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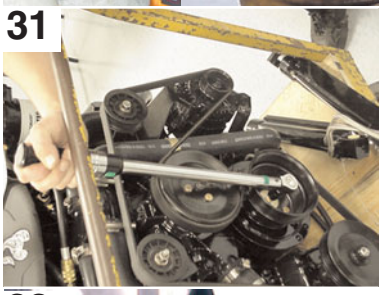

CURRENTS

EDITED BY JAN MUNDY

So What's Interspeed?

I read the article titled, "Bottom Protection," in 2003-#1 issue. Our Saturna 33 Pilothouse is painted with Interspeed 640 CDP, an antifouling not mentioned in this article. I'm curious as to how this paint compares with other bottom paints? *Jim Scott, "Noranna," Sidney, British Columbia*

Jim Seidel of Interlux replies: "I don't know of any direct comparison between Interspeed 640 and other antifouling types. Interspeed 640 is a "marine" product rather than a "yacht" product and though they share some of the same technology, the paints are usually very different. CDP stands for "controlled depletion polymer," which is another way of saying "controlled solubility copolymer" or CSC as in Micron CSC. The polishing rate of these types varies with the rosin-to-resin ratio. The more resin, the slower the polishing rate; the more rosin, the faster the polishing rate. Water temperature, alkalinity and salinity of the water and boat speed are other factors that affect the polishing rate. Resins are more expensive than rosins so manufacturers can make a less expensive CDP paint by using more resin but it would not last as long. Coatings with a high resin content give the paint longer life and also the ability to be hauled and relaunched without having to recoat, such as Micron CSC or Micron Extra. Coatings that contain more rosin, often referred to as "ablative" types, are less expensive to make and thus a lower retail price but they polish faster and in some situations don't retain their antifouling ability during haul out. Examples of rosin-based coatings with little or no resin are Bottomkote and Bottomkote XXX. These paints are inexpensive (by comparison to the Microns), they dry fast so that they can be painted on a tide and they wash off pretty quickly, especially in warm water. This paint type must be launched within 72 hours of painting."

Paint Poll Results

Whose antifouling paint do you use?

According to the survey posted on DIY ONLINE, one manufacturer has the lion's share of the market. A total of 54% apply Interlux bottom paints, followed by Pettit with 16%. Boat/US and West Marine house brands tallied 5% and 7% respectively, and 5% for"Other" brands. Awlgrip received 3% of the market share, Sikkens and Nautical Coatings tied with 2% each. Boats without any antifouling totalled 6%.

Our polling software accepts only one vote per Internet address, so these results are somewhat precise. To cast your vote in our new poll, log onto DIY ONLINE at www.diy-boat.com. Results are posted in upcoming DIY issues.

Manuals Wanted

"I'm looking for manuals for my boat" is the one inquiry asked more than any other on DIY's Technical Helpline. Unlike the automotive sector, boat manufacturers rarely provide a single comprehensive how-to owner's manual. A boat is a collection of other product manufacturer's equipment, much like a house, which never comes with operational specifics on plumbing, wiring, etc. Manuals for steering systems, electronics, power systems, pumps, stoves, toilets, winches, windlass and other components not made by the boatbuilder are typically included with the equipment or should be available from the manufacturer. If a boatbuilder were to provide a manual it would be more generic to operational issues. Engine service manuals are usually available to purchase. If the companies who built the boat and/or components are still in business, there is a good chance of getting a manual. Boat builders come and go and the large companies with long production runs can usually help with a specific concern. Outside of the boat builder, there's a wealth of information to be found among friendly marine surveyors, boat yards and the Internet, especially among the boat class associations. Make a list of each brand, model, etc., of all components and do some digging on the Internet. My favorite search engine is www.google.com.
— *Jan Mundy*

Are Battery Additives a Cure-All?

There are numerous battery additives, also called battery conditioners, sold in stores under different brand names. Are they effective? The claims made by manufacturers appear to offer significant battery performance enhancement. The compounds are specifically designed to prevent sulfation or dissolve sulfates on the battery plates. But as the latter would only occur on plate surfaces and plate sulfation occurs through the entire plate, only a partial improvement is achieved.

These products may, however, help in salvaging a suspect sulfated battery and provide some significant short-term improvements before purchasing a new battery. They are not recommended for adding to new or nearly new batteries. Will they stop sulfation as a substitute for bad charging? Not likely. Triple battery life as some claim to do? I don't think so as this computes to about 15 years for a deep-cycle battery. If a battery is properly charged, frequently used and well maintained, a battery doesn't sulfate. Battery longevity is based on cycle life. It's about material shedding as plates stress during charge and recharge. Just be sure your battery is properly charged and used and you won't need to alter the battery electrolyte to prevent sulfation.
— *John Payne*

Bragging Rights

Now you can brag about your boat to other DIYers by showing it off on DIY ONLINE. "Reader's Boats" is a special forum where we highlight boats and projects. To include your boat, send an email to tech@diy-boat with your name and email address (don't fret, we don't publish email addresses); boat name, make, model and year and photos of your boat. Be sure to include a short description and list any prior modifications or customizing to the exterior, interior or mechanical as well as any future refits planned.

Head:Avoid the "Hot Slip" Syndrome

Faults in AC system grounds can result in fatal swimming accidents. Should an AC electrical fault occur onboard (your boat or somebody else's) or in the dock wiring, some of the current doesn't return as its designed to do via the shore ground through the marina's dock wiring and instead, is passed through the boat's ground into the water where it seeks a path back to earth through the water. This poses a dangerous risk to swimmers near boats plugged into shorepower. Should an AC fault occur, the consequence is electrical paralysis and possible drowning.

To eliminate any risk, always unplug your boat from shorepower before doing any underwater work. Be safe and never swim when docked in a marina. Perhaps, add a galvanic isolator for peace of mind.

When Smoke Signals, Rockets and Meteor Flares Expire

Next time you take inventory of the safety equipment onboard, check the expiration date on the flares, meteors and orange smoke signals. The life for pyrotechnic devices is 42 months from manufacture, according to Coast Guard regulations. Be sure you have the minimum of three currently dated flares but don't dispose of the expired ones. Instead, keep them because in all likelihood, if they have been kept dry, they probably still work. Should you ever need to ignite them you'll discover that a single flare burns very fast and it pays to have spares in reserve.

If you decide to dispose of expired flares, you have several options. One is to return them to the flare manufacturer. These companies would like to see the expiration dates be extended and your outdated flares can help them document that these flares, when properly stored, can be serviceable for longer periods. Contact the pyrotechnic maker to see if they have such a program. Ultimately, helping with

this research will save you money if the utility dates can be extended. If throwing away the old flares is your chosen disposal method, contact your local fire department, sanitation department or environmental protection department and determine your local hazardous waste material disposal rules. Then follow the rules. Sometimes the local Coast Guard Auxiliary or Power Squadrons like to have old flares for training purposes. Even some marine stores sponsor training days for the public. Such pyrotechnic demonstrations are a great venue to become acquainted with your safety gear. Knowing how to ignite them, seeing how they burn and how the slag drops can make a big difference should you ever need to use them.

Nonsuch Celebrates 24 Years

In celebration of the 25th Anniversary of the Nonsuch, a rendezvous is planned on July 25, 2003 at the Royal Canadian Yacht Club, Toronto, Ontario. Designed by Mark Ellis from a concept proposed by Toronto yachtsman Gordon Fisher, the Nonsuch could have fallen in the "Less Likely to Succeed" category. It's singular cat-style rig, bulky styling and titanic accommodations, all drastic departures from traditional sailboat designs, passed muster (or cut the mustard) gaining broad acceptance and almost a cult following. Originally built by Hinterhoeller Yachts, there are currently about 1,100 member boats in the International Nonsuch Association (www.nonsuch.org).

Water, Water, Just "Pure" Water

Complaints of water tank odors are common and come in two categories: swamp water and plastic taste, each requiring a completely different remedy.

Foul-smelling "swamp water" is due to bacterial and algae growth in stagnant water or in the plastic or rubber compound lines from the tank to the faucet. The tank must be drained and disinfected. This is easy to do with a common household bleach solution and, where algae or mold grows on the tank sides, add a good scrubbing if there is access into the tank. (If not, consider adding an access port as described on page 49.) Severe cases may need the treatment repeated. Keep flushing and refilling until the bleach odor is gone. ABYC Standard H-23 recommends these procedures for disinfecting a potable water system: a) Flush entire system thoroughly by allowing potable water to flow through it: b) Drain system completely; c) Fill entire system with a chlorine solution having a strength of at least 100 parts per million and allow to stand for one hour. Shorter periods will require greater concentrations of chlorine solution; d) Drain chlorine solution from entire system; e) Flush entire system thoroughly with potable water; f) Fill system with potable water. If hoses are flexible (plastic or rubber compound), replacing them can bring an enormous improvement in water taste.

Plastic taste is a lesser complaint as the water is probably potable but has a bit too much off-flavor. Most activated charcoal water filters do a good job removing residual plastic taste. A simple solution is to use a portable water filter jug, (e.g. Brita). Reserve it for drinking water and refill it as needed from the boat's potable water system.

I recommend against charcoal filtering normal chlorinated city water on its way into the tank. When stripped of chlorine, water festers more quickly in the tank. Charcoal filtered water should be consumed quickly due to its limited storage-life. The charcoal doesn't remove microorganisms and is only useful treating water that is clean enough to be considered "potable." Water from a reverse osmosis water-maker is different. It's essentially sterile, "pure" water and has a long storage life provided it doesn't get contaminated.

[Ed: An excellent product for cleaning water tanks is Capt. Phab Water Tank Purge. It cleans and deodorizes and doesn't leave any off taste. Check out www.captphab.com. It's a good addition to your cleaning stores.]

— Nick Bailey

DIY boat owner the MARINE MAINTENANCE MAGAZINE

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Without Trailer Assist™

You're Just Spinning Your Wheels

It happens more often than you know. A couple of feet too far and you're off the ramp, stuck and embarrassed with unhappy boaters piling up behind you. Fortunately, Trailer Assist includes winching your vehicle and trailer out of the mud and back onto the ramp—a service not offered anywhere else.

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TREND SETTERS

Some of the newest gear to hit the boat shows.

Top Down

Just when you thought you had all the conceivable accessories on your boat, along comes the convertible top. Developed by Taylor Made Systems, (Tel: 518/773-0636, Web: www.taylormadegroup.com) it's a power-driven convertible top for boats similar to the ones used in the automotive industry.

At the touch of a button, the aft sunpad opens, the hydraulically operated convertible top rises out of its compartment and latches directly to a Taylor Made windshield frame. To lower the top, simply unlatch the top from the frame and press a button. The entire mechanism disappears beneath the sunpad, leaving an uncluttered appearance.

Available in a broad range of marine fabrics, types and styles, the top is geared to runabouts and small cruisers in the 6.4m to 8.5m (21' to 28') range. Prices are comparable to its automotive cousin. Depending on market response, you'll likely see this option on some 2004 models.

Fuel Flow Meters for DIY Installation

Monitoring engine fuel flow to minimize fuel consumption and maximize operating efficiency is a boon to boat owners. Installing fuel flow monitoring instruments in diesel-powered boats is a complicated job, even for a skilled mechanic.

Floscan's (Tel: 206/524-6625, Web: www.floscan.com) new Series K Diesel Fuel Flow Monitoring Systems are designed for consumer installation using basic tools. It's a

matter of installing two flow sensors in the fuel system, one on the forward flow line to the engine and the other on the return line. The average single engine install takes a day or less. Series K systems are available for most diesel engines from 70hp to 3,000 hp. Prices range from US$650 to US$2,000, depending upon diesel engine make and model.

Quick-Release Fasteners

When you need to fasten a removable panel made of thin plywood or acrylic, such as an electrical panel, electronics' box, floorboards, engine bulkhead, etc., PYI (Tel: 415/355-3669,

Web: www.pyiinc.com) has the ideal fitting. Panel Anchors come in various stud, head, grommet and receiver styles. There are screw or toggle-type heads, raised or flush grommets and adjustable, fixed or floating receivers. Just mix and match, depending on your application. A complete set retails for less than $20 each.

Swim Platform Craft Mount

St. Croix's Roll-On System (model 850) is an off-the-shelf solution to stowing a hard-bottom inflatable or personal watercraft on a swim platform. Rated for a 453.6kg (1,000lb) craft and weighing about 22.6kg (50lb), it's completely portable. It takes about 30 seconds to remove after launching the boat for an obstacle free swim platform, or reinstall it to reload the boat. Compact, it folds into a space about the size of a Group 8 battery. Made of satin glass-finished stainless steel, it can be fitted with a manual or motorized winch.

Quiet Onboard

QuietPro panels are water resistant, sound and vibration absorbing panels from insulation specialist Soundown (Tel: 800/359-1036, Web: www.soundown.com). Expanded polypropylene pellets are formed into rigid boards, resulting in a lightweight structural board. For example, a 19mm (3/4") QuietPro board is lighter, by a factor of almost three, to a comparable plywood sheet. Uses include: acoustic liner in water-exposed areas; energy absorbing panel to dampen sound and vibration; a thermal panel that doesn't absorb condensation.

Available in common thicknesses starting at 6mm (1/4"), panels are sold as core-only or faced with Maranti plywood constructed to BS10 marine plywood specs. A 19mm (3/4") faced board sells for US$120 a sheet. A core-only board costs less than US$3 per .09sq. m. (US$3 per square foot). Construction follows the same procedures as any cored material. There is no minimum order; Soundown accepts single panel orders.

TALK BACK Q&A

HELP LINE TECH@DIY-BOAT.COM

Low-Down on Ozone

Q: Has there been any recent research done on the Bilge Buster odor eliminators. Is the ozone produced dangerous? Apparently, from boaters that have used them they work very well but the Bayfield chat line recently suggested that ozone corrodes gaskets and is a health risk. *Robert Carlson, Peoria, Illinois*

A: Ozone generators have had their share of controversy but there is no better tool to eliminate odors and prevent mold and mildew. For a more scientific reply, we asked Jeff Ramos, director of operations of Quantum Pure Aire, manufacturers of the Bilge Buster, to comment: "Concerning ozone and health issues, the concentration level is what is most important. As with almost anything, too much is bad for you. On a boat there are two distinct areas to be concerned with. Occupied areas (the cabin) and the bilge and engine room, which are considered unoccupied areas. Maintaining safe ozone levels in the occupied areas is a primary concern. All cabin models (occupied areas) are equipped with an air quality sensor that controls the ozone output and maintains ozone levels at or below the levels recommended by OSHA and the EPA for long-term exposure. These units have a manual override but it's suggested use is only when no one is onboard. Bilge units don't have sensors and are designed to be a continuous source of ozone. Since ozone is heavier than air the ozone produced in the bilge stays in the bilge and doesn't affect the cabin air. When it's necessary to work in the bilge or engine areas, it only takes about 20 minutes for ozone to deplete down to safe levels. Ozone has a very short shelf life when left alone (about 45 minutes) and a shorter life when reacting with contaminants, such as the type found in most bilges. This short life prevents the build up. As for any risks ozone poses to other components, ozone does react and break down pure rubber but most of the rubber products today are synthetics and blends that are not reactive with ozone. Additionally, marine hoses that are certified for bilge use must be ozone resistant. Ozone reacts with chemicals in the air that causes the odors generated from a boat's engine, holding tank or bilge and removes them. Our units get rid of these chemicals, which means you are no longer breathing them."

Rating AC Charger Amperage

Q: What is the formula to size an AC charger for my batteries? When I purchased the boat it had a 20-amp unit with a 500-amp starting battery and 105-amp house battery. I have refitted the boat with a 1,000-amp start battery and two, 205-amp house batteries connected in parallel (all lead-acid type). What's the risk of continuing with my 20-amp charger? *Chip Lohman, "Whispering Swan," Quantico, Virginia*

A: There is no strict formula for determining charger sizes. The same general rule of 30% to 40% of total installed battery capacity still holds. The start batteries are not really an issue as they tend to only dip a few percent and soon recharge from the alternator. Another factor is the time requirement and how long a time period is required to recharge. In many boats a gen-set and AC charger, rather than alternator, do the charging so the question of minimizing run time is a similar issue to engine charging. If it's entirely shore-power-based charging, you'll have an 8-hour or better period. The common sizing of a charger is typically in the 20 to 40-amp range. There is no risk as long as the charger is of sufficient quality to control voltages and not boil the batteries. If the charger is doing its job and maintaining battery condition without excess electrolyte loss, then I suggest sticking with it. The worst thing that can happen is it runs at peak output for long periods and fails. In many cases charging is equal to the charge current plus loads on the electrical system, such as lighting. Higher loads on the system may require moving up to a better quality 30 to 40 amp charger, such as a lightweight, electronic switch mode type unit.
— *John Payne*

Motor Box Clearance

Q: I'm in the process of updating the interior of my 240SRV Weekender Sea Ray. It has a lounge area above the engine, even with the boat sides, that I plan to remove and install bench-type seats and a new motor box. Is a clearance of 7.6cm (3") between the flame arrestor and the underside of the new seats sufficient?
Bob Herndon, "Jenny B II," Evansville, Indiana

A: New Mercruiser engines only require a minimum 12mm (1/2") clearance between the boat and any engine component so 7.6cm (3") will be more than enough. It's more critical to ensure the engine compartment has adequate ventilation, about 600 cfm for a small block V-8 engine.
— *Steve Auger*

Maintaining Hydraulic Pressure

Q: On my 9.7m (32') sailboat, the Navtec hydraulic backstay adjuster has lost pressure after not being used for 2 weeks. When pumped, it now only increases pressure slightly then

stops. There is no noticeable leak. How do I check the level of fluid? What exactly do I put in it? How do I expel air out if that is the problem?
Richard Foy, Moose Jaw, Saskatchewan

A: The most likely problem is an airlock, a common problem after storage or infrequent use. To clear the airlock put the adjuster in a vertical position, open the release valve and fully extend, by hand, the piston. With the piston fully extended, close the valve and pump the adjuster back down to its normal position. Repeat if needed. This procedure should clear the airlock. Store the unit in a vertical position to prevent this from reoccurring.
— Nick Bailey

Substitute Rocker Switches

Q: I have installed GFCI duplex outlets in my boat's cabin for AC current. I want to install rocker arm switches of the same style for 12-volt, 20-watt interior lighting, but the only ones I can find are the household type marked 15 amp 120-volt AC. Can I use these on a 12-volt system?
Henri Degioanni, "DDIV," Montreal, Quebec

A: You can use AC-rated switching equipment on DC however the contacts on AC switches are much smaller and DC power tends to reduce the life of switches by up to 60% or more depending on the number of operations. The arcing tends to be much greater and this erodes and pits the contacts quite rapidly. DC-rated switches generally have a faster breaking action to draw and quench any arc when opening the contacts. Use the largest contact rating possible which you are doing and while they are available buy a spare switch unit for later.
— John Payne

Varnish versus Urethane

Q: I'm finishing my boat's mahogany window frames and need to know if the exterior house grade urethane sold at hardware stores is a good substitute for a quality marine varnish? Dry time is quicker and the claims of UV protection are the same.
Brad Indicott, "Leah Gent," Lenoir, North Carolina

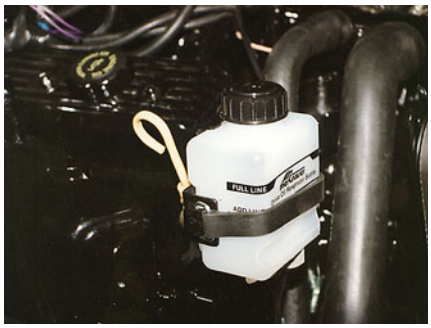
A: Differences in varnishes are a function of the raw materials. Marine products generally use the more expensive light stabilizers and UV absorbers. The resins that are used are different as well. The products for home use (called trade sale products) are made with less expensive resins that may be harder, for use on floors

etc., but don't have the flexibility, durability or water resistance of marine varnishes. Household type varnishes generally use a phenolic resin that is modified with some sort of alkyd resin. Marine products use urethanes or tung oils, which are more expensive, to modify a phenolic resin.
— Jim Seidel, Interlux (Technical Service Line: 800/468-7589)

Maintaining Sterndrives

Q: My engine's sterndrives are undergoing some repairs and the mechanic noted that the port drive has water in the oil, corrosion of the aluminum parts around the seals and salt deposits in the water intake/passages. After every outing, I flush both engines for a five-minute minimum using flush ears and a hose. Is there anything else I can do to make sure both drives are well flushed?
Steve Carstensen, "Dive-Inity," Anacortes, Washington

A: Water in the drive oil means the drive has worn or failed O-rings and/or seals. Install a gearlube monitor kit (part number 69622a7) to monitor the condition and level of the drive oil from inside the boat. Corroded aluminum parts is a sign of insufficient corrosion protection. I would advise installing a Mercury Mercathode kit (part number 98869a14) that uses battery current



to neutralize the harmful electrochemical reaction known as galvanic corrosion. Both parts cost around US$300. The only way to reduce saltwater damage to the water passages is to upgrade your freshwater flushing of the engine and run the engine more frequently.
— Steve Auger

"Awl" Care for Painted Finishes

Q: I need recommendations to protect my boat's newly painted Awlcraft 2000 finish. How long should it last?
Jay Friedland, "Wanderlust," Haven Beach, New Jersey

A: The paint you've applied will last for many seasons provided it's kept free of dirt and other contaminants. Just wash and dry. No additional protection is needed. When Awlcraft 2000 appears dull, Awlgrip recommends washing the surface frequently with Awlwash Wash Down Concentrate (73234), diluted as specified on the label. Rinse well and wipe with a clean chamois. Don't let this cleaner dry on the surface. Never wash the topsides with marine soaps or any cleaners containing alkalis, acids or abrasives. Besides being too harsh, they may yellow the finish. To remove hard water spots, add a water softener to the final rinse. Awlcare Protective Polymer Sealer (73240) also removes water spots. Protecting the topsides with this product helps to maintain and/or restore the gloss. Use a mild solvent to remove stubborn stains. Awlgrip recommends its Awl-

prep T0008, Awl-prep 400-T0170, mineral spirits, xylene or kerosene for use on Awlcraft 2000 but do a spot test first in an inconspicuous area, don't let it dry and rinse well with freshwater. Distilled white vinegar and hot water remove stubborn salt stains. Follow any harsh cleaning with a thorough rinse, wash with Awlwash and reapply Awlcare.
— *Jan Mundy*

Leaking Tank? Remove or Refit

Q: When I purchased my 1983 11m (36') Chris-Craft Commander, the previous owner hadn't pumped the waste-holding tank completely and it froze and fractured. This 62L (75 gal) aluminum tank is located under the companionway and extends under the wall of the head and side berth. Do you know of a good solution to repair this? Would a repair product that coated the inside of the tank work?
William Bodette, Big Bobber", Garden, Michigan

A: The right thing to do is remove the tank for a welded repair or replacement with a new one. I doubt the inside surface can be adequately cleaned and prepped to successfully coat the inside with some kind of sealer. Unfortunately, judging from the installed location you describe, this big tank isn't going to come out without cutting. It is a difficult job to cut away floors and bulkheads to extricate a tank in one piece and even then it may not fit through the companionway. Often the best solution is to get a saber saw and cut the tank into pieces for removal. Replace it with a new smaller tank that fits through whatever opening is available. It may also be possible to install two smaller tanks and plumb them together to increase the overall capacity. A third option is to cut away enough of the existing tank top to install a flexible bladder tank inside the original tank. This approach may be complicated by the presence of baffles that obstruct the interior of the old tank. Leaking tanks are a big problem in older boats. As boatbuilders install tanks and other components before the deck, it's obvious they were never designed to be replaced.

[Ed: Aluminum is a poor material choice for a sewage holding tank as it reacts to chemicals often used to clean a toilet and the ammonia that forms from urine also attacks the tank. The best choice for replacement is a high quality plastic tank. Bladder tanks are a last resort as they are subject to permeation, the real source of marine sanitation system stench.]
— *Nick Bailey*

Stripe Removal

Q: I have two stripes that need removing: a 12.7cm- (5") wide tape stripe that has faded badly and a badly painted stripe of the same width. What do you recom-

mend to remove both from fiberglass.
Abed BenBrahim, "4Play," Clear Lake Shores, Texas

A: Though some people use solvent and a scraper, which leaves a gooey mess and risks scratching the gelcoat, the best product to remove stripes is an "eraser" made by 3M Marine and Ferro. Both products literally erase the tape, leaving no adhesive residue and no sticky mess. All that's needed is a quick wipe with solvent. I used a Stripe Eliminator (800/343-3776) to remove a name with letters about 48cm (18") high and covering a 3m (10') span on each side of our project boat, in less than an hour. The faded gelcoat underneath is easily restored with rubbing compound. Rubbing compound and lots of elbow grease does a great job of removing painted graphics.
— *Jan Mundy*

When Wax Won't Wipe

Q: We applied Meguiar's One-step Cleaner/Wax to the entire hull of our 9.4m (31') Hunter sailboat and when we were ready to buff it off, it was rock solid. The temperature was around 12.7°C (55°F) and sunny. What can we do to remove the haze that remains on the boat?
Bill Vollmer, Elmhurst, Illinois

A: It's likely the air temperature was too cold for the wax to set. Fortunately, there is an easy fix. As all waxes are water-soluble, just take a spray bottle of water and lightly spray the surface, then wipe clean. Ambient and surface temperatures are critical to achieving an effective

wax bond. When applied at cooler temperatures, wax takes longer to harden and haze, which gives a strong bond. When applied on a hot summer's day where the surface temp is even higher, the wax often dries before it has time to chemically bond to the gelcoat and most of it is removed when buffed.
— *Jan Mundy*

Water Pump Service

Q: My recently purchased a 1976 Bayliner 2750 Command Bridge has two water holding tanks and a hot-water tank. Before leaving the boat, I shut off the water pump. When I returned and turned on the water pump it ran for about 5 minutes before I turned it off. Would this continuous running be caused by evaporation of water in the hot-water tank and the pump is refilling this tank? Do you think I have a leak in the system. Also should I not be shutting the water pump off when I'm not using the boat?
Roger Paulsen, "Patches," Reid Point, British Columbia

A: You are correct in turning off the power to the pump when leaving the boat. It appears that the pump is losing prime over the period of time you are away. The pump will run continuously until it expels the air from the system and it can again build water pressure. Be sure a faucet is open to allow the air to escape. Often, when pumps loose prime, the cause is debris caught under the valve flappers. We suggest that now and then you run the pump with all faucets and/or valves open to allow the pump to run at full flow for at least 2 minutes. This allows the valve flappers to open fully and, more often than not, clear the debris and allow the valves to seal.
— *Dick Lee, director of product management Flojet, ITT Industries*

TECH TIPS

KRYSTAL CLEAN: To easily remove stains and spider droppings on gelcoat hulls, decks and non-skid, spray on a little Krystal Clean (US$4.95) and wipe off with a shop rag. [Ed: Remember to do a spot test before applying and never let any cleaner dry on the surface.]
James Allen Discher, "Bear Boat," Lewisville, Texas

TUBE BENDER: When you need to bend some copper tubing simply seal one end with tape, and then fill the tube with dry sand. That will prevent the tube from kinking at the bend.
Alan Porter, "Te Tiaroa," Victoria, British Columbia

PURGING SEACOCKS WITHOUT HAULING: To remove marine creatures that collect on engine and other raw-water thru-hull intakes, don't haul out or hire a diver. Instead, close the seacock valve, remove the intake hose and temporarily attach a hose on the seacock tailpiece that is long enough to reach above the waterline and support that hose in a vertical position. Open the seacock and insert a rod, wood dowel or a wire coat hanger through the hose to clear the obstruction. Be sure the bilge pumps are operating at peak efficency and have handy a wooden thru-hull plug in case something goes wrong.

CLEANING CABIN TEAK: Next time you decide to renew the oiled teak in the cabin or perhaps a teak table, apply a solution of TSP (trisodium phosphate) and scrub with either a white 3M Scotch-Brite pad or fine sandpaper.

SUPER POOPER UNCLOGGER: When you need to clear a clogged head hose or remove solids in holding tanks and have tried the usual drain cleaning products but to no avail, pour about a gallon of microbe-enzyme treatment down the pump-out hose, let it brew for five days or longer, then pump out. I used a proprietary blend from Environmental Tactics, Big Pine, Florida, which is produced by Bayer. A similar microbe fix, instead of taking stuff apart, is available from Eatscrap (http://www.skimoil.com/eatscrap.htm). It's a great alternative to getting your hands dirty!
Larry Johnson, "Miss Charlotte," Key West, Florida

DECONTAMINATE BILGE WATER: Install a Vetus bilge water-oil separator in the bilge pump hose and put aside all worries about pumping water that's contaminated with hydrocarbons overboard. This unit can cope with about 8L (9.5 gal) of pumped-through bilge water, hopefully, more capacity than you'll ever need.

REMOVING STRIPPED SCREWS: To remove screws whose heads have stripped, use the Craftsman Screw Out (part #32154). Insert the proper bit (three are included) into a variable speed drill, run it in reverse at very slow speed and the bit cuts into the head and spins out the screw.
Jim Adams, Orillia, Ontario

CHAFE GUARD: Available at automotive suppliers, self-adhesive plastic bodyside moldings double as durable and attractive chafe strips for boats.
Bill Macklin, Stratford, Ontario

DETHRONE A PIGEON: There is a solution to pigeons roosting in the rafters of a boathouse and soiling all things below. Cut plastic fencing to a 15cm (6") width, cut away the top edge to expose the "forks," drill small holes at the base in every few squares and install on the rafter with galvanized nails or screws.
Ray Bunt, "Chapulin," Pender Harbour, British Columbia

BOTTOM CHECK-UP: If you're unsure of the type of antifouling paint on your boat, give the dry hull a wipe with a soft, wet cloth. Should abundant color transfer to the cloth, the paint is a soft paint, most likely a traditional sloughing or ablative (wears away) type.

GREASE JAM: If you feel some resistance when lubricating with a grease gun coupled to a grease nipple, stop immediately as it's possible there's a blockage. Also, never depress the ball bearing on the grease fitting head, which causes grease to expel at dangerously high pressure.

PRO SERIES

SCHOOL OF HARD KNOCKS

Repairing a sailboat's protective "armor" involves highly skilled metalworking techniques, such as welding, jig bending and the ancient art of a blacksmith. Here's an inside look at how a professional service shop repairs aluminum toerails from minor damage to rail sections to major repairs and total rail replacement.

BY NICK BAILEY

One of my powerboat-owning customers noticed our service docks are often occupied by sailboats undergoing collision repairs.

"How come these guys run in to each other so often?" he asked. I often pondered this myself so my answer was ready.

"Sailing is more dangerous than it looks," I said. Then I went on to explain how sails create mutually overlapping blind spots, that sailing under autopilot steering can be much too relaxing and inattentive and, when sailing upwind on opposite tacks, boats are naturally on a collision course. We discussed how racing sailors also enjoy deliberately "tilting" at each other while overcanvassed and barely in control. At the last second, the imminent collision becomes a near miss as the opposing skippers scream at each other chapter and verse of the rulebook as well as other graphic terms of endearment.

"It's quite a sport and good for business!" said I.

Look at the rails on any veteran sailboat and you'll see the scars, each with a story to tell. Though most aluminum toerails resist minor bumps and indignities, that doesn't qualify them as armor plating. Sometimes a collision can absolutely mutilate a toerail. Such damage presents the repair shop with a challenge. Rail repairs can be difficult or even impossible and straightforward replacement is not always an option.

Damage Assessment

When a repair pro inspects a damaged toerail (usually accompanied by the insurance company surveyor), the first consideration is whether or not it's repairable, and if not, is an identical replacement available. Repairs are often dictated by the rail's color. Black anodized toerails are convincingly touched up or completely re-anodized. Clear or silver anodized rails are more finicky and any repair work tends to show. If the rail cannot be repaired, hopefully, there is a replacement available otherwise the only option is completely new port and starboard rails with a different profile. Insurance companies hate to hear this because it's very expensive but sometimes, there is no other satisfactory option.

Availability Issues

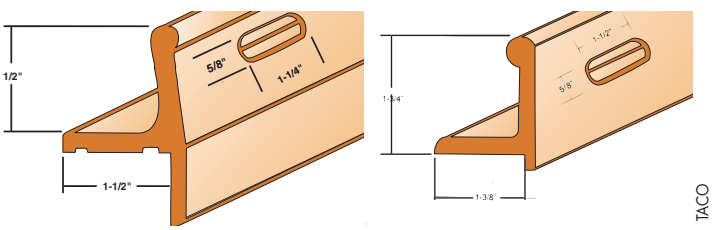
Repair shops spend plenty of time scouring the country for matching rail sections. If a boat is still in production the original style toerail can usually be purchased from the boat builder.

Often, there is a matching off-the-shelf rail sold purchasable from a boat hardware manufacturer. Many high volume boat builders have rails custom extruded in large batches. Sadly, when the boat is long out of production or the boat builder is defunct, replacement rails are not readily found. So, if the rail is black anodized, even a difficult repair is worth doing, particularly if the only other option is to completely replace the rails on both sides. With this as an incentive, some service yards have developed a lot of toerail repair expertise.

A candidate for replacement: any repairs to this damaged aluminum rail will show through the clear anodized finish.

Rail Removal

Severe rail damage demands complete removal regardless of whether it's due for repair or replacement. Some boats have separate fore and aft rail sections; others have a single piece rail on each side. Disturbing a well-sealed hull-to-deck joint to remove a 12m (40') rail with only a short span of damage seems like an unnecessary pain. Provided the customer is willing to accept this compromise on perfection, it makes sense to cut the rail amidships and remove only the damaged section.



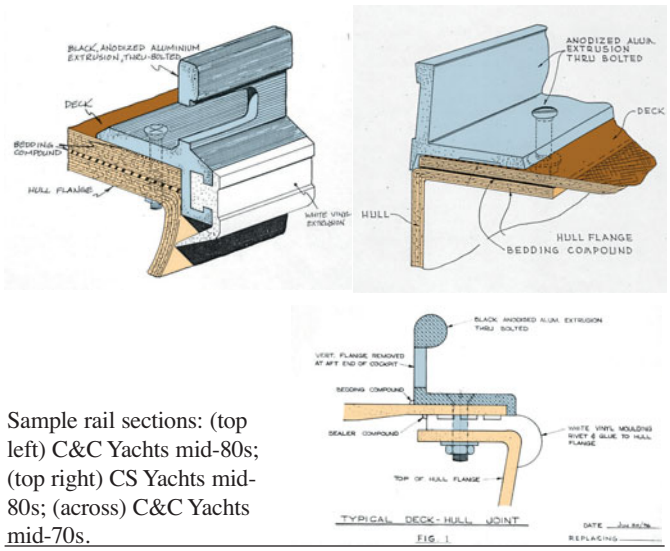
When replacement isn't available, there are different styles of aftermarket profiles available.

Over-the-rail fittings allow invisible rail joints.

To prevent this from appearing as a cheesy shortcut, and the corresponding reduction in the boat's value, the joint is made under an existing fitting, such as stanchion base. Alternatively, a new fitting can be added to the rail to cover the joint. Amidships-mounted springline fairleads or cleats are ideal to improve the outcome and add function in the deal.

After determining how much rail to remove, a two-person team unfastens the rail. Most toerails are bolted through the hull-deck joint and removal is simple in theory. The inside person uses a socket wrench to hold and remove the nuts while the topside partner uses a screw driver (powered if possible) to unscrew the bolts. In practice, this work is complicated by difficult access to the nuts on the underside of the hull-deck joint (see below) and the reluctance of the sealant clogged bolts to unscrew or even turn. It's not unusual to have to carefully knock the bolts out from underneath. Most toe rails are caulked with a sticky non-hardening bedding compound like gray butyl tape or polysulphide sealant. These sealants have a ferocious grip so it's usually necessary to drive a putty knife and wedges under the rail to break the seal and then carefully pry up the rail.

Where cabinetry prevents direct access to the underside of the joint and the rail fasteners, it may be practical to remove interior panels for access. Alternatively, circular access holes are neatly cut using a holesaw. It's important to choose a hole size that matches a stock plastic liner plug that is later used to neatly cap the opening. Clean up involves removal of all the gooey old sealant and the surface given a solvent wipe to remove contaminants.



Sample rail sections: (top left) C&C Yachts mid-80s; (top right) CS Yachts mid-80s; (across) C&C Yachts mid-70s.

Removal or reinstallation is usually a two-person job.

Repair Process

Many of the diverse skills available in a professional marine service shop are pressed into service during the repair of a toerail, particularly metalworking techniques such as MIG (metal inert gas) welding, jig bending and most elemental of all, the blacksmith's ancient art of judiciously applying heat and hammer over a trusty anvil. Gradually, the warped and twisted rail is persuaded

back into an approximation of its original shape. Sharp broken edges and burrs are ground off or filed down. If chunks are missing, new aluminum is cut and shaped to bridge the gap and welded in place. MIG welding is not for amateurs. In the hard ultraviolet glare of the electric arc, a wire of new metal is carefully fed in to fill the cracks and rejoin fractured pieces with pure molten aluminum. Simultaneously, oxygen is prevented from igniting the white hot metal by blowing inert helium gas onto the arc and weld surface.

When the rail has been restored to one piece and straightened, the surface is restored with marine body-fillers and block-sanded using the same filling and fairing techniques described in a previous Pro Series article. (Ed: Refer to "Filling and Fairing" in DIY 2003-#1 issue.) Fastener holes are carefully drilled and countersunk. It's important to preserve the original fastener spacing and rail length otherwise the rail won't fit neatly back into the same holes in the boat. Priming and painting (usually with flat black enamel) is the final repair step. However, if the rail can be welded and repaired without using any body fillers, it's better to send it out to be re-anodized. Proper hard-coat anodizing is more durable than paint but it won't stick to fillers.

Other than major welding and straightening, most of these techniques can also be used to repair a moderately damaged rail without removing it from the boat. Individual dents to the slotted vertical part of the rail are carefully squeezed out with a custom screw jig similar in some ways to a portable vise.

Reinstallating Existing Rails

A repaired rail is easier to reinstall than a new one because it's already bent into the correct curvature and the fasteners holes line up. New caulking is applied to the entire rail length using strips of butyl rubber with regular polyurethane or polysulphide sealant slathered around each fastener hole for extra leak protection. It's good practice to coat each bolt liberally with polyurethane sealant before inserting. All bolts are inserted before tightening begins. The tightening procedure, like removal of the rail, requires two persons. But unlike the rail removal procedures outlined above, when reinstalling, the person inside the boat does all the tightening. It may be tempting to just hold the nut fixed and torque the bolt from above but this method results in leaks at the fasteners. [Ed: refer to "Torque Tech" on page 31 in this issue for torque wrench selection and user's know-how.] As a bolt spins, its threads are very efficient at transporting all sealant out of the fastener hole. So the person on deck must hold the bolt in a fixed position if possible. Some toerails use carriage bolts

Using a large C-clamp to bend the rail.

New toerail arrives as a straight section and is bent into place.

Installing the last fasteners. Note butyl sealant squeezing out at the lower edge.

which forces use of the correct technique. The rail is then tightened in several stages with gradually increasing torque until the butyl sealant begins to squeeze out around the edges. The exact tightening sequence is usually not critical. To allow the butyl time to slowly ooze to its final location, the final tightening isn't done until a few days later with less time needed in hot weather. At this point, excess butyl can be trimmed from around the rail edges with a knife.

New Installations

New toerails are more difficult to install because they arrive as straight pieces and must be bent to conform to the curve of the boat. Examine the new rail to confirm that fastener holes are in the same place with respect to the end of the rail. Even if the new rail is an exact match for the old with respect to cross section and hole spacing, most rails need to be trimmed to get the fastener registration to match. Most rails are also a bit over-length and must be shortened but this can be done during installation.

With the right bending equipment, it's possible to pre-bend a rail to match the boat's shape but isn't really necessary. In most cases, the rail is gradually bent to fit during installation. After the rail is trimmed to get the correct fastener registration, installation begins with bolting one end of the rail firmly in place. Attach a block and tackle or large C-clamp farther along the rail to bend it in towards the boat a little at a time. Each successive fastener is installed once the hole in the rail and the boat line up. A perfectly matched rail can be bent and installed "wet," complete with sealant, in one procedure. A different style rail from the original will require "dry" fitting without sealant, particularly if new fastener holes must be drilled into the boat all the way along the rail. Sealing and fastening "do and don'ts" are the same for new rails as outlined above for repaired rails.

About the author: Nick Bailey has spent 25 years in the boat repair business and is service manager of Bristol Marine in Mississauga, Ontario.

DIESEL

EXHAUSTING SOLUTIONS

Have you checked the color of your engine's exhaust smoke lately? Follow these guidelines to do a color check to determine the health of your power plant.

STORY AND PHOTOS BY LARRY BLAIS

When most diesel engines are first started, the engine is too cold to completely burn all the fuel being injected, so the exhaust belches smelly smoke. As the engine warms-up and then runs under load, the smoke should lighten until it's completely clear. If the exhaust never clears there is probably something wrong or, at the very least, the engine is not at its best operating potential, and the color of the smoke can help find the problem. Take notice when exhaust smoke is blue, black, white or just clear steam.

Blue Equals Oil

Sometimes, it's difficult to visually distinguish blue smoke from black smoke. But just one whiff of blue smoke quickly brings back memories of driving behind a car that is burning oil. Blue smoke results when lubricating oil is burned in the engine. This is not normal operation and you should find and repair the oil source. If lubricating oil enters the combustion chamber through leaking valve seals, replacing the seals may cure the problem. If valve guides are worn, they require replacement and this involves cylinder head removal.

When oil leaks past worn or damaged piston rings, the engine may need rebuilding. The exception is an engine that has not run very much, where the rings are not worn enough to stay seated to the cylinder as it changes shape as it ages.

Here is a Lehman's (dry) exhaust stack underway shortly after coming up to speed. The exhaust is still smoky, as the engine comes up to full combustion temperature and burns out the remaining unburned fuel and soot that accumulated during warm-up.

Sometimes, just running the engine (under load) reseats the rings; however, in engines where rings and cylinders are well broken in, the rings may never reseat in the cylinder and the engine needs re-ringed. Some mechanics have claimed success with abrasives introduced into an engine while running. This procedure, however, can easily result in extensive internal damage and is not recommended.

Oil that is forced past the rings or valve seals by high crankcase pressure results from a restriction in the crankcase vent piping or excessive blow-by that is overwhelming the vent system. Finding and correcting the restriction is usually pretty easy but excessive blow-by often requires an engine overhaul. If oil is leaking into the air intake through a cracked casting or a bad gasket, repairing or replacing the casting or replacing the gasket typically solves the problem.

An engine equipped with a turbocharger may have oil leaking past the shaft seals as a result of worn seals or bearings. This requires turbocharger overhaul. A clogged oil-return pipe can also force oil past the seals. Clearing the pipe should solve the problem.

Black Link to Fuel

Black smoke contains hydrocarbons that are not fully oxidized (partially burned fuel). By far, the most common cause is overloading (lugging) the engine. This occurs when the boat bottom or propeller becomes

After running under load for several minutes, the exhaust has cleared up completely, typical of a clean and healthy engine.

dirty or fouled and simply cleaning both often solves the problem. An incorrectly sized or pitched propeller (over-propped) also causes black smoke from lugging. Check the prop and rework or replace it to solve that problem. A transmission with the wrong gear ratio means the propeller cannot provide efficient operation when pitched to compensate. Rework or replace the tranny. In some cases, poor engine or shaft alignment contributes to lugging the engine. Double check engine and shafting for correct alignment.

Excessive fuel is the next most common cause of black smoke. This results from defective injector(s), incorrect injector nozzle(s) or the injector pump incorrectly set. If recently serviced, the cause could be two sealing washers under the injector; the injector was reinstalled with a new washer without removing the original washer. This raises the injector out of the combustion chamber far enough to disrupt the pattern of the fuel spray that's critical for complete combustion.

Low-grade fuel also causes black smoke when it does not burn completely. An engine that doesn't get enough air leaves some fuel only partially burned. Check the air-intake filter and clean or replace if it's clogged. If the air intake is restricted, the cause should be discovered and corrected. Diesel engine combustion needs lots of air. The whole engine room may lack adequate ventilation (very common with gasoline-to-diesel repowers). Resolution is simple. Get more air into the engine room by adding intake vents. These vents are

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passive, i.e., they don't require any blowers. The engines will suck in what they need for good combustion. The air just needs to be available. Excessive exhaust backpressure can keep enough air from reaching the combustion chamber. You'll need to find and remedy the restriction in the exhaust. When the inlet or exhaust valves are not properly seating and leak enough, the engine may not fully burn the fuel. In this case, a valve grind is the remedy.

Engines equipped with a turbocharger can have one or more of the following problems: dirty compressor blades reducing the turbo's output; leaking exhaust gasses that drive the turbocharger or somehow restricted gases before they reach the turbo; air from the turbocharger leaking before it reaches the engine; binding or seized turbocharger.

If the engine is equipped with an intercooler, sodium can build up on the raw-water side of the cooler, impeding its ability to cool the air. This increases the backpressure against the turbocharger that reduces its air output to the engine.

(left) Starboard engine showing smoke from a leaky fuel injector, while the port twin (right) is running perfectly.

Bleached White

White smoke is actually a mist formed of unburned fuel and indicates that fuel didn't even ignite. When air in the cylinder doesn't get hot enough to ignite fuel, poor compression may be to blame. Leaking inlet or exhaust valves, worn piston rings and cylinders or piston rings stuck in their grooves can result in poor compression and require extensive repair.

When low-ambient temperature prevents compressed air in the cylinders from reaching a temperature hot enough to ignite the fuel, white smoke is the result. Fixing this requires installing some sort of intake air heater. Pumping summer-grade diesel fuel in cold climates or low-grade fuel with poor ignition qualities that can fail to ignite, results in white-colored exhaust. Injection timing that is so retarded that fuel is injected so late that the air in the cylinder has cooled too much to ignite it also causes white smoke.

Poor atomization of fuel in the combustion chamber is caused by one or more injector nozzles stuck open, worn and leaking injector nozzle seat or a too low injector nozzle opening pressure. The only remedy is to rebuild or replace the injector.

A much less common problem in the combustion chamber is water in the fuel. The water absorbs heat and quenches the fuel as it starts to ignite. Water may come from a leaking cylinder liner, cylinder head or defective cylinder head gasket or a leaking exhaust water jacket. Pressure testing the various components often reveals the damaged part. Water can also come from contaminated fuel but a good fuel filter should catch it before it reaches the engine.

Water Turns to Steam

Steam should not be confused with white smoke. Whereas white smoke tends to settle to the surface where it leaves a fuel residue, steam disappears very quickly without a trace unless the outside temperature is below the dew point. Exhaust gases are comprised largely of oxidized hydrogen, so, in colder climates, it's fairly normal for exhaust gases to condense forming visible steam. Steam visible in warmer climates could indicate trouble such as coolant leaking into the exhaust system from a cracked waterjacket.

An engine equipped with a wet exhaust system, a bad raw-water pump or restriction in the raw-water system leads to a lack of sufficient raw-water flow into the exhaust system. The result is raw-water overheating that is turning to steam. Thoroughly check the raw-water flow into the exhaust if it's ever interrupted. Costly repairs ensue when parts of the wet exhaust system are badly damaged from hot exhaust gases.

A sailboat engine "lugging down" because it's overpropped, a very common problem.

CORROSION CONTROL

A bonding system is only as good as its conductors, connections and sacrificial anodes. Using a digital multimeter or analog corrosion test meter, you can measure current at an underwater metal fitting and prevent costly damage from self-generated corrosion.

STORY AND PHOTOS BY SUE CANFIELD

The potential for galvanic and stray current corrosion is a fact of life for many boats, especially those that operate in seawater. Galvanic corrosion can occur whenever a boat's dissimilar underwater metals are electrically connected, whether by direct contact, a wire conductor or even an opportunistic conductor like bilge water. Differences in the inherent electrical potential of dissimilar metals in seawater, typically measured in millivolts (mV), generates low-level currents (**Figure 1**). These currents over a period of months or years gradually erode the least noble metal (anode) while protecting the more noble metal (cathode). Stray current corrosion is induced by the leakage of higher levels of current from an external electrical source, through a boat's underwater metal fittings. Stray current (DC) is like galvanic corrosion on steroids; it can destroy underwater metals in a few weeks, days or even hours.

A proper bonding system, one that electrically ties together all of your boat's metals in contact with the water prevents corrosion damage due to self-generated (coming from your own boat) galvanic and stray current. It does not prevent damage due to galvanic or stray current coming from sources outside your boat. That requires measures that are beyond the scope of this article.

In a bonding circuit installed solely for corrosion control, the interconnected metals are protected by one or more sacrificial anodes typically made of zinc, although magnesium and even aluminum anodes are sometimes used (see "Sacrificing the Anode" on page 24.) On most boats, this corrosion protection circuit is part of a larger bonding system connected to the engine negative terminal or its bus. This system typically includes other major metal objects onboard: rigging and chainplates, engines, metal tanks, metal cases on electrical equipment and so on. By providing a low-resistance electrical path to ground, a proper bonding system prevents the build up of voltage differences between otherwise isolated metal objects. It also minimizes stray current corrosion.

A bonding system is only as good as its conductors, connections and sacrificial anodes. If a low-resistance electrical path is not main-

The reading taken at this bronze seacock (935 mV) indicates it's actually overprotected, although not dangerously so. Note the copper bonding strip.

	Galvanic Series	Corrosion Potential Range in Millivolts	
Anodic or Least Noble (Active)	Magnesium and Magnesium Alloys	-1600	-1630
	Zinc	-980	-1030
	Aluminum Alloys	-760	-1000
	Cadmium	-700	-730
	Mild Steel	-600	-710
	Wrought Iron	-600	-710
	Cast Iron	-600	-710
	13% Chromium Stainless Steel, Type 410 (active in still water)	-460	-580
	18-8 Stainless Steel, Type 304 (active in still water)	-460	-580
	Ni-Resist	-460	-580
	18-8, 3% Mo Stainless Steel, Type 316 (active in still water)	-430	-540
	Inconel (78% Ni, 13.5% Cr, 6% Fe) (active in still water)	-350	-460
	Aluminum Bronze (92% Cu, 8% Al)	-310	-420
	Nibral (81.2% Cu, 4% Fe, 4.5% Ni, 9% Al, 1.3% Mg)	-310	-420
	Naval Brass (60% Cu, 39% Zn)	-300	-400
	Yellow Brass (65% Cu, 35% Zn)	-300	-400
	Red Brass (85% Cu, 15% Zn)	-300	-400
	Muntz Metal (60% Cu, 40% Zn)	-300	-400
	Tin	-310	-330
	Copper	-300	-570
	50/50 Lead/Tin Solder	-280	-370
	Admiralty Brass (71% Cu, 28% Zn, 1% Sn)	-280	-360
	Aluminum Brass (716% Cu, 22% Zn, 2% Al)	-280	-360
	Manganese Bronze (58.8% Cu, 39% Zn, 1% Sn, I% Fe, 0.3% Mn)	-270	-340
	Silicon Bronze (96% Cu Max., 0.80% Fe, 1.50% Zn, 2.00% Si, 0.75% Mn, 1.60 % Sn)	-260	-290
	Bronze-Composition G (88% Cu, 2% Zn, 10% Sn)	-240	-310
	Bronze ASTM B62 (thru-hull) (85% Cu, 5% Pb, 5% Sn, 5% Zn)	-240	-310
	Bronze Composition M (88% Cu, 3% Zn, 6.5% Sn, 1.5% Pb)	-240	-310
	13% Chromium Stainless Steel, Type 410 (passive)	-260	-350
	Copper Nickel (90% Cu, 10% Ni)	-210	-280
	Copper Nickel (15% Cu, 20% Ni, 5% Zn)	-190	-250
	Lead	-190	-250
	Copper Nickel (10% Cu, 30% Ni)	-180	-230
	Inconel (78% Ni, 13.5%, Cr, 6% Fe) (passive)	-140	-170
	Nickel 200	-100	-200
	18-8 Stainless Steel, Type 304 (passive)	-50	-100
	Monel 400, K-500 (10% Ni, 30% Cu)	-40	-140
	Stainless Steel Propeller Shaft (ASTM 630: # 17 & ASTM 564: # 19)	-30	+130
	18-8 Stainless Steel, Type 316 (passive) 3 % Mo	0	-100
	Titanium	-50	+60
	Hastelloy C	-30	+80
	Stainless Steel Shafting (Bar) (UNS 20910)	-250	+60
	Platinum	+190	+250
Cathodic or Most Noble (Passive)	Graphite	+200	+300

FIGURE 1
The galvanic series of metals in seawater (relative to a Na/NaCl reference electrode) flowing at 2.4 to 4m (8' to 13') per second and at a temperature range of 10°C to 26.6°C (50°F to 80°F). In general, the greater the difference in electrical potential between two connected underwater metals, the greater the likelihood for galvanic corrosion. Actual corrosion rates are the product of many factors, including the exposed surface area of the metals, the conductivity and flow rate of the electrolyte.

tained, galvanic and stray current corrosion can occur. If the anodes supply too little voltage, bonding will actually promote corrosion by providing the electrical connection needed for galvanic current to flow.

System Continuity Scan

To insure a low resistance current path, bonding circuit conductors should be at least 8 AWG insulated, stranded copper or, if copper tubing or strips are used, have a minimum thickness of .8mm (1/32") and a minimum width of 12mm (1/2"). Per ABYC, insulated conductors should be green or green with a yellow stripe. Check for bonding system continuity while your boat is blocked ashore or sitting on its trailer. After setting your multimeter to measure ohms, just touch the probes of a digital multimeter to any two metal fittings tied into the bonding circuit, such as the propeller and sacrificial anode on the propeller shaft, the rudderstock and an adjacent thru-hull fitting. All readings should be electrically perfect, such as 1 ohm or less. If not, check for damaged conductors and loose or corroded connections at the affected fittings. Make repairs as needed and retest. Once your boat is back in the water, the electrical current produced by dissimilar underwater metals will make continuity readings impossible.

Performance Check-Over

After you've launched your boat, you can avoid potentially costly and time-consuming repairs by checking bonding system performance at regular intervals. Hire a marine surveyor or marine electrician to do a corrosion control survey for you, or save money by doing it yourself. In the latter case, you'll need an analog corrosion test meter or a good quality digital multimeter, and a silver/silver chloride (Na/NaCl) reference electrode. Reference electrodes, stable mixtures of a metal and metallic salt, are often called half-cells. They function as one electrode in an electrochemical cell when measuring the electrical potential of other metals. (Refer to **Figure 2** for equipment sources and prices.) A multimeter with high input impedance allows you to test your boat in either fresh- or saltwater with repeatable results.

You'll also need paper and a pen to record your test data. Start by listing all the underwater metal fittings (those that are accessible from inside the hull) that are or should be included in your boat's bonding circuit. Fittings include thru-hulls, transducers, engines, strainers, propulsion and rudder shafts and logs, sacrificial anodes, etc. Don't worry if you forget some, you can add them later as you move through the boat.

Next, unplug your boat's shorepower cord (if any) and disconnect your batteries. If you'll be using a multimeter, set the function switch to DC volts. Connect the reference electrode to the volts input jack. Lower the electrode over the side until it's a foot or more below the water's surface. You'll get more reliable readings if the electrode is near rather than not immediately next to the fittings being tested. If necessary, tape the lead to the toerail or tie it to a nearby stanchion so you won't pull the electrode out of the water as you move through your boat. Connect the test probe you'll be using to contact each underwater metal fitting to the multimeter's common jack.

Starting at one end of the boat and working toward the other, take a voltage reading at each metal fitting. If the lead on the reference electrode is too short to allow you to reach all of your boat's underwater fittings, buy or fabricate an appropriate extension.

Analog corrosion meters typically display all millivolt readings as positive values and indicate the degree of protection for bronze, steel and aluminum. When using a digital multimeter to test your boat's bonding system, keep a copy of the table in **Figure 3** handy for quick reference.

Voltage at all bonded underwater hardware should be the same. If not, check for damaged bonding conductors and loose or corroded connections at the affected fittings. Make repairs as needed and retest.

You can check the performance of your boat's bonding system using an analog corrosion test meter (left) or a good quality digital multimeter (right) and a silver/silver chloride (Na/NaCl) reference electrode. The corrosion meter above is the Capac unit sold by US Filter; Guest and Professional Mariner make less expensive models.

How much sacrificial anode alloy does your boat need? Enough to maintain a minimum negative shift of 200 mV relative to the potential of the least noble metal being protected as listed in **Figure 1**. If the voltage shift is less than 200 mV, add more anode. Allow for normal wastage during the boating season. Remember that overprotection can create problems, especially for wood or aluminum boats.

Be sure to write down the voltage reading for each fitting. You'll want to keep a copy of the data you collect with your boat's maintenance records for future reference.

Stray Current Audit

Next, reconnect your batteries and turn on each DC circuit, one at a time. Check the voltage at any bonded fitting as each circuit is activated. Make sure that the equipment controlled by the circuit is turned on as well. If the voltage reading changes, stray current is leaking into the bonding system, either from DC circuit wiring or the equipment it serves. Turn off the circuit until you can track down and eliminate the problem. Hire a qualified marine electrician to help you, if needed.

Finally, plug in your boat's shorepower cord. If doing so produces a sustained change (not just a

FIGURE 2 Corrosion Test Equipment

If you own a good quality digital multimeter, you can buy everything else you'll need (blue type) to monitor your boat's bonding system for US$100 to US$130.

Guest	Analog meter, Na/NaCl reference electrode on	
Tel: 203/235-4421	20' lead, 10' test lead with clamp (#2434)	$210
www.guestco.com	Na/NaCl half cell on 10' lead (#2435)	$ 70
Professional	Analog meter, Na/NaCl reference electrode	
Mariner	on 20' lead, 10' test lead with clamp (#20086)	
Tel: 603/433-4440	Na/NaCl reference electrode on 20' lead (#20008)	$169
www.pmariner.com	20' red lead extension (#20009)	$ 33
	10' black test lead with clamp (#20007)	$ 33
	Corrosion Workbook (#20001)	$ 50
US Filter	Capac analog meter, Na/NaCl reference electrode	
Tel: 800/553-5228	on 75' lead (33419)	$760
www.usfilter.com	Na/NaCl reference electrode on 75' lead (#33428)	$225

Listed prices are in U.S. funds. Prices for Guest products were taken from West Marine 2003 catalog. All other prices are for direct purchase from the manufacturer. Prices may be lower than those listed.

pulse) in the voltage reading at any bonded fitting, current is leaving or coming onboard via the cord's green grounding wire. To correct this problem, you'll need to install a galvanic isolator or isolation transformer. [Ed: Refer to DIY 2001-#4 issue for more on isolator installation.] Now check the voltage at any bonded fitting as each AC circuit is activated. Again, make sure any associated equipment is turned on as well. If there's a sustained change in the voltage reading, stray current is leaking into the bonding system from the AC circuit that has just been turned on. Since alternating currents are equal and opposite, stray AC current theoretically causes little corrosion. That's the good news. The bad news is that it poses a potentially lethal electrical shock hazard. Keep the shorepower cord unplugged until you can track down and eliminate the problem. As needed, hire a qualified marine electrician to help you.

How often should a bonding system be checked? At least annually, after moving to a new (permanent) slip, or whenever there is accelerated wastage of the sacrificial anodes on your own or neighboring boats.

About the author: Susan Canfield is a NAMS-certified, SAMS-accredited marine surveyor in Annapolis, Maryland. A frequent DIY contributor, she also teaches marine surveying at WoodenBoat School in Brooklin, Maine.

FIGURE 3

If you use a digital multimeter to test your boat's bonding system, keep a copy of this table handy for quick reference.

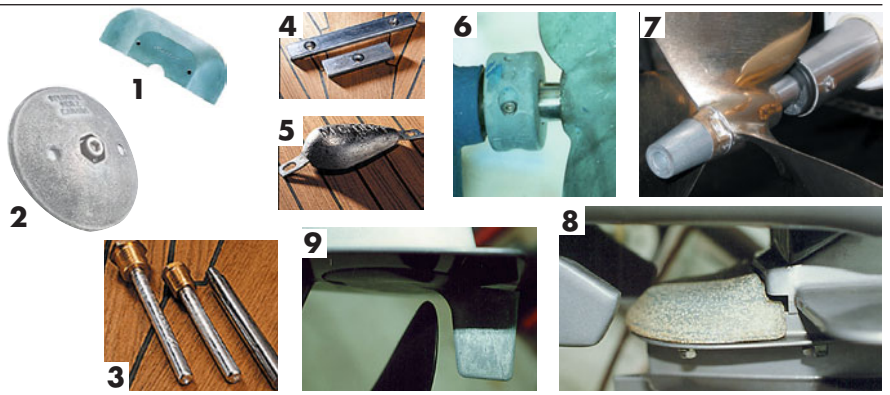
Metal	Degree of Protection/Millivolts			
	Freely Eroding	Protected	Overprotected	Damaged*
Bronze	<500	500-700	>700	>1250
Steel	<750	750-950	>950	>1200
Aluminum	<800	800-1050	>1050	>1200

*To metals and/or paint coatings

SACRIFICING THE ANODES

The who, what, where and when of anodic protection (a.k.a. zincs).

BY JAN MUNDY



1 Magnesium anode for freshwater use only. 2 Streamlined disc anode bolts directly onto the rudder forward edge or trim tab; 3 "Pencil" anodes for engines and heat exchangers; 4 Power trim bar anodes; 5 Anode with tabs for attaching to a bonding wire; 6 Two-piece collar anode mounts directly over the shaft; 7 Bolt-in-place prop nut zinc; 8 Anode mounted on outboard gearcase, 9 Sacrificial zinc trim tab on outdrive.

Every pure metal or alloy immersed in an electrolyte, in this case seawater, produces an electrical voltage, known as its corrosion potential. When two or more dissimilar metals are in direct contact in seawater, the electrical connection results in a galvanic cell. Accelerated corrosion of the less-stable (least "noble") metal is the resultant damage. This metal is referred to as the "anode," while the more stable metal (more "noble"), known as the cathode, remains intact and doesn't corrode.

All metal underwater gear, such as propeller shafts, propellers, rudders, trim tabs, outdrives, struts, bow and stern thrusters, stabilizers and thru-hull fittings could either be the anode or cathode depending on their proximity on the Galvanic Scale (see table on page 21) and whether they are immersed or just splashed with seawater. To prevent galvanic corrosion damage to all underwater gear, an even less stable metal, a sacrificial anode, is added to the cell. (Note: Any metal gear inside the boat or on deck frequently exposed to seawater also needs protection. Sometimes, this is achieved by isolation, e.g., mast fittings.) Should galvanic corrosion occur, sacrificial anodes generate a low current that makes the underwater gear cathodic. The anode deteriorates while protecting the cathodic metals. There are other means to control corrosion, such as controlled sacrificial anode systems and impressed current systems but these are beyond the scope of this article.

Made of aluminum, magnesium or zinc alloy, which anodes you install depend on where you do your boating and the metals used in your boat's underwater gear. Saltwater is a more effective electrolyte than freshwater but freshwater boats still need corrosion protection. Use the table on this page to determine the anode weight required for fiberglass hulls and metal hulls for 18 to 24 months of service. (Wood hulls, particularly older traditionally built boat, require specialized attention.)

Use only magnesium anodes for protection in freshwater, aluminum or zinc alloy anodes for use in salt or brackish waters. Look for anodes with military certification (MIL) for best galvanic efficiency.

When attaching a sacrificial anode to metal gear (e.g., a prop shaft), be sure the metal underneath the anode is clean and bright for the best possible (electrical) contact. Tighten the bolts then seat the zinc with a couple of raps from a plastic hammer and tighten again. Never paint the "working" surface of an anode. Some engines also have anodes (internal on inboards; external on outboards) for corrosion protection. Refer to your engine manual to determine how many and where they are located. Always check anodes at regular intervals (add this to your maintenance schedule) and replace any anode that is wasted by more than half of its original material volume.

Whenever there is accelerated wastage of the sacrificial anodes on your own or neighboring boats, you should check your boat's bonding system immediately. This is caused by stray current corrosion, typically a 12-volt DC current leaking to ground. Other sources include batteries, common shorepower connections, where the fault is on somebody else's boat but becomes your problem when you are connected to the same shorepower source, broken wires or connections, battery charger and other electrical equipment. It's good practice to measure hull potential with a corrosion monitor and reference electrode as discussed on page 21 in this issue.

Calculating Sacrificial Zinc Anode Weight

Use this handy formula to determine weight of zinc alloy anodes for 18 to 24 months of service.

Wz= kL(B+2d)/15.6

Wz = weight of zinc in pounds
L = length of boat in feet
B = beam in feet
d = draft in feet
k = 0.165 for fiberglass hulls
1.000 for steel hulls
.625 for aluminum hulls

Courtesy: Ward Eshleman, Ward's Marine Electric

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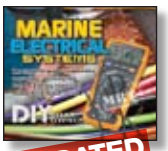

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ELECTRICAL

IN ELECTRO SPEAK

When things go wrong, you are best equipped to make the repairs if you follow straightforward procedures. A systematic approach to diagnosis can often get you underway again or be the logical precursor to having cost-efficient service.

BY JOHN PAYNE

As a boat owner, it's important to develop some diagnostic skills and strategies. Diagnostic skill is what separates the rookies from the masters. It follows a logical process of evaluating equipment or a system and determining why it's not functioning or is deviating from normal performance. This process involves the collection and identification of evidence, such as signs of burning or heating, any unusual sounds or any acrid or other unusual burning smells, a rise in temperature or variations above normal. This physical round of investigation is then supported by the proper use of instruments and data analysis. This forms the basis for testing theories and assumptions, so that the precise fault can be identified and subsequently rectified.

Key D-Factors

Consider the factors in any electrical or electronics diagnostic exercise. First is "systems knowledge." Understand the basic operations of the equipment. It's common to find that faults are in fact only improper operation of the equipment. If there is a basic understanding of the system it's considerably easier to divide the system into functional blocks, which makes the process much easier. A circuit diagram, for example, shows all system components, which makes it a primary functional block.

Next is "systems configuration." Understand where all the system components are installed, where connections and cables are and where supply voltages originate.

The third factor is "systems operation parameters." Understand (and memorize) what is "normal" operation and the parameters or operating range of the system. All too often, expectations are very different from reality. Last, is "test equipment." Understand how to use a basic multimeter. Be able to perform the simple tests of voltage and continuity of conductors. [Ed: Refer to DIY 2000-#1 issue for instructions on how to use a multimeter.]

Five-Part Harmony

The following approach should be used in troubleshooting electrical and electronics systems. This is the groundwork for possible service person intervention and follows procedures commonly done in the trade.

System Inputs. Check that the system has the correct power input. Don't assume anything. For example, there may be a voltage input but it may be too low. Check it with a multimeter.

System Outputs. Does the system have an output? Is the required voltage or signal being put out? If there is input and no output, then you have already isolated the main area of the problem.

Fault Isolation. In any diagnostic exercise split the system in two. This method is ideal when troubleshooting lighting circuits. It instantly isolates the problem into a specific and smaller area.

Fault Complexity. Most problems usually turn out to be rather simple. Start with the basics. Don't try to apply complex theoretical ideas you don't fully understand, as the result is a lot of wasted time. Stop and ponder the situation first.

Failure Causes. When a fault has been isolated and repaired, ascertain why the failure occurred, if possible.

Verify the Evidence

For many, calling a service person is an inevitable part of boating with modern electronics. In some cases, the fault is obvious and the call could have been avoided. Before you seek professional help, ask yourself the following questions and consider the related tasks.

Did I operate the equipment properly? Read the manual again and go back to basics. When you are sure that you have operated the equipment properly and it doesn't work then call a pro.

Are all the plugs in and power on? It's amazing how many people forget to plug in an antenna or put on the power. If power is on at the breaker and not at the equipment double-check that the circuit connection on the back of the switchboard is not disconnected. Check that the equipment fuse has not ruptured.

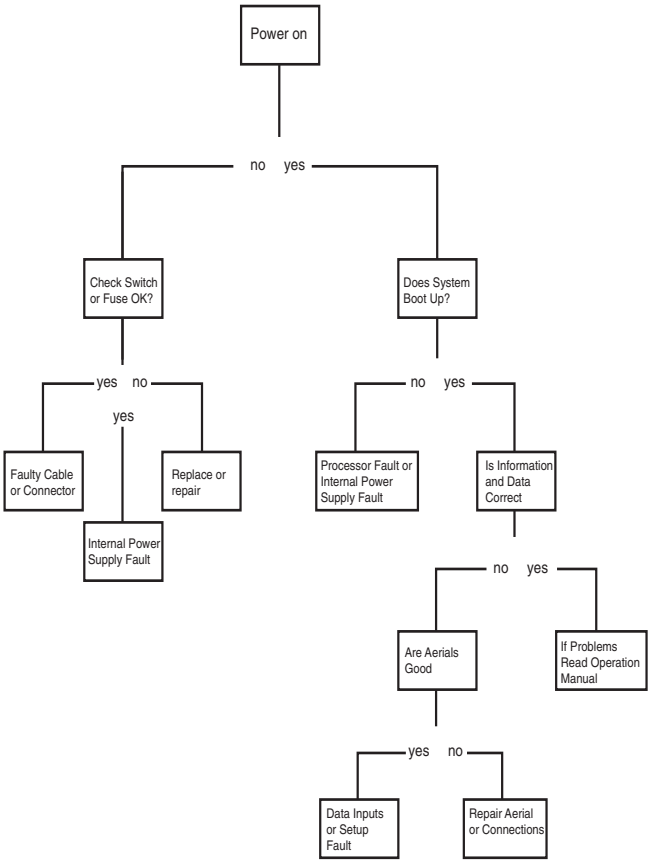
What were you doing immediately prior to the problem? Numerous faults occur immediately after working on often unrelated systems. The inadvertent disturbance of connections can and does occur regularly so check again.

Clearly document the sequence

TIP POINT OF REFERENCE

When servicing any electrical or mechanical equipment, replace one part at a time. If after replacing a part, the problem is still not solved, remove the new one and reinstall the old one. If you replace multiple parts until you find a solution or hope you find a solution, you have no starting point in which to determine the probable cause of the failure. If you're ever unsure about a specific procedure, consult a qualified marine technician for advice.

— JM



of events before the failure and the symptoms at failure. Building a profile may point to some other factors. This assists the technician and may also assist you in resolving the problem and avoiding the service call. Keep a current technical file onboard. If possible obtain copies of all needed technical manuals. This helps the service person and saves you time (and money) if you supply the information. When you contact a service person, ask for credentials and references. Technicians who have earned an ABYC certification in their field are usually top shelf.

Dealing with Technicians

Far too many boaters surrender control to a service person and elevate them to supreme status. It's better that you are present during the service call, if possible. It's your boat and your money, so be proactive. Here are some helpful pointers when dealing with tradespeople.

Be at the boat at the appointed time. I have lost count how many times I'm left waiting at the dock. Just like a taxi driver, wait time is extra. Have everything opened up and provide good access, where required. I have often wasted hours, while lockers are emptied, panels are removed and so on. If you are a liveaboard get everyone up and out of their bunks. I have had several occasions where I literally had to wake someone up and request access to the area under the bunk.

Pre-clean the working area. It's quite unfair to expect service people to work on filthy engines or dirty bilges and elsewhere. Consider laying down drop cloths to prevent grime being tracked through the boat; if you don't mind, then ignore this advice. Have a good tool kit ready. It's impossible to carry a complete tool set onto every boat. Such assistance is greatly appreciated and saves both time and money.

Don't waste time drinking coffee and "jawboning." It's costing you money. Likewise don't keep asking if they have found and fixed the problem. You'll find out soon enough. Stay out of their way but be ready to provide help with any required tasks. Watch and listen. This is a valuable opportunity for you to develop some additional skills.

Be sure you receive a properly completed service sheet, along with a listing of parts replaced and why. Question what is unclear; unfortunately, there are unscrupulous people around, with less than the required skills, who simply keep changing parts until the device works.

About the author: John Payne is a professional marine electrical engineer and author of "The Motorboat Electrical and Electronics Manual" and "The Marine Electrical and Electronics Bible." His website (www.marineelectrics.org) features an online marine electrical training school.

ENGINE TROUBLE SHOOTING

THE COLOR OF PLUGS

Once you've verified that the ignition system is operating correctly, a systematic approach to spar plug diagnosis can provide an accurate indication of what is going on inside the combustion chamber of your gasoline engine.

BY STEVE AUGER

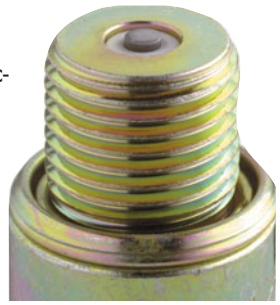
For decades, before marine engines had computers that provide self-diagnostics and real-time readouts, all mechanics would read the spark plug to determine if the subject engine is operating correctly. Plugs would be inspected first to help determine if the problem is fuel related, spark supply or other factor that affects engine performance. There are times where the spark plug itself is the culprit but, more often than not, the condition of the electrode and surrounding ceramic gives an experienced technician information on how the engine has been performing since its last service.

Step 1: Put the Spark in the Plug

In order for spark plugs to perform correctly the ignition system must be provided with the correct voltage and current. For engines that use points and condensers (breaker type) there is usually a 2 ohm resistor on the coil power supply wire that reduces the voltage from the approximately 14.5 volts output by the alternator down to 8 or 10 volts. As this resistor goes through heat cycles, the resistance increases, which in turn, drops the voltage to the ignition system causing poor spark. Electronic ignition systems have their resistors inside the coil and run at 14.5 volts into the coil. Verify the type of system you have on your engine and then, using a multimeter check the voltage at the positive terminal on the ignition coil with the engine running. Once you've verified that the voltage and ignition system is operating correctly, the condition of the spark plug electrode and porcelain will give a fairly accurate indication of what is going on inside the combustion chamber of the engine.

Step 2: Check Plug Type

Always check to ensure that the spark plug used in your engine is the correct type and heat range for your engine. Never presume that the spark plugs that are presently in the engine are the right ones unless you put them there after checking the engine manufacturer's specification. What's in there now may be the right specification or they might just be what were handy to the last technician who changed them. The best way to ensure you have the correct plugs is to check your owner's or service manual for the manufacturer's recommendation. This also ensures that the threaded portion of the plug is the correct length and that the heat range is correct. Never switch J-electrode plugs with surface gap plugs or vise versa unless approved for use by the manufacturer.



Surface gap plug. NGK

Plug Condition: carbonized and worn electrode
Problem: Engine misfires during acceleration, increased fuel consumption, poor high-speed operation. This spark plug should have been replaced a long time ago.

Plug Condition: white or gray insulator, often blistered
Problem: This plug shows overheating, possibly caused by a loose plug, lean fuel, wrong heat range or bad ignition timing.

Plug Condition: black with heavy deposits of unburned fuel and oil
Problem: Seized piston rings have caused oil to leak by the rings and oil fouls the spark plug ceramic and the electrode.

Step 3: It's All in the Gap

In order for spark plugs to function as intended they must be gapped correctly. A plug not gapped correctly cannot perform in the desired rpm range. Plugs must also be installed with the correct torque. If a plug is not torqued into the cylinder head the tremendous heat generated can-

Always ensure the new plugs are gapped correctly to manufacturers spec and torqued correctly to prevent damage to the spark plug or cylinder.

Plug Condition: dry or wet fouling
Problem: Fouling caused by too rich air-fuel, extended slow speed driving, choke abuse, electrical trouble or too cold plug heat range.

Plug Condition: black with soot
Problem: A restricted air flow or rich fuel mixture is the likely culprit.

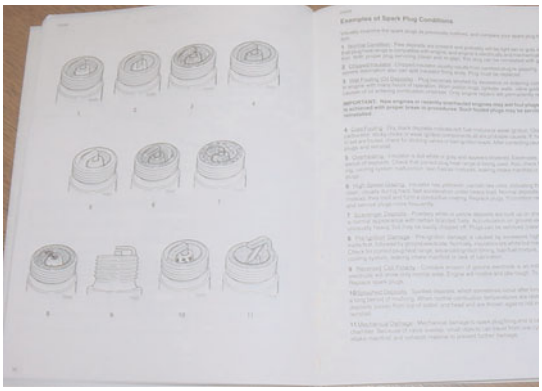
Plug condition: molten metal attached to the plug
Problem: This spark plug shows a detonated piston and the engine in need of a costly rebuild.

not be transferred to the cylinder head. This causes the plug to overheat and possibly cause major engine damage.

Normal firing condition. Be sure to check the gap on new plugs before installing.

Step 4: Color Matching

Most spark plug manufacturers have an excellent chart in their catalogs that show color photos of the different engine conditions and how the electrode area of the spark plug is affected by these conditions. Also, most engine service manuals have a spark plug chart with illustrations that depict the different spark plug failures. A proper firing plug operating at the correct temperature range should be dry with an insulator colored light gray. Some plug conditions to watch for are: wet or dry fouling; heavy carbon-like deposits; rust-colored deposit on the firing end, which may indicate water has entered the cylinders through the exhaust manifold and a dark insulator with few deposits, which indicates the plug is running too cool, a condition caused by low compression or by a plug of the incorrect heat range. Below are a few examples of spark plug deposits including some extreme examples that indicate major problems with the engine and/or other support systems.



Refer to service manual for plug damage reference chart.

Don't use a socket wrench to tighten a plug. Use a torque wrench and tighten to the manufacturer's specifications. This is a critical step if the cylinder head is made of aluminum.

About the author: Steve Auger is an advisor to DIY's Technical Helpline and a service training instructor and Mercruiser product support specialist for Mercury Marine.

TIP BY THE NUMBERS

Remove each plug in a planned order and place it on paper or cardboard and write the cylinder allocation beside each one. Reinstall each plug in the correct order.

DIY MECHANIC

TORQUE TECH

As your mechanical skills improve you'll eventually need a torque wrench for certain mechanical exercises. Here's a look at the different types of torque wrenches and how they are typically used in a repair.

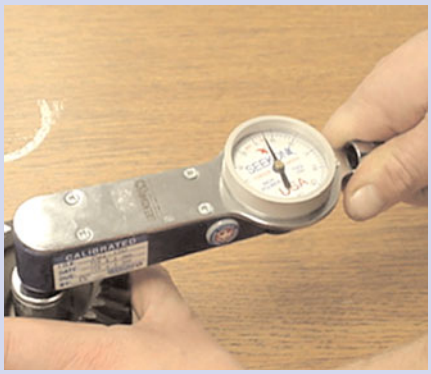
STORY AND PHOTOS BY STEVE AUGER

There are certain repair procedures that require the use of a torque wrench. Parts, such an engine cylinder head, will warp and leak causing costly damage if not correctly torqued to specification. It's easy to casually break a nut, bolt or stud by overpowering it with a ratchet or power bar. Fasteners all have a breaking point. Using a torque wrench and specification chart guarantees that you'll never under or overtorque a fastener. Nuts on keel bolts, outdrives and propellers loose torque by design. Torque a prop nut to 55 foot/pounds in the spring and as the thrust washers wear out, the prop nut torque registers around 20 foot/pounds by season's end. If the prop nut was not initially torqued correctly, the net result of a loose prop is a broken propshaft, lost prop and a bad day on the water. Considering a minimum repair cost of US$2,000 for this failure, a torque wrench is a good investment in boating peace of mind.

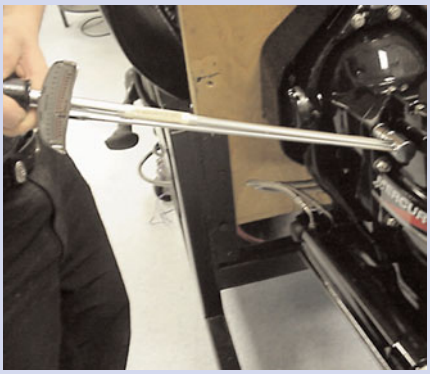
Selection

Torque wrenches come in three styles: dial indicator, beam and ratcheting click.

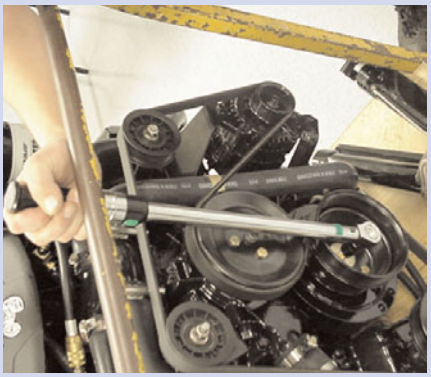
Dial indicator torque wrenches are used to measure (Timken) bearings that require a specific amount of pre-load (drag). If these bearings have too little preload, they allow the shaft bearings support to deflect, causing premature wear. If bearings



A dial indicator wrench provides much better accuracy to check rolling torque.



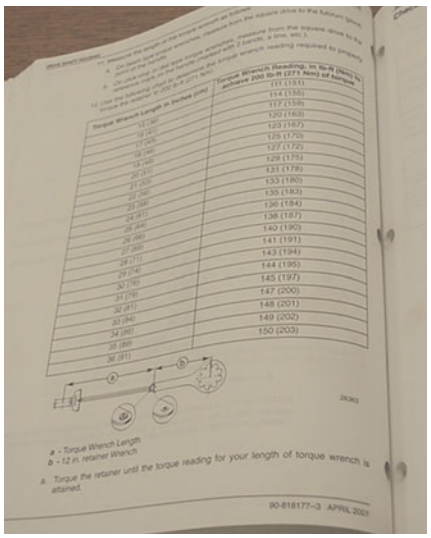
Rugged, durable and inexpensive, a beam wrench is the most common one used in engine repair.



Though expensive, a ratcheting click torque wrench is invaluable when working blind in tight quarters.

have too much preload, they overheat and fail. The dial indicator torque wrench measures the preload with great accuracy and is easily adjusted as necessary. The numerical value of preload is referred to as "rolling torque." For example: the correct preload for an Alpha One universal joint Timken bearing is 6 to 10 inch/pounds. Dial torque wrenches are delicate and require specialized storage and recalibration every two years to ensure accuracy. Wrenches start at US$80 and can be as expensive as US$1,500.

Beam torque wrenches are the most common torque wrench used in engine repair. Unlike the dial and click type wrenches that require special care to protect them from damage and require recalibration, the beam is a rough service tool that does not normally require recalibration. It can live in your toolbox until needed and is accurate enough for most engine repairs that require a standard torque sequence. You can use a beam torque wrench to check rolling torque; however, a dial indicator wrench provides much better accuracy. Beam torque wrenches are typically the most economical choice, costing less than US$100.



Sample torque application chart in marine engine service manual.

Ratcheting click wrenches are expensive and temperamental. However, when you are trying to install and torque a harmonic balancer on the front of a 502 CID motor in a tight engine compartment, it's the only tool to use. With a ratchet feature that allows the wrench to be used in very tight confines and a loud "click" that indicates when the required torque has been achieved, this wrench is invaluable when working blind or procedures where it's impossible to see the indicator on a beam or dial-type torque wrench. Click torque wrenches require recalibration every two years and when stored must be backed off (zero torque status) to ensure accuracy. A quality, low-range click type starts at US$300 and can be as much as US$3,000 for specific application wrenches. This wrench is more for professional mechanics and skilled DIYers that use the tool often enough to justify the high cost.

Buying Tips

Torque wrenches come in many lengths. Be sure to check for a torque application chart in your service manual when combining special tools with a torque wrench. Some service tools provide a torque advantage that is compensated for in the chart. As torque wrenches are sold in different calibrations, inch/pounds, foot/pounds, Newtons, meters etc., be sure to purchase the torque wrench with the correct calibrations as outlined in your service manual.

Torq'd Steps

Some torquing procedures require the torque to be applied in sequential stages to prevent warping of parts, such as a cylinder head.

For example, if the total torque required is 90 foot/pounds, first consult your service manual for the sequence in which to torque the fasteners. Now, torque each fastener to 33% of the value required, which is 30 foot/pounds, then torque to 60 foot/pounds and finally the end value of 90 foot/pounds. When completed, as a final step, always place the wrench on each fastener and double check the value to ensure all fasteners are equally torqued.

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SAIL BOAT RIGGING

GETTING A FIX ON FURLING

A good jib furling system is pretty much a cruising boat essential. If you're a cruising sailor without a jib furler you'll enjoy your boat a lot more if you add one. Here's a comparison of the more popular systems plus installation, maintenance and troubleshooting tips.

BY NICK BAILEY

A good jib furling system handles a big jib quickly and safely. No perilous wrestling with a headsail on the foredeck; no dragging the sail off the boat to fold it and stuff it in a bag that always seems too small. With the proper furling unit and necessary sail modifications, it's also practical to partially furl the sail to reef it. Here are some highlights of the more popular and enduring furling systems available. They are all proven performers.

Harken

Now on its third generation, the U.S.-manufactured Harken (Tel: 262/691-3320, Web: www. harken.com) jib reefing and furling systems are considered an industry standard. They come in 11 sizes to fit boats from 6m to 30.4m (20' to 100') and larger plus a line of all-carbon and power-driven units for the high end of the market. Harken pioneered the use of high-strength Torlon composite ball-bearings in open races that are not only immune to corrosion but offer low friction with minimal maintenance. Tack and head shackles that swivel independently of the foil and drum also make these units well suited for headsail reefing. This allows the sail to begin furling at the fullest part of the sail mid-luff instead of starting at the tack and head, which typically causes distortion in the middle of the partially furled sail. If you plan to race, a Harken unit is a good choice for several reasons: the split drum allows easy removal, converting the furler quickly into a double groove racing headstay for use with normal racing sails; the elliptical headstay extrusion offers low windage and weight aloft; fine-tuning is simplified as Harken replaces the original equipment forestay turnbuckle and relocates some of the forestay length adjustment to the bottom of the drum. This is more accessible for adjustment than other units where the turnbuckle is buried in the center of the drum. Harken furlers can be set up with the

Race-ready Harken furler with drum removed, upper swivel dropped to bottom of stay exposing double groove headstay system. Note pre-feeder for smooth headsail changes.

drum very close to the deck, which also favors use with a performance sail.

Some features may have undesirable aspects. Removing the original turnbuckle and modifying or replacing the forestay, for example, means a more complicated assembly than other brands and usually requires professional assistance to swage the new end stud on the forestay or use Stalok (or Norseman) fittings. It also means you must be very careful to "measure twice, cut once." The elliptical foil also causes some vibration when quickly unfurling the sail, a minor issue perhaps, but it bothers some people. Harken pricing is mostly in the upper middle range and the units have a 7-year limited warranty.

Profurl

French-made Profurl (Tel: 800/852-7084; 514/334-4548 in Canada, Web: www.profurl.com) furling and reefing units have a reputation for bulletproof durability offshore but have been viewed in the past as strictly a cruiser's choice due to the bulky circular foil and a drum location that is typically high off the deck, which increases visibility and is a great benefit when handling

Profurl kit complete with everything needed to mount over the existing forestay and turnbuckle without mods to the rig.

Profurl's patented Wrapstop eliminates halyard wrap.

bow-mounted anchors. The aerodynamic aspects of the latest Profurl units have improved, which has also increased its racing appeal.

Profurl uses sealed, permanently lubricated, high-strength steel bearing system as well as an unbreakable composite furling drum. This drum is an open spool with the emphasis on easy access for clearing a jammed furling line. An important and unique Profurl feature is the wrap-stop fitting at the top of the foil. This black composite disc acts as an end stop to prevent over-hoisting and jamming the halyard swivel. More important, it has a notch that accepts the vertical halyard attachment link plate on the upper swivel and so locks the halyard in place to prevent it from inadvertently winding around the stay. A halyard wrap is the most common furling mistake. Mistakes happen, so anything that contributes to safe and foolproof furling is an advantage. (See "Beating the Wrap" on page 36 for how to avoid the dreaded halyard wrap). Installation is similar to Harken units but it can be mounted over the existing forestay and turnbuckle without modifications to the rig.

Profurl has a broad range of units available. The most popular models are the Classic with medium-high pricing and a 10-year warranty, and the Basic with lower-mid pricing and a 5-year warranty. Just launched are the NEC furling systems with models available for boats from 6m to 30m (19.6' to 98'). These units replace the removable inner stay, providing easy handling of a staysail, storm jib, gennaker, etc.

Hood Sea Furl

The Hood Sea Furl is the only remaining brand name from the first-generation American jib furlers. Available as the fifth-generation Sea Furl 5 as well as the lower cost SL and LD series, it's now manufactured by Pompanette (Tel: 603/826-5791, Web: www.pompanette.com).

The Sea Furl 5 unit has received good reviews recently and features independent swivels for the tack and head, a low friction-high strength combination of stainless steel and Torlon bearings in spherical open races. (Open bearings require no maintenance other than frequent flushing with freshwater.) Assembly is simplified by the fact that the unit will fit over the existing forestay and turnbuckle assembly. Suitable for conversion to a racing configuration, the elegant, polished stainless-steel drum splits for easy removal and the foil has aft facing double grooves.

Pricing is now upper midrange (it used to be high end) with a unique lifetime warranty for the original purchaser.

Schaefer

Schaefer Marine (Tel: 508/995-9511, Web: www.schaefer.com) builds jib furlers for boats from 4.8m to 19.8m (16' to 65'). The smaller Snap Furl units feature an innovative composite foil that snaps together over the forestay. The larger models are similar to the Hood Sea Furl and have an excellent reputation for durability. Schaefer was a pioneer in roller furling in its early days with a system that furled on a wire luff in the headsail and the company has emerged again with a system that combines the best ideas from several makes into its units. Features include a circular aluminum foil with double aft facing grooves, Torlon bearings in open races, a large diameter aluminum and stainless-steel drum that splits for easy removal. Units are designed to fit over the existing headstay and turnbuckle.

Price range is competitive with Harken and Hood, with a warranty of 5 years.

Schaefer stanchion block and line kits ensure smooth furling.

Furlex

Furlex is part of Selden (Tel: 843/760-6278, 604/921-4446 in Canada; Web: www.seldenmast.com), the Swedish spar manufacturer. These units are similar in concept to Harken, including a foil of aerodynamic elliptical shape with twin aft-facing grooves. Installation requires the existing forestay be replaced or modified. Independent swivels on the tack and head provide best

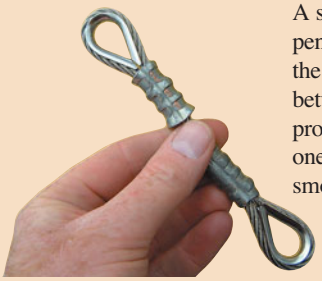
(above) Furlex roller reefing system; (below) Furlex hydraulic system for large yachts; (bottom) Furlex installation kit.

BEATING THE WRAP

Halyard wrap is the #1 cause of grief with jib furlers. Most furlers (except Profurl and furlers with self-contained halyards) cannot tolerate more than 5cm or 7.6cm (2" or 3") of "unrestrained" or exposed halyard showing between the halyard sheave at the masthead (or the forestay tang if a fractional rig) and the upper swivel. Any halyard showing here is a soon-to-be wrap around the top end of your furler. This usually happens when the sail is unfurling quickly in a good breeze. All that sail power is rapidly turning the foil as it unrolls and if the halyard gets wound into the works serious damage can result. The top end of the foil gets mangled, the halyard destroyed and on some occasions the forestay is compromised. You'd be lucky to get the sail furled again or even take it down without a trip aloft to untangle the mess. This problem can be avoided. Furling systems operate nicely without wrapping a halyard provided the sail and rig are set up properly.

Correct Foil Length The foil should cover the forestay wire completely to allow the upper swivel to extend as far as possible to the top of the foil. If the foil is a bit short you cannot avoid exposed halyard and need to fit a halyard restrainer (see below) to prevent wraps. If the end stop on the foil is missing or inadequate, a short foil also can allow the sail (and upper swivel) to be over-hoisted so the swivel tries to come off the upper end of the foil and jams.

Fitting Pennants Hoist your biggest jib until the upper swivel is fully hoisted against the upper foil stop or the mast truck. Don't connect the tack yet. Use binoculars to check if there are more than 5cm or 7.6cm (2" or 3") of jib halyard showing. If so, you will need to fit a halyard restrainer block to tuck the halyard against the mast before it connects to the upper swivel. If not, check the tack position, which should be dangling slightly above the tack swivel, just enough to allow adequate luff tension. If the tack is too far from the shackle to be connected within comfortable stretching distance, you will need to fit a short lash-line or wire pennant to connect the sail. This can be done at the tack or the head; it doesn't matter as long as the upper swivel is allowed to go to full hoist when the jib is fully set up. The most disastrous thing is to fit a short luff jib without the necessary pennant that puts the swivel (and halyard) out of harm's way at full hoist. This error exposes several feet of halyard and the resulting wrap can be quite a spectacular foul-up. If you plan to fit short luff sails on your furler for heavy weather, be sure they have the correctly size pennants attached.



A short halyard pennant can make the difference between a wrap-prone set-up and one that furls smoothly.

Pennant can attach to the bottom of the upper (halyard) swivel.

Halyard Restrainers On some boats the configuration of the halyard in relation to the forestay is risky no matter how you tweak things. Enter the halyard restrainer. This is a block or fairlead that fastens to the front of the mast below the jib halyard sheave but above the top of the upper swivel on the furler. The halyard goes through this block before jumping across to the upper swivel. This keeps the halyard away from the top of the forestay and foil.

Housekeeping The other kind of halyard wrap occurs when an idle halyard is clipped to the bow pulpit and gets reeled into the furler. Don't put any other halyards anywhere near the furler. Clip them at the base of the mast or even behind the spreader. In extreme cases, spinnaker halyards are hung from an extended bale projecting well out from the masthead.

reefing performance and the drum splits for easy removal in race mode. Unique engineering in the patented "load distributor" bearing design uses exposed stainless-steel bearings in the upper swivel and a lubricated bearing at the bottom. Other details like the sail pre-feeder that automatically retracts when not in use make the Furlex more than just a Euro-Harken. More important for the do-it-yourselfer, this is probably the only jib furler on the market that includes absolutely everything you need in a kit, including the forestay wire, Stalok fittings, furling line, lead blocks to run the line aft, halyard restrainers to avoid wraps and even the correct drill bit and a Torx key set.

Pricing is a bit less than Harken and units have a 5-year warranty.

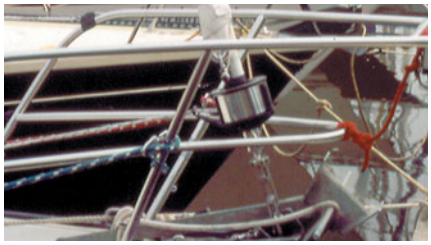
CDI

CDI (Tel: 978/371-5508, Web: www.sailcdi.com) makes inexpensive furlers for small to medium sized cruising boats (4.8m to 10m/16' to 36'). The Flexible Furler is designed as a hassle-free unit to fit over the existing forestay. Made mostly of composite materials, this unit has a self-contained jib halyard with a sheave built into the top of the foil. This prevents halyard wrap as long as the unused halyards are stowed against the mast and out of the way. Units can be used to furl and reef and are less than half the price of the heavy hitters listed above. Units come with a 6-year limited warranty.

CDI Flexible Furler is a popular low-cost furling unit.

Installation Tips

Before shopping for a system, measure the pin-to-pin length of the forestay. This is the length of the entire forestay assembly including the turnbuckle and toggles with the turnbuckle two-thirds open. You also need to know the forestay wire size and the clevis pin sizes. It's important to note, at this stage, that both ends of the stay need toggles to minimize metal fatigue. Fit a toggle on the bottom fitting; the top end of the forestay may not need one. Omitting the toggle action has broken a lot of forestays.



Note toggle on the forestay tack fitting and extended links to raise the drum above the anchoring gear.

Simple tools are all that is required to assemble most furlers.

Most of the furlers mentioned above require removal of the turnbuckle from the bottom of the forestay. Connector links then slide onto the forestay from the bottom. Each section of luff foil is joined to the next at a connector, usually with machine screws and Loctite although some units use pop rivets. With a Harken furler, you must measure the

Cut forestay to the required length, if required.

forestay to determine if the existing lower end fitting can be cut off and still leave enough forestay length to reuse the wire with the Harken proprietary stud. If not, you need to purchase a new forestay wire of adequate length. You must also order the new end fitting separately and specify if it's a roller swaged or a manually installed (Norseman or Stalok) mechanical fitting. The Furlex kit comes with a new forestay that must be cut to the correct length. Manually install the lower end fitting. Make sure all connecting links are on the forestay before you install the end fitting.

Once links are installed, the foil pieces are fitted. The bottom foil is designed to connect to the drum and torque-tube assembly. The next foil piece carries the luff feeder (which may require installation and cutting). The very top piece usually needs cutting to size with a hacksaw and the top cap (or Wrap-Stop device in the

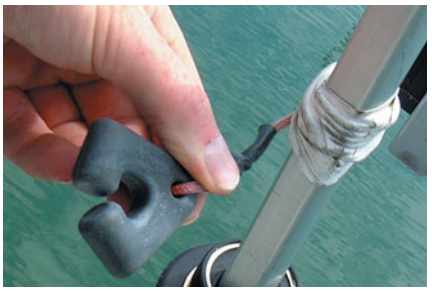
Lead block kit may be optional.

case of a Profurl unit) is fitted to the top end.

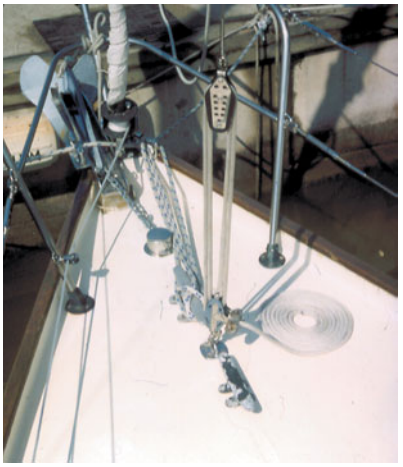
At this stage, the halyard swivel is slid onto the stay and the torque tube, plus the lower bearing and drum assembly are installed. If using the existing forestay and turnbuckle, the inner drum connects to it by a through pin, bolt or link plate arrangement.

Now hoist the new furling forestay (or restep the spar) and adjust the stay tension and drum height off the deck (where such adjustments are possible) to your satisfaction. Provide your sailmaker with the measurements needed to finish your new sail or modify an existing one. Obtain the exact luff measurement by securely attaching the end of a long tape measure to the lower shackle on the upper swivel and hoisting (with the jib halyard) the swivel into place against the stop at the top of the foil. Note the distance from the head shackle above to the tack shackle below. Note also on which side of the boat

Acrylic cover protects sails from UV damage.



Prefeeder simplifies loading a headsail into the groove.



A sample installation. Photo is of the Canadian-made Ultra-Furl, an affordable furler for cruising boats with dual-aft facing grooves, stainless-steel bearings and a two-piece aluminum extrusion that feed over the existing stay. Distributed by North Sails (Toronto).

you want to run the furling line. This dictates which direction (clockwise or counterclockwise) the drum turns when pulling the furling line. This also dictates which side of the leech the sailmaker installs the anti-UV leech cover. (A portside line means anticlockwise furl and UV cover on the starboard side of the sail and vice versa.)

Just about the correct amount of forestay sag.

Options and Accessories

Although the Furlex kit is all-inclusive, most other systems don't include lead blocks for the furling line. Purchase these separately. Another tidy little accessory is a pre-feeder. This transforms the task of hoisting a sail onto the foil from a two- person job into a one-person job. If you plan to race and foresee doing quick headsail changes the pre-feeder is essential.

Always use the recommended furling line.

Maintenance

Stiff furling is a common complaint, especially on older units where the bearings have become arthritic. In some cases, the furling line has to be cranked in on a winch to furl the sail. The risk here is that the loaded coil of the furling line digs deep into the other coils wrapped on the drum and becomes tightly jammed. Reducing forestay sag can help because a sagging foil is hard to turn. Keeping the bearings clean in units using the "open race" design is also important. The correct furling line can also reduce the tendency to jam on the spool. (Check manufacturer's recommendations for the furling pennant.)

About the author: Nick Bailey has spent 25 years in the boat repair business and is service manager of Bristol Marine in Mississauga, Ontario.

DOCKING A SINGLE SCREW

Whether you operate a sailboat or powerboat, mastering the art of maneuvering your boat in close quarters makes the last 30.4m (100') of any journey less stressful and more predictable. A professional skipper discusses the inter-relationship of the propeller and rudder and provides drills you can do with your boat.

STORY AND ILLUSTRATIONS BY PETER P. PISCIOTTA

Walk the docks on a sunny afternoon and chances are you won't find many vacant slips. Crowded schedules may be the primary culprit, but anxiety over close-quarter maneuvers — docking in particular — rank second. Docking can be nerve racking.

I have a friend who bought a 18m (60') sailboat in California, sailed through the Panama Canal and ultimately to Florida. He spent two years and 9,655.8km (6,000 miles) anchoring, sailing and weathering storms, eventually earning his USCG operator's license. With all that experience, he was still not comfortable docking a boat.

Fundamentals

At full operating speed, a boat is just like a car: point it and go. As speed reduces, so does steering control until the boat is at the mercy of the elements. If the helmsman doesn't drive the boat, wind and current will. With a few tools, however, even a single-screw boat can be controlled in close quarters under adverse conditions.

Understanding the basic principles about how a boat moves is a key to mastering the skill and overcoming the anxiety of being in close quarters. A boat rotates around an axis roughly one-third of the boat length aft of the bow (**Figure 1**). Most modern sailboats have the mast at this point. Many trawler yachts and some motor yachts have the helm station here too so the skipper feels like the boat spins beneath his feet. This is why the stern swings wide during turns. Just watch a boat turn in a narrow fairway. Look for stern swing and try to determine where the pivot point is.

A boat naturally lays beam to the wind, not bow into the wind (**Figure 2**). This counterintuitive effect is the result of a complex equilibrium of hydrodynamic (below water) and aerodynamic (above water) forces.

The exact attitude depends upon above and below waterline profiles but all boats have problems holding their bow into the wind. The helmsman must allow extra time and space in handling the boat.

Underpowered boats are particularly vulnerable. Add a full keel and long overhangs and it may be impossible to turn through the wind. Next time, before you anchor in a breezy area, let the boat drift and see what position it naturally assumes. Ever notice how an anchored boat swings back and forth in a breeze? The bow is tethered into the wind but the boat naturally wants to be beam to creating conflicting forces.

Propellers are optimized to push water aftward. On the ascending side of the rotating propeller, centrifugal force slings water up into the hull and is deflected laterally, creating sideward thrust. The stern "walks" sideways in the opposite direction, a phenomenon known as "prop walk" (**Figure 3**). Although prop walk exists almost equally in forward and reverse (the prop is more efficient in forward so the effect is asymmetric), it's virtually imperceptible in forward because the rudder masks the effect. However, in reverse, the effect can be prominent. Look at your prop shaft to see which way it turns. If it turns counterclockwise (viewed from astern), it's a left-hand propeller. It

FIGURE 1

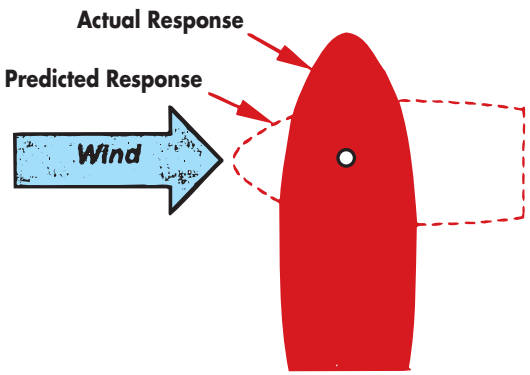
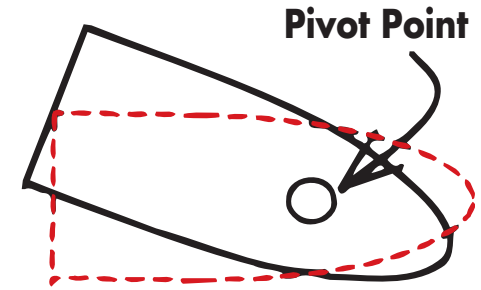


FIGURE 2



will pull the stern to the right (starboard) in reverse (**Figure 4**).

A boat turns because the rudder deflects flow — no flow, no response. Sluggish response causes some helmsmen to conclude they must "go fast to maintain headway." Unfortunately, going fast means there is less time to recover from mistakes, increasing both the likelihood and severity of an accident. There is an alternative: engage the gear in forward to induce propeller discharge current past the rudder (**Figure 5**). Even better, the water moves at a higher velocity thus increasing rudder effectiveness. To test this on your boat, bring boat speed up to about three knots in an open area, then put the gear in neutral. With the boat coasting put the helm hard over to either side and make a note of the circle diameter. Now, with the boat stopped and the helm hard over, put the gear in forward and perhaps raise rpm a few hundred. This turn is much tighter because the rudder is deflecting propeller discharge current. Backing out of slip into a fairway creates rudder discharge current. Most skippers back out, stop the boat by going into forward, and turn the helm in the desired direction and go. Combining the last two steps results in a crisper turn. As you are backing and preparing to put the gear in forward to slow and/or stop the boat, put the helm hard over in the desired direction first. When the gear is put in forward, discharge current over the rudder will simultaneously slow and turn the boat.

Putting it all Together

At low speeds a propeller does more than just move a boat forward and backward; it can also induce turning forces via prop walk. Prop walk is only noticeable in reverse and pulls the stern to one side or the other depending upon whether the prop is left or right handed. The rudder can be used, even if the boat is stationary, by putting the gear in forward with the helm hard over. Used together, these tools are incredibly powerful.

Combined use of prop walk and rudder deflected propeller wash is an approach known as "back and fill." This term comes from the old square-rigger days when ships in close quarters would backwind the sails to slow or reverse progress, then fill the sails to go forward. While engines have replaced sails, the process is similar; the boat is alternately placed in forward and reverse to achieve a tight turn (**Figure 6**).

A single screw boat can be turned in just over a boat length but only in the direction that prop walk facilitates. A left-hand prop will pull to starboard in reverse therefore, whenever possible, all tight turns should be executed making a port turn. Back and fill refers to this favored-side technique. Turning in the opposite direction fights prop walk: whenever the gear is reversed, prop walk terminates,

FIGURE 3

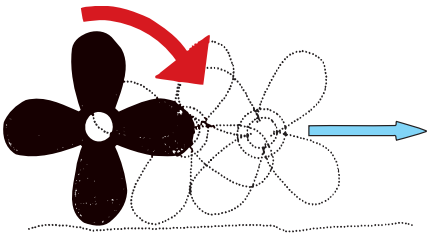


FIGURE 4

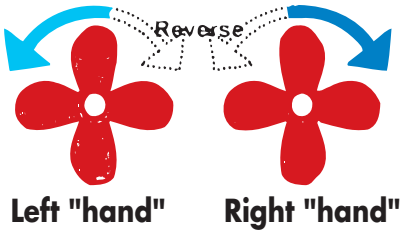


FIGURE 5

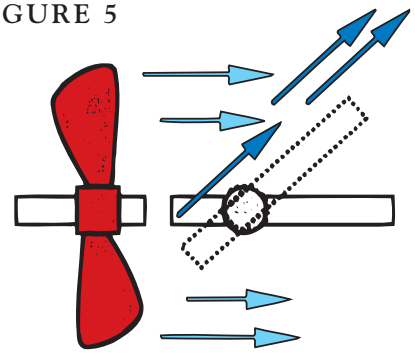
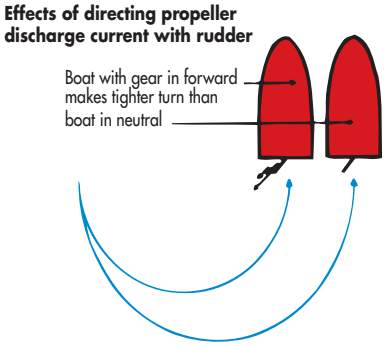


FIGURE 6



TIP DOCKING AGAINST THE PROP

What if you must land on the wrong side, the side that is not favored by prop walk? You must minimize the tendency of prop walk to pull the stern away from the dock. Here are four ways to manage an offside approach.

1. Use a shallow angle approach.
2. Go slowly. You will use the rudder to deflect propeller discharge current, also building speed. Plus the faster you are going, the more undesired prop walk develops.
3. Place the stern in the desired direction to counteract prop walk by putting the helm hard over and give a "burp" of forward speed.
4. If at all possible, go past your destination and return in the opposite direction to make a favored-side approach.

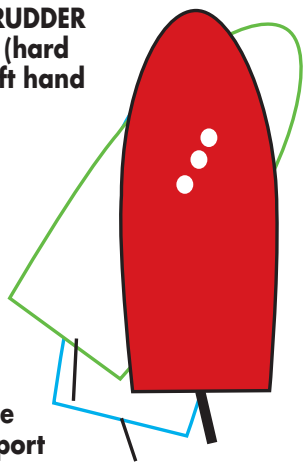
instead of contributes to, turning momentum.

There are two key components to making a back and fill turn: timing and controlling turning momentum. Prop walk is usually most effective as the boat comes to a stop. At this moment the helm should be hard over in the other direction and the gear placed in forward to augment the turn. As soon as forward momentum starts to develop, place the gear back in reverse. The goal is to develop rotational momentum without building either forward or reverse speed.

Practice on a Side-Tie

Side ties are great places to practice because there is usually an open approach area and they are frequently free of obstructions (**Figure 7**). Here, prudence prevails. Select a safe area with minimal boat traffic and no other boats in your target landing area and a calm day as wind and current mask the procedures described below. It helps build confidence if there is no audience on the dock, as well. Whenever possible, dock on the side that prop walk pulls the boat toward. Docking this way is a simple three-step process.

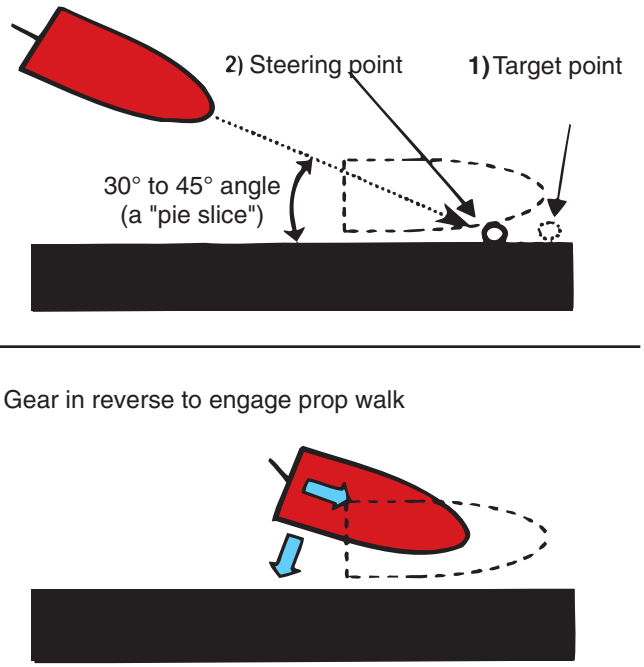
FIGURE 7



First, pick a point on the dock where you want the bow to end up, usually a cleat or bollard. Aim about one-third to one-half boat length aft of this point.

Now, proceed at about a 30° angle, at slow speed, 1-1/2 knots or so. Give your approach a lot of space so you can proceed in a straight line. Finally, when you are about one-half a boat length from the dock, swing the helm away from the dock to initiate the turn and simultaneously put the gear in reverse. Prop walk will pull the stern toward the dock. As soon as the boat stops, put the gear in neutral. If everything has gone perfectly, the stern will still be swinging a little bit and gently rest against the fenders (**Figure 8**).

FIGURE 8



Timing, feel and finesse are everything so it takes a lot of practice. Every boat is different. The same boat fully loaded with guests will respond differently. Use "burps" to modulate the approach. ("Burp" is defined as a very short burst of throttle, with a near instantaneous return to neutral or idle, to maintain headway.)

Even if dissecting and describing every docking situation were possible, it simply would not be practical. Your docking plan must be adaptable in case a wind gust rises or another boat unexpectedly appears (or your shift cable parts). Once mastered, these tools enable you to conquer almost any docking situation. After all, there are only two moving parts beneath a single screw boat: a rudder and a propeller. Once you learn the effect, control and inter-relationship of these, the last 30.4m (100') of any journey will become less stressful and more predictable.

About the author: Peter P. Pisciotta, founder of The Trawler Institute, is a licensed USCG 100 ton vessel operator and owner of SeaSkills Personal School of Seamanship (www.SeaSkills.com). He also conducts demonstrations on boating skills and safety at several West Marine Trawler Fests (www.trawlerfest.com).

DOCKING KNOW-HOW

PIVOT POINT: When proceeding down a narrow fairway, stay in the middle or just starboard of middle. Be wary of wind or current pushing you toward a lateral obstruction. Plan enough lateral space for stern swing.

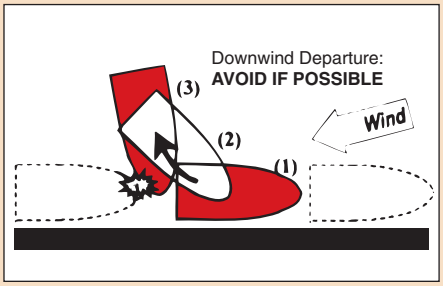
WIND LOCK: When turning into a slip, think about aligning the pivot point with the centerline of the slip, not the bow.

PROP WALK: This has its greatest effect as the vessel stops. Approach an open side tie on a straight course, perpendicular to the dock. Put the boat in reverse and note which side and how much the stern pulls. Finally, you will probably notice the walk increases as the boat comes to a stop.

PROPELLER DISCHARGE CURRENT: Always put the helm over before putting the gear in forward.

BACK AND FILL: Keep the helm hard over throughout the maneuver. No adjustment is necessary. Practice "burping" the throttle by bringing the throttle up 200 to 300 rpm for two or three seconds. These short blasts are very effective, especially in reverse to amplify prop walk without building speed. Leave the gear in reverse until the precise moment the boat stops. Look abeam and find a stationary object, as soon as the boat stops moving place the gear in forward with only a momentary pause in neutral.

MANEUVERING: Always go slowly. It looks crisp and it gives you time to think. Panicked helmsmen almost never respond appropriately and just dig themselves a deeper hole. No jumping, no yelling.



1. Boat docked bow into wind, the typical docking maneuver.
2. On departure, boat backs downwind.
3. Difficult to avoid having bow blown down.

AVOID DOWNWIND: Whenever possible, always work into wind or current. Down-wind and/or current maneuvers are extremely dangerous!

TAKE A POWDER: Remember, not everything is possible so prudence prevails. Anchoring out or taking an end tie is always preferable to risking damage. Even professionals pass on some situations.

LEAN-TO: If you ever find yourself too close to an obstruction and contact is inevitable, stop the boat so it rests up against the obstruction. A late attempt to drive away from danger guarantees the stern will strike an expensive glancing blow.

PRACTICE FOR FIVE: Set time aside to practice. Try docking five times and five 180° turns using back and fill one day a week for five consecutive weeks.

UPGRADE

TO STOP A THIEF

You can never keep a determined thief off or out of your boat but you can make access to your valuables as difficult, uncertain and unpredictable as possible. There are sensors and surveillance systems for most any layout or equipment and budget.

BY JOHN PAYNE

Onboard security covers a range of hazards. Security of the boat against complete theft, security against intruders who are intent on stealing the contents, security of the boat against fire, water, deadly vapors and, of course, security of the boat's occupants against injury, attack and harm. In most cases, modern security systems incorporate protection against all of these risks.

Most readers are familiar with some of the home and automotive security systems but keeping villains out of a boat is another kettle of fish. A good insurance policy is no substitute and, once the deductible and higher renewal premiums come into play, it also makes sense to have a good boat security system. Theft alarms can also save you money as some insurance companies extend premium discounts of 5% to 20%, depending on the type of system installed.

Access the Risk

The first step is planning and that involves an audit to assess all areas of the boat that have ingress points or access to areas where valuables are stored, lockers with generators or other machinery and such locations and equipment that are critical to starting the boat and driving it away. The best method is to prepare a layout of your boat, with a list of the contents in each area (**Figure 1**). It's easy to overlook things and you have to put yourself in the prospective thief's shoes. The audit must be thorough and should reveal all the exposure points and risks.

Sensor Sense

Boats move and stress while at dockside, so a range of sensors are required to eliminate false alarms. There are many packaged systems available for powerboats and sailboats that start at US$150 and most have similar components used in various combinations. There is a sensor type or surveillance technique for virtually every situation or equipment and these are summarized below. It's important to choose marine grade equipment. Unlike expensive units used for home use, marinized systems have coated circuit boards, corrosion-resistant terminals, tinned-copper wiring, etc. (Automotive systems are not common on boats.) Quality systems have a tamper proof design, good immunity against radio noise and other electrical interference. There are numerous alarm sensors available and use depends on application and installation parameters and, of course, your budget.

Magnetic or proximity switches (US$5 to US$15) remain the backbone of security systems when installed on all ingress points such as windows, doors and hatches. The switch comprises a magnetic reed or proximity switch and a magnet. The magnet keeps the reed switch closed and, when the magnet moves away, the circuit is broken to activate a relay and an alarm. They do tend to have relatively high false alarm rates unless they are sealed and adjusted properly. When the alarm is activated, the intruder is usually caught out in the open while still attempting the break-in. Some alarms are designed for wide gaps while others are small gap and flush mounted with integral pigtail wires. Avoid using the foam tape-backed switches, as the adhesive tends to fail.

Thin, completely sealed, vinyl, pressure sensitive pads or mats are placed at strategic points of access. Standing on one activates a switch to initiate an alarm or activate external lighting. Usually placed under a cockpit mat or carpet so they are unobtrusive, they consume no power, however, they are easily damaged. Available in numerous sizes, prices range from US$45 to US$80.

Passive infrared (PIR) sensors direct or radiate a pattern of infrared beams over a defined area. Detecting a radiant heat source, such as a human body, activates the alarm. Some PIR units also use pattern recognition to screen out pets. Only one properly located unit is required to cover a typical saloon but the installation sight must be carefully

FIGURE 1

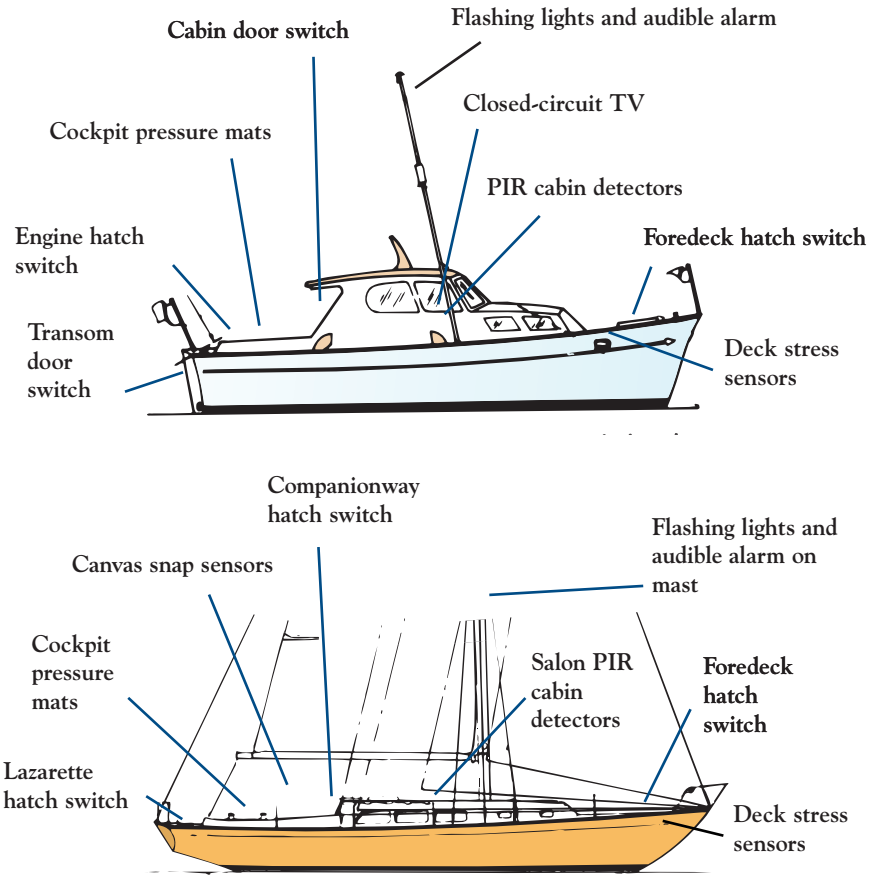
Anchor well	Contains anchor, tools, ropes
Foredeck hatches	Provide access to forward cabins and the whole boat
Side windows	Provide access to the saloon and the whole boat
Aft doors	Provide access to the saloon and the whole boat
Deck lockers	Provide access to equipment
Flybridges	Provide access to navigation electronics, engine starting etc.
Engine access	Provides access to engine and machinery

selected so that it's not easily visible. These units have relatively low power consumption and can be disguised quite well. IR beam detectors are also available.

Photoelectric beams are easily hidden and installed where it's not possible to fit pressure mats or deck movement sensors. When a light beam between the transmitter and a reflector point are broken, the alarm is activated. This method of securing an area on the boat is very effective.

Motion sensors are reasonably effective when installed within main cabin areas. They use K-band wavelengths to reduce false alarm rates. Dual passive infrared and microwave (PIR/MW) sensor units combine a microwave motion sensor and a heat sensing infrared (IR) sensor into one module. The infrared sensor detects the body's radiant heat energy, while the microwave motion sensor looks for movement. When two positive results are detected, they initiate an alarm. Some systems are declared pet immune, up to 45kg (100lb) dog or several cats. Wide-angle detectors typically have a 110° view and a maximum range of 10m (33'). Mounting sensors at the forward saloon bulkhead wall facing aft should cover the whole cabin. Prices for dual units range from US$50 to US$80 each.

Another system comprises a series of deck motion or stress sensors located in strategic locations beneath the deck. When an intruder steps onto this monitored area, the stress, flexing or strain is detected and activates the alarm. These systems are efficient, reliable, well hidden and rarely put out false alarms when set up correctly but are difficult to install. A system with three sensors and monitor costs around US$400.



Many larger motorboats have installed closed-circuit surveillance (CCTV) systems. If used for security, particularly in port, the camera-mounting site must ensure there are no blind spots and is relatively remote from the potential for tampering. As they must be monitored, CCTVs are installed as an addition to other security systems. Cameras must also suit the environment, outside units having robust and weatherproof, corrosion-resistant housings. Larger boats often have a series of CCTVs that sequentially or simultaneously show multi-camera images.

Powerboats with flybridges and any boat with an enclosed cockpit also have protective options. Canvas snap sensor systems that replace existing dome fasteners are an inexpensive way to secure any area on a boat where the access is only protected by a canvas boat cover.

To secure an outboard engine there is an inexpensive locking mechanism that attaches to the pull start, which prevents unauthorized starting. These are clearly visible and relatively successful. There is also a fuel locking mechanism that installs between the outboard motor and fuel tank. It serves a dual function of deterring theft of boat and outboard motor. Magnapull cable (less than US$50) comprises a flexible stainless cable with a magnet installed at one end to secure outboards and outdrives. When removed, an alarm is activated. For trailers, a sensor mounts in the boat's bow close to the trailer winch. If the trailer is moved or excess vibration occurs, an alarm is activated.

Alarming Elements

Once an alarm sensor is triggered, various systems are activated to indicate the presence of the intruder. My own philosophy is to both indicate the presence of and scare the intruder. They then either depart in haste or start making fundamental

A MARKED BOAT

These additional steps also help deter thieves. Clear notices or security decals or stickers posted at all access points, stating that vessel is protected by alarms, can make thieves think about risk. Hide valuables and keep curtains drawn. Connect a light and radio to a time switch, with varying on/off times to simulate random activity on board. Engraving all equipment with your driving license details and contact information makes resale difficult.

errors under stress that lead to their apprehension.

Mounting a high intensity Xenon strobe light on an elevated location for maximum visibility is the most common indication method. Many install a blue light, but you simply cannot see them easily, which is why police forces worldwide now use a red-blue-white light combination. I have installed orange xenon strobe lights. Better units are rated at 100,000 candlepower and cost around US$30. External boat lights can also be interlocked to come on with alarm activation, though this requires relays inserted within power cables and some considerable work.

Install the highest output sirens that are available. Install two outside and two inside in different, unobtrusive locations to stop easy disabling. A high decibel output unit inside can be very painful to an intruder and simply cut short his stay. Several different alarm signals can panic or disorientate the thief. An independent siren system that is sourced from a different supply is critical. Since continuous use of a boat's horn may result in damage to this essential piece of safety equipment. The independent siren should be fused to prevent thieves attempting to short out the alarm. A 105dB electronic piezo unit costs around US$25.

In many places, laws exist that limit an alarm sounding to 4 minutes and then alarms must cease or reset. A popular practice among ambitious thieves is to set off the alarm and come back when the silence returns to verify whether it's an auto reset type. Another is to keep setting alarms off to simulate a faulty alarm. The owner deactivates the "false" alarm to keep his neighbors happy and the thieves then have an open target.

Security systems are normally subdivided into zones. Zone 1 is usually the default entry and exit zone. This is programmed to give you a set time, usually 45 seconds to enter the correct alarm code on the keypad before the alarm system is fully activated. On setting the alarm, a 2-minute delay is given. Each zone can be programmed with different alarm characteristics. You can have Zone 2 for other access points, Zone 3 for external areas, Zone 4 for gas and fire detection, etc.

Installing a Security System

Every boat has different requirements. After purchasing sensors and alarm devices, there are some installation basics to consider. In most cases, components are mounted or located relative to the ease of wiring. Always install the main control box somewhere out of sight but still readily accessible. The most common location is a hanging locker. Mount internal audible alarms well away from the main control box so they don't lead an intruder to its location and risk vandalizing it. Locate the keypad out of the elements but visible to an intruder so that access triggers a motion detector alarm and gives the user a default entry time delay (normally 45 seconds) before setting off the main alarm system.

Most quality systems use tinned, stranded 2 and 4 conductor AWG wiring to interconnect sensors and controls. Most multicore cables are colored black, red, green and white. Red is always 12-volt positive; black is always 12-volt negative, with green and white for the switch or control wires to the sensor device. When installing wiring, take the same care as you would any other system. The smaller diameter wiring is prone to damage and must be well supported. When stripping insulation on small diameter cables, do so with care as it's easy to damage conductor stranding. This causes early failure. A common failure point in security system wiring is poor connections. Make sure all loose strands are captured under terminal blocks and that none short out adjacent terminals. Ensure all connections are secure; give the wire a gentle tug to make sure. Fuse the power supply to the control unit. Any other separately powered control circuits, relays, strobes and sirens also must be fuse protected.

About the author: John Payne is a professional marine electrical engineer with 29 years experience. He is author of "The Motorboat Electrical and Electronics Manual" and "The Marine Electrical and Electronics Bible." His website (www.marineelectrics.org) features an online marine electrical training school.

OPTIONS

Remote Arming and disarming systems (US$100 to $US200) eliminate the need for a time delay before gaining access or leaving the boat. Key fob operated wireless remote systems use vehicle-type code encryption technology.

Interlocking systems insert interlocks to immobilize the boat control systems. Volvo Penta has an electronic immobilizer that shuts off the engine fuel feed for those intent on stealing the boat.

The panic button is a simple pushbutton mounted by the bunk or elsewhere. It activates alarm systems if an intruder has already breached security systems. They are often interlocked with exterior lights as well to scare off an intruder. In many cases, owners don't set the alarm when on board, so this option is sensible.

An onboard transmitter, driven by the boat's security system when alarm activation occurs, activates a hand-held pager carried by the boat owner. The downside is that transmission is limited to 304m (1,000') line of sight.

Some boat security companies offer a monitoring service. They monitor any alarm activation and determine the level of response. These systems incorporate total vessel alarm monitoring, including bilge levels, smoke and fire detection, gas vapor detection and security. In fact, it's not difficult to do this with your own computer via Internet BoatCam. Alarm transmission is wireless and doesn't depend on cables and telephone lines. Some systems call up to eight different numbers when an alarm occurs, including a pager. One system has a "listen in" feature that allows you to listen in to whatever is happening in your boat during an alarm.

Marine tracking systems use GPS and a transmitter beacon unit to track a boat once stolen. Usually found on the top-end boats, they are worth installing in high-risk areas.

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BASIC THRU-HULL INSTALLATION

Follow these steps when installing a thru-hull or seacock and refer to DIY 2003-1 issue for a discussion on the differences between thru-hulls, valves and seacocks and examples of good and bad installations.

BY NICK BAILEY

If your boat has a solid (non-cored) fiberglass or wood hull, the installation of a small diameter mushroom-style thru-hull is rather straightforward. That's, of course, once you've overcome the fear of drilling a hole in your boat.

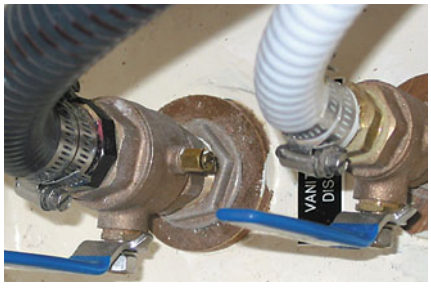
Plan on hauling out for an overnight in the yard to give the sealant time to cure. Aside from the thru-hull and valve (if the installation is below the waterline) you'll need the correct size holesaw to cut a neat opening in the hull to do this job. You'll also need a tube of polyurethane sealant, such as 3M 5200 (for a permanent installation) or 3M 4200 (for removable fittings). To reinforce the hull at the new fitting's location, fabricate a backing block made of marine plywood, StarBoard or other suitable composite material, at least 12mm (1/2") thick and slightly larger than the diameter of the thru-hull nut. It's not recommended to use solid wood for a backing block.

Placement of a thru-hull is critical, especially when connected to a valve or when installing a seacock. Consider the direction of the valve handle. It must be reachable with limited effort and oriented to operate easily. Check for clearances for the valve and hose (**Figure 1**).

Once you have selected an accessible location and have verified you are not drilling into the keel or an integral tank, begin by drilling a 6mm (1/4") or smaller pilot hole (**Figure 2**) from the inside out (where possible), then go outside the boat and line up the holesaw pilot with your guide hole and begin cutting (**Figure 3**). When you are halfway through, stop. Go inside the boat and finish cutting. This prevents ragged edges on the finished hole. Dry fit the thru-hull and file the edge of the hole, if necessary, for a snug fit. Before removing, trace its outer edge onto the hull. Lay masking tape outside the traced line. This prevents any contaminants from migrating into the bond area and also makes for easier cleanup of the bedding compound. Clean the inner and outer mating surfaces with solvent to remove any contaminants that might interfere with a good seal, such as antifouling paint or oily bilge water. Now, lightly sand and solvent wipe again.

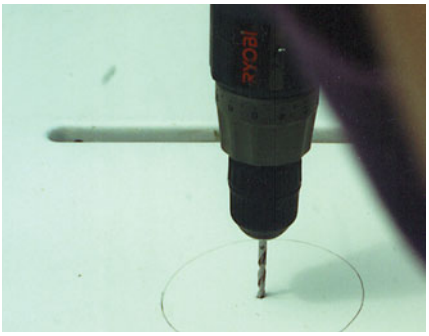
Drill the backing block as you did the hull and prepare the thru-hull, thru-hull nut and backing block for sealant and assembly. For below-waterline installations, have the proper size ball valve ready to thread onto the thru-hull. Apply at least a 6mm (1/4") bead of sealant around and adjacent to the hole on the inside and outside (**Figure 4**). Also caulk the inside hole edge. It doesn't hurt to spread the caulking so that it's thick and even with no gaps leading to the hole. Use lots. The worst effect of using too much caulk is extra cleanup work.

Figure 1



Before cutting the hole, be sure there is adequate clearance for valve handle operation and hose attachment.

Figure 2

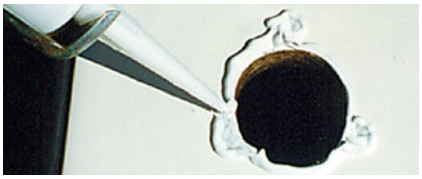


Drill a small pilot hole first.

Figure 3

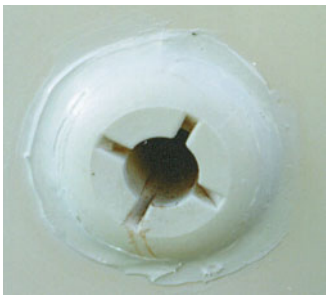
Cut the hole with a holesaw of the exact diameter as the thru-hull.

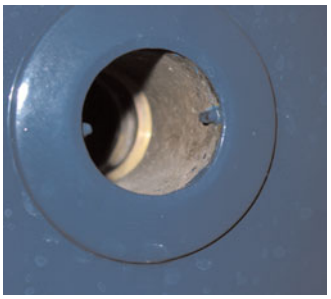
Figure 4



Don't skimp on the caulking.

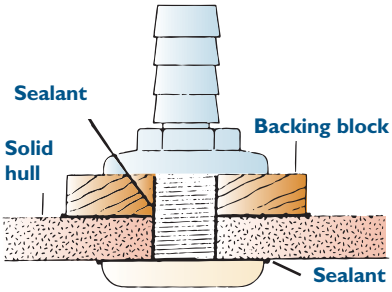
Figure 5





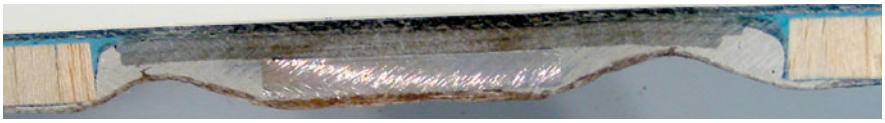
Use a screwdriver to "clamp" the securing tabs on the plastic or metal thru-hull when tightening the securing nut.

Figure 6



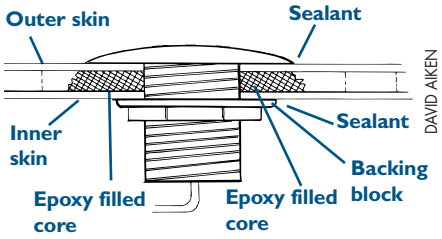
Typical installation of a thru-hull in a solid core.

Figure 7



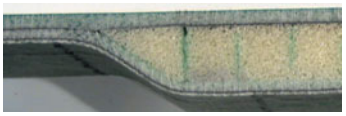
C&C and Tartan are two manufacturers who remove the core and reinforce the laminate with aluminum flatbar in areas where hardware is to be installed.

Figure 8



Potting technique, a method for reinforcing cored hulls.

Figure 9



Sample installation in a foam cored hull.

Installation takes two people. Have a helper push the thru-hull into the hole. Working from inside the boat, slip the backing block over the thru-hull fitting stem, then thread on the securing nut. Your helper likely needs to wedge a large screwdriver against the securing tabs on the mouth of the thru-hull (**Figure 5**). This prevents the thru-hull from turning as you thread on the nut. Hand tighten the nut, then snub down taking one turn or so with a wrench to obtain a good seal. Don't overtighten. This causes too much sealant to squeeze out and might crack a plastic thru-hull fitting. Remove excess sealant and clean up with solvent (**Figure 6**).

Let your work cure overnight, then install the valve (where needed) using Teflon tape and launch the boat. The sealant may still be tacky but this should not pose a problem. Most polyurethane sealants require moisture to completely cure and are not bothered by water provided the thru-hull is mechanically well fastened to the hull.

These procedures are for installing small thru-hulls. Large flush-mounted thru-hulls and seacocks install in a similar fashion but may require bolting or countersinking. If your boat has a cored hull, you can install the fitting on the hull where the core has been deleted (**Figure 7**) or first reinforce the hull where you intend to install the fitting. The quick method, known as the potting technique (**Figure 8**), is to drill the hole, dig out the core all around the opening and fill the void with thickened epoxy. Install the thru-hull when the hole filling has cured. Another method is to drill an oversize hull just through the inner skin and core, then adhere the inner skin to the outer skin so there is a single skin at this point (**Figure 9**). Glue on a backing to build up strength on the original skin.

PROJECTS

Indicates the level of difficulty with 10 being the hardest, 1 the easiest.

1 10

30-MINUTE ACCESS PORT INSTALL

6

By Jan Mundy

DIY magazine is part way through a complete remake of a 1990 6.7m (22') walkaround cuddy. This includes a redesigned deck to remove the livewells and add a new seating arrangement, remove all wood and replace with StarBoard components, install a washdown system and docking lights, all new deck hardware, a full canvas top, replumb cockpit scuppers and much more. We plan to document the refit and publish it in the next issue if finished in time.

Trim ring-style port; One-piece Deckplate.

The boat has ample aft storage compartments but access ports that are so small they limit storage to shoe size items. In our "out with the old, in with the new" approach, we came across Armstrong deckplates. These one-piece plates hold without any mechanical fasteners. This eliminates the trim ring, drilling, fasteners, caulking with sealant and cleanup required when installing conventional access ports. Instead, turning a T-handle tightens the screw clamp against the back of the mounting surface and compresses the heavy-duty watertight seal. Available in large diameters in black, white or ivory, we installed the 30cm (8") deckplate.

Our installation was a quick four-step process.

Step 1: Transfer the cutting line to the bulkhead.

Step 2: Cut out the hole with a jigsaw.

Step 3: File the edges smooth.

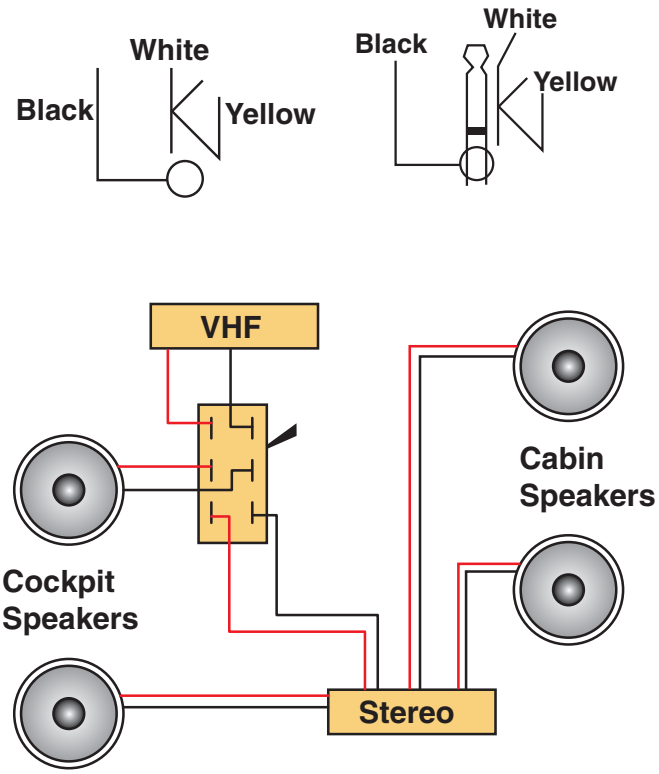
Step 4: Install the deckplate.

COCKPIT WIRED FOR SOUND

8

While looking for a solution to improve the cockpit sound level of the VHF radio mounted in the cabin, I dug into DIY archives and read the project titled, "Remote Speaker Switch," from the 1997-#2 issue. While this article provides a means to prevent the radio's internal speaker from turning off when plugging in a remote speaker, it seems to create a host of other problems. It's impossible, for example, to have both the cockpit and local speakers switched on at the same time. It also requires the installation of two auxiliary speakers, in addition to the VHF radio's internal speaker and, in my case, a set of stereo system speakers in the cockpit.

The VHF radio's external speaker jack functions as both a jack and a switch. Insert a plug end and one of the plug's conductors contacts a ring connect to a black wire, the other conductor contacts a spring connected to a yellow wire. At the same time, the plug pushes the spring away from the contact connect to a white wire, breaking the ground circuit for the internal speaker. (Note: wire colors may vary.) Apparently, VHF radios are set-up this way because their amplifiers are not powerful enough to run two speakers at once, which, if this set-up is over ridden, can damage the radio.



External speaker jack without plug (top left), with plug inserted showing wiring modifications (top right). (bottom) Wiring diagram for two-way communications.

To render the switch inoperative on two older Ray Jefferson models, I simply unsoldered the white wire from its contact and soldered it to the spring, along with the yellow wire. Once modified, it's easy to patch the jack into a cockpit speaker. Use a double-pole, three-way switch but instead of connecting the two center contacts to the VHF radio, connect them to one cockpit speaker. Connect the top two contacts to the radio and the bottom two to the stereo (refer to illustrations above).

With this setup, I can hear my VHF radio in both the cockpit and cabin at the same time. When I prefer not to broadcast to the entire harbor, I flip the switch to stereo and only the internal speaker functions. The stereo's volume control determines whether the sound is heard in the cabin, the cockpit or both. For music in mono, flick the switch to "VHF" mode and use the stereo's volume control. For stereo sound, turn the switch to "stereo" mode. This enables you to listen to your favorite music in the cockpit while monitoring Channel 16.

For boats without cockpit speakers, install a single waterproof speaker in the cockpit and install a double-pole two-way switch. Connect one set of contacts to the VHF radio, the other to the speaker. You now have a choice of listening to the VHF radio in the cabin or in both the cabin and the cockpit.

— Jamie Halpin, St. Clair Beach, Ontario

TRIP LINE: THE KEY TO DOCKING

2

This is a handy and simple method to control your boat's headway and sideways movement when docking in a Med mooring. Take a floating line of any size and the length of your slip plus enough extra line to tie a few knots. Make a couple of carefully spaced (see below) large loops in the line, add some floats, then tie it loosely between the mooring ball and a dock cleat. When entering the slip, pick up the first loop using a boat hook and place it on a cockpit winch. Walk forward and pick up the second loop and place it on a foredeck cleat. The winch loop stops the boat's foreward motion; the foredeck loop keeps the boat from veering to port or starboard.

DAVID AIKEN

SIMPLE TABLE BASE PLUG

6

When a flush-mount pedestal table is not in use, the base-mounting hole is a trip hazard and poses risk of injury to bare feet. Here are two quick and cheap ways to plug the hole.

Fashion a plug of 3.8cm (1-1/2") diameter PVC cap and pipe (shown on the left side in the photo). Lightly sand the outside of the cap and glue on a short piece of PVC pipe. Measure the depth of the hole, then cut the pipe to a length so the cap sits flush with the base top. The cap plugs the hole and the pipe stops it from falling into the mounting hole. This method allows excess deck water to channel through the cap and out the drain hole in the base.

The second solution is a cap made from an empty fishing line spool (shown as a before and after shot on the right in the photo). Cut off the lower flange from the spool so that there is a solid side with a hub. Remove the label and fill the hole in the spool with a small wood plug, setting it flush with the smooth side. This method provides a cap for the hole, that stops water from entering, is easy on the feet and is a residual benefit of buying fishing line. In both examples, I painted the plug and cap to match the base.

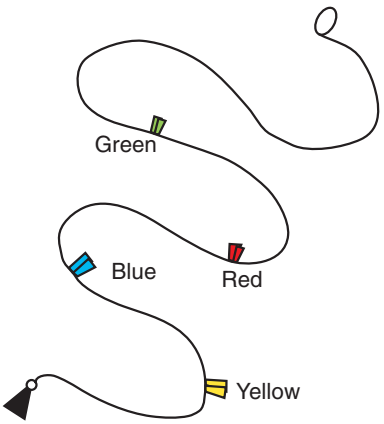
— Bob Hamme, "Hurricane Bob," Elizabethtown, Kentucky

PROJECTS

HANDY DEPTH READOUT

4

Murky, weedy and rocky waters can cast doubt on the accuracy of an electronic depth sounder's readings. When cruising into an unfamiliar channel or anchorage, shallow waterway or fishing hole, a mechanical lead line can help allay such concerns.



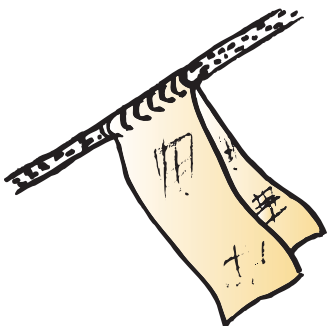
To make a simple depth sounder, buy 9m (30') or so of Venetian blind cord. Attach a 453-gram (16oz) lead sinker to one end and make a wrist loop in the other. Cut strips of nylon or use ribbon of different colors and tie these around the cord at 1.5m (5') intervals. Make a small bag for storage

— Kevin Dean, "Via Sophia," Surrey, British Columbia

CATCHY CUSTOM GALLEY

9

When I designed and built my corner galley in my 1940 6.7m (22') converted U.S. Navy lifeboat, I wanted it to reflect a marine theme, so I made these leaded glass panels using driftwood, barnacle encrusted stones and an assortment of sea shells.



Cabinets are constructed of light-colored cherry, maple and birch to contrast with the darker teak and mahogany of the cabin and provide a bright area for cooking. Using stained glass techniques, I intertwined my sea "treasures" with glass and lead soldered the arrangement. For a similar effect without the leaded glasswork, glue your collection to plain panel doors or plain glass panels.

— Bert Small, "Sea Eagle," Salt Spring Island, British Columbia

EASY REPAIR FOR LEAKING POLY TANKS

6

BY JAN MUNDY

We thought it was impossible to repair a leaking polyethylene water tank until a DIY reader asked for help and our research lead us to Kracor, a manufacturer of such tanks. The company provided the following procedures to repair small cracks and holes in poly tanks.

You'll need a heat gun or propane torch, drill and 1.5mm (1/16") bit, strips of a polyethylene container or polyethylene welding rod and small metal putty knife or similar tool. It sounds easy, so if you give it a try let us know the outcome.

Another product that has successfully "welded" poly tanks is 3M Scotch-Weld Structural Plastic Adhesive DP-8005, a two-part adhesive that bonds StarBoard, as tested in DIY 2000-#4 issue. Cost for a glue applicator and cartridges is about US$150, which is a bargain considering the cost (and work involved) of a new tank. For specs,

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EMAIL: info@diy-boat.com

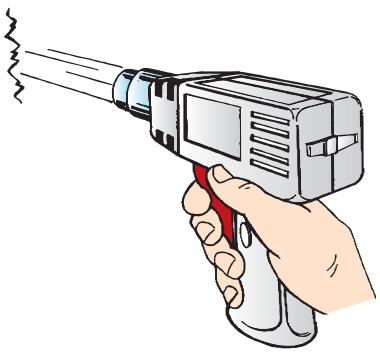
contact the 3M Helpline at 1-800-3M-Helps. Follow these steps to repair poly tanks with polyethene strips or rods.

Step 1: Thoroughly clean the surface of the tank in the area to be welded. Be sure the area is completely free of grease, oil and any silicone-based lubricants.

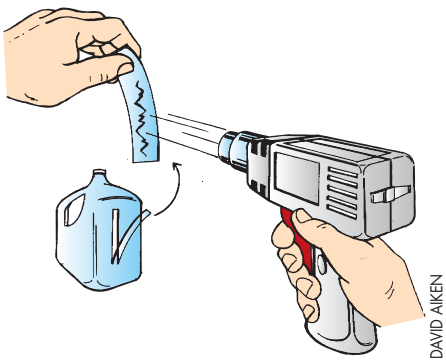
Step 2: For small cracks, use a 1.5mm (1/16") drill bit and drill one hole all the way through on each side of the crack in order to prevent the crack from radiating.

Step 3: Preheat a wide area around the area to be welded. A heat gun is best used for this process as it heats a wider area and provides good control over heat application. If using a propane torch, be careful not to overheat and adjust the flame to a very low setting to prevent carbon deposits that can contaminate the weld area.

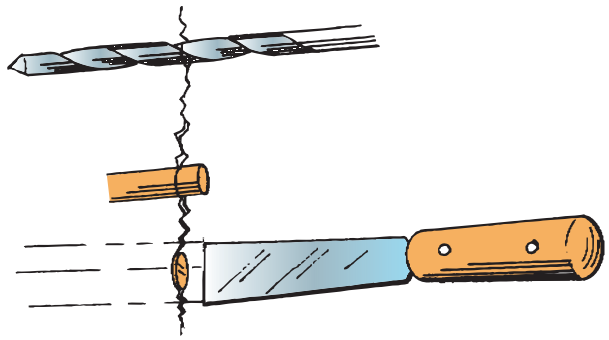
Step 4: After preheating, place the rod or strip of polyethylene perpendicular to the surface and, where it contacts the tank surface, continue to heat the area. As the fill material starts to soften, apply a light pressure forcing it to roll forward until the entire crack area is covered. Let the filler material cool, then trim off any excess.



Step 5: For holes, push the heated rod through the hole being patched to form a plug. Add additional welding rod to the outside of the plug to



DAVID AIKEN


DAVID AIKEN

form a head that is then melted to the outside of the repair area.

Step 6: Upon completion of the weld, flatten the weld area with a slightly preheated putty knife. The knife must not be so hot that it melts the plastic but hot enough to avoid a cold shock to the weld. This flattening action firmly presses the melted surfaces together while aiding in slow cooling.

GEN-SET CUTOUT SWITCH

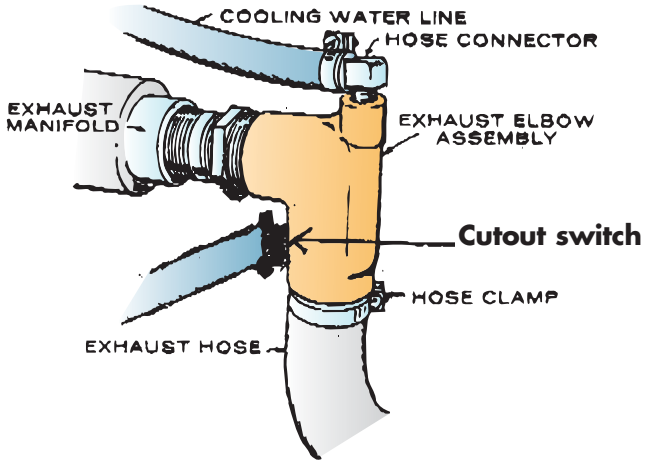
8

Most marine generators have a high-temperature cutout switch mounted on the block of a gasoline engine. Should a clogged intake or water-pump failure interrupt the cooling water, there is a time delay until the automatic shutdown operates. Installing an additional cutout switch on the exhaust manifold assures a quicker response to overheating, long before the exhaust hoses burn out. This switch opens the ignition circuit at 110°C (230°F) and closes at 87°C (190°). When it senses a high-temperature condition, the switch interrupts the ignition causing generator shutdown.

Purchase a switch (about US$30) from a generator parts dealer. For my older Onan twin-cylinder MCCK model, I purchased one from a Cummins dealer (part number 309-0259). Late-model manifolds have two holes drilled and tapped to mount the switch or attach it with a hose clamp. Remove the original wiring from the engine block-mounted switch. Make up a short harness to extend this circuit to the new "kill" switch mounted on the manifold. Installation takes about one hour.

If the gen-set is equipped with a high-water temperature cutoff switch, mount it on the engine cylinder block and connect the exhaust temp cutoff switch in series with the existing cutoff switch.

— George van Nostrand, "Dream Catcher," Keswick, Ontario



Good Boatkeeping

ANOTHER KIND OF BOW LIGHT

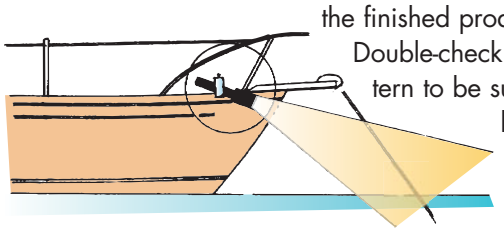
BY DAVID AND ZORA AIKEN

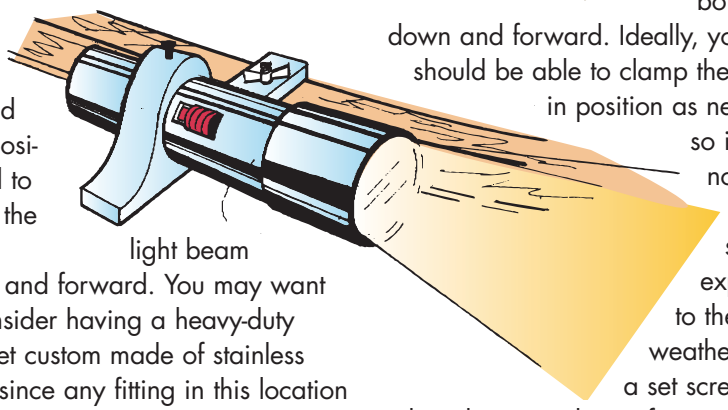
A light installed under the bowsprit or anchor roller may seem a curious addition to your boat, but the first time you arrive at your chosen anchorage after dark on a cloudy night, its purpose becomes clear. Even more telling is the sudden need to deal with the dreaded dragging anchor, when the usual quiet night is interrupted by some unexpected disruptive weather. The wind shifts, then strengthens. The comfortable rocking motion changes to a most uncomfortable pitching. You can feel the anchor as it starts to move and though you try to get some bearings, there's not even a hint of moonlight to help. Darkness makes any problem worse.

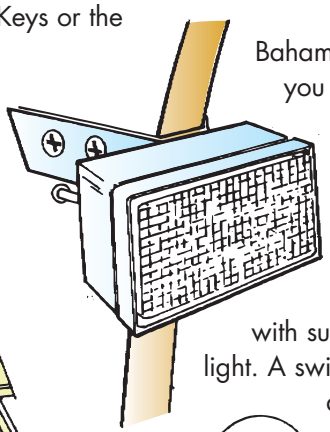
You ascend to the deck and race forward, flashlight in hand (if you remembered to grab it from its emergency station) but you need another hand to hold the light while you work with the anchor rode. Spreader lights, deck lights or spotlights often make the situation worse, destroying night vision all around the boat.

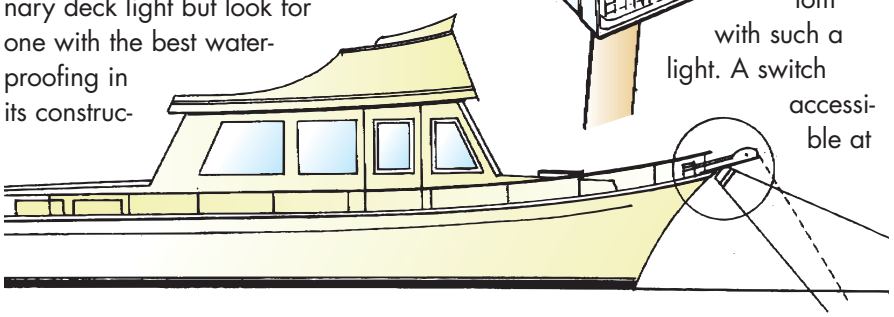
Here are two ways to shed light just where you need it. Mount a permanent light fixture under the bowsprit or bow roller. Use an ordinary deck light but look for one with the best waterproofing in its construction. Naturally, all wiring must be meant for a marine application and the installation should follow ABYC guidelines as well. [Ed: refer to DIY 1998-#4 issue or MRT CD-ROM "DC Electrical Systems" for wire specifications.]

The actual mounting bracket must be a custom design because each boat is unique. Make a template of the bracket. It must be shaped and positioned to direct the light beam down and forward. You may want to consider having a heavy-duty bracket custom made of stainless steel, since any fitting in this location must be able to withstand the pounding it will inevitably receive. When positioned properly, the light will illuminate enough of the anchor rode so you can see its direction and also watch as it slackens or pulls taut. In clear and calm waters of the Florida Keys or the Bahamas, you can actually read the bottom with such a light. A switch accessible at the bow allows the anchor crew to control the light. Of course this must be the waterproof variety, too, and located where it won't be unintentionally activated.









The second option is a small removable spot or a bright-beamed flashlight. Design a bracket to hold this type of light. Once again, a pattern would be helpful initially, especially if you plan to use stainless for the finished product. Double-check the pattern to be sure the light will be directed both down and forward. Ideally, you should be able to clamp the light in position as needed, so it will not be constantly exposed to the weather. Use a set screw or other clamping device for installation, something that is relatively easy to put in place but that will also provide a secure hold.

Plan the wiring so the shortest possible length of wire remains outside the hull. Where wiring comes through the deck, be sure to use watertight connections made for just such a purpose and seal the deck opening to prevent moisture intrusion.

About the authors: David and Zora Aiken are the authors and illustrators of numerous boating, camping and children's books, including "Good Boatkeeping" and "Good Cruising"