose from there are only a few different switch types available as outlined below.

Mechanical Basics

The concept here is simple: rising bilgewater lifts a float that triggers a switch allowing current to flow to the bilge pump. In practice the details are tricky enough that after decades of development manufacturers are still trying to create the perfect float switch. The design criteria can be conflicting.

Size: small enough to fit in a cramped bilge yet large enough to house the switch mechanism.

Sensitivity: the float must rise when needed but as sea conditions slosh the bilgewater back and forth it should not flop about creating endless on-off cycles.

Corrosion resistance: electrical switch components must be sealed from the very elements in the water to which they must react.

This style of mechanical float switch contains a moving metal ball that rolls down to trip an internal switch as the float rises. They are available under several brand names and the original version is reported to have been used by Noah.

Rule's new line of mercury-free float switches with improved waterproof wiring and, on some models, a detachable base bracket to simplify installation.

Resistance to fouling: to prevent debris from jamming the float and to damp out bilgewater surges, a perforated housing or cage is preferred and keep the bilge clean. Unfortunately, in an oily bilge, the housing itself can gum up and foul the float as well as making service access to the float a bit more difficult.

Current capacity: few mechanical switches combine compact size with the ability to handle more than 15 amps of 12-volt current, a requirement for the larger bilge pumps (3,000 gph or more).

Environmentally friendly: the most popular switch mechanism in years past was the mercury switch. It had few moving parts, was inherently well sealed and had no contact points to wear or corrode. Unfortunately, mercury is a persistent toxic substance and subject to strict environmental controls. Mercury's days are done.

Cost: it may be possible to build a perfectly reliable mechanical switch but will anybody buy it if it costs more than $50?

Float Switch Types

Although the search continues for the perfect, low-cost mechanical bilge switch, pivot arm float or vertical float switches are options one and two.

The pivot arm float is the most common variety of mechanical bilge pump switch, consisting of a fixed base with a buoyant arm attached to the base with a hinge or axle. As the water level in the bilge rises, it floats the arm upwards, actuating a switch within the unit. The arm may or may not be enclosed in a protective cage.

Given the phasing out of mercury switches, your choices are limited to moving ball and assorted other designs. The moving ball is a venerable, time-proven design offered under many brand names as a low cost "environmentally responsible" (mercury free) option. Externally, they all appear to be identical.

The float contains a steel ball that rolls down toward the pivot axis as the float rises. Here it clicks against a microswitch and closes the circuit. Recent improvements include an "anti-spike" feature in the circuit design that works fine until water leaks in at the wires or the microswitch wears out or the power supply wiring fatigues due to the float's motion. Another problem reported by users is that the ball tends to stick inside the float. The low-tech solution is to rattle the switch every couple of weeks to keep the ball free. Current examples include the AS888 from Johnson Pump; Mayfair 26012 (a division of Johnson); and West Marine 543561 along with other private label brands.

The simple mercury switch mechanism consists of a small, partly filled vial of mercury (a toxic liquid metal) connected to the circuit and built into the pivoting float. When the float is at rest the mercury remains in the inert end of the vial but when the float is raised the mercury slides down to the live end where it bridges the contacts built into the sides of the vial. Power flows through the highly conductive mercury and completes the circuit to the pump. This style works well until the float gums or jams or water gets into the live circuits in the unit.

Regardless of their popularity in the past, these are being discontinued for sound environmental reasons. For example, the best selling line of low-cost bilge switches, the ubiquitous Rule Superswitch and Rule-A-Matic that used mercury switches up until very recently, have been replaced by a new improved line using mechanical contact switches. So too, the mercury containing Sure-Bail DEL-30 has also been superseded by the new Sure-Bail ES-2, which uses an electronic sensor. New environmental regulations may have persuaded the manufacturers to say goodbye to mercury, but no doubt

ONE-STEP PUMPING

If water sensing pump switches can be a problem, why not build a pump that can work automatically without any additional switching? Rule Industries has done just that with a line of automatic microprocessor controlled pumps ranging in size from 600 to 1100 gph. These pumps activate themselves momentarily every 150 seconds and sense the amount of load on the impeller. If water is present the pump continues running until the load eases, indicating the water has been removed and then it shuts down until the next test cycle begins 150 seconds later. The amount of power consumed during the test cycle is low but it could be a problem if the boat is not equipped with an automatic battery charger plugged into shorepower but that is true for any pump that is switching on to capture nuisance bilgewater. A minor drawback to light sleepers aboard is the slight noise these very quiet pumps make as they cycle.

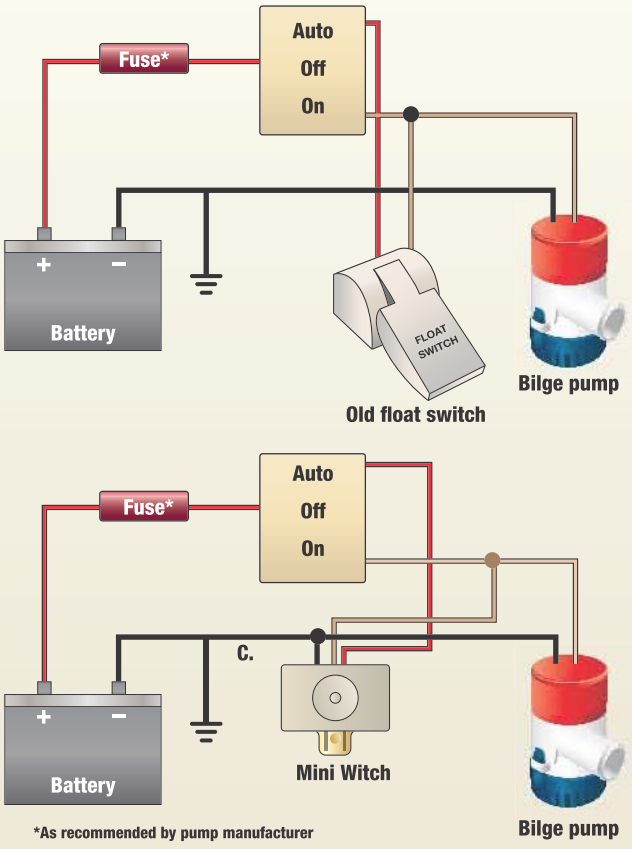
– NB

The unique ITT Rule automatic bilge pump requires no water-sensing switch but instead turns on briefly every 150 seconds and, by sensing the load on the motor, determines if there is any water to pump.

The Attwood 4201 float switch is mercury free.

Johnson Pump makes a variety of bilge pump switches including this #36152, which features a vertical float with a sealed magnetic sensor. The housing dismantles easily for cleaning.

The Piranha from Shurflo, is another vertical float switch. This one requires removal for cleaning.



Replacing a mechanical float switch with an electronic switch is fairly straightforward but the electronic switches need a negative ground wire added to complete the power supply circuit to the new switch.

there are many toxic older models available at clearance sales wherever they are still legal for sale or until retail stocks are depleted.

The catch-all category for "other" pivot arm switches includes units using contact points, reed switches and various micro switches.

Rule has completely redesigned the internal workings of their new switches to use a heavy-duty set of mechanical contact points, which survived testing of over one million cycles without failure. No electrical components remain in the float arm itself, which eliminates flex and fatigue issues with the wiring. To keep the unit sealed, the new wiring enters through a waterproof grommet and the pivot arm uses the same sealing system as the motor shafts on its successful line of submersible bilge pumps. The multi-strand wiring itself is blocked inside the insulation with silicone. This prevents moisture entry due to possible insulation damage from wicking along the strands of wire back into the switch. They are also now easier to install: the new detachable mounting bracket frees the mounting holes from underneath the pivot arm.Another example of a pivot arm float switch using a mechanical contact switch is the Attwood 4201-7.

The vertical float switch style is a vertical tube or chamber containing a small donut or ball-shaped float on a slide. The top of the float contains a magnet that triggers a sealed magnetic microswitch when the float rises to the top of the chamber.

The Aqualarm SS-209 is a more elaborate vertical switch ($88) that includes an alarm and is programmed to delay pump shutdown for 15 seconds to clear water from the discharge hose.

This is a simple switch design and because it has fewer moving parts than the pivot arm style it should have a longer service life. Due to the float enclosure, this switch type is also less affected by sloshing bilgewater. However, if installed in a dirty bilge, accumulations of grease and scum inside the housing require periodic maintenance to remove and clean the unit's interior. Relatively low-cost examples are the Johnson 36152 and its West Marine clone 3685443 and the Shurflo Piranha. Both of these units have opaque float chambers.

Easier to monitor and clean are the Aqualarm and Ultra Safety Systems (USS) vertical float switches with clear acrylic float chambers.

The Aqualarm Smart Switch models come standard with a high-water audio alarm and have a built-in microprocessor programmed to keep the pump running for 15 seconds after it senses the water level has dropped. This feature, also found in the Water Witch electronic switches (see "Electronic Sensor Switches"), allows the pump to fully clear the water out of the discharge hose, avoiding all of those endless drainback and pump-cycling situations that many pump installations suffer.

Don't be tempted to install a one-way check valve to overcome cycling. It's prohibited by ABYC and can cause flow restrictions or may jam close.

For those who are really serious about getting bilgewater out of the boat, the

These Mirus field-effect switches, (top) the Ultima from Johnson Pump (34-36303) and (bottom) West Marine house brand unit (7865637) appear to be identical. Compared to the Water Witch, both offer similar advantages over mechanical switches. The Ultima draws even less stand-by power than the miniscule .006 amp hour (12 volts) consumed by the Water Witch.

SLIMLINE USE #22:

WASHING THE FAMILY DOG.

The SlimLine Pump is compact, powerful, simple to use and stores away in just seconds. With so many diverse uses like these, it may be the most versatile pump you'll ever buy for use on and off your boat!

- General wash-down use anytime
- Easy pump-out in tight bilge areas
- Livewell drain and fill quickly
- Rapid diesel refueling and transfer
- Deck showers
- Engine & water systems winterizing

Available kits includes hose, battery clips & adjustable spray nozzle.

ITT

Visit www.rule-industries.com for more information

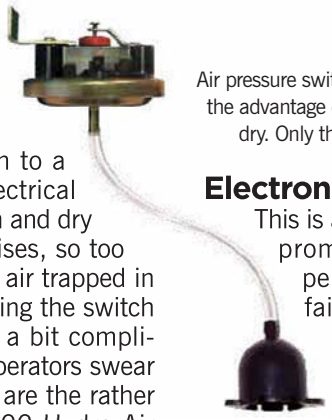
rule®

USS Ultra Pumpswitches are constructed of heavy-duty materials and most come with a five year warranty; the top of the line Ultra Pumpswitch Sr ($152) comes with a lifetime warranty. The USS switches might be hard to find at recreational boating chandleries but are available from suppliers of commercial fishing boat gear.

Air Pressure

For those who recoil in horror at the idea of installing anything electrical and possibly submerged in bilge water, there are bilge switches based on a pneumatic water level sensor.

These devices consist of a small cup or bell designed to trap air as the water rises. The bell is connected to a hose, connected in turn to a diaphragm triggered electrical switch mounted in a high and dry location. As the water rises, so too does the pressure of the air trapped in the bell, eventually tripping the switch to start the pump. It is a bit complicated but commercial operators swear by them. Two examples are the rather industrial looking AS-100 Hydro Air made by Groco. This unit is not to be confused with the ITT Jabsco 59400-0012 Hydro Air, which has now been superseded by the nearly identical ITT Rule Eco-Switch 39. The Jabsco/Rule unit has a switch housing tidy enough to mount in plain view in the cabin.



Air pressure switches like the Groco AS-100 have the advantage of keeping their electrics high and dry. Only the air bell is subject to immersion.

Electronic Sensor Switches

This is a category that has always promised freedom from the perennial causes of switch failure; namely, no moving parts and hermetically sealed sensors. In the past, many newfangled devices, such as resistance probes, sonic sensors etc., have arrived with fanfare and then vanished from the market. The problem is that they work nicely in the lab but their real life in the bilge was another matter. That reputation appears to be changing with the latest

HOW TO GET THE MOST OUT OF YOUR BILGE SWITCH

Many pump switches never have a chance to operate reliably because they are badly wired and installed but the switch always gets the blame. Electricity and bilge water, especially electrically conductive salty bilge water, are a risky mix. Any break in the wiring insulation submerged in bilge water causes electrical leakage from the hot or live positive wire to ground. This causes rapid galvanic corrosion of the wiring in the bilge and accelerates corrosion of any submerged underwater metal in the ground path such as anodes, outdrives, props, thru-hulls etc.

Electrical current from the pump wiring leaking into the bilge water wants out of the boat and it finds whatever available conductive path to seawater and a ground. To prevent stray current corrosion, all wiring connections to the pump and switch should either be high and dry or hermetically sealed. Wires twisted together and wrapped with electrical tape or fastened with household wire nuts will not survive long in saltwater. In any case, it's a bad practice in marine wiring. With any luck, the new bilge pump switch you choose has a long wire pigtail that allows you to connect it to the circuit somewhere high and dry. If the connections are likely to get wet, the best way to provide a sealed connection is with a heat-shrink adhesive walled crimp connector (**Figure 1**). In fact USS provides this style of connectors with its Ultra Pumpswitches and voids the warranty if you don't use them.

Many new switches are designed to quickly clamp to the pump body or discharge hose.

Nick Bailey

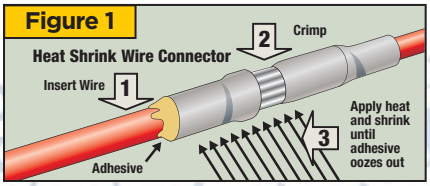
Jan Mundy

(top) Worst connection method for submerged wiring. (bottom) Best connection method uses adhesive-lined heat-shrink connectors. If you don't have any, cover crimped splices with heat-shrink tubing for a second best installation.

Some switches come with a short wiring pigtail and are difficult to install in the confines of the bilge. In this case, mount the switch to a piece of stainless-steel flat stock to create an extension bracket, bending the bottom at right angles if necessary to accommodate a horizontally mounted float switch (**Figure 2**). Do all the wiring before you lower the bracket into the bilge and fasten the top end of the bracket to the underside of the floor or the side of a stringer. This also avoids the hazards of drilling holes into the inside of the hull to mount the switch. Many of the new switches are also designed to simply clamp to the pump or discharge hose.

All bilge pumps and switches benefit from a clean bilge. Drip trays under the engines and oil absorbing socks or pads are all weapons in the fight against oily bilges and oil discharge. Periodic cleaning and inspection of mechanical float switches and any protective cage guards is essential and even electronic sensors like an occasional wipe with a damp rag. Avoid excessive soap bubbles around some electronic sensors as they falsely trigger the pump. **– NB**

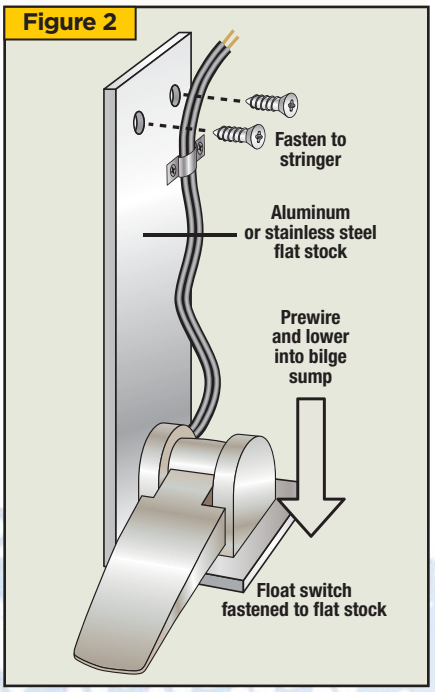
Figure 1



Ultra Safety Systems/Joe VanVeenen

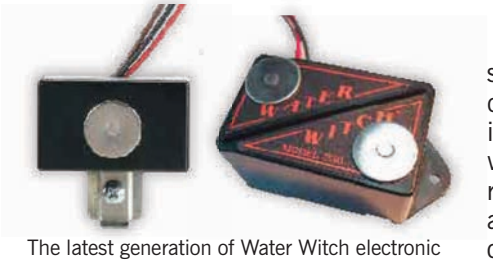
The Ultra Pumpswitch comes supplied with crimp connectors with an adhesive wall heat-shrink. This is the correct way to seal a submerged connection. Better yet, keep the connections high and dry.

Figure 2



Nick Bailey/Joe VanVeenen

A basic mounting bracket simplifies switch installations in a deep, narrow bilge.



The latest generation of Water Witch electronic switches are fully sealed, relatively inexpensive, have no moving parts, are not triggered by fuel or oil, come with an excellent warranty and have developed a reputation for reliability. Shown are (left) model 230 and (right) the new 101 Mini Witch.

generation of electronic sensors reputed to work reliably. This new generation of switches has found favor with commercial fishermen and has been chosen to equip U.S. and Canadian Coast Guard vessels.

One of the unique and important features of electronic sensors is that they do not trigger the pump if immersed in oil or a bilge full of fuel. This eco-friendly characteristic could potentially save you a hefty fine for illegal discharge. Minor oil contamination from dirty bilgewater does not adversely affect the sensors.

The best known brand of electronic switches is by Water Witch. Its line of compact, relatively inexpensive switches includes models suitable for installation with 12- to 32-volt DC bilge pumps ranging in current draw from 10 to 20 amps. These switches use a patented capacitance sensor technology and carry one of the best warranties in the business (five to seven years) plus they are simple to install, although they require running a negative wire to the switch. Among the useful operational features of the Water Witch is an 8-second start delay to avoid unnecessary pump cycling and a 14-second finish delay to clear the water from the discharge hose.

The other major player in the electronic switch market, using patented Mirus field effect sensors, is Johnson Pump's new Ultima Switch 34-36303 and its West Marine clone 7865637. This switch also appears easy to install and features start and stop delays similar to the Water Witch units. It is interesting to note that the Ultima Switch clone is the only electronic bilge pump switch that is customer rated on the West Marine website, getting a "Three Star" rating while all customer reviews of mechanical float switches are generally negative "One Star" ratings.

Could it be possible that modern technology has finally conquered one of the most inhospitable environments on your boat? The new electronic switches may be the best answer yet but only time will tell if the bilge, the last frontier, has finally been conquered.

About the author: Nick Bailey is a boat repair professional with 32 years experience and also an avid amateur astronomer. His hands may be in the bilge but his head is in the stars.

ADDITIONAL READING

DIY's MRT Series "Plumbing 101" CD-ROM is a boat owner's guide to the inspection, maintenance, repair, troubleshooting and upgrading of onboard plumbing systems and includes bilge pump product selection, installation options and other information you need to evaluate and plan a bilge pump upgrade.

www.vetus.com

BIG IN PERFORMANCE...

...THE 'SMALL' DIESELS FROM VETUS

Like nobody else, boaters understand how to make the most their freedom. Everything is possible but there is no compulsion to do anything. Discovering the most attractive waters in a relaxed and peaceful atmosphere is not fiction but reality. With a reliable VETUS diesel every trip becomes a delight, without irritating vibrations or excessive noise fromthe engine. It doesn't matter whether you have an 11 hptwo cylinder or the superb286 hpsix cylinder, a worldwide network of dealers ensures you can always enjoy your passionwherever you happen to be.

The complete range of VETUS marine diesel engines comprise 15 models, from 11 - 286 hp and 8 versions with available with saildrive.

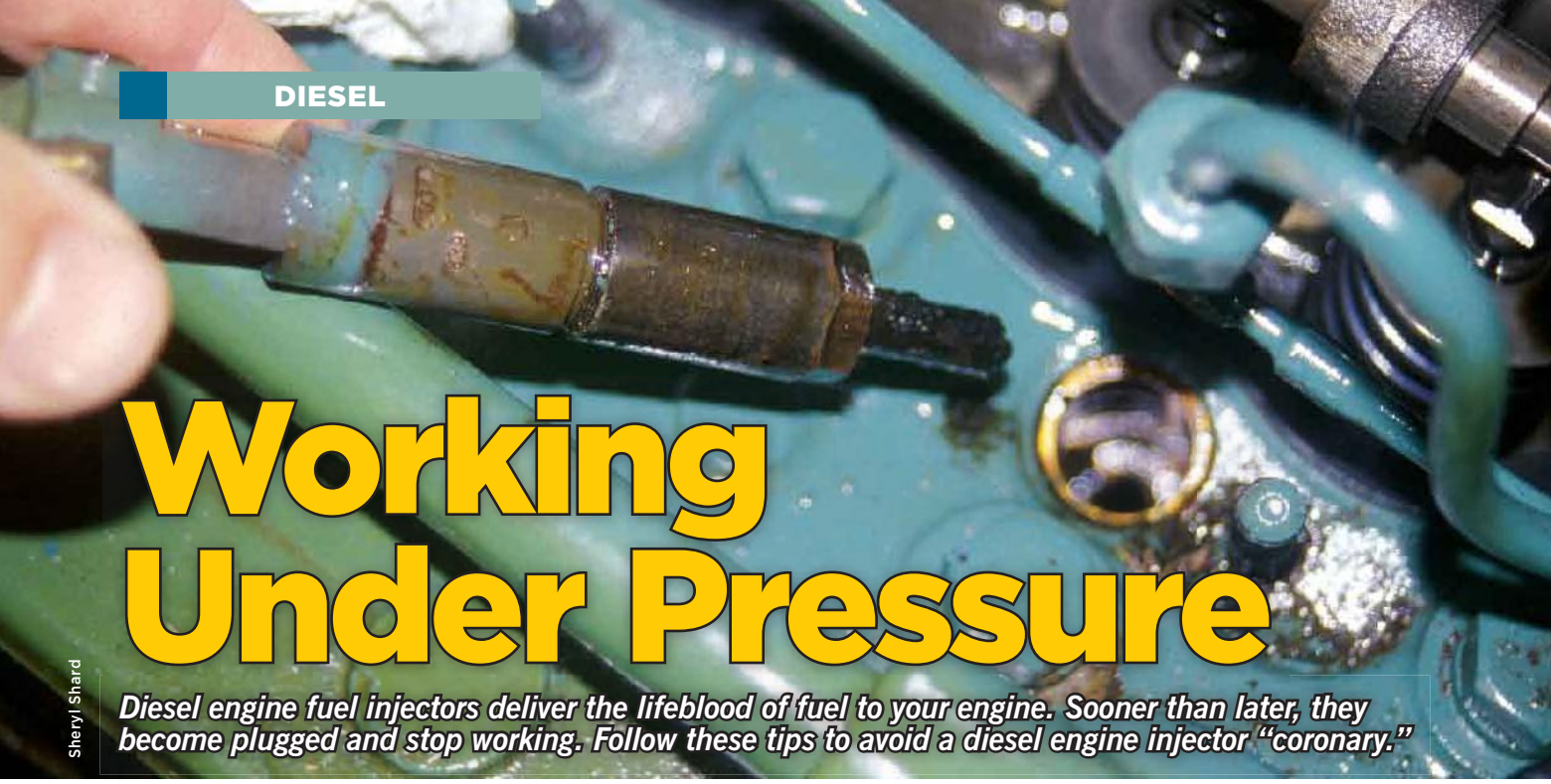
The choice is yours.

VETUS OFFERS:

- THE VERY BEST MARINE DIESEL ENGINES
- A COMPLETE RANGE OF "AROUND THE ENGINE" INSTALLATION COMPONENTS
- MAINTENANCE-FREE MARINE BATTERIES
- HYDRAULIC STEERING SYSTEMS
- SOME 2,000 OTHER TECHNICAL MARINE PRODUCTS.

VETUS AMERICA - 7251 NATIONAL DRIVE - HANOVER - MD-21076
PHONE; 1-410-712-0740 FAX: 1-410-712-0985 EMAIL: sales-service@vetus.com

vetus america - full ahead



Sheryl Shard

Working Under Pressure

Diesel engine fuel injectors deliver the lifeblood of fuel to your engine. Sooner than later, they become plugged and stop working. Follow these tips to avoid a diesel engine injector "coronary."

Story and photos by Randy Renn (exceptions noted)

Mechanical diesel fuel injectors may be the least attended, least understood, most complex and yet most important components on your diesel engine. These parts are in constant use while under power, cycling millions of times a season, working within thousandths of a second's accuracy and are in real danger of decay when laid up during their host engine's seasonal time out. Few owners give them any service consideration albeit there is little hands-on maintenance, outside of the repair shop, that the boat owner can or should perform on the injectors themselves. Given this as fact, you should still be aware of some fundamentals, parts and pieces, and those areas where you can affect preventive maintenance to derail a failure.

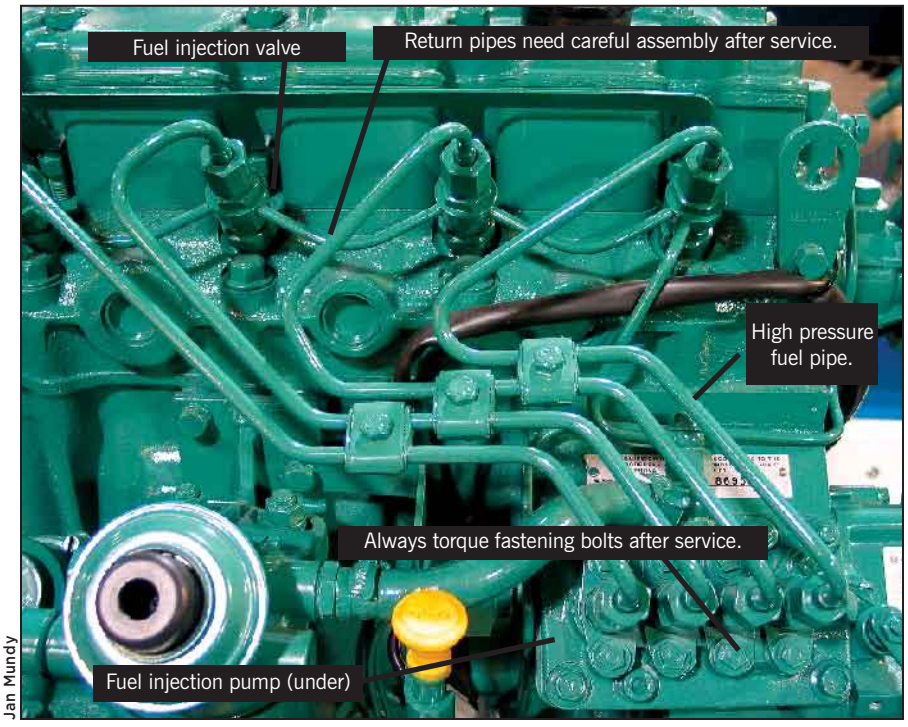
Fuel injectors are fine instruments, as well designed and built as any self-winding wrist watch and much more vulnerable in the wrong environment. Since their introduction around 1895, fuel injectors have been plagued by the demons of fuel quality, water and contaminating particles.

Injection Mysteries Unraveled

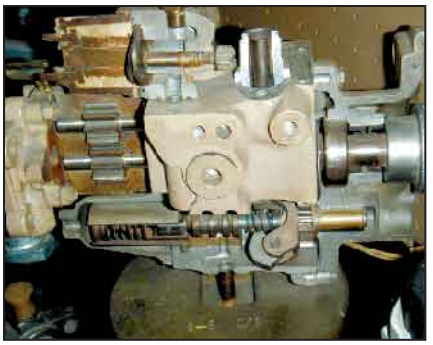
Very high-pressure pumps supply diesel injector fuel or the injectors are high-pressure pumps themselves. Pressures in most injectors that are not on "common rail" diesel engines are in the forcible 3,200 psi to 5,000 psi range. Common rail engines, not discussed here, can have staggering pressures up to 29,000 psi.

The high pressures are required to atomize the fuel to a very fine mist, very quickly, within micro windows of timing but in varying amounts, depending on speed and load. Additionally, the fuel pressure must remain almost exactly the same at all speeds. The injection pump forces fuel at great pressure towards the injectors, where the pressure overcomes the tremendous spring resistance within the injector. The injector "pops" open for a micro second, releasing pressure. Fuel is injected into the engine combustion area where the engine's pistons have compressed air heated to such a point that, when the mist of fuel hits it, the combination explodes. The injector then slams closed. This rapid opening and closing is crucial to proper injector performance.

With that level of pressure comes several necessities. First, heat must be



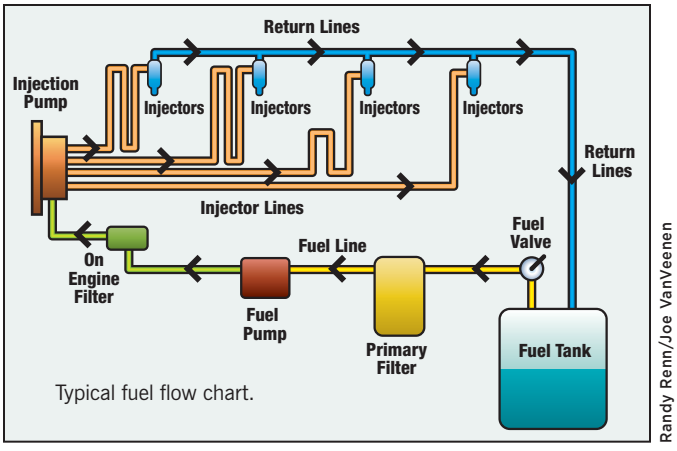
Jan Mundy



A gear type injection pump with numerous gears and vanes.

Typical injection pump.

Two injector types, internal and external spring. Injector on right has its own throttle rack.



Typical fuel flow chart.

Randy Renn/Joe VanVeenen

dissipated. Diesel combustion temperature can easily be 1,300F to 1,600F (704C to 871C) and injector tolerances are very tight.

One end of the injector lives in the combustion part of the engine and one part is wrapped in the engine's 170F (76C) cooling system, while the remainder is exposed to open air. This results in different levels of expansion happening along the injector length. Many injectors have a fuel return pipe that delivers unspent fuel back to the fuel tank and that carries away considerable heat. The heat situation has a second effect; namely, the fuel's capacity to keep the moving parts of the injection system lubricated. This is known as lubricity and it measures a diesel fuel's ability to prevent wear on fuel pump and injector surfaces. Fuel must be maintained in a fresh state at all times to keep additives that are important to lubricity working and heat makes matters worse.

Diesel fuel is measured by cetane rating, which indicates how easily the fuel ignites and how fast it will burn and is the diesel equivalent to octane ratings in gasoline. In order for a diesel engine to run properly and the fuel to burn correctly in the heat of the combustion chamber, a precise amount of very good fuel must be added in a precise time frame. When fuel does not burn correctly in the heated air of the combustion chamber, more fuel is added (via the throttle) but engine heat cannot burn all the fuel and some remains as ash or varnish, which contaminates injectors.

Injectors come in variations of similar shapes and are basically comprised of an injector body upper part and a shiny injector nozzle lower part. The nozzle and needle are very, very finely machined. In fact, with a new nozzle, the fit is so fine that holding a new needle in your hand and letting it warm may cause it to expand and not fit into a cool nozzle.

The injector connects to the rest of the fuel system by a fuel delivery line and likely a fuel return line, a much smaller line that may have "hollow bolts" through it.

All parts of the system must be kept extraordinarily clean at all times. Never handle any internal part of an injector with dry hands or allow parts to become dry. For this reason injector parts are usually non-returnable. Parts are always coated with oil so the machined parts do not become etched with salts from dry handling.

Cracking Test

Besides damage sustained from improper handling, injectors are subject to damage from contaminates and water. A smoking, power-starved or very noisy engine may have an injector issue. A quick way to determine if an injector is not working is to short the injector by cracking it open while the engine is running.

"Cracking" means using a proper line wrench to open the injector main feed line at the injector with the engine at idle. Opening the injector as little as a quarter of a turn, while wearing goggles, gloves and keeping the surrounding area covered with a cloth, has the effect of turning it off. If fuel leaks and engine rpm does not slow or change, then the injector is faulty. If the cracking does have an effect (i.e. engine stalls), move on to the next injector. If the engine makes loud hammering noises and, on cracking the injector, the noises stop, then the injector is the faulty one or there is a different problem with the engine. Either case requires removing the injector. This is a messy operation but you will lose very little fuel.

I suggest having your engine's valves adjusted as part of this test. In general, if you find one weak injector all should be serviced. Suggested service is every 1,000 hours or when fuel has aged badly or been heavily contaminated by water.

Injector Service

If you carry a spare injector, you may replace a weak one by removing the fasteners or unscrewing it from the cylinder head. Most injectors break free easily with gentle prying and penetrant. I like PB Blaster, although fresh diesel fuel works well. Loosen all injector lines and line keepers (little braces) before removal. Be careful not to bend any lines. Once a line is removed, keep all openings covered with plastic caps. Before

Injector service tools: (top to bottom) line wrench; conventional wrench (do not use); torque wrench; and injector puller.

Various injectors all have one thing in common: they require servicing at specified intervals. Red plastic caps protect injector nozzles.

For those times when you cannot access a service shop carry an injector cleaning kit to clean small engine injectors.

Fuel return line with hollow bolt.

Clean (right) and fouled injector nozzles and tips.

Service demands a sophisticated pump and injector test equipment.

doing any service work, check your engine service manual for detailed instructions.

When replacing injectors, take care to replace the copper heat/seal ring. This means removing the old one from the cylinder head if it did not release with the injector. Always consult your engine parts manual for the placement of seal rings. The fasteners have a torque setting and require tightening with a torque wrench to prevent applying too much pressure to the cylinder head.

Injector service is nearly impossible outside a specialized shop because, once apart correct reassembly demands a pop tester tool. This tool simulates an injection pump by building very high pressure until the injector "pops" opens very quickly, sprays evenly and closes just as fast, the way good injectors operate in the engine. If the injector pops too quickly or at too low pressure then it cannot spray correctly, at the right time or have proper fuel burn. If it closes slowly or leaks then smoke, hammering engine noises and possible engine damage can occur. Service all injectors at the same time as pop testing pressures varies from one shop or builder. Diesel fuel injectors are quite expensive and don't hesitate to use rebuilt items when possible.

Remember how high and dangerous injector pressures are? Never operate a removed injector that has been reattached to the fuel line. This results in a very fine, high-pressure mist that, if touched while working, will puncture skin and cause serious blood or tissue poisoning.

Following injector service, bleed the fuel system and test run the engine. Be sure to change all filters, separators and crush washers during this activity.

To get long service life from a diesel engine, give it clean and uncontaminated fuel, clean air and an unrestricted exhaust. Change filters on a regular basis (consult your owner's manual for servicing and recommendations) and keep valves adjusted. Engaging a technician to inspect your engine's timing will increase longevity, very likely smooth out a smaller engine and improve larger engine performance. Adding additional fuel filters with a bypass system and water temperature and flow alarms are other positive investments.

ENGINE MYTHS

1 "It's alright if my diesel engine puts out black soot." False! Heavy smoke or soot deposits are an indication of poor quality fuel, injection system failure, exhaust or air restrictions. Diesel, unlike some other distillates aboard, does not improve with age.

2 "My diesel shakes and rocks at idle but that is just fine because it goes away in gear." Sorry, another fallacy. Much idle clatter and shaking can be adjusted with proper injection timing. The idea of a noisy, uneven diesel is so pervasive that most technicians do not bother to suggest or are afraid to attempt the correct timing procedures.

3 "A fellow at the boat club said to add 1 gallon (3.78L) of gasoline to a tank of diesel to clean the injectors." Wrong again! Never do this for any reason. Having seen the result of an owner or fuel dock person filling a diesel tank with gasoline by mistake, poor engine performance could be the least of your problems. Purchase and add the proper fuel additives according to the engine manufacturer's instructions.

About the author: James R. (Randy) Renn is a USCG licensed operator, avid sailor, sport fisherman and one of a few marine surveyors who is also accredited as an engine surveyor. He operates Marine Forensic Technicians in Stevensville, Maryland.

Gear & Gadgets

A collection of useful boating stuff.

Smart Water Heater Monitor

When was the last time you checked the water heater anode? This internal anode protects water heaters from corrosion. The anode shown in the photo below was just two years old and was completely consumed sacrificially, after which the metal components of the tank start to corrode. This causes contamination of the water and eventually the tank deteriorates, leaks and requires an expensive replacement. Performance Metals' (performancemetals.com) Water Heater Anode Monitoring System eliminates this potential damage. An electrode features an embedded probe that detects its condition. The monitoring system connects to a battery-operated detector box and, when the anode is depleted, a series of beeps and flashes indicate a broken circuit. A snooze button quiets the alarm for one week. The box mounts with Velcro on the heater or a bulkhead and three AA batteries power the unit. Available in two sizes, the system costs $62.

Brush Wet Storage

The Epifanes Brushkeeper is the ideal product for storing expensive natural China bristle brushes. This translucent polyethylene container measures 5" square by 14" high (127mm by 355mm) and suspends one to eight brushes in a bath of kerosene or diesel fuel. A tight-fitting lid prevents spills and evaporation. This keeps the brushes clean and the bristles soft. A mineral spirits rinse and spin several times before and after every use can extend the brush service life from 10 to 20 years. Brushkeeper is available at epifanes.com for $43.45.

Easy Throw Flotation Device

Anyone who can throw a stick can throw the award winning Mustang (mustangsurvival.com) Rescue Stick. Compact, measuring just 14" (355mm) in length, and lightweight, it can be thrown as far as 100' (30.4m), twice the distance of a ring buoy or rope, to a person in distress in the water. Ideal for sport boaters who don't have space onboard for a traditional life ring, this device's handle incorporates a 35lb (15.8kg) cylinder that automatically inflates a horseshoe buoy on contact with water. The inflatable ring has grab straps so the person in the water can hold one and climb inside the ring and await rescue. The weight of the handle and ring, once inflated, help to reduce drift in strong winds. The device is packaged in a waterproof bag with a hole for hanging near the helm. It retails for $139 and the rearm kit includes handle with cartridge for $40.

Portable Bag Dispenser

With the space saving Knot-a-Bag from Davis Instruments (davisnet.com), you'll have a supply of bags of any size when you need them. Use them for trash, carrying groceries, storing gear, picking up dog droppings or anything else you want to be protected from or protect. Pull out the desired length of plastic, cut it with the built-in safety cutter and then knot the end to create the perfectly sized bag for any purpose. The 4" (101mm) high dispenser contains a roll of 32.5' (9.9m) long by 24" (609mm) in circumference high-strength waterproof and recyclable polyethylene. Weighing just 3oz (86 grams), the dispenser can be clipped to a belt or handbag. Included with the dispenser are two rolls of polyethylene film for $7.50. A refill pack of three rolls also sells for $7.50.

Replacement Bulkhead Compass

The Venture SR-2 ($199) offers a wide range of mounting angles, can pivot up to 30 degree from the bulkhead and mounts without a leveling block. Designed primarily for sailboats up to 36' (10.9m), this new compass from Ritchie (ritchienavigation.com) is fully gimbaled, allowing for 45 degree of pitch and roll. In refit applications, it fits the footprint of Plastimo and C. Plath Merkur compasses. Included are an inclinometer, front and back cover, mounting hardware and a five-year warranty.

Tracking via Satellite

No matter where you roam, Spot ($150) gives you a vital line of communication with friends and family and can dispatch emergency assistance when and where you need it. Unlike a traditional GPS device, which only receives a satellite signal indicating your location, Spot utilizes dual satellite networks to receive your location as well as transmit it along with pre-programmed messages that let contacts know where you are. You can also send and save your location and allow contacts to track your progress using Google Maps. For world travelers, this device has a 90% probability of successfully sending a single message within 20 minutes from most countries except the far reaches of South America and the lower half of Africa, Indonesia and coastal areas of Brazil and India. The basic service costs $99.99 yearly; the tracking upgrade option using Google Maps costs $49.99 extra; and the GEOS Search and Rescue is also extra. Spot is available at Cabela's and West Marine.

SYSTEM Sentinels

Call them meters, instruments or gauges, they are the windows to the vital signs of your engine and electrical system. Here's what you need to know about the operation, maintenance and troubleshooting of gauges and meters.

By John Payne

Though gauges and meters sit unobtrusively on our boat engine control panels, switchboards and navigation stations, they are our windows into our boat systems. Without them, our systems and equipment would operate invisibly and fail without warning. Such devices are absolutely crucial to ensuring that boat engines run correctly within the normal operating parameters and that we don't overload electrical systems.

These days our gauges and meters may be an array of discrete analog meters, just a couple of basic meters or a new generation of integrated digital and visual screen displays. I am one who still favors analog displays and it's for a very good reason that aircraft still use them even as parts of the latest high tech screen displays. A quick glance is all that's needed to see that your systems are all go and all in the green. That is an important point to remember because, when considering meters and gauges, it's not always about the numbers, it's also about the monitoring trends, up or down, of the system that the gauge or meter is monitoring.

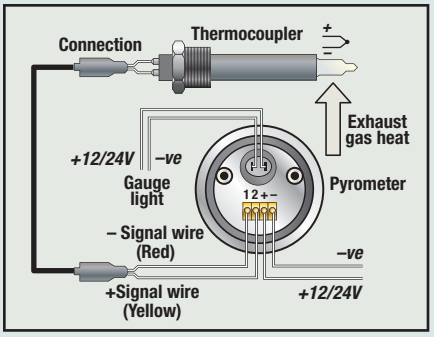
Engine Watch

We are all most familiar with engine gauges and, while there is a trend to simply have an alarm, I prefer the ability to monitor pressures and temperatures on a gauge or meter. Of course, there are many possible pressures and temperatures to monitor, including lubricating oil and oil filter differential pressures, fuel and fuel filter differential pressures, engine coolants (seawater and freshwater), turbocharger charging air pressure and charger air inlet pressures, gearbox and transmission oil pressures, to name a few. It all depends on what and how much you want to monitor. The basics are sufficient for most boaters.

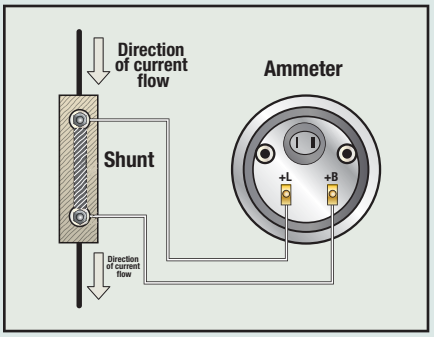
Oil pressure is one of the fundamental parameters that needs a gauge. The oil pressure sender or transducer unit for the meter uses variable resistance inside a housing that changes in proportion to the pressure applied to it. Low oil pressure readings are caused by low lube oil level or a clogged oil filter and worst case by a faulty oil pump so always believe the meter indication and stop the engine. Many do not trust the meter and learn by the consequences, when it's too late.

Temperature monitoring is another vital parameter that we always monitor. The main temperature points generally comprise lubricating oil and engine cooling water, etc. The proper monitoring of water temperature is essential to safe operation of your engine as temperature extremes can cause serious damage. The meter transducer units are resistive and output a resistance that is proportional to the temperature. The main causes of high temperatures typically include faulty freshwater pump impeller, low engine cooling water levels and fouled coolers. In addition, your meter might

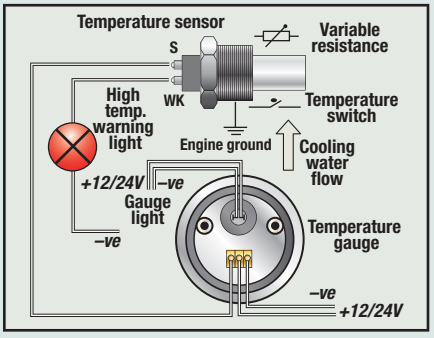
Illustrations by John Payne/Joe VanVeenen



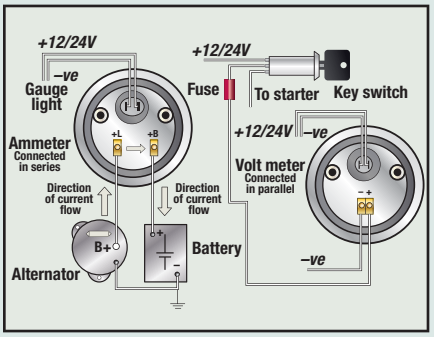
Exhaust temperature meter circuit.



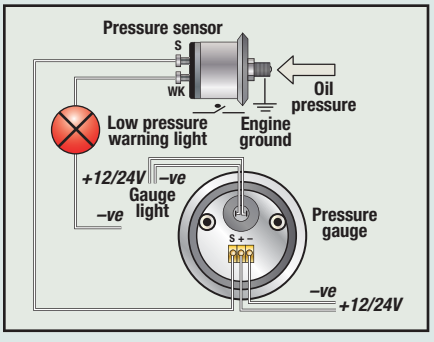
Shunt ammeter meter connection.



Water temperature meter circuit.



Voltmeter connection circuit.

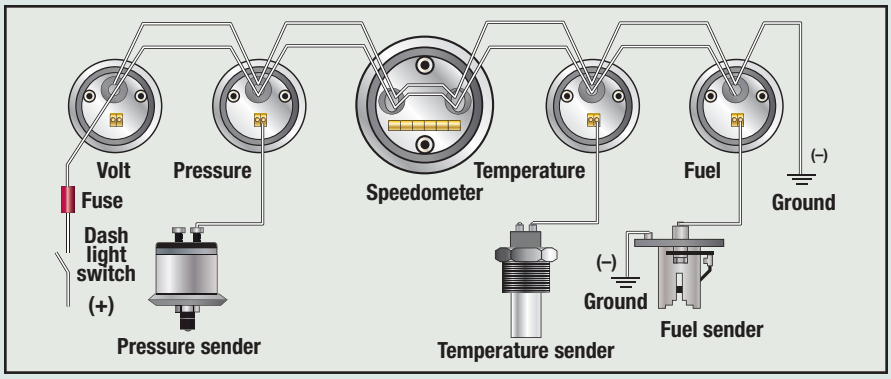


Oil pressure meter circuit.

TROUBLESHOOTING CHART

- The gauge does not operate: *The power supply may be off or disconnected at the back of the meter.*
- The temperature gauge needle is hard over: *This may be caused by a sensor fault or a cable fault.*
- The pressure or tank gauge needle is hard over: *This may be caused by a cable fault.*
- The oil pressure sensor is reading low or erratically: *If the engine is proven to have normal pressures, check the sensor unit for blockages in the input orifice.*
- The alternator tachometer has no indication: *The alternator has not "kicked" in and revving the engine may start the meter; otherwise, you may have the wire off the alternator or possibly an alternator fault.*
- The generator tachometer has no indication: *The generator may be faulty, power to the meter is off or there is a cable fault. In some units, you may also have a broken or damaged generator drive mechanism.*
- The inductive tachometer has no indication: *Check the negative connections to the engine block. The sensor may be mechanically damaged. Check the sensor clearance. Its being loose and too far off the flywheel causes problems.*
- A mechanical capillary tube temperature gauge has an incorrect indication: *Check that the sensor bulb is fully immersed or that the capillary tubing is not bent sharply.*
- A mechanical capillary tube pressure gauge has an incorrect indication: *Check that sensor orifice is not fouled with debris.*
- A capillary tube gauge has no reading: *The capillary tube may be broken or worn through from rubbing on another surface.*

– **JP**



Typical multiple gauge connection arrangement.

be telling you that you have problems with the saltwater (raw-water) cooling system.

The engine tachometer is another essential meter and is indispensable for monitoring engine speed. Observing this information on the meter enables us to make informed decisions on fuel consumption and boat performance.

There are several tachometer types, based on the type of sensing system with the meter. The generator tachometer inputs a signal from a mechanically driven generator unit, which outputs an AC voltage proportional in amplitude to the speed and this is then decoded by the tachometer. Variations in speed give a proportional change in output voltage and therefore a change in meter reading. The inductive tachometer has an inductive magnetic sensor that detects changes in magnetic flux as the teeth on a flywheel move past the sensor head. This transmits a series of on/off pulses to the meter that are then counted and displayed as speed on the tachometer. The alternator tachometer takes a pulse from the DC charging alternator AC winding. This signal is a frequency directly proportional to the engine speed.

Exhaust gas temperature monitoring is commonly used in commercial ships and is becoming more common on powerboats and even on sailboats. Engine problems are often easier and faster to identify with this instrument than water temperature and oil pressure monitoring. Exhaust temperature meter sensors are also known as thermocouples or pyrometers. The sensors consist of two dissimilar metals, which, at the junction, generate a small voltage proportional to the heat applied to the sensor and the voltage is measured in millivolts (mV).

Liquid Level Monitoring

The monitoring of fuel and water quantities is essential and a simple electrical gauge can be installed. Most tank sensors operate on the same principle of varying a resistance proportional to the tank level volume.

The immersion pipe sensor consists of a damping tube that has an internal float that moves up and down along two wires. These units are generally only suitable for fuel tanks and the one advantage of these sensors is that they are well damped and fluctuating meter readings with fluid movement are reduced by the damping effect.

The lever type sensor comprises a sensor head that is installed on the end of an adjustable arm. The sensor head has a variable resistance and float arm pivot. As the float and arm moves relative to the fluid level, the resistance also alters and the meter reading changes to read the actual level.

The capacitive sensor operates on the principle that the value of a capacitor is dependant on a dielectric between plates. The sender unit measures the capacitance difference between air and the liquid. The sensing circuit outputs a voltage proportional to the level in the typical range of 0 to 5 volts.

Essential Electrics

Within an electric gauge system, a voltmeter or ohmmeter is scaled or graduated to display the voltage or resistance output from a transducer or sender unit. The VDO gauge range characterizes this type of meter. In a diaphragm-based mechanical system, the meter connects to capillary tubing and operates using vapor pressure to mechanically change the meter via the diaphragm. These types also may incorporate electrical alarm contacts within the meter. These are characterized by the Murphy Swichgage range (fwmurphy.com).

Many instrument panels incorporate a voltmeter to show the level of the charging voltage. Charging voltmeters have a color marked meter scale to allow rapid observation of the condition, a red zone for under or overcharge and green zone for proper charging range.

The in-line or series ammeter has the main charging alternator output cable connected directly to it and then to the batteries. The long cable runs to the meter often causes significant charging system voltage drops and resultant undercharging. Another

more noticeable problem is that the heavy current carrying cables are run with other cables and this is a cause of radio interference; often you will see other meters "twitching" or pulsing.

The shunt ammeter is essentially a resistance or shunt inserted in the charging cable. The twisted pair meter wires are connected to the shunt and can be run to any meter location without voltage drop problems as the output is in millivolts.

Hour Counters

Operating hourmeters and counters are necessary to track engine hours for service and maintenance. The meter and counter are only activated when the engine operates. The ignition switch is probably the most practical method of activating the meter, which is simply connected across the ignition positive and a negative so that it operates when the engine is running. The oil pressure switch activation method is now uncommon although some older installations activate through the oil pressure switch.

Testing and Troubleshooting

If you think that your meter may be faulty use the following troubleshooting hints on suspected electrical gauge faults. This advice applies to VDO gauges.

1. Open sensor test. Remove the sensor lead from the back of the gauge. Switch on the gauge supply voltage. The gauge needle should now be in the following positions:

Temperature gauge: left-hand hard-over position
Pressure gauge: right-hand hard-over position
Tank gauge: right-hand hard-over position

2. Sensor ground test. This test involves the bridging of sensor input terminal on the gauge to negative. The sensor lead must be removed and the gauge electrical meter supply switched on. The gauge needle should now be in the following positions:

Temperature gauge: right-hand hard-over position
Pressure gauge: right-hand hard-over position
Tank gauge: left-hand hard-over position

3. The next step is to test the sensor (applies to VDO gauges). Disconnect the wiring, set your digital or analog multimeter on the resistance (Ω) range to around 200Ω. Place the positive or red meter probe on the terminal marked "G" on the sensor (if VDO); a dual alarm and sensor output the alarm output is marked "W." Place the negative or black meter probe on the sensor housing thread.

For temperature sensors, the meter indications should be in the following ranges: at 104F/40C = 200Ω to 300Ω, at 248F/120C = 20Ω to 40Ω.

For pressure sensors the meter indications should in the following ranges: high pressure (the engine is off) = 10Ω; low pressure (the engine running) = 40psi:105Ω, 60psi:152Ω.

For fuel tank sensors the meter indications should be in the following ranges: tank at empty = 10Ω; tank at full = 180Ω.

For additional troubleshooting refer to the chart on page 26.

Basic Maintenance

The simple meter and sensor arrangement does require some basic maintenance. Remove oil pressure sensor units from the engine every year and clean any oil sludge or deposits out of the sensor orifice. These do tend to clog and cause incorrect readings. When sensor units are badly grounded on the engine block, it is often found that Teflon tape is incorrectly applied to the threads. Do not use Teflon tape as this creates a high resistance contact and causes incorrect or even no meter readings. Insert and screw down the sensor without using any anti seize solutions or other materials to ensure the sensor is grounded properly. The same advice applies to temperature sensors.

Check that tachometer sensors that pickup from the engine flywheel are secure. A common cause of failure is damage to the sensor head caused by striking the flywheel when it comes loose.

Check wiring and ensure it is secure and not chafing or rubbing on any surfaces. Check that the sensor terminal and wire connections are tight and clean.

For mechanically activated gauges, check capillary tubes for any signs of rubbing or chafing and ensure that the tubing is secure.

About the author: John Payne, DIY's electrical consultant, is author of "The Marine Electrical and Electronics Bible," now in it's third edition, and "Motorboat Electrical and Electronics Manual" (Sheridan House).

THE BOTTOM LINE: SELECTING ANTIFOULING PAINT

Developments in antifouling paint technology mean that there are even more choices and selecting the right paint demands some research before paint day arrives.

By Jan Mundy

It's that time of year when the DIY technical helpline lights up with questions regarding antifouling paints. For many boaters, bottom painting is a major task on the spring "to do" list. For some owners, it's also a source of mystery and confusion.

There are a number of reasons to keep your boat's bottom free of fouling. Heavy fouling growth causes drag, reducing boat speed and efficiency. On powerboats, increased drag increases fuel consumption, raising fuel costs. Fouling adds weight and translates to cumbersome reactions to maneuvers, especially in heavy weather. Prolonged fouling also can degrade gelcoat, the high-gloss resin coating on a fiberglass hull, as the marine critters attach themselves with formidable adhesion.

Regardless of whether you keep your boat on a coastal or inland waterway, the only way to avoid fouling is to apply an antifouling paint to discourage marine growth or to habitually scrub the stubborn stuff off the bottom. We boat on freshwater lakes and, for many years, we elected not to apply bottom paint to our walkaround cuddy. Even after numerous sessions of intense, time-consuming scrubbing, the bottom was a slime farm by season's end. We soon realized that spending a few hours applying bottom paint before launching in the spring would be time well spent.

A boat that is constantly moving through the water likely does not need bottom paint but for most of us this is an impractical situation and once fouling establishes a hold, it rapidly spreads. Antifouling paints retard weeds, grass, algae, barnacles, "candy" coral, zebra mussels, slime (mostly prevalent in freshwater) and other marine organisms from colonizing your boat's bottom.

Formulations

Antifouling paints are comprised of four basic ingredients: biocide, resin, solvent and pigment. A biocide is a compound that repels or inhibits the growth of marine life. With the ban of tributyltin (TBT), manufacturers have invested heavily in R&D to develop capable replacements. Nowadays, various copper compounds are the most common biocides, the majority of which are sourced from recycled copper wire and water pipes. Copper was used for centuries and long before TBT to repeal marine growth and is a safe and effective ingredient. Zinc pyrithione or zinc omadine is also added in small quantities as a booster biocide. Some paints are copper free and use zinc pyrithione, hydrogen peroxide and other biocides. It is the biocide used that affects performance and some work more effectively than others to discourage the attachment of marine growth.

Resin is the binder that gives the dried paint its mechanical properties and controls the release of the biocide. Manufacturers use different binders, including rosin (from trees), alkyd, one-part epoxy ester, hard vinyl and Teflon plastic.

Solvent provides the flow and drying characteristics of the paint, makes it easy to apply and delivers a smooth finish. Some manufacturers have replaced organic solvents containing high volatile organic compounds (VOCs) with carbon-free solvents, such as water, to comply with environmental regulations.

HARD EPOXY
40% CUPROUS OXIDE

HARD EPOXY
75% CUPROUS OXIDE

HARD TEFLON, TRANS-LUCENT FOUL-RELEASE COATING; COPPER-FREE

ABLATIVE
47.5% CUPROUS OXIDE

ABLATIVE WITH IRGAROL
40% CUPROUS OXIDE

ABLATIVE, WATER BASE
40% CUPROUS OXIDE

COPOLYMER
WITH IRGAROL
40% CUPROUS OXIDE

HARD EPOXY
75% CUPROUS OXIDE

ABLATIVE
42% CUPROUS OXIDE

COPOLYMER
37.2% CUPROUS OXIDE

COPOLYMER
20% ZINC OXIDE,
COPPER-FREE

COPOLYMER
45.7% CUPROUS OXIDE

NOTE: PERCENTAGE OF BIOCIDE VARIES WITH THE PAINT COLOR.

THIN-FILM TEFLON, FRESHWATER ONLY
20.35% CUPROUS OXIDE

COPOLYMER WITH BIOLUX
39% CUPROUS OXIDE

HARD TEFLON COPPER-FREE

ABLATIVE EPOXY WITH IRGAROL
42.75% CUPROUS OXIDE

ABLATIVE TEFLON WITH BIOLUX
24% CUPROUS THIOCYANATE

HARD WITH SLIME FIGHTER
65% CUPROUS OXIDE

ABLATIVE COPPER-FREE

HARD VINYL, SALTWATER ONLY
42% CUPROUS OXIDE

COPOLYMER, WATER BASE
26% CUPROUS OXIDE

SLOUGHING
37.5% CUPROUS OXIDE

HARD EPOXY 20% CUPROUS THIOCYANATE

HARD EPOXY WITH IRGAROL
70% CUPROUS OXIDE

Pigment provides the paint color and thickness. Cuprous oxide-based paints use different grades and levels of this reddish-brown metal to produce the various hues of red, blue, green and other colors. It is this additive that precludes making a white bottom paint in conventional cuprous oxide-based paints. Newer antifouling technology, such as Pettit Vivid, containing cuprous thiocyanate, a white powder, and zinc biocides, has given rise to a bright spectrum of colors.

Some paints contain a fifth ingredient, a slime fighter. Trade names Biolux and Irgarol are organic boosting agents added to paint to reduce slime and boost the copper's repellent performance. These additives work like a sunscreen to block the sunlight required by algae and slime to feed, grow and multiply on the hull surface. Without the slime, barnacles are less likely to attach themselves to the hull bottom. Antifouling paints containing anti-slime additives are rated with an SPF or "slime protection factor" ranging from 20 SPF to 40 SPF and higher.

Paint Types

Bottom paints are classified into two categories: polishing or paints that wear away, and paints that don't wear but build up. Polishing paints release a very thin biocide layer (normally copper) that, along with accumulated fouling, washes away as the boat moves through the water. Rub a hull coated with a polishing paint and the color transfers onto your hand. Wrongly grouped as "ablative" antifoulings, there are in fact three types of polishing paints: sloughing, ablative and copolymer.

Low cost sloughing paint types contain soft rosin binders and low amounts of copper. These traditional paints slough off a very thin layer of biocide (copper) along with accumulated fouling when the boat moves at high enough speeds through the water. As the paint film slowly washes away over a short season, the surface becomes rougher and eventually accumulates barnacle growth. The boat is hauled in the fall, the bottom scraped and prepped for repainting. Such paints are much too soft for planing boats.

The often-related soap analogy is the best way to describe an ablative paint. These paints wash away like a soap bar pulled through water, releasing biocide for up to 16 months. True wear rate is determined by water temperature, boat speed, film thickness and local fouling conditions. As the surface wears away, it becomes rougher but is smoother than the sloughing types. More durable than sloughing types, ablative paints are a lower cost alternative to the more expen-

PANEL TESTING

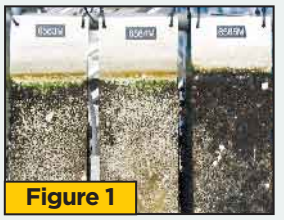


Figure 1

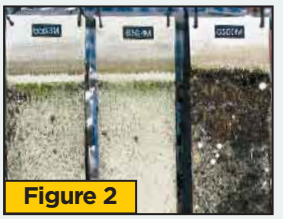


Figure 2

It takes several years from the time chemists develop a new antifouling to when that new formula is ready for market. After proving a new paint in the lab, it then undergoes panel testing before being applied to boat hulls. Chemists use the test data to tweak the formulation and, once finalized, the paint is submitted to the EPA for registration. From concept to store shelves takes five years or longer and a million-plus dollar outlay.

In-water testing is ongoing for existing paints as well in order to monitor service life. The major paint manufacturers submerge paint panels with sample strips of their paints and competitor's formulas in saltwater and freshwater. Panels are inspected at six months, 12 months and 18 months, although some are left in place until complete failure to test longevity.

Figure 1 and **Figure 2** shows a panel series coated with three formulations from tests conducted by Interlux. The panels are photographed immediately after removal from the water for inspection.

Figure 1 shows the unwashed panel. Panel numbered 6563M is covered with about 50% slime and 10% algae plus about 10 barnacles and has some grass at the waterline. Panel 6564M has much less slime but more algae and only five barnacles. At the waterline it appears to have about the same polishing (wear) rate but less grass. Panel 6565M is completely covered with slime and doesn't appear to be polishing at the waterline. There seems to be some detachment as shown by the bright white spots.

Figure 2 shows the panel after rinsing with water flowing from a garden hose (no nozzle) to simulate normal boat movement. This "washing" removes anything that is easily removed and then another photo is taken for comparison. Here the differences become more apparent. Panel 6565M looks to be the best in this group and 6565M is at a stage when no boat owner would be pleased with the poor performance. **JM**

ONLINE PAINT SELECTOR

There are two quick reference sources for antifouling paint selection available online.

If you are considering a Pettit paint, log onto pettitpaint.com/perfect_pick.asp. Answer four questions about where you do your boating, type of boat and how used (trailered, dry stored, etc.) and what properties are most important, e.g., effective antifouling or economy. The answers you provide are used to calculate the recommended paint. You will also find a handy paint selection calculator online at pettitpaint.com/paint_calculator.asp.

The Interlux Paint System Advisor on yachtpaint.com offers paint selection for all systems, calculates surface areas for the hull, deck and topsides and includes application instructions all on one easy input screen.

sive copolymers that are formulated with a controlled wear rate. Both ablative and sloughing types are considered single-season paints. Power washing at haul out strips excess paint and prevents paint buildup, obviating that nasty job of removing thick layers of accumulated paint before applying a fresh coat.

Copolymer types are classified as self-polishing paints. They are the Cadillac of antifoulings and differ from ablative types in that they do not rely on water movement to activate the biocide. The copolymer process binds the biocide and binder so that the paint works much like a timed-release cold capsule. A chemical reaction between saltwater and the resin (these paints are not recommended for freshwater use) causes fresh biocide to release at a controlled rate for superior protection against all types of fouling for up to 36 months. Some of these multiseason paints offer performance equal to TBT. The polishing effect actually makes the hull surface smoother over time, which minimizes drag and potentially translates to improved fuel economy. Self-polishing paints require less biocide for protection, which makes them more environmentally friendly than traditional coatings.

The most durable of all bottom paints are the conventional hard epoxy ester and vinyl types. Recommended for the toughest fouling areas, these paints are heavily loaded with copper in order to maintain effectiveness over a single season. Ultra tough hard paints may expire over time but they won't wear off. They work by dumping high levels of biocide into the water during the first three or four months following launch. After this time, biocide continues to release but at a much slower rate until the paint runs out of the biocide that prevents fouling. Depending on the product used and boat usage, hard bottom paints may require frequent hull scrubbing to dislodge growth, especially boats that stay put for long periods of time. Annual recoating causes paint film buildup and, after four or more seasons, small pockets form that allow algae and slime to populate. The rough bottom adds drag and decreases fuel efficiency and the only remedy is to completely remove the paint layers by chemical stripping or sanding.

The properties that make Teflon perfect for non-stick cookware also make it an ideal ingredient for antifouling paint. Thin film Teflon provides a hard, low-friction surface that does not break down or wear away. A favorite among freshwater and saltwater racing sailors and performance power boaters, the slick Teflon makes it difficult for fouling to attach to the hull. The foul-release coatings that contain no biocide are ideal for rack stored or trailerable boats. Teflon coatings are easily cleaned but require scrubbing on boats left in the water for longer than a few days.

Copper-free alternatives include Bluewater Coronado, Epaint EP2000, Interlux's just released Pacifica, Pettit Vivid Free and SeaHawk Mission Bay. These are copper-free, medium strength, single-season antifouling paints that work best in freshwater and cooler coastal saltwater.

Special purpose bottom paints are generally applied on aluminum boats, sterndrives and other underwater metals. Paints in this category use alternative biocides other than copper. Some contain a slime fighter and, when properly applied over a primer, offer excellent antifouling protection for fiberglass and wood as well.

Due to government legislation, not all bottom paints mentioned in this article are sold in all countries or in California. Check paint regional availability with your dealer and don't consider importing such paints into areas where their use is prohibited.

Match Making

Now that you know the difference in paint types, how do you choose the right one for your boat? That depends on what type of boat you have (planing versus displacement) and the hull material, where you keep your boat and how often it is used, what paint is currently on the boat and how much you are willing to spend.

You can apply most any bottom paint to a fiberglass or wood hull; aluminum hulls require a non-coprous oxide based coating to prevent corrosion of the aluminum from exposure to the galvanically incompatible copper. Cuprous thiocyanate is a copper derivative used in several aluminum paints. While most antifouling paints can be used in fresh, salt or brackish waters, some are developed for freshwater use only and generally are not intended for boats used in saltwater. Boats located in warm, southern waters need more effective antifouling protection than boats in northern regions and benefit best from an ablative, copolymer or a heavy metal hard paint. No single paint is best for all boats, at all times or in all conditions.

For boats that are used infrequently, a hard type with a high copper content is a better choice versus an ablative paint that requires movement or some tidal action to maintain the self-washing effect. Recommended for the toughest fouling areas, hard types can overcoat most paints, an advantage if you are unsure of what is on the bottom. Fast drying resins allow a three-hour or so overcoat window and launch the same day. This makes them ideal for painting pad areas before launching. Hard paints offer only one season protection, may require maintenance scrubbing to keep clean and you cannot haul out mid-season without losing protection.

Single-season soft or sloughing antifoulings offer a low cost alternative for non-planing, low-speed boats, generally those that travel under 10 knots. These coatings have a short two-day coat-to-launch window to maintain effectiveness.

Dry stored boats benefit from a hard Teflon paint. These are the easiest of

THINK OF IT AS WILDLY COLORFUL UNDERWEAR, NOT OFTEN REVEALED BUT, WHEN IT IS, GRAB YOUR SEAT AND HANG ON.

ViViD, THE MOST EFFECTIVE, ABLATIVE ANTIFOULING IN 24 BRIGHT COLORS PLUS THE WHITEST WHITE AND BLACKEST BLACK.

www.pettitpaint.com • 800-221-4466

TOP PAINTING MYTHS

- **Myth #1:** The biocide quantity does not determine how well an antifouling paint works. Heavy metal paint containing 75% copper is not necessarily more effective than one containing 39% copper. It is the formula of biocide, combined with other ingredients, that determines a paint's effectiveness.
- **Myth #2:** Color is obviously a personal preference but it should not be the first consideration. Select paint for its performance, not color.
- **Myth #3:** Not all copper biocides are equal. A black antifouling that dries purple when applied contains a cheaper grade of cuprous oxide.
- **Myth #4:** An antifouling is not a barrier coat. Water still migrates through the paint film to the substrate. If you are concerned about the fiberglass laminate absorbing water, consider applying a barrier coat before bottom paint.

all antifoulings to apply and require no sanding. Transparent VC Eco and white VC Performance are both brushable foul-release Teflon coatings. They are the ideal solution for boaters who want to keep a white hull, don't want to apply an antifouling but still want a clean bottom. There is no paint buildup and most are overcoated after a light sanding, when and if it becomes necessary to apply a biocide-based antifouling. Conversely, applying Teflon paint over an antifouling necessitates complete removal of the existing coating. Teflon type hard paints help to keep underwater metals clean when applied over a barrier coat (e.g. Interprotect).

Ablative paints need water washing action to keep the hull clean. Meet this precondition and you might get two-season protection with little maintenance. On the other hand, a boat that is seldom used builds up a resin layer at the surface that blocks the biocide from releasing and fouling occurs. Just like a soap bar that wears away faster in warm water versus cold water, these paints, when in tropical waters, need recoating more often.

Quite the opposite, copolymer paints self-polish by a chemical reaction so the biocide is constantly renewed regardless of whether the boat is underway or sitting at the dock. There is not a critical coat-to-launch time and, as long as the coated surface contains paint, there's no limit as to the number of times you can haulout and then launch again. This is especially beneficial if it becomes necessary to haul out for a few weeks to undergo repairs or ride out stormy weather ashore. Hard bottom paint would require prep and repaint before relaunch. Since both ablative and copolymer paints wear away, there is no paint buildup, which means no stripping and many types require no sanding between coats. These paints do, however, require application of multiple coats (see "Application Tips" on the next page) for maximum protection. This makes for a higher initial investment in paint and labor to apply it but you'll save in the long run by eliminating routine haulouts, hiring a diver to scrub the bottom and successive season paint purchases.

For boats that are dry land stored for the off-season, copolymer paints are the best choice. Marginal decay from UV degradation doesn't affect the paint. Lightly scuff the surface with a Scotch-Brite pad and, when launched,

the paint softens to provide the same fouling protection of the original coating. Take advantage of the long paint-to-launch window by applying the paint in the fall so the boat is ready to launch in the spring.

Sportfishing and other fast boats running over 50 mph will quickly erode a polishing paint. These hulls are treated with a hard, high-performance Teflon-based antifouling paint, usually spray applied, and then given a "Carolina belly band," a copolymer applied around the waterline.

If you keep your boat in an area that naturally gets a lot of slime and sediment or your boat rarely leaves the dock, select paint with a slime additive.

Service life is directly proportional to environmental conditions, such as water temperature, oxygen content, salinity, UV exposure, etc., as well as boat speed and how the boat is used. Even the paint color choice may affect performance. Consult your marine store or contact the paint manufacturer directly for help in choosing the right paint for your boat.

Application Tips

Antifouling paints are applied using the traditional painting methods of brush, roller or spray. Most are ready to go straight from the can after a thorough stirring. As a rule, do not thin a bottom paint that is brushed on. The exception is in hot, humid climates when it becomes necessary to add a couple of capfuls of thinner to augment paint flow. For every coat thinned, you will need to apply another coat.

Whether sanding or painting, safety is critical. You are working with potentially harmful products and this requires full body coverup. Don protective overalls and wrap masking tape around the wrists and ankles to seal openings, wear a headscarf or hat, goggles and gloves. Immediately after sanding or painting remove your clothes, turn them inside out and stuff in a plastic bag for next week's wash.

Some paints require surface preparation by light sanding with 80-grit paper. Pros recommend using 3M Purple sanding discs, a resin-backed diamond abrasive, to achieve the best sanding anchor pattern; other sandpapers are too soft. Change the paper often to maintain the scratch depth. Sanding begins with 80-grit paper for most paints, followed by 120 grit. Ablative and copolymer paints do not normally require sanding, other than at the waterline, provided the boat was pressure washed at haul out.

Before painting a new hull, check the hull warranty. Sailboat builder Beneteau, for example, stipulates sanding only with 600 grit or finer before painting or voids the gelcoat warranty. Refer to the paint manufacturer's surface preparation procedures on the can label.

ADDITIONAL READING

DIY's MRT Series "Painting & Refinishing" CD-ROM contains all past articles that discuss in detail surface preparation, paint application and solutions for professional results.

It is common practice with ablative and copolymer paints to apply a "signal" coat as the first coat. This is a different color than consecutive coats and acts as a marker to indicate paint wear. This means, if you want a blue bottom, put a coat of red on first and then two coats of blue. Wearing away of the outer paint layers exposes the red or signal coat and it is soon time to book a haulout and repaint. Exposure to intense UV light along the boat's waterline and about 8" (203mm) below causes all antifoulings to wear away faster. For maximum protection, it is good practice to apply extra coats at the waterline.

Custom tints are possible by mixing colors within the same paint category together. Mix blue and green Micron CSC, for example, to make an aqua color or mix blue and white Trilux for a powder blue. With Pettit Vivid, you can custom mix to create a multihued color for that one-of-a-kind look.

Lest you assume that having the perfect paint will cure your fouling blues, there are other factors in assuring success at fending off marine growth. Whether you do the job yourself or assign it to professionals, the right combination of humidity and air and surface temperatures is crucial to a successful paint job. Follow the application instructions for your chosen paint.

Just as important is applying the recommended dry film thickness. The film thickness for boats under 70' (21.3m) length overall is 3 to 4 mils (1 mil equals 0.001 inches). Check the film thickness by measuring the depth of the paint ledge along the masking tape line. It is equally important to strictly adhere to the dry-to-recoat and dry-to-launch times. Failure to do this or to apply the recommended number of coats at the suggested film thicknesses can decreases the paint's service life. If applying by roller, a 7" (177mm) wide phenolic core roller with a chunky 3/8" (9mm) nap helps to apply sufficient paint. If the instructions advise using 2 gallons over "X" square feet of wetted surface, apply the full 2 gallons.

Long Term Outlook

Asia's appetite for copper has driven antifouling prices skyward. West Marine prices for high load copper paints, such as Pettit Trinidad and West Marine Bottom Pro now cost as much as 33% more than in 2005.

The necessity for environmental responsibility drives many technological developments and, since the TBT ban, antifouling paints have evolved into high-tech, complex coatings. As manufacturers continue their quest for the Holy Grail of antifoulings, a formula that is more tender to the marine environment yet controls fouling on the hull, we boaters benefit from an ever-increasing multitude of better antifoulings. It's a win for all sides of the issue.

About the author: Jan Mundy is co-founder and editor of DIY.

A compatibility chart comparing all the major antifouling brands is available on the DIY Ezine, the online edition of DIY magazine, accessible to digital subscribers only. To subscribe go to diy-boat.com.

PAINT COMPATIBILITY CHART

OLD ANTIFOULING / NEW ANTIFOULING	Micron Extra Micron CSC Tri-Lux II Ultima Awlstar WM PCA	Micron 44/c Micron 33 Trilux II T/33 Alumacoat/SR Vivid Aluma Spray BioCop	Fiberglass Bottomkote ACT Super Ablative Epoxycop Ablative Horizons WM CPP Cukote	Ultra Ultra-Kote Unepoxy Fiberglass Bottomkote Super KL Epoxycop	Trinidad Trinidad SR WM BottomPro WM BottomShield BW Coastal	BottomKote BottomKote XXX Komposition Premium SSA Tropicop	VC Offshore Baltoplate Vinyl Antifoulings	VC 17m Extra VC 17m SR-21 WM FW-21	Fiberglass BottomKote Aqua Neptune II Aquaclean Hydrocoat
Aquagard	Heavy sand & apply	Heavy sand & apply	Heavy sand & apply	Heavy sand & apply	Heavy sand & apply	Heavy sand & apply	Heavy sand & apply	Remove all paint	Heavy sand & apply
ePaint EP-2000	Remove all paint	Remove all paint	Remove all paint	Remove all paint	Remove all paint	Remove all paint	Remove all paint	Remove all paint	Remove all paint
ePaint EP-21	Heavy sand & apply	Heavy sand & apply	Heavy sand & apply	Heavy sand & apply	Heavy sand & apply	Remove all paint	Heavy sand & apply	Heavy sand & apply	Heavy sand & apply
Interlux Micron CSC	Lightly sand & apply	Remove all paint	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint	Lightly sand & apply	Remove all paint	Lightly sand & apply
Interlux Fiberglass Bottomkote ACT	Lightly sand & apply	Remove all paint	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint	Lightly sand & apply	Remove all paint	Lightly sand & apply
Interlux Fiberglass Bottomkote	Heavy sand & apply	Thoroughly sand & prime	Heavy sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint	Lightly sand & apply	Remove all paint	Lightly sand & apply
Interlux Tri-Lux II	Lightly sand & apply	Thoroughly sand & prime	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint	Lightly sand & apply	Remove all paint	Lightly sand & apply
Interlux Trilux Prop & Drive	Heavy sand & apply	Thoroughly sand & prime	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint	Heavy sand & apply	Remove all paint	Lightly sand & apply
Interlux VC 17m	Remove all paint	Remove all paint	Remove all paint	Remove all paint	Remove all paint	Remove all paint	Lightly sand & apply	Clean & apply	Remove all paint
Interlux VC Offshore; Baltoplate	Remove all paint	Remove all paint	Remove all paint	Remove all paint	Remove all paint	Remove all paint	Lightly sand & apply	Remove all paint	Remove all paint
Interlux BottomKote XXX	Lightly sand & apply	Remove all paint	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint	Lightly sand & apply
Nautical Super Ablative	Lightly sand & apply	Remove all paint	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Heavy sand & apply	Lightly sand & apply	Remove all paint	Lightly sand & apply
Nautical Epoxycop Ablative	Lightly sand & apply	Remove all paint	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Heavy sand & apply	Lightly sand & apply	Remove all paint	Lightly sand & apply
Nautical Super KL	Heavy sand & apply	Remove all paint	Heavy sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint	Lightly sand & apply	Remove all paint	Heavy sand & apply
Nautical Epoxycop	Heavy sand & apply	Remove all paint	Heavy sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint	Lightly sand & apply	Remove all paint	Heavy sand & apply
Pettit Trinidad/SR/VOC Unepoxy/VOCC	Heavy sand & apply	Heavy sand, prime & apply	Heavy sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint	Lightly sand & apply	Heavy sand & apply	Heavy sand & apply
Pettit Vivid	Heavy sand & apply	Heavy sand, prime & apply	Heavy sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint	Thoroughly sand & prime	Heavy sand & apply	Heavy sand & apply
Pettit Horizons Ultima SR	Lightly sand & apply	Remove all paint	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint	Lightly sand & apply	Heavy sand & apply	Heavy sand & apply
Pettit Hydrocoat	Lightly sand & apply	Heavy sand, prime & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint	Lightly sand & apply	Heavy sand & apply	Lightly sand & apply
Pettit Premium SSA Seamate Yacht Copper	Heavy sand & apply	Remove all paint	Heavy sand & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Heavy sand & apply	Heavy sand & apply
Pettit Alumacoat SR	Heavy sand & apply	Heavy sand, prime & apply	Heavy sand & apply	Heavy sand & apply	Heavy sand & apply	Remove all paint	Thoroughly sand & prime	Heavy sand & apply	Heavy sand & apply
Sea Hawk Mission Bay Cukote	Lightly sand & apply	Lightly sand, prime & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply		Lightly sand & apply
Sea Hawk Mission Bay CSF	Lightly sand & apply	Lightly sand, prime & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply
West Marine FW-21	Remove all paint	Remove all paint	Remove all paint	Heavy sand & apply	Heavy sand & apply	Remove all paint	Lightly sand & apply	Clean & apply	Heavy sand & apply
West Marine PCA	Lightly sand & apply	Remove all paint	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint		Heavy sand & apply	Heavy sand & apply
West Marine BottomShield	Heavy sand & apply	Heavy sand, prime & apply	Heavy sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint	Lightly sand & apply	Heavy sand & apply	Heavy sand & apply
West Marine CPP	Heavy sand & apply	Thoroughly sand & prime	Heavy sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint	Lightly sand & apply	Remove all paint	Lightly sand & apply
West Marine BottomPro	Heavy sand & apply	Heavy sand, prime & apply	Heavy sand & apply	Lightly sand & apply	Lightly sand & apply	Remove all paint	Lightly sand & apply	Heavy sand & apply	Heavy sand & apply

Notes: Use this chart as a guideline only. Check specifics with the paint manufacturer.

LUBE JOB

Follow these lubrication steps to get your sterndrive ready for the coming season.

Story and photos by Steve Auger

Lubrication is the life blood of your sterndrive and most of this service work is easily performed by weekend mechanics with standard hand tools. The key to a successful job is in the proper selection of grease or oil since all lubricants are application specific.

Each drive manufacturer has recommended oil for each specific make, model and year of sterndrive unit. Refer to your owners' manual or service manual for the specific oil or lube for your application. Never substitute a non-approved oil for the specific oil required. Using the wrong oil or insufficient oil can result later in a very expensive repair due to gear set or bearing damage. Cheaping out here is a false economy.

Early OMC drives from the 1970s have two gear set oil cavities that use hypoid oil in the upper gear set and OMC type "C" in the electric gear case. Later '80s 400 and 800 series OMC models use hypoid in both gear oil cavities. Both the electric and 400/800 series drives have a dipstick to check the oil level and condition in the upper gear set. Having a dipstick that shows oil at the full mark does not mean the lower gear case is full so check each cavity independently. These early OMC drives also have a tilt system clutch pack oil cavity that requires annual oil servicing and an output shaft oil cavity requiring service as well. OMC Cobra drives from the '90s have a single oil cavity. On these models, the clutch pack and output shaft oil cavities were eliminated.

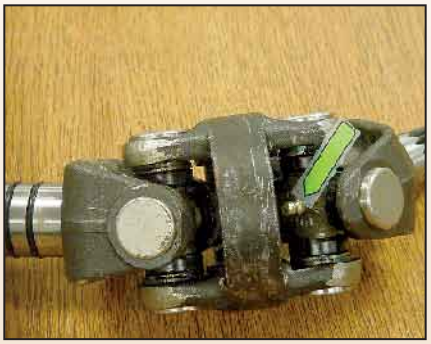
Early Volvo drives require 10W-30 motor oil and later models use hypoid gear oil.

Mercruisers' original oil recommendation was hypoid oil but that recommendation has been changed to a semi–synthetic, high performance gear lube.

Most marine drive manufacturers recommend changing the oil every 100 hours or annually, whichever comes first. [Ed: Step-by-step procedures for doing a drive oil change appears in DIY 2007-#1 issue.] Always purchase a little more oil than you require as most consumer-type oil pumps do not pump all the oil out of the bottle. It's good practice, when draining the gearcase,

Use the specified lubricant for your application — no substitutions!

Engine couplers and the shaft splines require a special high-pressure grease.



Universal joint grease fitting on an older Alpha One sterndrive.

One of two hinge pin grease fittings located on an older (1990) Alpha drive gimbal ring. Note the protective cap.

Engine coupler grease fitting on a 2008 Mercruiser.

Green arrow shows the full mark on the gear-lube reservoir.

(top) This hand pump greatly simplifies refilling the drive oil. The pump connects to a 1 quart (946ml) gearlube bottle and the hose end screws into the fill hole on the drive. (bottom) The pros use a Stevens Equipment gearcase filler model S-33 to change gear oil.

to capture a small amount of oil in a clear plastic container for inspection. Look for large chunks of metal or any signs of water. If you find either, your sterndrive unit needs professional attention from a marine mechanic. If the oil is black (burnt), change the sterndrive oil more often. Modern sterndrives have a magnet pressed into the fill screw to capture the fine metal particles and a small amount of metal filings is normal. Always replace the fill and vent screw gasket or O-ring with a new one to prevent seawater from getting into the gear oil. If the fill/vent screw is not in good condition, replace it with a new one.

Some oils are specific to the application. Never mix oils or you could contaminate the original lubricant. Green arrow shows the full mark on the trim pump.

Lubricate propshaft splines once a year and always torque on the prop nut.

After completely draining the old drive oil, place a gearcase pressure tester in the vent hole. Install and tighten the fill screw, complete with a new washer in the fill screw fitting of the gear case, and pump up to 7 psi. Turn the input shaft and prop shaft and note the reading. The pressure should remain constant at 7 psi. If not, inspect the drive for a leaking oil seal. If the drive passes the pressure test, install the oil pump in the fill screw hole, remove the vent screw and pump the oil into the drive until you see new clean oil run out of the vent screw hole. Install the fill screw (with the new gasket) and tighten securely with the large flat tip screwdriver. Remove the oil pump fitting from the fill screw hole and install the fill screw and tighten securely. Repeat this process for each oil cavity of the sterndrive. Early Mercruisers (1969 to 1971) have two oil cavities and OMC drives up to 1984 have four separate oil cavities in the drive that need filling separately. You'll find this information in your service manual.

For models with a gearlube monitor, fill the reservoir with oil to the full line and then remove the vent screw from the drive and allow a small amount of oil (1 to 2 ounces/29ml to 59ml) to flow out of the vent screw hole. This allows any air in the oil reservoir line to bleed off. Reinstall the vent screw and tighten securely and then top off the reservoir to the full line. Note the oil level in the reservoir prior to operating the boat each day. It is normal for the level to drop a little after servicing; however, if the oil level continues to drop after operating the engine a couple of times, there is a leak and the drive needs further inspection.

Servicing Power Trim Pumps

Other than the proper power trim oil, an oil can and shop rags, modern power trim system oil fills do not require any special tools. Use a large flat-tip screwdriver to remove fill screws on older trim pumps. When using metal tools on a trim pump, be sure to remove the trim pump battery cables prior to servicing the pump. Most sterndrive power trim systems use 10W-30 motor oil though some systems require special lubricants so refer to your engine's service manual prior to servicing the pump.

Power trim oil does not need changing unless it is contaminated with metal or water. Inspect the power trim oil in the power trim pump reservoir. If the oil is clean, all that's needed is to ensure the oil level in the reservoir is correct. Always check the oil level with the drive in the full down or "tucked in" position. If the oil is contaminated replace the oil and have the system tested by a professional using a power trim pressure test kit.

Most modern sterndrives offer passenger impact protection that is part

TIP

Oil Booster

When changing gearlube in cold weather, heat the oil by placing the container in a pail of warm water, which will make the oil flow more easily.

of the power trim system. If the oil is contaminated, then the impact protection system may be compromised. You would not drive a modern car without a seat belt so keep the system in good working order with clean oil to be sure that the impact protection is working at peak efficiency.

Zerk Overhaul

Most sterndrives have grease fittings, often referred to as zerk fittings, for the drive and transom assembly. There are specific lubes for universal joints and gimbal bearings, input shaft/engine couplers and some pivot points, such as the power steering control valve and OMC drive trunions. Always refer to your service manual prior to purchasing grease as some of these specific application lubricants are not compatible with one another and actually break down if contaminated with an incompatible lubricant.

Most grease fittings are easily serviced using a standard automotive grease gun and grease points include but are not limited to the following areas: upper and lower steering shafts; universal joints; input shafts; gimbal bearings; hinge pins; propshafts and engine couplers.

Gimbal bearings, hinge pins and steering pins and some modern engine couplers are usually lubricated without removing the drive from the transom assembly. Models incorporating universal joints and older style (around 1985 and prior) engine couplers require removal of the sterndrive unit from the transom assembly. If this is out of your skillset, then hire a pro. When removing the sterndrive, check and, if required, adjust the engine alignment prior to reinstalling to ensure maximum engine coupler and universal joint life.

Many current sterndrives use plastic bushings for their steering and bell housing hinge pins, instead of bearings, and these models do not require lubrication.

Remove the propeller and lube the splines with a high quality water proof grease such as Quicksilver 2-4-C or equivalent and reinstall the prop. Always torque the prop nut to spec.

Remove trim ram anchor pins and coat with waterproof grease and reinstall. Always tighten trim ram nuts until they are seated against the anchor pin. Discard and replace old or worn fasteners. Common practice is to discard and replace most prop nuts and sterndrive installation nuts after being torqued three times.

From start to finish this entire lubrication process takes about an hour to an hour and a half unless you get into a major engine alignment issue.

About the author: Mercury Mercruiser master technician and DIY's engine technical advisor, Steve Auger, has more than 35 years experience in marine retail, manufacturing and training, mostly with Mercury Marine.

ADDITIONAL READING:

Step-by-step instructions on preparing your sterndrive and transom assembly for another boating season including changing the drive gear oil appears in DIY 2007-#1 issue.

Slip Sliding Away

Keep your grip on deck with a reliable skid-resistant painted surface that provides secure footing and looks great.

Story and photos by Zuzana Prochazka

About the only thing more frightening and annoying than a slippery deck surface when you are trying to reef the mainsail is discovering that the aging non-skid is cracking and peeling right under your feet. That was the case on our 1985 Celestial 48 center cockpit ketch when the slip-resistant surface started peeling as if after a bad sunburn and therefore launched us into full non-skid repair mode.

The first signs of non-skid (a common misnomer and more appropriately named slip-resistant) trouble showed up after a boat bath. Areas of non-skid bubbled up and trapped the wash water underneath, which oozed out for hours as the boat dried. Soon, long, spidery cracks in the non-skid appeared and the gelcoat surface started to show through.

Since we'd owned the boat for only five of its 22 year life, we had no idea of the origin of the non-skid. The Celestial has molded-in, raised, gelcoated areas (intended for non-skid) separated by water channels on the cabin top. The rest of the deck is teak. This deck repair involved clearing six sections out of the total 10 for approximately just over 50 sq.ft (4.6 sq. m). During removal, we noticed that the starboard side, where the non-skid came up easily in dinner plate sized chunks, was yellow underneath as if it had been epoxied. The port side, where the non-skid came up only under extreme protest, had a white undercoating. We deduced that one side (probably starboard) had been repaired already by the previous owner.

Diagnosis and Removal

We wanted an aggressive surface but one that wouldn't remove skin when sat or knelt upon and, once we realized how difficult it was to remove the old non-skid in the areas where it wasn't already sloughing off, we decided that we would do only the affected areas. Therefore, we needed to match not only the color but also the texture of the previous non-skid. The question of which medium to use was quickly answered: neither ground cork nor walnuts, neither plastic pellets nor premixed non-skid paint, neither Treadmaster nor Flex-Mold. Sand was the answer, or rather 20-grit silica from a hardware store, and Awlgrip two-part polyurethane paint.

A metal scraper and gloved hand did most of the removal on one side but the other required a heat gun and much elbow grease. Working from the edges, the metal scraper was inserted under the non-skid and then firmly pushed as the heat gun warmed up the surface ahead. The key here was to avoid overheating the gelcoat and nearby varnished surfaces.

Surface Prep

The raised surfaces actually helped in surface prep. First, it was easy to follow the curves of the areas when taping and second, it was easier to keep the power sander only on the areas that stood proud rather than scratching the rest of the gelcoat.

We roughed up the surface with an angle grinder and a 6" (152mm) disk with a soft backing pad and 80-grit sandpaper. We then dusted and wiped before taping. We used 3M Fine Line 1/4" (6mm) masking tape first because it hugs curves easily. Rubbing the tape with a Scotch-Brite pad made sure it adhered evenly. Regular 1" (25mm) tape was then used to widen the protected edge. A third layer of 1" (25mm) tape was applied for removal between coats of paint.

We had only a few minor gelcoat dings to repair, which were faired to provide an even surface before application of the first layer of paint. Color matching wasn't an issue since the patches would never be seen.

Application

We used Awlgrip two-part polyurethane paint mixed with Awlgrip topcoat converter (H3002). There is a third ingredient, the Pro-Cure X-138 accelerator, or "hot sauce" as known by the boatyard folk, and it was the catalyst that determined the drying time. The more hot sauce, the faster we needed to work. We found about a capful to a quart (946ml) worked well.

Our primer coat was Awlgrip Matterhorn White, applied directly to the gelcoat. We investigated doing an epoxy coat but since that is what seemed to fail on the last repair, we skipped it. The white paint contrasted with the gelcoat to show coverage.

This part most definitely required two people as one painted and one liberally sifted the sand onto the wet paint spreading it to an even depth of about 1/8" (3mm) as if tossing feed to chickens. It's key to keep about a foot of clean wet edge between the painter and the sifter and to work with the wind or during early morning calm.

Within 45 minutes, we used a leaf blower to remove all the excess sand and were left with a very even and consistent surface. We then pulled the top layer of tape to minimize the mess on the sandy edges.

Our next two coats were done in cream that matched the sections we were not redoing. We did not use a flattening agent so the decks have a bit of sheen but are still quite grippy. We found that rolling with the edge (rather than toward or away from it) minimized the tiny splatters. We used ordinary short nap 6" (152mm), small diameter rollers from a hardware store.

Awlgrip needs to be applied in coats when it is still tacky so we had no more than 45 minutes between the two top-

The first signs of non-skid failure on the cabin top appeared as bubbled areas, which cracked and ran in extended veins in all directions.

On the starboard side, which was apparently repaired once before with an epoxy base, the non-skid came off easily in large chunks.

On this boat, the areas originally covered with non-skid are molded in as raised platforms. This made the taping and sanding easier.

On the port side, where there were fewer cracks and no evidence of a previous repair, the removal was tough going, requiring multiple scrapers, a heat gun and lots of elbow grease.

The starboard side with the non-skid removed, just prior to sanding. The yellow epoxy was markedly different from the white underneath on the port side.

The medium, in this case 20-grit silica, was applied liberally to the first coat of paint. One layer of the regular tape was pulled after this application. The more medium that is applied, the better the chances of it being consistent but excess sand does get everywhere.

coats, which was just enough to start mixing a new batch. We found that two coats gave us the texture we were looking for but a third coat can be applied for a smoother surface.

We used about 1 gallon (3.78L) of paint in total for the three coats. The first coat over the silica needed mixing additional paint as the sand provided more surface area. We did have leftover paint after each coat, which we used for engine room floorboards and even to paint the dock box so it's difficult to estimate exactly how much we used for our deck.

Finishing Touches

We began pulling tape 30 minutes after the last coat of paint. Waiting longer resulted in the slippery vinyl tape separating from the paint unevenly. Where we didn't get a clean edge, we trimmed the non-skid with a razor and then pressed it down with our fingertips. It was all dry to the touch after about 90 minutes and fully cured after 24 hours.

Four of the sections were done one weekend when there was a cool breeze. The other two sections were done the following weekend when local conditions known as the Santa Anas sent blasts of hot, dry wind across the deck. Those last two sections were problematic in that they dried quickly and kept us hustling between coats. The high temperature also caused the tape to leave an adhesive residue behind. We found the best clean up for this was to wait a week as the adhesive dried and yellowed so it was visible and then scrape it off with a plastic scraper to avoid gouging the gelcoat.

Reflections

A quick word about sand. There is no nook, cranny, channel nor pocket that it won't find and settle into. It makes for an extremely messy job that revisits you weeks and months later when you

DIY BILL OF MATERIALS

1 gallon (3.78L) Awlgrip Polyester Urethane Topcoat Base	$292
1 quart (946ml) Topcoat Converter and Pro-Cure catalyst or "hot sauce"	$95
25lb (11.3kg) 20 grit silica (approx 25 lbs)	$4
3M Fine Line and regular tape	$13
6" (152mm) short nap rollers, frames, mixing cups, paint trays, sanding pads	$28
Band-Aids and burn gel (heat guns are not for the uncoordinated)	$2
Total:	**$434**

The first coat applied on the medium requires mixing extra paint due to the increased surface area the sand creates.

A liberal application of the medium topped with two coats of paint resulted in a consistent, clean and grippy surface. The 3M Fine Line tape rubbed with a Scotch-Brite pad left a clean edge that looked as if it came from the factory.

shake out an outboard cover or pull a winch handle out of a locker. Sand or silica medium is also abrasive and can scratch Lexan, gelcoat and varnished surfaces and therefore it is best to clean thoroughly, and then repeat.

Wanting to avoid splatters on our new hatch lenses, we left the Sunbrella covers on. However, the silica found its way underneath the covers and had to be blown off, followed by rinsing and finally wiping the lenses to prevent scratching. After a repair like this, check every surface before walking or sliding on it to make sure it is clean.

The lighter color the silica, the better. No matter how good the paint, a non-skid surface has many points and ridges from which the paint will eventually wear off and a light colored medium will look better under a light colored topcoat.

It is best to leave any small bugs or other airborne presents that land on the last coat until the coat is completely dry. Most will brush or wash off later and you don't want to make indentations as you pick anything out.

If prep was 40% of the job, then clean up in this case was another 40%, which left a very quick and easy repair job in the middle. We expect our new non-skid will last at least five years, hopefully longer, so we can avoid slip sliding away as we move around on a wet deck in the future.

About the author: Zuzana Prochazka has been sailing Pacific waters for 10 years and holds a USCG 100 ton license. She and her husband Ike are refitting a Celestial 48 center cockpit ketch in hopes of one day cutting the lines.

Software SHOWDOWN

The market for chart data navigation software displays continues to expand with even better features and more integration but how good are they? This review will help you with your buying decisions.

Story and photos by John Meskauskas

Poll any group of cruisers about how many in the audience have a computer aboard and a lot of hands go up. Are these onboard computers for email and web surfing? There's more to this trend than that as all-electronic charting, updated via satellite link, is a reality for recreational boaters. Hydrographic technology and the marketplace now give boat owners options like raster charts, vector charts and commercial versions of vector charts produced by Navionics and C-Map.

Software to display this data spans the gamut in features and pricing and all of them do a good job of the basics of chart display. Increasingly, programs also integrate shipboard instrument displays, control autopilots and other devices, and provide communications links with satellite-based weather information providers.

The field of electronic charting is at a curious juncture. The electronic image of a paper chart (a "raster" chart) is the starting point for all other charts. If you display a raster chart and zoom in more than, say, four levels, the problems become obvious. As the symbols grow in size, you can't identify the precise coordinates of a sounding or a buoy. Vector charts fix this problem by linking the data and its display. The vector chart is a series of overlays on a base outline controlled by databases that control what you see at various zoom levels. This method also allows information to be geo-referenced. As the pointer position moves over the chart, windows pop up to display information, such as depths, buoy characteristics, commercial installations or marina locations. There is no limit to the amount of this ancillary information.

The S-57 chart, required on all boats larger than 150' (45.7m) engaged in international voyages, is the commercial standard worldwide. Although free online for the U.S. at nauticalcharts.noaa.gov/mcd/enc/index.htm, S-57 charts are often not very useful to boaters because they don't always include information for channels, like the Intracoastal Waterway. Boats less than 150' (45.7m) are technically required to carry paper charts even though they may have a system capable of displaying electronic charts (unless that system meets SOLAS ECDIS specifications). This requirement may well be met by printing charts for one's route before departure.

Navionics and other map companies create vector charts for most areas of the world, depicting all data one would expect on a raster chart, plus other data such as marina information. As the recent discovery of numerous errors in Nobeltec Passport charts and software shows (see "Nobeltec Admiral" on page 44), errors may be introduced in the process of making commercial charts or display software, so caution is required.

Navigation programs have many features to consider but quilting is one of the most significant. As your boat nears the edge of a chart, quilting "stitches" charts together, selecting adjacent charts automatically, adjusting to a common scale, and showing the result as a continuous display. This allows you to "see ahead" across chart boundaries, seamlessly and automatically.

Commercial ships are required to automatically transmit their identification and route information through the Automated Identification System (AIS).

HARDWARE FOR CHART DISPLAY

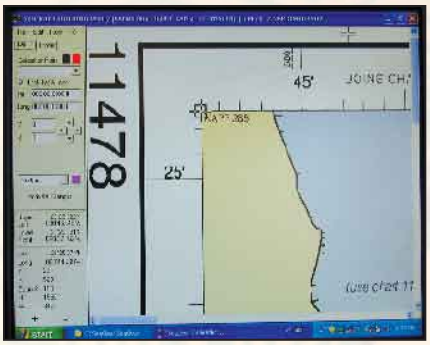
Selecting a computer for displaying charts is a major consideration. If your boat has an enclosed navigation station or a weatherproof enclosure, virtually any computer may work. If not, choices narrow to equipment capable of exposure to the elements.

Rugged laptops for military and field work are designed to a Mil-spec standard that requires being able to withstand 4"(101mm) of rain per hour and being dropped from heights up to 4'(1.2m). These machines are sealed, use sealed connectors and have latching doors. They are available new from Dell, Hewlett-Packard, Itronix and Panasonic at costs typically above $2,000. Models coming off lease are available used at prices as low as $200. Used equipment lags current equipment by several generations but that's not a problem as navigation software is not particularly demanding of computer resources. Use eBay search arguments like "ruggedized laptop," "Itronix," and "Panasonic Toughbook." Look for a machine that has a touch screen, a wonderful feature on a rocking boat. It will spoil you.

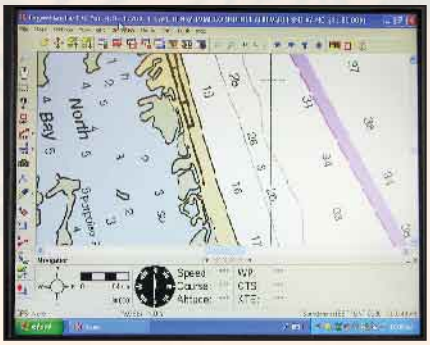
You also need a GPS capable of producing NMEA 0183 output. The connection is made to a serial port or (increasingly) USB port. Check the output cable on the GPS and the available ports on your computer. If your GPS has a nine pin DB9 connector and the computer only USB, get a USB-to-serial adapter from Quatech or Jeppesen Marine. These adapters can be tricky to set up for some reason. If an adapter does not work properly on your computer, consider a new GPS antenna, which has the connector you need. Waterproof antennas are commonly found for car navigation uses but if you use a car-quality GPS, buy a spare for when it fails.

If your boat has an open helm, you have two major issues: finding a computer with a screen bright enough to be seen in full daylight and a way to mount it. The Panasonic Toughbook CF-08 wireless battery-powered screen designed for outdoor point-of-sale use works well for marine use. It allows the computer to be in a weather-protected environment while the screen is out in the open.

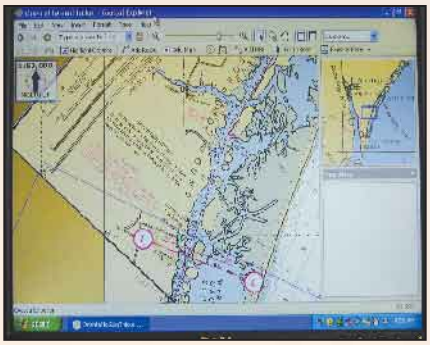
Beyond these basics, consider integrating instrument displays, which allows the removal of a lot of bulky equipment and pods around the helm. Most of the programs reviewed in this article allow display of instrument data but the issues in making these connections are beyond the scope of this discussion. **– JM**



SeaClear map calibration utility whereby the user can scan a chart and calibrate it using known points.



A raster chart on the Fugawi main screen with speed, course and altitude and route information.



Coastal Explorer's quilting feature shows a map inset, a scale inset and a green boat icon showing the position of the boat.

Several of the programs reviewed here are capable of reading the output of an AIS receiver and displaying AIS information on the screen. This is a wonderful safety feature. Single-handers and those crossing shipping channels will not want to leave port without it. [Ed: the selection and installation of AIS devices will appear in DIY 2008-#4 issue.]

Testing Criteria

This article reviews seven navigation software packages. Five of the programs run on Windows, one on Mac and one on Linux. I evaluated each package in much the same way that a potential buyer would: compare and appraise, leading to a purchase then install, select charts and build routes followed by on-water usage.

Among the selection factors shown in **Table 1**, the feature set rating is primarily an opinion. Each package offers a very impressive set of capabilities, going far beyond the core requirements of chart display, boat position and route creation. You may well find features, such as AIS data plotting, that you want to add to later.

Installation experience (**Table 2**) summarizes my experiences in installing the software, associated charts and connecting a GPS.

The charts and routes (**Table 3**) covers chart display, manipulation and routes. If you're a traditionalist like me, you may be most comfortable with raster charts in north-up orientation. Others may prefer vector charts, perhaps in course-up or waypoint orientation. Chart manipulation when displaying boat position shows major differences among programs. With the GPS on, your boat is at a fixed position on the screen and the chart is moved to display where you are. Quilting, the "stitching together" of charts, allows you to "see" beyond the edge of the chart. The ease with which routes can be created, edited and named is also a major differentiator.

Program usage shown in **Table 4** reviews a variety of factors that affect the use of the program under way or when needing support.

The on-the-water testing was done primarily aboard a Hallberg-Rassy pilothouse ketch. An attempt to use an Itronix laptop in an open Boston Whaler center console showed that the screen visibility was poor in bright daylight. Such usage requires a daylight viewable monitor (see sidebar "Hardware for Chart Display" on page 41).

Below are the seven programs tested in no particular order.

TABLE 1 SELECTION FACTORS

	SeaClear II V1.0.0.180	Fugawi Marine V4.5.14	Coastal Explorer V1.1.61	Nobeltec Admiral V9.2	Ozi Explorer V3.95	MacENC V5.50	SeaFarer LX V1.9.0
Operating System	Windows 98, 2000, XP	Windows XP, Vista	Windows XP, 2000, Vista	Windows XP, 2000	Windows	Mac 10.4 or later	Linux. See manufacturer for details
RAM required	Not available	512MB	128MB	512MB	Not available	1GB	128MB
Hard Drive Space							
Programs	2MB	250MB	50MB	160MB	9MB	4MB	20MB
Charts	200MB*	2-4GB	500MB*	2-4GB	500MB*	1GB	500MB*
CD drive	No	Yes	Yes	Yes	No	No	Yes
DVD drive	No	Yes	No	Yes/No	No	No	No
Feature Set	Good	Very Good	Very Good	Excellent	Good	Excellent	Fair
Marine Data	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Land data	No	Yes	No	Yes	Yes	No	No
Weather data display	No	GRIB	GRIB, Text	GRIB, Skymate	No	GRIB	No
AIS display	Yes	Yes	No	Yes	No	Yes	No
Radar display	No	No	No	Yes	No	Yes	No
PDA support	Yes	Yes	No	No	Yes	No	Yes
Cost	**$0**	**$219**	**$369**	**$999**	**$95**	**$140**	**$45**

**Reviewer's suggested minimum allocation.*

SeaClear II for Windows

SeaClear version 1.0.0.180 is available as a free Internet download (sping.com). There is no fee; it is the developer's true gift to the boating community. The manual contains well-written instructions, lots of technical data and has been translated into an impressive number of languages.

Installation is very simple. The program works on Windows operating systems from Windows 95 through XP. It takes very little hard drive space.

SeaClear is well designed and contains a long list of features. It displays raster charts and scanned-in charts that the included Mapcal utility calibrates. There are two modes: planning and navigating. In navigation mode, when routes are activated and it is set to automatic, SeaClear keeps the ship centered on the

(left) Nobeltec Admiral displays a large-scale harbor chart (shown on the screen left) quilted together with a smaller-scale sailing chart (right on the screen). This is the same area covered in the vector chart (right). Note the additional detail the raster chart provides due to its scale.

screen and scrolls and changes charts automatically.

The display shows a "dashboard" on the right side of the screen to display data. It can show a surprising range of data from NMEA "talkers," such as wind and boat speed, depth and others. It also sends data to NMEA "listeners," such as an autopilot. You can link an AIS receiver to your computer system and plot ship transit information. This is an impressive product that deserves consideration, particularly by those who are technically sophisticated.

Fugawi Marine ENC for Windows

Fugawi Marine (fugawi.com) ENC version 4.5.14 references a very impressive list of features. The installation package contains one CD and two DVDs. The charting and streets provided are matched to the buyer's country of residence. A small printed manual is included; an extensive manual is found on the CD.

The software loads very easily (Windows XP Pro, SP2) with good controls provided for the installation process. The program finds and indexes any charts you may have previously loaded on your computer.

Charts and related land information are a major strength of this package. The entire U.S. is provided in raster and vector charts (plus street information), with an example of Navionics charting.

On the water, it found and displayed a raster chart appropriate to the GPS position. Display controls are very extensive. When the center GPS control is "ON," it displays a chart right up to the edge before it changes it (default is 3 seconds from the edge). This feels like you're going to sail off the edge of the screen at times. There are workarounds, like turning AutoLoad and GPS centering off and using the directional "Load Next Chart" feature. This behavior may well force the user into more preplanning and route creation than you might otherwise do, which is a good thing since route creation is very well done.

Application screen controls and features are extensive, perhaps to the point of excess on a moving boat. Internet support is helpful, knowledgeable and reasonably fast. The features and charts available are professional grade and would take you almost anywhere.

Coastal Explorer for Windows

Installation of Coastal Explorer (rosepointnav.com) version 1.1.61 is very clear and straightforward. A small but concise, well-written printed manual is provided. Also included is an extensive but somewhat dated list of vector and raster charts for the U.S. Since these charts are now free online, users will want to install their own. Chart loading is very flexible. It finds charts previously installed and creates an index to their location.

Coastal Explorer runs in two modes: planning or cruise mode. Use planning mode to create routes, view charts and for other tasks associated with system setup and voyage planning. If the software detects that the boat is moving at 1 knot or more, it automatically selects

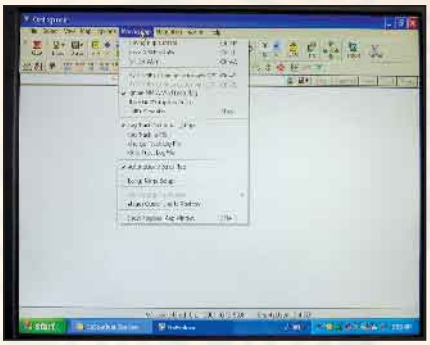
TABLE 2 INSTALLATION EXPERIENCE

	SeaClear II V1.0.0.180	Fugawi Marine V4.5.14	Coastal Explorer V1.1.61	Nobeltec Admiral V9.2	Ozi Explorer V3.95	MacENC V5.50	SeaFarer LX V1.9.0
Complexity of Installation	Simple	Simple	Simple	Required support call	Complex GPS installation	Fairly complex	Complex
Help Resources	PDF manual Blog	Manual Web Email	Manual Helpfile Email	PDF manual Phone	Helpfile Email	Helpfile Email Phone	Helpfile Email Web

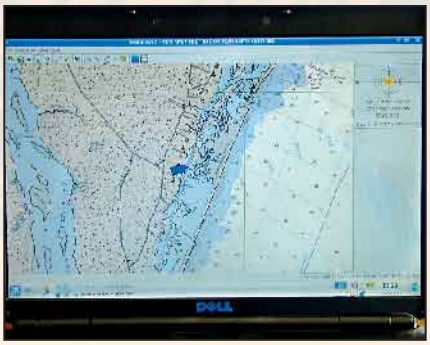
TABLE 3 CHARTS AND ROUTES

	SeaClear II V1.0.0.180	Fugawi Marine V4.5.14	Coastal Explorer V1.1.61	Nobeltec Admiral V9.2	Ozi Explorer V3.95	MacENC V5.50	SeaFarer LX V1.9.0
Geographic coverage							
US	No	Yes	Yes	Yes	No	No	No
Canada	No	Yes	No	No**	No	No	No
Europe	No	Yes*	No	No**	No	No	No
Rest of World	No	Yes*	No	No**	No	No	No
Chart Display Capability							
Raster	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vector	No	Yes	Yes	Yes/No***	No	Yes	No
Navionics	No	Yes	No	No	No	No	No
Other formats	Yes	Yes	Yes	Yes	Yes	Yes	No
Chart Manipulation:							
Autoload	Yes	Yes	Yes	Yes	Yes	Yes	Yes
GPS-driven moving map	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quilting	No	No	Yes	Yes	No	Yes	No
Route creation	Very Good	Very Good	Very Good	Excellent	Good	Very Good	Good
Ease of editing routes	Very Good	Very Good	Very Good	Excellent	Good	Very Good	Good

** Purchaser receives data according to the country they live in.*
*** Available for purchase from Jeppesen Marine.*
**** Starting with V9.3, S-57 charts will no longer be stored or displayed.*



OziExplorer main screen and the Moving Map screen used to control map functions.



SeaClear raster chart on the screen with GPS coordinates of the boat and a boat icon showing location and direction.

Cruise Mode. The screen is simplified, more area is given to the chart and speed and course information are prominently displayed. With the Virtual Instrument feature, you can display data such as depth, heading or rudder angle. It also outputs data for your autopilot.

Chart display is a particular strength of Coastal Explorer and the quilting feature works well. It also quilts together vector and raster charts and matches their scales. Route creation is easy and intuitive, made easier by quilting.

When displaying a chart, a tide prediction utility shows tide height and current for the nearest location to the position of the cursor. This program is definitely worth consideration.

Nobeltec Admiral for Windows

Nobeltec Admiral version 9.2 from Jeppesen Marine (nobeltec.com) feels more like a life partner than a navigation program. The first installation did not go well but the phone service tech resolved the problem very quickly. My virus program had interfered with the loading of some modules. With that out of the way, the adventure of learning the software began. A very extensive and well-written manual is provided in PDF format. The use of graphic materials is extensive, the annotations helpful and very well done.

As shipboard electronics' systems become more extensive, installation can be challenging. The combination of the manual and telephone support should be able to handle any installation issue.

Sailing and general charts for the U.S. came with the Nobeltec package. I was surprised to find that most of these charts were 2-1/2 years old. Regional vector charts can be purchased from Jeppesen or free NOAA vector or raster charts can be loaded and displayed as well.

A Planbook screen is a nice feature to organize routes and plan transits. A Route Wizard creates routes and gives start and finish coordinates. On a route between Wrightsville Beach and Charleston, the route wizard recognized the need to avoid shallow water and found a gap in Frying Pan Shoals that I didn't know existed. Underway, NavView maximizes area devoted to the chart. The few controls needed underway are shown as large buttons. With a touch screen, you would never need to touch a mouse.

Any feature I looked for was implemented in a technically sophisticated manner, with extensive control options and with thoughtful consideration for the way a user would use it. This software appears expensive at first look, but you receive good value.

Just before this issue went to press, I became aware of a notice from Jeppesen dated December 13, 2007, of errors in Nobeltec software and Passport charts going back several years. A fix for the affected software and charts is offered but the latest version of Admiral (9.3) no longer can store and display S-57 charts, the world standard for commercial ocean vessels. This is a very questionable step in my opinion. Refer to nobeltec.com/company/pr/pr_07_12_13.pdf on the Jeppesen Marine website for additional details.

OziExplorer for Windows

OziExplorer ("Ozi" is Australian slang for "Aussie") version 3.95 is available as an Internet download (oziexplorer.com). Installation instructions are clear and there were no installation surprises. In addition to English, the software is available in 11 other languages. No charts are included. If charts (which they call "maps" and so will I) are loaded before installation, it leaves them where they are and creates an index to them, which is called "loading." A very extensive list of map types can be displayed besides nautical ones. It's best to load maps before you run the software.

All the functions you expect to find are there although the implementation is a bit quirky and opaque. For example, drivers apparently are written for particular GPS receivers and if you have one of the supported models, you're in good shape. If not, you may have some setup issues. I gave up on it recognizing a U.S. Globalsat GPS, which other programs reviewed saw immediately.

OziExplorer seems aimed at a market segment where the computer is used to set up waypoints and routes and data are downloaded to the GPS, which is then used for navigation. This would be a good application for fishing in a center-console boat on open water, for example.

MacENC for Macs OS X10.3+ V 5.50

For Mac users operating OS 10.3 and up, MacENC version 5.50 is also an Internet purchase (gpsnavx.com). Installation is reasonably straightforward although it requires more knowledge of the software environment than is required for a Windows install. There are no proprietary

(Continues on page 51)

TABLE 4 PROGRAM USAGE

	SeaClear II V1.0.0.180	Fugawi Marine V4.5.14	Coastal Explorer V1.1.61	Nobeltec Admiral V9.2	Ozi Explorer V3.95	MacENC V5.50	SeaFarer LX V1.9.0
Users Manual (pages)	PDF (29)	(36)	(45)	PDF (230)	Helpfile	Helpfile	(12)
Help features	Not tested	Excellent	Very good	Excellent	Average	Good	Minimal
Support	Blog	Very good	Excellent	Excellent	Good	Not tested	Very good
Ease of use underway	Excellent	Good	Excellent	Excellent	Not tested	Good	Good
Instrument displays	Yes	Yes	Yes	Yes	Some	Yes	No
Autopilot control	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Keep the Rig STANDING

A sailboat rig is only as reliable as its weakest link. Selecting and installing the right terminal fittings is an exercise in weighing diverse opinions and options.

Story and Photos by John Meskauskas

Keeping the rig in a sailboat took on a new perspective after a stay parted from a swaged fitting in the rig of a friend's five-year old boat while he was sailing in 20-knot winds. The mast bent at the spreaders, the rig came crashing down, sails were torn and the dodger destroyed. Fortunately, no one was hurt but it was a dangerous and expensive moment that had me reconsidering the state of the rigging on our boat, a Swedish-built Hallberg-Rassy 35' (10.6m) cutter-rigged ketch.

During a visit to the U.S. Sailboat Show in Annapolis, I had a discussion with Tom Bigsby of Rigging Only, Fairhaven, MA, on the merits of swaged versus mechanical fittings. I then read the extensive discussion in Rigging Only's catalog, visited websites and discussed this issue with boatyard buddies. Several factors emerged. Corrosion is a major adversary of stainless steel, which, depending on the alloy, is not totally "stainless." It is corrosion/rust-resistant but it is not impervious to corrosion damage. Some rigging has swaged fittings at the top end, reasoning that rust inside is minimized because they drain. Effectively keeping water and corrosives out of the bottom terminals of swaged fittings seems impossible and vigilance is the only safe path to monitoring for deterioration. Time is another factor. Stainless steels work-harden. They fail less from high loads than from cycling of loads. Rerigging has been kind of an ultimate cruiser's mystery for me and I wanted the experience of doing it so, taking what I learned into consideration, I chose to use mechanical terminals, top and bottom during the rerigging of my boat, and to do it myself.

Measuring and Planning

I presumed the rig was original equipment, now 32 years old. The time to rerig was now.

I developed a specification sheet for turnbuckles listing the stay name, turnbuckle thread size, body length, pin sizes and the turnbuckle's pin-to-pin length as fitted. Because my turnbuckles were near the middle of their adjustment range, I could use the old stays as models for new ones. Each turnbuckle was marked with dye marker at the top, according to the attached stay. Headstays were coded H1 and H2, stays coming to the boat's sides P1 to P7 for port, S1 to S7 for starboard, starting from the bow. The ketch rig is stayed with a lot of wire serving as headstays, backstays, shrouds, numbering 17 stays in all.

It took three hours for the local yard's riggers to lower the deck stepped masts and now it was time to measure and assess. Unless your boat is still in production and you've owned it since new, it's best to assume nothing. The original brochure specified that the mainmast wire size was 7mm and turnbuckles 1/2" but the mizzen specs (4mm and 5/16" turnbuckles) were not listed. I removed and rolled up the wire assemblies for further measurement at home.

In my shop, I attached a 5/16" bolt vertically to an end wall at floor level, laid a 50' (15.2m) tape alongside, stretched each stay as much as I could, measured them and noted the type and size of the top and bottom terminals (refer to **Table 1** on page 48).

In a rig that uses both metric and U.S. fractional measurements, the final measurements were complicated by the switch to mechanical fittings in that the sizes of the new terminal fittings may not match the old swaged fittings. This was an important consideration for getting accurate measurements for the new stays.

Component Selection

The mainmast wire size, at 7mm, is nominally 0.275". When wire stretches, it elongates and the diameter decreases. My measurements of the old wire were consistent at about 0.261". I was tempted to downsize a bit but I decided to stay with the original dimensions in a fractional equivalent, installing 9/32" for the mainmast wire and 5/32" for the mizzen.

Two types of 316 alloy stainless-steel rigging wire are available. My boat had the common 1x19 type, which winds a six-wire layer around a single center to make a seven-wire core, followed by a 12-wire outer layer or 19 wires in all. Dyform wire is stronger, size for size, but is much more expensive.

In this project, the major decisions were: rigging components supplier; wire size; swaged or mechanical fittings (including use of both); the fitting manufacturer; whether to reuse

Figure 1

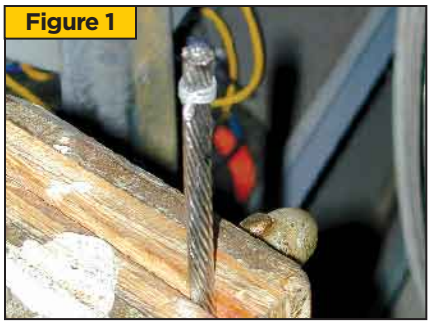


Figure 2

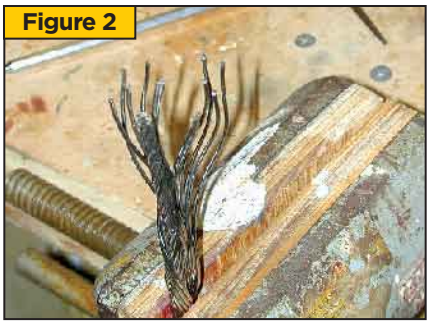
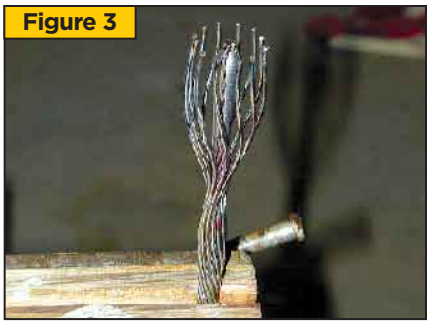


Figure 3



turnbuckles or not; and, no small trick, scheduling everything. Keeping lists, tables and notes was essential.

I called Tom Bigsby to discuss fittings. Quick Attach was my early choice because of simplicity of assembly. Cut the wire, insert it into the fitting and tighten. The principle is equivalent to that of swaging. However, they are not available in 9/32" sizes. Hi-Mod, Norseman and Sta-Lok fittings all insert a cone with a slit in it between the seven-wire core and the 12 wire outer layer. In Norseman and Sta-Lok fittings, the ends of the outer wires are bent a small amount as the assembly is tightened. This may result in a wire being pushed into the central slot, perhaps interfering with the clamping process of the wire in the fitting. If this happens you'll never know it because the fitting is assembled. Hi-Mod provides a "crown ring" that aligns the wires during assembly and keeps them in the desired positions.

Here's one more issue. Water penetrates the layers of wire and drains down to the fitting. To prevent rust, Sta-Lok recommends using silicone rubber in the joint. My old headstay had a Sta-Lok done this way and it worked fine and looked good on disassembly. However, Lin and Larry Pardey caution us (landlpardey.com/Tips/Tips_2000_November.html) about using silicone sealants that smell like vinegar as they contain acids incompatible with Type 316 stainless. Use polyurethane rubber instead, or use the Hi-Mod fittings, which are designed to assemble dry and easily disassemble to be flushed at any time. I chose Sta-Lok fittings for my rig.

In disassembling the rig, the headstay turnbuckle was found to have failed. The original turnbuckles use stainless-steel bodies and jaws. If the lubrication of the threads breaks down, this type of configuration can actually weld itself into immovability as you try to loosen it. I've had this happen but the other turnbuckles looked so good that I chose to re-use them. I disassembled and cleaned them,

Figure 4

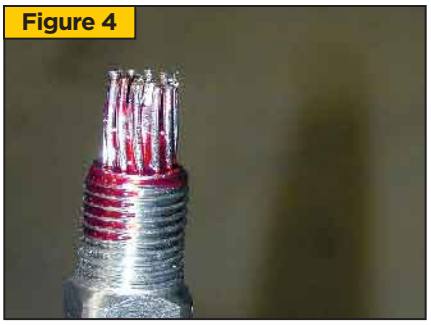


Figure 5

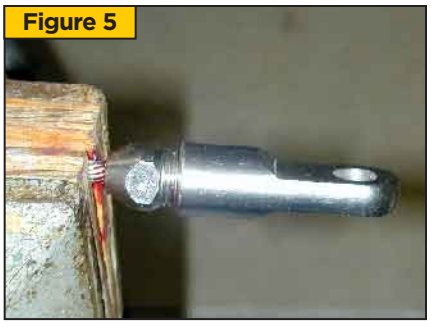
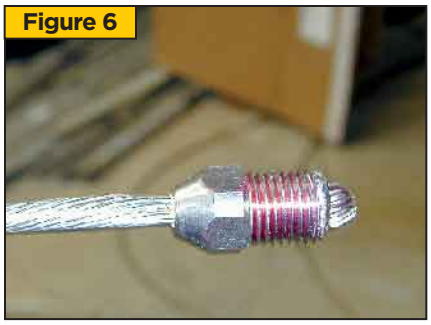


Figure 6



checked for cracks and bad threads, lubricated with anti-seize compound and reassembled. I did replace the headstay turnbuckle. The final step was to adjust them to be about 1" (25mm) longer than the original measurement.

Terminal Fit

By this time, all the components had arrived: 350' (106.6m) of 9/32" wire; 120' (36.5m) of 5/32" wire; eye and jaw configuration end fittings; SSB antenna insulators; three sizes of pins; cotter rings and Loctite. It was finally time to begin assembling the new rig.

I hung the roll of wire on a 2 by 4 supported at both ends so that I could more easily feed material. Attaching a Sta-Lok fitting involves the following steps: Deburr the wire end with a stone or very fine file if the socket won't go over the wire; tape 12" (304mm) from the wire end and slide the socket to the tape; gently clamp the wire in a soft-faced vise about 4" to 6" (101mm to 152mm) from the end (**Figure 1**). (Hi-Mod website at hayn.com has a video showing a very elegant unwinding of the outer layer of wire.) I used an eyeglass screwdriver to pick the wires off, in twos or threes, until the inner core is exposed (**Figure 2**). Next, slide the wedge cone on until the end is the indicated distance, about 3/32" for 5/32" and 9/32" wire, past the wire end. Wind the wires back until they are in their original order (**Figure 3**) then hold the wire in your hand and give it a clockwise twist. It will roll up over the wedge, looking somewhat like a bud. Loosen the vise and slide the socket up until it begins to put pressure on the assembly. Now, align the outer strands so that they are reasonably evenly spaced and none are in the cone's slot. Loosen the vise entirely and pull down hard from underneath so that the assembly is pulled into the socket as far as it will go.

It's time to apply optional thread locker and sealant. I have confidence in Loctite so I used it liberally on the threads as threadlocker and copiously between the

MICROSCOPE

Two swage fittings from the same wire stay, cut in half, show significant rust in the bottom (left) terminal. Rust is surrounding the wire and extends to the wire end yet there are bright areas as well and one wonders what the effect is on the holding power of this terminal. The top fitting (right) is virtually rust-free. Fatigue is the enemy of both ends, of course.

wires as a sealant (**Figure 4**). Sta-Lok recommends two to three drops on the threads and a cherry-sized amount of silicone in the eye.

To thread on the eye, invert the assembly so that the former component in the eye stays in place while the eye threads on as far as possible by hand. Place the wire horizontally in the vice with the fitting right next to the jaws and tighten using the adjustable wrench. I put as much force as I could in tightening and assembly; the end result has about two threads visible (**Figure 5**). The supplied instructions are a bit confusing in that they wrongly suggest that you turn either the socket or the eye. Turn only the eye! **Figure 6** shows how an 1/8" (3mm) turn on the socket bends the outer strands the wrong way.

Wire Duplicating

The next step was to place the eyes of the new and corresponding old cable over the vertical bolt discussed above, stretch out these cables until straight and tight on the floor and mark the location of the center of the old eye on the new cable. The distance from the center of the eye to the barrel for 9/32" fittings is 1-1/4" (31mm). Since the cable stretches, in this case, about 1" (25mm) per 50' (15.2m.), I allowed 1/2" (12mm) for short stays, 3/4" (19mm) for long ones. That meant that the cuts would be either 1-3/4" or 2" (44mm or 50mm) short of the eye position. It's a good idea to mark

this in a different color so that you'll always cut at the right spot.

The wire cutting tools are not critical. A hacksaw with a rod blade, Dremel cutting wheels or cable cutters all work. I used a metal-cutting fiber blade on an air-powered automotive 3" (76mm) cutoff tool running at 25,000 rpm (**Figure 7**). Any rotary tool throws hot abrasive and cut metal fragments so be sure to use appropriate eye and other safety protection. The force of the cut tends to separate the wire a bit so I wrapped several turns of wire on both sides of the mark before cutting to avoid this and to serve as a small heat sink (lower wrap is shown in **Figure 1**). In retrospect, this is probably more useful in the small sizes, which are less stiff, than the larger sizes. Because a cut generates a lot of heat, I made cuts at 12, 3, and 9 o'clock, pausing for a few seconds in between.

Attached the Sta-Lok to the other wire end and check the completed assembly for length against the original. Label the stay and it's on to the next one. In round numbers, measuring, cutting and assembling took about 20 minutes per stay.

Now, it's back to the mast to get it ready to finish the job. Check chainplates and tangs then install the new stays, check electrics, wash the mast and it's ready to step. (A detailed discussion on chainplate corrosion appears in the DIY EZINE, the online version of this article, accessible to digital subscribers only.) Preliminary tuning left a lot of adjustment on the turnbuckles so I was happy. [Ed: For step-sy-step rig inspection refer to "Rigors of Rigging," from DIY 2004-#1 issue and available on DIY MRT Series "Sailboat Rigging" CD-ROM.]

This job took more time than I expected and the cost was about $2,300 in parts and $800 in yard fees. Having a shop and all the tools was an advantage. In the end, what surprised me, considering how critical the rig is, little engineering information or tabulated user experience is available. Be prepared to sort out varying opinions and options.

About the author: Captain John Meskauskas is an offshore delivery skipper based in Wilmington, North Carolina.

TABLE 1 SPEC SHEET

Stay Code	Description	Main Mast Length pin-pin	Stays Tang hole	7mm= 9/32" Top terminal	Bottom terminal	Wire size	Notes
H1	Headstay	480est	10mm,0.41		1/2 eye	7mm	Replace screw
P2	Upper shroud	428.25	0.41		1/2 eye	7mm	
S2	Upper shroud	428.25	0.41		1/2 eye	7mm	
P6	Backstay	500.5	0.4	1/2 eye	1/2 eye	7mm	
S6	Backstay/SSB antenna	501	0.4	1/2 eye	1/2 eye	7mm	Need antenna insulators
H2	Staysail forestay	334.875	0.504	Fork, .415 pin	1/2 eye	7mm	
P4	Staysail backstay	328.375	0.504	Fork, .415 pin	1/2 eye	7mm	
S4	Staysail backstay	329	0.504	Fork, .415 pin	1/2 eye	7mm	
P1	Forward lower	203	10mm,0.41	1/2 eye	1/2 eye	7mm	
S1	Forward lower	203	0.41	1/2 eye	1/2 eye	7mm	
P3	Aft lower	205.375	0.41	1/2 eye	1/2 eye	7mm	
S3	Aft lower	205.25	0.41	1/2 eye	1/2 eye	7mm	
	Total, 12mm wire	4,147.875" or 345.57'					
		Mizzen	**Stays**	**4mm=5/32"**			
P7	Upper shroud	254.875	5/16+,0.33	5/16 eye	5/16 eye	4mm	
S7	Upper shroud	254.75	5/16+,0.33	5/16 eye	5/16 eye	4mm	
P5	Lower shroud	194.875	5/16+,0.33	5/16 eye	5/16 eye	4mm	
S5	Lower shroud	195	5/16+,0.33	5/16 eye	5/16 eye	4mm	
MH	Mizzen headstay	463.75	5/16+,0.33	1/4 fork	5/16 eye	4mm	
	Total, 4mm wire	1367" or 113.9'					

Stainless and Chainplates

Corrosion has seriously weakened these two chainplates. Once corrosion starts it can penetrate deeply into the metal, much like termite damage in wood.

Aspects of what I've read about stainless steel and crevice corrosion were confusing to me, that is until I read the article titled, "Shades of Stainless Steel," in DIY Boat Owner 2002-#2 issue.

Stainless steel, like aluminum, is self-healing up to a point. It contains chromium, which reacts with oxygen to form a surface layer of highly corrosion-resistant chromium oxide. As stainless steel works, some of the surface molecules eventually break down. If there is oxygen for chromium to react with, the oxide will re-establish and protect the surface. On the other hand, if the stainless is standing in oxygen-deprived (stagnant) water, the chromium oxide layer cannot form and corrosion begins. Note that the presence of water by itself is not sufficient; it must be stagnant, oxygen-deprived water. Once corrosion begins, it can proceed to a level where the part fails relatively quickly.

What about chainplates that are glassed in? How does oxygen get to them? This may be debatable but in practice if the chainplate has never been in standing water it should be okay.

Be careful and conservative in your investigation. The experience of other owners is frequently helpful. For bonded-in chainplates, drill a weep hole at the bottom of the chainplate covering material to double check if you have any doubts. I hadn't previously considered checking for moisture around internal chainplates and after drilling was reassured to find there was no standing moisture and no sign of corrosion. Needless to say, I resealed all chainplate deck cover plates with a bead of polyurethane sealant as insurance.

-- John Meskauskas

DIY Technical CD-ROM Library for Boat Owners

$19.95 EACH

MRT SERIES CDS CONTAIN ARTICLES FROM PAST ISSUES OF DIY BOAT OWNER MAGAZINE

Building With Starboard

UPDATED

22 Projects and Fabrication Techniques: The ideal choice for replacing wood components onboard – won't delaminate, rot or splinter and requires no paint.

Plumbing 101

A boat owner's guide to the inspection, maintenance, repair, troubleshooting and upgrading of onboard plumbing systems.

DIY Mechanic

Gasoline and diesel engine service. How to maintain, troubleshoot and repair outboard engines, sterndrives and diesel inboards.

AC/DC Electrical Systems

UPDATED

A guide to expanding, upgrading, surveying and troublshooting your boat's AC and DC electrical system. All articles follow ABYC Standards.

Painting & Refinishing

The complete guide to painting and refinishing hulls, topsides and decks with marine coatings.

Launch & Haulout

UPDATED

How to prepare your boat for spring launch and winter storage. Includes lay-up checklists, maintenance and lubrication guides, engine servicing, haulout guidelines, easy-to-build storage covers and more.

Marine Equipment Installations

UPDATED

Here's how to choose, install and operate equipment for your boat including: air conditioning and heating systems, audio systems, bow thrusters, davits, lightning protection, propane systems, refrigeration, windlasses and more.

Fiberglass Boat Repair

How to survey, repair and prevent cosmetic and structural damage in fiberglass hulls, decks and transoms. Includes the step-by-step repair of minor cracks and gouges, large holes, water-soaked decks, delaminated hulls and proper installation of hardware.

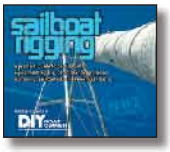
Nautical Necessities

From cleaning to fuel filtering to waterproofing charts, you'll find ideas and inspiration in this compilation of tips to do-it-yourself boat maintenance, repair and troubleshooting. Divided into 20 categories to make look up easy.

Better Boats

More than 200 do-it-yourself projects. Practical solutions to deck and cockpit refitting, interior renovations, rigging upgrades, space-saving equipment storage, safety add-ons and other nifty items to customize your boat.

Sailboat Rigging



A practical guide to deck layouts, equipment repairs, performance upgrades, rig tuning, sail controls and steering systems.

1995 – 2007 52 Issues of DIY:

A technical reference library for powerboaters and sailboaters. The editorial archives of DIY from 1995 to 2007, organized by year and issue from cover to cover.

$99.95

MRT BOX SET

12 of the MRT Series in a custom vinyl case. Power version has Powerboat Rigging and Sail version has Sailboat Rigging.

$119.95

(Specify power or sail)

Electronics Connection

Provides the information you need to consider when purchasing, installing, operating, and troubleshooting marine electronics for most any layout or equipment and budget in a step-by-step approach.

$19.95

Powerboat Rigging

From gauges to propellers to steering systems, here's everything you need to know to maintain and repair your boat and trailer, improve boat handling and performance, and find solutions to common servicing problems.

DIY BOAT OWNER
THE MARINE MAINTENANCE MAGAZINE

TO ORDER CALL 1-888-658-BOAT
OR SHOP ONLINE AT WWW.DIY-BOAT.COM

Spring Fitting Out Checklist

A safety inspection of the engine, hull and other systems and attention to maintenance details this spring can make the upcoming boating season a lot safer and more enjoyable.

By Bob Adriance

✓ Out of the Water

• Inspect and lubricate seacocks. Inspect hoses and hose clamps (though not mandated, two at each fitting below or near the waterline gives peace of mind) and replace as necessary. This is also the best time to replace gate valves with seacocks. The pot metal stems in gate valves are prone to disappearing from corrosion. You'll know when this happens because the valve wheel turns eternally and will not tighten. Plan to replace any gate valves with seacocks, a marine grade valve with a quarter-turn handle that visually indicates the valve's open or closed status.

• Inspect the hull for blisters, distortion and stress cracks. Large blisters may require professional attention. Note that most hull blisters are only noticeable for a few weeks and in some cases within just hours of hauling out but there are symptoms that are detectable later by an expert long after. If you're suspicious, ask a marine surveyor to take a close look. Distortion and/or stress cracks are two other hull problems that should be addressed by a marine surveyor or fiberglass repairer.

• Replace sacrificial anodes (commonly referred to as "zincs") that are 50% or more wasted. Note: If a zinc has vanished or has been reduced to powder,

Jan Mundy

check other underwater metal fittings to make sure they aren't corroding. Zincs that disappear after less than one season might indicate a problem with the boat's bonding and/or electrical system or galvanic corrosion activity. Look for chafed wires or battery cables, which also have the potential to cause a fire.

• Inspect propeller(s) for dings, pitting and distortion that can create excessive vibration and can loosen everything from screws and bulkheads to dental fillings. Make sure cotter pins are secure. Damaged props can be rejuvenated by a prop repair shop for about half the cost of a new one. On inboard powered boats, grip the prop and try moving the shaft within the bearing. Any play indicates the cutlass bearing probably needs replacing.

Jan Mundy

• Check that the rudderstock is not bent. Also try moving the rudder. Any looseness must be corrected. The remedy depends on the type of installation you have.

• Make sure the engine intake raw-water strainer is free of corrosion and properly secured. Marine growth can block external grate strainers inside the grate and inline. In winter climates, the internal strainers that were not drained properly in the fall can be damaged by ice that cracks the strainer housing. Replace any questionable parts.

✓ Outboards and Sterndrives

• Inspect the flexible sterndrive bellows for cracks or other deterioration. The folds usually hold the clues to damage from UV exposure, critters, etc. Replace any suspect bellows.

• Replace deteriorated sterndrive zincs.

• Check power steering and power trim fluid levels. Follow the manufacturer's maintenance schedule.

ADDITIONAL READING

How to prepare your boat for spring launch and winter storage or plan the annual haulout. Includes launch and lay-up checklists, maintenance tips, gelcoat restoration, engine servicing, haulout guidelines, easy-to-build storage covers, step-by-step shrinkwrapping and more.

SEAWORTHY

✓ Control Cables

• Inspect outer jacket. Cracks or swelling in the outer jacket covering the cable indicate corrosion and the cable requires replacing. Don't try to remedy the problem by squirting lubricant into the cracks or wrapping duct tape around the outer jacket. This is a system you don't want to shortcut.

✓ In the Water

• Check the engine shaft and rudder stuffing boxes for leaks and looseness. Some weeping or even an occasional drip can be tolerated at the engine shaft stuffing box. If leaking cannot be stopped by tightening the nut, repack the gland. Never overtighten the nut. You might stop the leak but the gland can overheat and destroy the packing material.

Pat Kearns

• Spray the deck, ports and hatches to check for leaks. Renew caulking or gaskets as necessary. Don't rely on a bilge pump to overcome a multitude of nuisance leaks.

Jan Mundy

✓ Engines and Fuel Systems

• Inspect all flexible fuel lines, including fill, vent and fuel return hoses, for indications of softening, cracking, chafe or other damage. Replace any suspicious hose and make sure all hoses are marked by the manufacturer as Coast Guard approved Type A (1 or 2) or B hose (depending on the application) and both labelled SAE J1527. Check all joints for leaks using a clean, white rag and look for stains under or around the fitting. Make sure all lines are well supported.

• Inspect all of the other components in the fuel system for leaks, e.g., fuel tanks, fuel pumps, filters. Use a dry rag at connections or you can trust your nose. Use an extendable mirror to get a look at places where you can't get your eyes or nose. Clamps should be snug and free of rust.

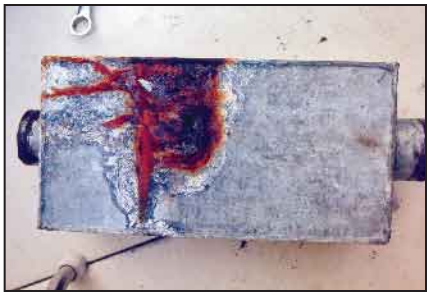
• Replace fuel filters.

• Periodically, remove exhaust manifolds and inspect for corrosion, which could be restricting water flow.

• Clean and tighten electrical connections, especially both ends of battery cables. Loose connections can create a high-resistance connection or arc. Both conditions create an enormous amount of heat, which is a fire hazard. Wire brush battery terminals and fill cells with distilled water (lead-acid batteries only).

• Be sure that all cooling hoses and system fittings fit snugly. Again, using double hose clamps is an option but good practice if there is room for them without impinging on the hose barb. Replace any hoses with cracked casings, hoses that are bulging, brittle or stiff or that are leaking.

• Inspect the muffler and exhaust system for leaks. Aside from excess noise and potentially fatal carbon monoxide, a leaking muffler could sink the boat.



• Inspect bilge blower hose for leaks.

✓ Sailboat Rigging

• Use a handheld magnifier to inspect rigging terminal fittings, especially swage fittings, for cracks and rust. Inspect all standing rigging, wire halyards and running backstays for rust and "fish-

hooks" (broken wire strands) that snag fingers and indicate that the wire should be replaced immediately. Make sure spreaders bisect the shrouds at equal angles.

• Remove tape on turnbuckles and lubricate threads. Give the turnbuckle a twist or two to help prevent mechanical seizing. Replace with fresh tape.

• Recaulk chainplates that penetrate the deck as necessary to keep water from migrating into the deck core and/or the chainplate bulkheads. Always remove all old caulking when rebedding hardware.

✓ A Few Other Chores

• Service or replace fire discharged extinguishers as necessary. Mount all extinguishers where they are clearly visible.

• Examine stoves and remote tanks for loose fittings and leaking hoses.

• Throw out or take ashore all solvents and rusted cans. Volatile solvents and paint thinners, among other chemicals, are fire/explosion hazards and should never be stored onboard a boat. Stow LPG and butane fuel cylinders for portable stoves and grills on the boat exterior where escaping vapors can flow overboard.

• Clean bilge. Inspect bilge pump and float switch to make sure they are working properly. Consider installing a high bilgewater level alarm.

• Inspect all dock and mooring lines and replace any that are worn or frayed. Where a line is only worn at one end consider reversing the line.

Jan Mundy

• Replace outdated flares and keep old flares onboard as spares. Check that all safety equipment is in good working order. Inspect life jacket closures and straps.

✓ Trailers

• Inspect tire treads and sidewalls. Replace tires with cracks on the sidewalls or worn treads. Use a gauge to check pressure and inflate tires to manufacturer's spec. Don't forget the trailer's spare tire.

• Sand and paint rusted areas.

• Inspect bearings. Repack as necessary.

Jan Mundy

• Test tail, signal and back-up lights. Replace any burned-out bulbs and chafed wires. Clean any corroded terminals and treat with a corrosion inhibitor. Make sure the white ground wire is securely attached to the trailer's frame.

• Test that the winch, manual or electric, is working properly.

About the author: Bob Adriance is the editor of Seaworthy, the quarterly loss-prevention news journal of the BoatU.S. Marine Insurance program.

SHOWDOWN

(Continued from page 44)

charts included in the package. The buyer is encouraged to download free NOAA S-57 vector charts and raster charts.

My review was a bit curtailed due to hardware issues but this is an application of impressive breadth. In addition to innovative chart display and manipulation, quilting is included, as are many other features such as radar display, great circle routing, tides and currents, weather, and instrumentation data send/receive.

MacENC implements an ingenious display combination of either raster or photo charts with an overlay of vector data. In what looks like a normal raster or photo display, take your mouse over to a mark and the information about it pops up, like it does in a vector chart. This is the best use of the information available in these charting systems.

For the Mac aficionado, this is a package of impressive depth at a very small price.

SeaFarerLX for Linux

To test SeaFarerLX version 1.9.0, I installed Kubuntu V7.10 Linux (a.k.a. Gutsy Gibbon) on my Windows PC and then installed SeaFarer. This was an adventure, to say the least. Gutsy is a very capable, visually and logically attractive, operating system with highly inconsistent documentation. For example, SeaFarer documentation mentions "mounting" a CD drive but the word could not be found in a search of the Gutsy documentation. The only thing to do was to try things and see what happens and, in general, this worked.

This program has the key features one needs to navigate but you'll need significant Linux knowledge to run it. It would not recognize my GPS, which most Windows applications found easily, albeit I tried every available setting. The developer, Patrick Cannon of Barco Software (barcosoft.com), was very helpful in responding to questions about this issue and numerous others. Turns out, this is a Linux security issue that was easily resolved. With the GPS on, it found the appropriate chart and the display was good although the ship symbol is much too large and dark. Route creation was good and it even has AIS detection.

About the author: Captain John Meskauskas is an offshore delivery skipper based in Wilmington, North Carolina and is experienced in the operation and maintenance of power and sailboats up to 50 tons.

Wiring Cover-ups

BLISTER FACTOR
INDICATES THE DEGREE OF DIFFICULTY WITH 10 BEING THE HARDEST AND 1 BEING THE EASIEST.

7

If you want to correct some or all of the imperfect installations on your boat or you are planning major additions, here are things to consider to help keep the boat's wiring organized and protected.

Story and photos by David and Zora Aiken

Neatly bundled wires exit the electrical panel.

Use cable ties to bundle wires and to keep them safely in place.

One of the favorite features of a new boat is often the new electrical panel. The owner is proud to show that the boat is equipped with all the necessary accessories and all the new toys, all very neatly installed, interfaced and identified.

The rest of us understand this enthusiasm for organization. The old boat's panel may have been the product of a KISS (keep it simple, stupid) philosophy, when the height of new-fangled electrical gadgetry on a boat was an electic toilet or a refrigerator. Many owners add on to existing systems without upgrading a panel or circuit controls and, while it's convenient to cite previous owners for questionable work, that's often unfair. In a hurry to use a new gadget, an owner may not take the time to install it properly, sometimes out of ignorance of the hazards of burgeoning a simple panel with extra connections.

Use a wood channel to cover the solar panel wire where it passes through the wheelhouse.

Wire clamped into a recessed area of the wheelhouse.

Wires can and should be bundled together wherever possible; the fewer individual wires running through lockers, the less chance of wires being damaged. Nylon cable ties belong in the category of things no boat should be without. They come in many sizes and colors, they cost very little, they're practically indestructible and hold wire bundles tightly. Mounting cable ties adds a base for securing bundles along their runs.

Once wires with a common destination have been bundled, lead them along their path by the most protected route. If wires are fed through a locker, drill holes at both ends of the locker and line them with a pass-through grommet, if necessary, to prevent abrasion or clamp the bundle to an interior surface of the locker so wires can't be damaged by items stored inside. Cover wires in a wiring loom for added protection.

A simple white channel covers wires on the galley bulkhead.

Wooden channels hide the wire leading to a cabin light.

The light switch cover is stained to match bulkhead.

In some places, wires can follow a slight recess along a bulkhead or under a seating area. The set-back provides some protection. Use cable clamps at regular intervals to keep the wire fitting neatly into the recess. This type of installation can be left as is, or covered with a trim piece.

No matter how you route the wires through the boat, you will ultimately have sections of wire leading from the last closed-in space to the final destina-

A custom-built cabinet provides storage for small items as it hides and protects the backside of the depthsounder and other instruments.

tion. This is where the decorator in you decides how to minimize the visual disruption while at the same time protecting the wires.

Some owners copy the new boat builder's "out-of-sight" solution and cover every interior surface (including the wiring that passes along those surfaces) with vinyl fabric or carpeting. While neatness does count, this particular choice has some drawbacks. Trapped moisture can cause corrosion from damp wall-coverings. Unseen wiring may suffer from chafe or abrasion anywhere along its path. When a light quits and the bulb is not the culprit, wiring that's hidden under a carpet hull or deck liner is not easily traced.

Boat owners who prefer the option of easy accessibility can cover the wire in a way that satisfies both the protective and the aesthetic aspects. In the cockpit, a flexible spiral wrap is easy to use, providing UV and abrasion protection as it follows the twists and turns of the wire connecting the GPS or VHF. Fire-retardant split loom is a tubular cover that is split along its length, making it easy to place over the wires and allowing individual wires to exit at any point.

Owners of traditional boats with lots of wood below can purchase teak channels, or they can make comparable pieces from whatever wood matches or complements the boat interior. Cut one 3/4" to 1" (19mm to 25mm) wide strip for the top and two narrow strips, about 1/2" (12mm) wide, for the sides. Glue them together and place the U-shaped channel over the wiring that leads to a cabin light, fan or other accessory. If you choose the DIY channel, consider making it larger than you currently need to allow for a future wiring addition. Light switch plates and plug covers can also be made of wood and stained to match the bulkhead, effectively blending them into the background.

For newer boats with fiberglass interiors, the same type of channel can be used, painted to blend into any surface or head for the home warehouse store and buy the parts to assemble a variety of wire-covering products. Some screw into mounting surfaces; some are adhesive-backed.

One type of channel has two parts: a back plate for mounting to a bulkhead and a snap-on cover. Wires are run between the two and the snap-on cover makes it easy to inspect the wire or add more wires later. Corner fittings allow wire to neatly turn the corner where two panels meet or to guide the wire from a horizontal to a vertical lead.

A special channel is made for floor use. Resembling a threshold, it could minimize the chances of tripping over wires that must run along the cabin sole for a short distance; for example, where wiring feeds into the base of a keel-stepped mast.

In one wire-hiding project, an entire cabinet was built to cover the wiring side of a depthsounder. The end result not only hid the mess, it helped to keep the unit clean and dry and it provided accessible space to store small items.

With lots of vacant corners in the boat's interior, opportunities for similar coverups are everywhere.

— David and Zora Aiken have been liveaboards for more than 20 years and are authors of "Good Boatkeeping," and "Cruising: The Basics."

When the Barbecue Leans

A simple, quick fix to an installation flaw restores service to this Force 10 barbeque.

Story and photos by Edward McDermott

6

Grill leaning badly. Notice the bend in the support rod.

I recently purchased a C&C Landfall sailboat that was equipped with a Force 10 barbecue grill. I didn't look at it very closely until I had some fish to fry. When I opened the grill, the weight of the top made it lean over at an angle of about 45 degrees. That presented the danger that my cooking would feed the fishes instead of the guests.

A close examination showed that the barbecue was attached by a bracket to one rail and had a supporting leg to the outside of the barbecue from the lower rail. This leg was made of a long piece of metal rod that was bent.

I straightened out the bend and the grill returned to the correct orientation. It looked great. I opened it up with a self-satisfied flip of the top and then jumped to grab it as the support bent once more and the grill sagged as before.

Something more sophisticated than straightening the rod was required. I examined the connection on the barbecue and the railing and groaned. Both were designed for a 1/4" (6mm) metal rod. I saw myself rooting through the hardware section in several boat stores looking for adapters of one sort or another.

Ideally, the solution would involve stainless-steel tubing, with the appropriate connections, similar to those used on a bimini or dodger. Each connector cost $20 dollars or more, if I could find the ones I wanted.

Then I had a stroke of genius. I thought of this rod as a leg on the grill. I didn't have to replace the leg, simply reinforce it, put a cast on it so to speak. I needed a rod that wouldn't bend and would fit around the current one. A hollow rod. A tube. The rod couldn't bend unless the tube did and bending an aluminum tube would take more force than the barbecue could apply under normal conditions.

At a discount boat supply, I purchased 18" (457mm) of 1/2" (12mm) diameter aluminum tubing at $2.50 per foot. Back on board, I disassem-

Existing support rod is slipped through an aluminum tube that is cut to fit between the grill base and support bracket and holds the existing support rod rigid.

bled the support, straightened the rod and measured. I cut the aluminum to fit the rod from the base to the grill. Finally, I reassembled the support with the aluminum tube as a sleeve held in place by the original rod.

Once more the grill looked perfect. The new support looked better than the original. I smiled with satisfaction as I flipped open the lid and everything remained in place and then I realized that I neglected to buy the new propane canister I needed for the barbecue.

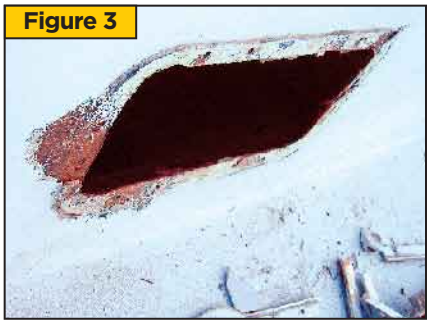
— Edward McDermott purchased his latest boat in 2007, which he sails along the U.S. southeast coast and the Caribbean. What the next year brings him depends on the wind.

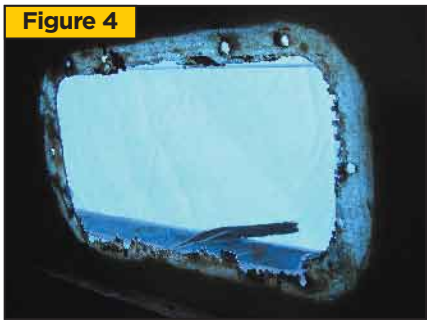
Portlight Replacements

8

Pesky drips from leaking portholes are a boat owner's nemesis and, over time, can damage interiors. Sometimes the only solution is to install new ports, which, in older boats, can compound your troubles.

Story and photos by Dave and Barb Heilman





Nothing is more frustrating than spending days carefully removing every porthole frame and glass, attentively replacing gaskets, scraping off excess caulking, oiling hinges and dogs, resetting the windows and then hosing them down to find that your ports still leak. Drips persist despite the advancement of caulks and sealants. Even if there are no obvious leaks, a hidden leak can cause significant damage before it becomes apparent. This is enough to make anyone paranoid. After four previous boats, we now have the dubious title of Drip Experts.

With drippy port windows, the goal is to find the leak's true origin. Is it seeping in around the frame, through a gasket, via the retaining screws, through the window edge or at a faulty dog (if the windows are of the opening type)? Sometimes, the lucky find it is simply a matter of gently tightening the adjustment screws on the hinges to get a tighter seal. Any of the above problems can be corrected and parts obtained at relatively little expense and effort, even for the oldest of boats.

If, however, you want to change the size and type of windows, this can create a whole new set of preparation issues. It may require you to cut larger holes for your ports or fiberglassing over existing portholes. This is very doable but be prepared for the extra work. Bottom line here is that, if the ports are in good condition, are esthetically pleasing and safe for the kind of cruising you do, the best advice is to fix them rather than replace them.

Our newest love object is "Jurate," a 38' (11.5m) Easterly. The Easterly is a short run production boat built by the Halter Marine Group in 1978. This incredibly sound fiberglass boat we purchased in 2006 was sorely in need of TLC and upgrades. From our initial inspection it was obvious that leaking below some of the 10 white plastic port windows was a problem. There were water stains and rippling on all the teak veneer below all the windows (**Figure 1**). Closer inspection indicated that the chainplates were also leaking, which contributed to the damage seen on the interior cabinetry. The previous owner owned the boat only briefly and

Figure 5

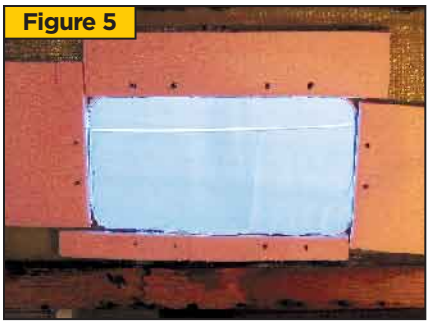


Figure 6

Figure 7

he had effectively sealed the windows, replacing one of the rotted teak panels with a piece of plywood, as shown in **Figure 2**, that did not match the rest of the interior wood. The effect was quite ugly.

Overall, the opening ports and screens were in very good condition and could have continued to serve for many more years but the white plastic didn't fit our refit image for "Jurate" so we opted to replace them with more esthetically pleasing metal ports. The cost for brass, bronze, aluminum and stainless were comparable and we opted for stainless, as this matched much of the other hardware on the boat. Also, stainless requires minimal effort to maintain a polished appearance. In our research and observations of older boats, there appeared to be little difference between stainless and brass or bronze ports in either functionality or longevity.

Demolition Begins

Removing old ports to reseat or replace them is usually not a difficult process and with two people averages 10 minutes per port. You can expect some trouble removing retaining bolts, a factor directly proportional to the age of the boat and whether the ports have ever been removed before. Penetrating oil dripped on and around the bolts and left for a few days to do its job can help. If a bolt head breaks off, it is no real problem as the bolt can be drilled out and replaced with a new bolt (use a slightly smaller drill bit than the bolt size).

In this case, we quickly learned that the previous owner used 3M 5200 to reseat the windows. The label on a tube of 3M 5200 cautions you to consider this caulk permanent. Our ports took two days to remove and involved saws and chisels (and many swear words) and the complete destruction of all teak panels on the interior. This process also resulted in the destruction of the old

Figure 8

Figure 9

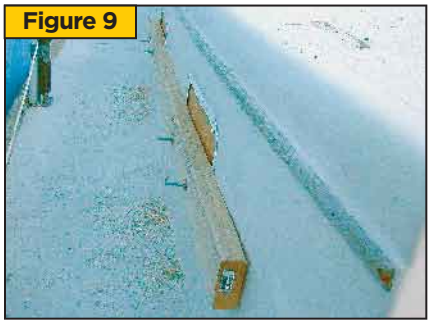


Figure 10

Figure 11

ports, which could have been recycled in another life, if not for the 3M 5200. It also involved minor gelcoat repairs from damaged incurred as we removed the old ports (**Figure 3**). [Ed: A tip for the non-destructive removal of hardware fastened with 3M 5200 is to use Debond. Spray it around the fitting parameter, let it soak in for 15 minutes or so and then carefully cut the edge with a sharp utility knife or hacksaw. Continue applying, cutting and prying until release.]

As with any restoration project on a boat, the real problems become evident as you get into the project. Cabin sides were extremely thin (**Figure 4**). The original installation used scraps of pink foam insulation (**Figure 5**) around the openings and strips of 1" (25mm) hardwood were then glassed along the tops and bottoms of the cabin sides. Teak plywood, 1/8" (3mm) thick, was placed over this and then the plastic portlights where screw fastened. This system, although weak, might have worked if previous owners had been diligent with the maintenance over the years. As windows began to leak, however, the owners tried to tighten the port screws, causing the pink foam to crush, the plastic frames to warp and continue to leak. As we intend to live on this boat, we needed insulation and strength in the cabin sides.

After considering and rejecting several materials, we decided on four layers of 1/4" (6mm) marine grade plywood rather than 1" (25mm) plywood, which allowed us to easily maintain the curvature of the cabin sides. In order to attach the plywood to the cabin sides, it was necessary to first grind off the uneven resin buildup below the ports (**Figure 6**). Donning safety glasses and a full-face respirator, we ground the laminate flush with the cabin sides (**Figure 7**).

Cabin Sides Reconstruction

The next step was to carefully craft a cardboard template of the cabin wall (**Figure 8**) then trace the pattern onto plywood. Plywood sections were glued together to make up the needed length with joining seams staggered to add strength. Next, the first layer of plywood installed on the inside of the cabin surface was epoxy coated to seal the wood against future leaks. The first layer attached to the cabin wall with a generous amount of 3M 5200 to even out the imperfections of the original surface. Braces of 2 by 4s, placed from side to side on the inside, as well as thru-bolted through the port openings (**Figure 9**) held this layer in place while the sealant cured. Each layer of plywood was allowed to dry for at least 24 hours before mounting the next layer.

The next three plywood layers were applied with high quality exterior wood glue. The second layer was held in place with wood screws through furring

DIY BILL OF MATERIALS

Jamestown Distributors

20 tubes 3M 5200 marine adhesive white	$219.80
3 yards (.91m) 1.5 oz fiberglass mat, 38" wide	$14.60
10 yards (.91m) 10 oz fiberglass cloth, 38" wide	$92.45
2 gallons (3.78L) epoxy resin	$137.98
2 pints (453g) epoxy fast hardener	$67.54
Wooden stir sticks, applicators, resin pumps, rollers	$52.00
3 pints (453g) each Weldwood resorcinol glue	$143.52
10 sheets 1/4" (6mm) marine fir plywood	$520.07

New Found Metals

7 7" by 15" stainless-steel ports, $239.95 each	$1,679.65
7 7" by 15" stainless-steel screens, $37.95 each	$265.65
3 5" by 12" stainless-steel ports, $189.95 each	$569.85
3 5" by 12" stainless-steel screens, $24.95 each	$74.85
10 rolls, 3/8" (9mm) butyl tape	$95.00
2 templates rental	$40.00
Shipping for above	$150.00

Miscellaneous

6, 2 by 4 by 10' and 10, 1" by 2" by 10'	$36.00
Assorted screws, drill bits, counter sinks, jigsaw blades, grinder blades, sandpaper, acetone, paint thinner, drop cloths, gloves, respirator, etc.	$341.04
Total	$4,500.00

Figure 12

Figure 13

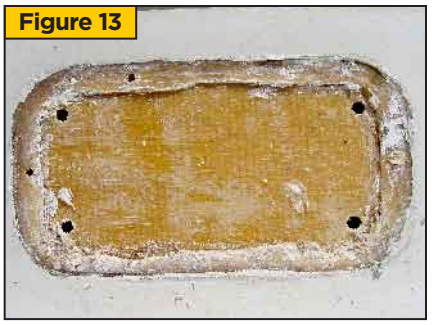
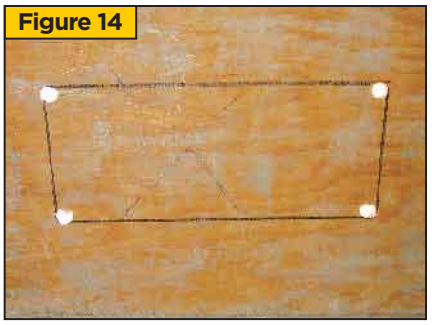


Figure 14



strips into the first layer (**Figure 10**). The last two layers were held in place by screwing them into the layer underneath (**Figure 11**). Of course, all screws were removed as soon as the glue set up (about 24 hours). Avoid using wood glue that expands when drying as this may force the layers apart. (Gorilla Glue is not a good choice here.)

Since we wanted a solid square corner at the bottom of the cabin sides, we epoxied one layer of 1/4" (6mm) marine grade plywood under the side decks. All seams were then filled with epoxy and the cabin sides tabbed to the cabin roof and area under the side decks with 8" by 12" (203mm by 304mm) strips of mat (**Figure 12**). The last step was to grind and sand all corners and seams.

Selection, Measuring and Prep

We opted to purchase our replacement ports from New Found Metals (newfoundmetals.com). Overall, we found its customer service very helpful both on the phone as well as online for obtaining measurements and ordering. It is very important that whatever style or brand you choose that you are very careful to get specific instructions from the company of how to measure for the ports in your boat.

In general, new ports should be the same size (width and height) or larger than the existing opening. The other essential measurement is the cabin wall thickness. As the opening ports we chose are the thru-bolt type, it was essential to have the cabin wall thickness measurement, to decide the size of bolts to use to obtain at least a 1/4" (6mm) protrusion of the spigots beyond the finishing ring. New Found Metals can also provide ports with extended spigots for thicker cabin sides.

Be very careful when obtaining your measurements that you do not assume all the windows are the same size or that all the cabin thicknesses are the

Figure 15

Figure 16

Figure 17

same. We found that there was a significant variation in the head compartment where there was a liner, versus other areas. We also found that there were two different sized openings, when they all appeared to be the same size.

At this point, you should decide what your intentions are for finishing the inside of the cabin walls. We opted to finish the inside with paint, to lighten the cabin but, if you intend on mounting a liner, be it wood, vinyl etc., you should consider doing it before you cut your openings.

We purchased 10 ports and screens, seven were 7" by 15" (177mm by 381mm) and three measured 5" by 12" (127mm by 304mm). The next step was to cut the holes for the new ports. The three smaller ports were the same size as the old ports so it was a simple matter of drilling a hole in each corner of the old opening and using a jigsaw to cut along the original hole (**Figure 13**). The remaining ports were just a bit larger, so we drilled four holes inside of the old opening and cut a rectangle inside of the original opening (**Figure 14**).

The next step, for each size port, was to clamp the template to the side of the cabin, trace the final opening and cut along the marked line with the jigsaw (**Figure 15**). New Found Metals provides instructions for making a cardboard template or you can rent them. We tried both and do encourage one to rent the templates as even the slightest angle or miss cut makes it very difficult to insert the windows. The templates are very sturdy and provide drilling guides that help to get the hole angles exactly right.

The final step was to bevel the inside of the cut so the butyl tape is not scraped off the main flange of the port when installing. **Figure 16** shows an opening cut and prepped ready for a port.

New Installation

For the actual installation of the ports we simply followed the sup-


Figure 18


Figure 19

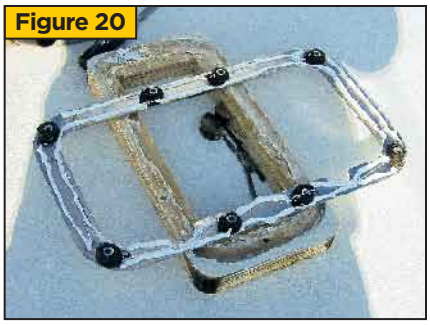


Figure 20

plied instructions. Along the way, we learned a few things that the instructions missed and our experience made installing subsequent ports much simpler.

First, order at least six extra bolts, because even with vigilance, it is easy to get one or two that don't go in properly or are lost and, unless you ask, suppliers only provide the exact number of fasteners. Second, dry-fit each screw by coating with beeswax or penetrating oil, insert all the way into the flange mounting post and then back it out again. Inserting the screws in the actual installation will be much easier.

Installation involves first wrapping the inside frame where it contacts the cabin sides with butyl tape (**Figure 17**). Next, we pushed in the port, pushing it in by hand and then using C-Clamps to pull it through the opening (**Figure 18**). Heavy cloth between the C-Clamps and the port rim prevented damaging the rim when clamping (**Figure 19**).

The next step was to prepare the outside flange by wrapping butyl tape around the mounting posts and putting Life Caulk or equivalent marine grade sealant (not 3M 5200) around the flange (**Figure 20**). Clamps were removed, the outer flange pressed against the cabin sides and then all was clamped to pull the two parts together (**Figure 21**). Again, be careful to protect the new ports from damage by putting heavy cloth between the C-clamps and the frames.

The last step was to insert and tighten the bolts. Let them sit overnight and over the next few days tighten them a bit more each day. After two days, remove the excess butyl and sealant from around each port frame. Don't try and remove all the excess butyl and sealant right away, as this makes a big mess on your deck and side walls. We discovered that, after a few days, the butyl and sealant are

Figure 21

Figure 22

not as gooey and come off more easily with a knife, followed by a cleaning with paint thinner.

Allow one to three hours to install each port, depending on whether you need to cut new openings or not. When completed, be sure to read the manufacturer's recommendations for tightening the dogs and hinges, so you get a nice tight seal.

Total cost of rebuilding cabin sidewalls and installation of 10 new stainless steel ports was $4,500. Having a new look for "Jurate," the security of high-quality opening ports and not having to deal with those pesky drips is priceless (**Figure 22**).

— The first article documenting the restoration trials of Dave and Barb Heilman's Easterly appeared in DIY 2007-#4 issue. Watch for articles in future issues as these consummate DIYers ready their boat for long-distance cruising.

Electric Flush

7

An inexpensive way to convert a manual toilet into an electric flusher saves the toilet and replaces the lower base.

Story and photos by Garrett Lambert

Components of Raritan SeaEra conversion kit: toilet base, strainer, hardware bag and optional seawater pressure pump.

When my wife, the admiral, casually suggested it would be more convenient if one of the two manually operated heads was replaced with a push-button, electric flush model, I promised to deliver "real soon."

By reputation, the Raritan PH II is one of the best manual toilets on the market and I've certainly been happy with ours. (Jabsco units on our previous boat were also reliable.) Raritan even offers a kit to convert it to electric flush, a straightforward base for base swap. Some Internet browsing suggests the product of that marriage is disappointing. On the other hand, the Raritan SeaEra electric toilet has a reputation that compares to its manual sibling and is reasonably priced. Raritan's customer support is forthright and informed me that I didn't have to buy a new toilet. Since the SeaEra uses the same bowl and seat as the PH II, buying just the SeaEra conversion kit would save a few hundred dollars.

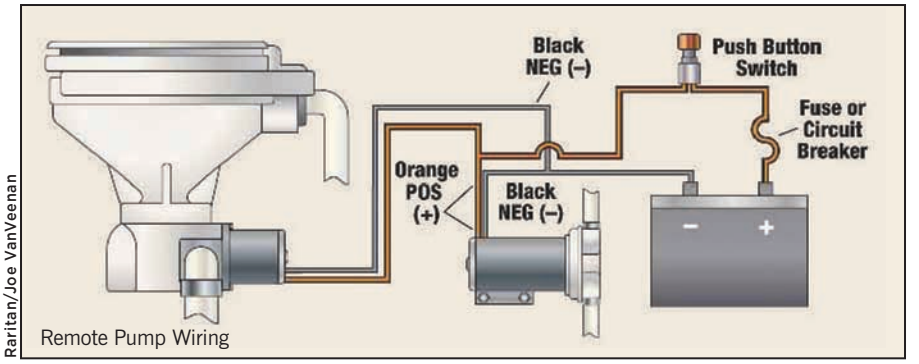
Raritan offers three versions but recommends the freshwater model with macerator because it reduces the possibility of odors and can be paired to one of its waste processing systems. (It's also the least expensive.) There are also two saltwater models. One combines a pump with the macerator but it's noisy according to Raritan. The other has the macerator in the toilet but uses a remote pump. It is a little more expensive but much quieter.

The key factor for us in making a choice between versions is that the Pacific Northwest offers some of the world's best cruising destinations but they are largely wilderness areas with few settlements and fewer sources of good quality water. We couldn't carry enough water for a two or three week cruise using a freshwater flush toilet. For those reasons, we chose saltwater and the remote pump. The kit contains almost everything required except wiring.

Prep

The first step was to take out the PH II. Removing it was straightforward but pulling the two hoses down into the tank room was not. They had "S" curves through holes offset in three layers of plywood, each separated with 3" (76mm) of dead space. In the end, brute force triumphed. The floor under

Inline strainer mounts to valve and connects to the seawater pump.



Raritan/Joe VanVeenan

Remote Pump Wiring

the toilet was stained from blue bowl cleaner and the old hole locations are far from where the new ones will go.

Both problems would disappear under a new floor for the slightly raised dais on which the throne sits. The shape is awkward so I made a pattern. Paper works but I've found that heavy plastic sheeting is easier and more durable. I took the toilet home, disassembled and cleaned it, put the base parts in a box for storage and set the bowl and seat aside to take back to the boat.

The dais is stock beige Formica on plywood. The Formica was a handy leftover from another project and I laminated it to some 1/4" (6mm) plywood and cut the sandwich to match the pattern. I also made some trim out of mahogany scraps.

On the boat, I set the new floor cover in place and positioned the toilet to get the new hose locations right while ensuring clearance for the toilet seat and lid when raised. After checking below that nothing was in the way, I used a long 1/4" (6mm) bit to drill through the dais and the sub floors into the tank room. I now had pilot holes for holesaws that would cut openings from both above and below, just a tad larger than the hoses. (If the original holes and these alterations result in machinery noise rising into the head, my fallback plan is to fill the voids with expanding foam.) Pushing the hoses through the new holes was relatively easy.

Plumbing

That done, it was time to consider where to locate the strainer and pump in the tank. Of course, "room" has nothing to do with space available, because most of it is already taken up with tanks. As a result, the only option was inline with the existing seawater intake hose and along the side of the starboard stringer. Because the shut-off for the saltwater intake is a long way away in the aft lazarette, inserting a second ball valve just before the new strainer eliminates much of the hassle of cleaning the strainer or doing any subsequent plumbing changes.

With the primary valve closed, I cut the seawater hose, sopped up the water that dribbled out and slipped on a hose clamp. (Having a small container ready to collect the water would have been smarter.) A heat gun quickly softened the plastic hose to accept the valve barb and I tightened the clamp. I then repeated this procedure to connect the strainer to the valve with a short piece of hose. It's directional and an embossed arrow points the way. Ditto for the pump, which attached to the stringer by drilling four holes and fastened with four 1-1/4" (31mm) #10 screws.

To make positioning easier, Raritan's pump has three ports: two intake (flow-through) and one output and is supplied with three interchangeable barbs, two straight and one 90 degree, as well as a blank cap. These fittings have O-rings that snap fit to seal the openings and are locked in place with little sliders. I used only one intake port and capped the other. The first real step forward had been completed.

Wiring

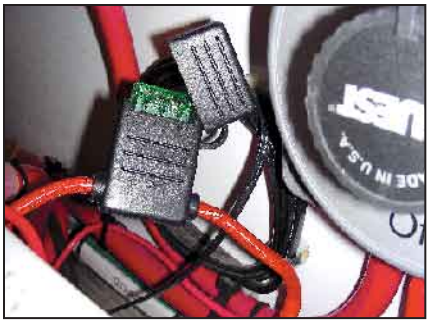
Time to switch from plumber to electrician. Raritan's instruction manual, available on the web at raritaneng.com, could be more conveniently organized but contains everything an installer needs to know, including wiring schematics for each of the configurations. Nevertheless, translating the schematic into the physical reality of a particular boat was challenging because lots of stuff blocks the most desirable route. However crooked, that route is a loop.

As per Raritan's diagram below (see **Figure 1**), it starts with a fused connection from a positive terminal (my choice was the battery bank) to one of the two screws on the momentary switch. [Ed:

Table 1

Units Voltage	Circuit Breaker/fuse size (amps)	Integral Pump and lower base Amp draw @ normal voltage	Remote Pump and lower base Amp draw @ normal voltage	Remote Pump only Amp draw @ normal voltage	15 feet	20 feet	30 feet	40 feet	50 feet
12 VDC	25	18	23	10	10 AWG	8 AWG	6 AWG	6 AWG	4 AWG
24 VDC	15	10	12.5	5	14 AWG	14 AWG	12 AWG	10 AWG	10 AWG
32 VDC	15	7.5	9	4	14 AWG	14 AWG	14 AWG	12 AWG	12 AWG

Seawater model recommended wire and fuse/circuit breaker size.



Inline 30-amp Maxi fuse with holder.

It is a bad idea to connect direct to a battery as, even though fused, this is a motor and should have a dedicated circuit.) From the switch's other screw, the positive lead continues on to connect in parallel to the positive leads on the separate macerator and pump motors. The returning flow from the motors becomes the negative side of the loop and connects to a negative terminal at the fuse panel. It's important to plan carefully and to keep the loop as short as possible.

The two motors run at the same time, drawing a combined 23 amps (versus 18 amps for the single motor versions). The length of the loop and the amperage are the two factors that determine the size of the wires. Amperage drops quickly with distance unless distance is offset with heavier cables. Since undersize wires lead to premature motor failure, it's not wise to scrimp. My shortest loop is just short of 40' (12m). (Didn't seem anywhere near that when I initially estimated it but it's surprising how much distance is added by obstructions.) Raritan's wiring chart, **Table 1** above tells the tale. Use this as a guideline only and refer to ABYC Standard E-11 for specifics.

To deliver 23 amps in a loop of this long length with not more than a 3% voltage loss requires 6-gauge wire. I bought the wire and some crimp connectors plus a fuse and inline fuse holder.

After checking to ensure all was clear below, I drilled a hole in a corner of the vanity floor to run the next leg of the positive cable into the tank room.

(top) Underside view of switch looking up inside the cabinet. (bottom) Switch on outside of cabinet. The "Head" sticker is a standard fuse panel label and cost $.50 at a marine store.

Connecting it to the positive leads from the two motors completed that half of the loop. I determined a convenient location for the switch, made sure there was enough clearance between the back of the vanity frame and the sink bowl, drilled a 5/8" (15mm) hole and mounted it from the rear. The rubber cover unscrews and acts as a nut on the face of the cabinet.

Last Connections

In the head, I inserted the 90-degree elbow on the toilet base into the 1-1/2" waste hose because of the macerator (a 3/4" waste elbow is an alternative) and clamped it. I used the base as a template to drill pilot holes and secured it to the floor with four heavy 1" (25mm) screws. Next, I inserted the four studs into the base through the rubber gasket.

With the bowl sitting in place, I slipped the four flanged nylon spacers over the studs and into the bowl's mounting

Base secured to the floor.

The finished installation. Note switch on left side of photo.

slots. Four nuts clamp it all together. Tighten gently by feel; just enough to lightly compress the gasket. Using the heat gun to soften the saltwater hose and with a clamp in place, I slipped it onto the barbed elbow on the back of the bowl's rim, tightened the clamp and snapped the motor cover on. Much more compact and tidy than the PH II.

I opened the sea valves and pressed the newly installed flush button. Success. A quick check below confirmed there were no leaks.

Delivered cost was just under $500 for the kit. Wire and miscellaneous stuff added another $100 or so. The refit consumed about 25 hours over several days, half determining how to do it and half getting it done. (I have several muscles reminding me that it also required a lot of climbing in and out of the bilges and scrunching in cramped spaces.) The reward is that my wife is a happier boater. Which, of course, means I am, too.

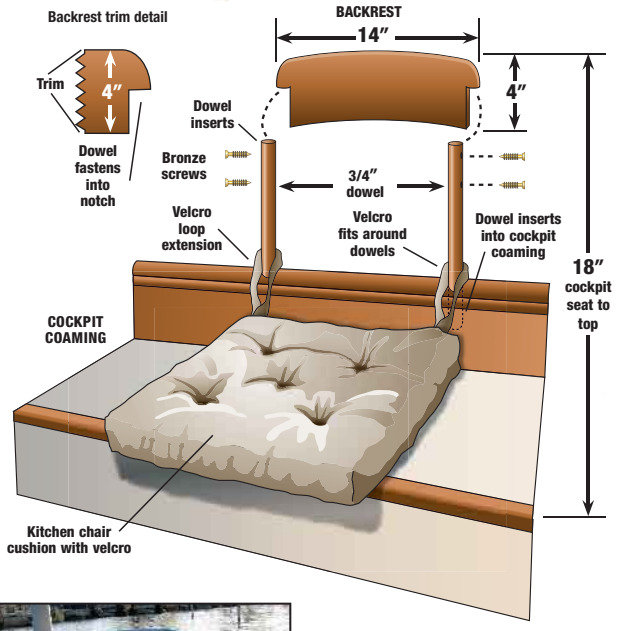
— Garrett Lambert is contributing editor of "Circumnavigator" magazine, editor for woodcentral.com and writes technical articles for boating and woodworking publications in Canada and the U.S.

Armchair Comfort

Easy-to-make rocking backrest offers kitchen chair comfort in an otherwise uncomfortable cockpit.

Story and photos by Marlin Bree

5



Marlin Bree/Joe VanVeenan

Completed backrest.

After years of stainless-steel lifeline wire grinding into my back, I wanted something that would be comfortable when I leaned backward in my cockpit. I'd tried several backrests made of nylon straps between lifeline stanchions and foam rollers over wire but nothing was comfortable on my 20' (6m) custom wood-epoxy sloop, "Persistence." What I finally created looks like the top half of an old-fashioned rocking armchair and that, in fact, was my inspiration. It also has a rocking-like action.

For cockpit comfort, DIYers can easily adapt my captain's rocking backrest to their own boats. All it takes for materials are two lengths of 3/4" (19mm) hardwood birch dowels, available at any hardware store, and a plank of 1" (25mm) thick mahogany, plus an ordinary kitchen chair cushion. You'll also have to dip into your epoxy and varnish supplies.

I began by cutting the mahogany into a rectangular shape, 14" (355m) long and 4" (101mm) high. About halfway down each side, I cut out a 3/4" (19mm) wide section about 2" (50mm) deep. This was where I inserted the 3/4" (19mm) diameter dowels. I drilled four holes, two on each side, for silicone bronze flat head screws to mechanically fasten the dowels to the mahogany backrest. I checked my fit, disassembled and then dabbed plenty of slightly thickened epoxy into the mahogany's end grain and inserted the dowels, held in place with screws. I faired the epoxy join with a plastic spreader to create a fillet between the mahogany and the dowel.

After the epoxy dried, I cut the top round on the corners and gave the top a slight inward curve for a nicely rounded shape to better fit my back. After some sanding, I brushed a coat of epoxy over the entire job to seal the wood.

Next, I fit the backrest. I wanted it to support my lower back but give me action room to move my arms. I finally decided on a height of 18" (457mm) from the cockpit seat to the top of the backrest. Allowing for a 2" (50mm) thick cushion, that gave me about 16" (406mm) of backrest or about the same height as an office chair. Some might like it higher, some lower.

To determine the backrest's location, I placed the assembly atop the cockpit coamings where I usually sit and angled it backward for comfort, again like an office chair. I marked and drilled two 3/4" (19mm) diameter holes in the mahogany coaming and inserted the two extra-long dowels into the holes to their predetermined marks. Dowels are located about 1" (25mm) from the cockpit coaming edge and angle downward so that the bottoms butt against the inside coaming side. This makes for strong construction.

After double-checking the fit and angle, I secured the dowels inside and out with epoxy thickened to a no-drip consistency to give the dowels extra support inside the coaming. Boaters who need extra support underneath the coamings can epoxy wood cleats to support the dowels' bottoms. To seal where the dowels entered the holes, I formed an epoxy fillet. A light sanding and two coats of UV-filter varnish finished off the woodwork.

Next, I worked on a little extra bottom (my bottom) comfort. After testing a number of cushions, I settled on a kitchen chair padded cushion (purchased from IKEA for $9.95). The cushion came with hook and loop fastenings and by my adding another 8" (203mm), these strips now fit around my armchair's dowels to hold the cushion in place. Naturally, I "spritzed" the cloth cushion with fabric waterproofing. Because of the cushion's handy size, I usually toss it below when the boat is not in use or when the weather turns foul. Then I prefer the hard bottom.

As for the building cost, I used two dowels plus a hunk of mahogany I already had. I did buy the cushion, though, and another foot or so of Velcro. Starting from scratch, I'd guess the backrest and cushion could be added to a boat for about $25 or so, not counting epoxy and varnish. This cost is a lot less than commercial cockpit cushions.

The end result is a functional, but compliment-drawing cockpit armchair that I've used for many years of cockpit comfort. It's delightful how a little padding, instead of the hard cockpit seat and something that allows you to lean back, can make your sailing more enjoyable.

Rocking? Sure, when I lean back, the dowels bend a little with me, just like those old wooden armchairs did. I've sailed with my armchair comfort backrest for about 10 years and it's seen me through several white-knuckled, long solo ventures on stormy Lake Superior.

— Marlin Bree (marlinbree.com) built his 20' (6m) wood/epoxy boat, Persistence, which he sails extensively on Lake Superior. His adventures have been chronicled in books including "Wake of the Green Storm" and "In the Teeth of the Northeaster."

Seafaring Idioms

Nautical terms from years gone by have disappeared with technology but some remain as familiar expressions.

By Roger Marshall

Do you have a baggywrinkle in your rigging or a spiderband on your spar? Maybe you have a spurling gate on your deck. Many of these old-time terms have passed out of common usage but it's still fun to look back at them and learn just what they mean.

A baggywrinkle is a device used to help prevent chafe on sails. It is made of pieces of oakum or old line cut into sections and woven onto a rope. The rope is then attached to a stay to prevent sail chafe. The result looks rather like a furry fender up in the rigging.

A spiderband is a metal ring that circles a mast or sprit. It usually has eyes welded to it to attach it to the rigging. The eyes around the central band look like a spider, thus giving rise to the term.

A spurling gate is the cast-iron hole through the deck that allows the anchor chain to pass down into the chain locker. A spurling line attaches to the rudder top and leads up to the helm station. The telltale on each end of the spurling line tells the helmsman the rudder angle. Nowadays, of course, this is done electronically or, in some cases, it's done by watching the bow of the boat. If the boat goes left, the rudder is turned to port or vice versa.

Do you know why the British Royal Navy flies a white ensign, merchant ships fly a blue ensign and just about everyone else flies a red ensign at the stern of a U.K. registered vessel? This history goes back to around 1617, the days of Queen Elizabeth I. The Royal Navy was on its way to becoming the largest navy in the world, a position it would not lose until the 1920s. In fact, the Royal Navy grew so huge that it was too difficult for one admiral to control. Communication in this era was accomplished by hollering from ship to ship or by crude signal flags. A typical signal might be: "When I fly the green flag, everyone turn to starboard," or "If I show a red flag, turn to port." Of course, if a ship was out on one wing of the fleet and the admiral flew a red flag, it ran the risk of sailing merrily into battle only to find that the rest of the fleet had turned to port. To avert any confusion, the fleet was divided into three squadrons: blue, red and white. If the admiral of the red flew a green flag, only his squadron made the turn. This system was discarded only in 1864 with the development of steam ships and a more sophisticated signaling system.

Do you know what a flake is in boating? In the olden days, it was the name used for a platform that was lowered over the side of the ship for men to sit on to paint the hull. Today, it can also mean to "flake a line down," that is, to lay the line down on top of itself so that it can be payed out easily. You might, for example, flake the anchor line before the hook is dropped to ensure that the anchor line runs out smoothly.

Maybe you have heard the term "between the devil and the deep blue sea," meaning that you are in a very precarious spot. This term, too, comes from the days of sailing ships. In this era, the seam next to the keel and the garboard plank was referred to as the devil. This was because, when the ship was hauled out on the ways and a person was caulking this directly overhead seam, hot pitch almost always dropped on the person as if coming from the devil himself. If the seam wasn't caulked properly when the ship was ashore, it leaked when the ship was at sea. To fix the leak, a sailor with a bucket of hot pitch was lowered over the side of the heeled ship until he could reach the devil seam. At this point he was between the devil and the deep blue sea and in a very dangerous position.

For the nautically inquisitive, there are numerous books published on the origins of seafaring terms. "Ship to Shore" by Peter D. Jeans and "Origins of Sea Terms" by John G. Rogers are two nautical dictionaries that I have in my library.

About the author: Roger Marshall is a boat designer and author of 12 books on sailing and yacht design, including "Rough Weather Seamanship for Sail and Power," a must-read for any coastal or inland boater.

We've got BIG news about something small.

We've combined Carnauba and PTFE with the revolutionary nanotechnology chemical process to engineer the most advanced marine wax on the market: MARYKATE NANO BOAT WAX.

Nano-sized particles will cover a greater surface area and penetrate deeper to fill fine scratches and swirl marks. The result: use less wax and get a better finish... faster!

www.crcindustries.com
800-272-8963

Proven. Global. Solutions. CRC

Interlux
yachtpaint.com

Choosing a bottom paint just got easier!

You can pick old technology...

...or Micron® Technology.

A compass works, a GPS works better.
Old bottom paint works, Micron Extra works better!

Unlike old fashioned high copper bottom paint, Micron Extra uses less copper more efficiently, providing many seasons of hassle free boating.

It polishes away like a bar of soap providing a smoother more fuel efficient surface. Old technology bottom paints build up and crack over time, but there's never any build up with Micron Extra so say good bye to sanding and scraping.

If you are not using Micron Technology, you are using old technology.
It is that simple.

Do yourself, your boat, and the environment a favor, choose Micron Extra.

Our World is Water

Visit our website for more information: yachtpaint.com

In Canada use Micron CSC.