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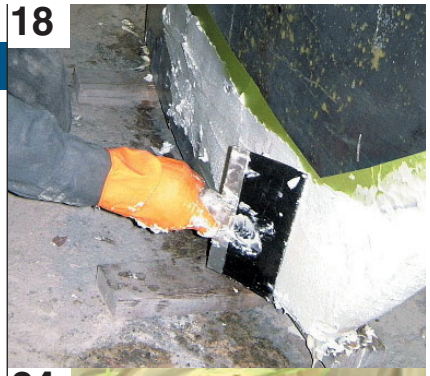


CURRENTS

EDITED BY JAN MUNDY

Who to Call For Tank Draining

In the article "A Systematic Approach to Engine Diagnostics," in DIY 2002-#4 issue, author Harry Swieca commented about service companies that drain fuel tanks but didn't provide any sources. If you're in need of such services check the Yellow Pages for commercial companies that recycle oil. In Harry's home state of Illinois, boaters call the Dukes of Oil to extract old fuel.

Conquering Odor-Fatigue

I would like to commend one of your advertisers for resolving our onboard odor problems. To overcome strong diesel and holding tank odors as well as mold and mildew we purchased a Quantum Bilge Buster. We installed one unit in the engine room and in eight hours all odors had taken leave and none have returned. We live onboard for six months every year and to eliminate strong cooking odors and cat scent that had permeated the cabin, we purchased a Cabin Aire shortly thereafter. It quickly vanquished all odors as well as mold build-up. Thanks for a great magazine and also for great advertisers who are truly professional and have wonderful products.

Robert and Marie Booth, Utica, New York

Synthetic Oil: Three Opinions

I'm about change the motor oil and filters in my 1994 twin 5.0L OMC (302 Ford) sterndrives. If I use synthetic oil, would I still have to do oil and filter changes in the fall and spring? Anything special I have to do to change from regular oil to synthetic?

Peter Kenefick, Chester, Connecticut

Steve Auger replies: Though I have not heard of a engine having a failure due only to the use of synthetic oil, Mercruiser doesn't recommend the use of synthetic oils due to the lower shear point of synthetic multi-grade oils available at the time they were tested (1997). Shear point occurs when the oil does not remain in between the connecting rod bearing and crankshaft due to load, resulting in a crankshaft to connecting rod failure. Mercruiser then issued a service bulletin indicating that the use of non-detergent oil, multi viscosity oil (other that Mercruiser 25-40), synthetic oil, oil that contains solid additives or low-quality oil are not recommended.

Harry Swieca replies: I am a believer in these oils, provided you use 100% synthetic not a part mix. I spent considerable time dyno testing Amsoil and Mobile 1 on my car and Amsoil by far exceeds expected performance. Manufacturers suggest using their oil only after the engine has been thoroughly broken in, say 100-plus hours. Amsoil recommends 2,400 hours between changes when an extra oil filter is added. The real disadvantage is that on an older engine you need to be very observant of leaks. The oil cleans so well it cleans away dirt that has clogged old gaskets. When I switched my boat engine over to synthetic oil, two seasons later I had to replace most of the gaskets.

Jan Mundy replies: The question of using synthetic oil in marine engines continues to be a popular one with boat owners. Some owners feel that because it's used in their cars or, as in one case, a fleet of gravel trucks, that it would be good for their boat engine. I've always been of the opinion that one should use only what the engine manufacturer specifies in the owner's manual. If synthetic oil is not mentioned, then don't switch.

What's your opinion? Why should or shouldn't boat owners use synthetic oil? Email your comments to tech@diy-boat.com.

Results of DIY Polls

Where do you buy marine products?
According to the survey posted on DIY ONLINE, a surprising 32.5% of boat owners shop at their local dealer, while 25% purchase from a discount store. Mail-order catalog sales were nearly tied with online shopping, tallying 15% and 16% respectively. Those preferring to buy at boat shows came up a close 11.6%.

To cast your vote in our upcoming polls, log onto DIY ONLINE at www.diy-boat.com. Results are posted in DIY ONLINE and in DIY print issues.

Regal to Host Owners' Rendezvous

If you own a Regal boat, there are two company-sponsored rendezvous planned for this summer. The first takes place June 26 to 29 at South Seas Resort, Captiva Island, Florida. The second is held August 14 to 17 at Cedar Point Marina and Amusement Park, Sandusky, Ohio. You can register online at www.regalboats.com or contact your local dealer for a reservation form.

Readers Benefit

I love the magazine and the services you provide. Your assistance through the Technical Helpline on propeller shaft packing inspired me to purchase the "Hands-On Boater 1995-2002" CD-ROM of 32 past issues. I finally found a legitimate hobby, expensive, but a hobby nevertheless and I'm having a ball with this whole thing. I wake up Saturday morning, throw on my work clothes and go to my other job!

James Discher, Irving, Texas

Mistaken Identity

I'm starting a major boat project, a 13m (43') Columbia that is completely gutted and the deck removed. There is so much information in your magazine that I can't put it down. I'm doing it myself with a lot of help from folks like you! I watch "DIY" on TV all the time but I didn't know there was a "DIY Boat."

If you ever consider making a show about a boat project I'd be happy to let you do some taping of my boat.
Kevin Plank, New Paris, Indiana

Ed: Though many people mistake DIY with *DIY boat owner Magazine* we have no affiliation with the TV show. In fact, we were hatched first!

Wagner Lives On

We have recently come across an article in DIY about hydraulic steering. In the article Nick Bailey comments that "Wagner is out of business." Nothing could be further from the truth. When Wagner Engineering ceased operation our company, Summer Equipment (Tel: 604/873-4545, Web: www.summerequipment.com), acquired all of the manufacturing rights to the Wagner product line. We maintain an extensive inventory of new equipment and spare parts including replacement parts for older Wagner systems.
Art Rendell, general manager, Summer Equipment Ltd.

Propane Storage Solution

DIY reader and contributor David Anderson who designed a custom propane tank holder, which was profiled in DIY Projects column, 2001-#2 issue, has now gone into production with his device. The Holder consists of a stainless steel bracket and retaining ring that mounts either on a transom rail or to any flat vertical surface. Two sizes of rings fit a single propane cylinder from 2.7kg (6lb) to 9kg (20lb). Available from Stand Sure Marine (Tel: 416/409-4089, Web: www.standsure-marine.com) cost is less than CDN$210, depending on the required ring diameter, with mounting fittings.

Seasoning with Salt

Your article on reconstructing deck grip patterns (DIY 2002-#4 issue) took me down memory lane. My wife and I have grown through dinghies, windsurfers and are now with our final yacht (probably). Our Mistral boards took considerable beatings and, after the professional repair of the first ding, I quickly learned to do it myself. To my surprise, after the structural repair and smooth sanding, the finish only required a thick spray of glossy white rust-resistant paint and while still wet, a sprinkling of common table salt. When the paint dried, I dissolved the salt in water by going surfing. It was a perfect color match and the imprint left by the salt seamlessly reproduced Mistral's random stipple pattern. For random stipple patterns, perhaps your interested readers might experiment with different water-soluble granules in different sizes, such as sugars, common salt or rock salt, combined with light sanding and perhaps repetition.

Milan Tytla, "Kantagree," Toronto, Ontario

Ed: This follows the adage, "If it works, use it!" Though it sounds like a good fix for small boats, I'd be very careful sprinkling the high salt concentrations needed to skid-proof an expansive deck surface, especially around certain metals, some painted and/or varnished finishes and metal boats.

Bragging Rights

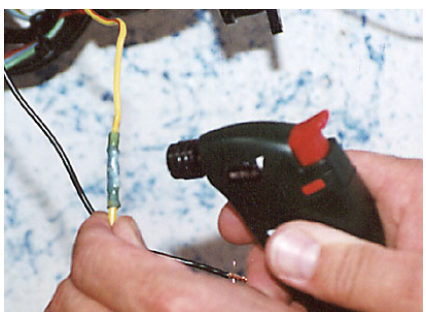
Now you can brag about your boat to other DIYers by showing it off on DIY ONLINE. "Reader's Boats" is a special forum where we highlight boats and projects. To include your boat, send an email to tech@diy-boat with your name and email address (don't fret., we don't publish email addresses); boat name, 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.

Marine Grade "Yes." Solder "No."

Further to the "Wiring Basics" article in DIY 2002-#4 issue, I would suggest adding the following. When installing or reinstalling equipment use marine-grade wire. Using the crimp tool is fine but, as an additional step, solder the point where the tunnel and the wire end using rosin core solder. You will find that using an electric heat gun will produce more consistent heat-shrink results than a butane torch. I have found that a very popular mass-produced sailboat using standard wire for the wiring harness and multiple conductor plug/sockets can, after a few years, be expected, in a saltwater environment, to have about a 4-volt drop between the battery and the glow plugs. All other equipment suffers loss in direct relation to current draw.

Alan Kirk, Saltspring Island, British Columbia

Ed: You are correct in mentioning that we omitted the wire specifics. And yes, we did use a mini heat gun, one sold by Ancor Marine exclusively for wiring use. One item that I do take issue with is your mention of solder. ABYC no longer recommends using solder. To quote standard E-9 9.17.12.8: "When a stranded conductor is soldered, the soldered portion of the conductor becomes a solid strand conductor and flexing can cause the conductor to break at the end of the solder joint unless adequate additional support is provided. If soldered, the connection shall be so located or supported as to minimize flexing of the conductor." In previous articles, namely DC Wiring Handbook (DIY



DIY boat owner the MARINE MAINTENANCE MAGAZINE

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Contributors: David & Zora Aiken, Steve Auger, Nick Bailey, Larry Blais, Susan Canfield, John Payne, Wayne Redditt, Paul & Sheryl Shard, Harry Swieca

1998-#4 issue) and in our "DC Electrical Systems" CD-ROM we recommend owners do not solder. What entails "adequate additional support" may not be enough and the connection may fail, causing a short and a potential fire hazard.

Not a Knot

Having been involved in aerial navigation, which is based on marine principles for almost 60 years and teaching navigation for 30 years, I was surprised to read for the very first time, in the article "Fuel Watchdog – Money in the Tank," DIY 2002-#3 issue, the term "knots per hour (kph)." In aviation "knots" or KTS are now universally used but in some European countries kph indicates kilometers per hour. You have used knots as being a distance whereas it's a speed. I did find your evaluations quite comprehensive and they remind me of my teaching the effects of "air nautical miles per hour" and "ground nautical miles per hour," the latter taking into account the effect of head or tail winds and therefore "range" performance.

Bryan Cox, email from New Zealand

Ed: According to my resources km/h is the abbreviation standard for kilometers per hour. So without checking the standard for knots, I thought it would be appropriate to use kph or knots, but that translates to knots per hour rather than speed in knots. If aerial navigators recognize Kts, it works for marine use.

Locking Deck Fill

Searching the Q&A section in DIY ONLINE I came across a question about locking deck fills for boats. It suggests that there is no product on the market that you knew of. Best Performance (www.tanklock.citymax.com) is the manufacturer of a product called Tanklock (US49.95). This two-piece device consists of a stainless steel cap and shield. It fits 1-1/2" deck fills and is installed in minutes.

Ty Cisco, Best Performance

In Search of a Stain Remover

During the repower of my 6.7m (22') Shamrock, an oil-based solution from the old motor stained the deck. I have tried all of the over-the-counter stain removers to no

avail. Any homemade concoctions you or other readers could recommend short of repainting?
Patrick Daley, "Boxing Dog," West Haven, Connecticut

Ed: I've heard this remedy is used to remove stains from masonry. I don't know if it works but it's worth a try. For fresh stains, first apply an oil degreaser to liquefy the oil stain, then use Spill Magic to absorb it. If it's an old stain, apply Pour 'n Restore after the degreaser. Both products are available at grocery stores.

Rubrail Guide

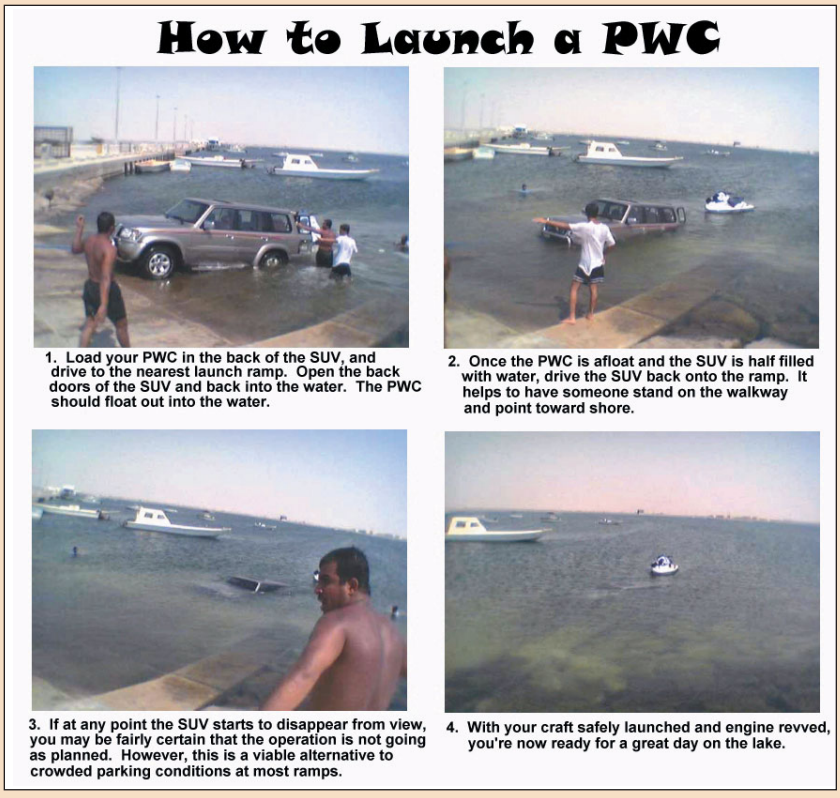
After extensive research, rubrail manufacturer Taco (Tel: 800/653-8567, Web: www.tacomarine.com), has at last released its "Rub Rail Replacement Selection Guide." This handy booklet cross-references rubrails installed on the top 50 powerboat manufacturers from 1993 to 2002 with the exact or nearest facsimile copy Taco replacement part number. Included under each boat manufacturer are the available rail and insert options for each model year. There are also sample profiles to ensure a perfect match. Booklets and rubrails are available from major retailers or log onto Taco's website where you can select your boat model, choice of rail and view a photo of an exact profile.

AWARD WINNING EDITORIAL

Congratulations to DIY contributor Susan Canfield who received second place in the Technical Writing category from Boating Writers International for her article titled "Fire Onboard" in DIY 2002-#3 issue.

A Double Launch

DIY contributor Dwight Powell emailed this to us. We're unsure of the origin and, hopefully, we don't offend anyone.



WANTED

A MOODY VIEW

San Francisco, California boater Jerry Brown is seeking information, such as wiring diagrams, sail, deck and any other plans for a 1968 Moody 36 Halbardier ketch. He's also interested in communicating with other owners. Contact him at jerry.brown@flysfo.com.

NAME YOUR OWNER'S CLUB

DIY reader Bill Radecky is compiling a list of boat owner's clubs on the web and has promised to share this information in an upcoming article in DIY. Email Bill at bradecky @frii.com.

TALK BACK Q&A

HELP LINE 1-888-658-2628

All Choked Up

Q: My boat has a 151L (40gal) holding tank connected to two SeaLand VacuFlush units. Pump out is slow to ineffective through the deck fitting, all other head plumbing flows freely and the vent is clear. I suspect the pick-up tube is clogged. I've tried the usual drain cleaning products but without success. What can I pour into the tank to dissolve the clog?

Larry Johnson, "Miss Charlotte," Key West, Florida

A: It may be that the pick-up tube has heavy calcium deposits from marine growth. Try pouring a gallon of the mild acid cleaner (e.g. CLR) or straight vinegar down the hose from the deck fitting and let it mellow for a few days. Another possibility is that the hose between the pickup tube and the tank has collapsed under suction and restricted the flow. I have seen instances where an inexpensive rubber hose looks fine on the outside but it's delaminated internally. A flap of rubber lifts off the inner wall of the hose and shuts down the flow as efficiently as the choker valves in your head system. This scenario is a lot less likely if you have the expensive cast white vinyl sanitation hose, which never delaminates. If this doesn't help, it's time to get up close and personal with the head plumbing. Replace any black rubber hose first and see if it makes any difference. If not, then check the pick-up tube. This may require manually draining or pumping out the tank. If you do all this and survive with your sense of humor intact you will be automatically enrolled in the "Headmaster Society."

— Nick Bailey

Ed: Dealing with sewage carries with it an obvious health hazard. Be sure to check with SeaLand Technology (Tel: 800/321-9886, Web: www.taylormadegroup.com) for cautions about the use of chemicals in a VacuFlush system.

Cure for Gen-set Vapor Lock

Q: My 1987 Sea Ray has an original Westerbeke BCG 6.5kW that runs perfectly for one hour but, if I shut it down and restart one hour later, it runs only for a minute or so then stops. What can be done to remedy this problem?

Charles Bradford, Vergennes, Connecticut

A: According to Joe Joyce, national service manager of Westerbeke, heat build up in your engine compartment might be your problem. When running for a period of time, heat causes fuel in the fuel pump to vaporize and the gen-set stalls. To diagnose, Joe offers this trick. When it won't restart, wrap an ice pack around the fuel pump and chill it for a few minutes. This will condense the fuel. If it starts after a few minutes then you have a vapor lock issue. Westerbeke offers a gas denser ($150 plus labor) for your gen-set that cools the fuel as it goes into the fuel pump to eliminate vapor lock. If it doesn't start after applying the ice pack, then it might be a fuel pump problem. After running for a while, heat builds up and the fuel pump stops running. As cylinder pistons pump fuel and fuel vapor locks, there is no liquid (fuel) in the cylinders to lubricate pistons and they eventually score and stick. Joe recommends that lightly tapping on the fuel pump with a mallet will sometimes free up the piston. If you hear a constant piston click, then it's working. If you hear a "burr" instead, then it's pumping air. – *Jan Mundy*

Faux Teak and Holly

Q: I'm planning to install a teak and holly sole in my O'Day 34 sailboat and can't decide between teak and holly plywood, the simplest, or solid teak. Any ideas on materials or the installation?

Daniel Ruder, "Second Wave," Green Bay, Wisconsin

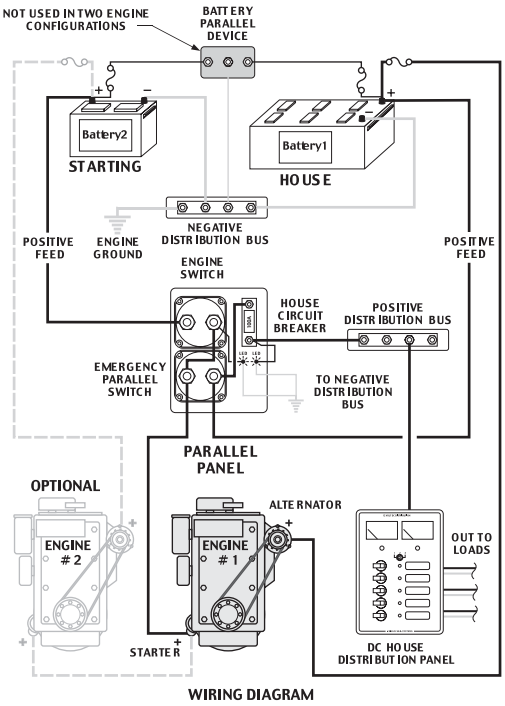
A: You can use teak and holly plywood (about $160 for 4x8 sheet) but the face veneer is so very thin I would suggest coating it with three coats of clear epoxy resin to ensure it can withstand the foot traffic. Alternatively, 10 or so coats of a quality varnish may provide the needed protection. Should you decide to use solid teak planks, you can learn from the classic wooden boatbuilders who make a faux holly inlay using a bead of polyurethane sealant. A 4mm or 6mm (3/16" or 1/4") space is left between the planks. After final prep, the planks including the seams receive three or four coats of varnish. This prevents the sealant from soaking into the wood grain. Sand the seams, mask with top varnished surface with tape, clean seams with mineral spirits, then apply a slow-cure polyurethane sealant. Follow with a putty knife to remove excess, then tool each seam with a gloved finger dipped in varsol or tongue depressor to form a slight convex shape. Apply eight or so additional coats of varnish, which gives the sealant a yellow hue. When professionally done it's difficult to tell the difference.

— Jan Mundy

To Switch Four-Way or Parallel?

Q: I'm in the process of replacing all the wiring, starting with the DC system, on my 1953 12m (40') Chris-Craft DCFB cruiser that I purchased last summer. There are two battery banks and I'm considering installing a battery isolator with a 300 amp continuous, 400-amp 5-minute rating battery switch to maintain a dedicated battery for the twin gas engines. Is this the proper route?
Bruce Smith, Belleville, Ontario

A: Scott Renné, president of Blue Sea Systems (Web: www.bluesea.com), recommends a parallel DC backbone system utilizing two On/Off switches or a DC parallel battery switch panel (Blue Seas part number 8080). This creates a system where the main house and starting circuits are not connected and operate independently of each other. It also overcomes problems associated with systems using four-position battery switches.
— Scott Renné, Blue Sea Systems



WIRING DIAGRAM

How to Calibrate a Knotmeter

Q: How do you know when a knotmeter reads 5 knots that it's actually 5 knots?
Richard Foy, Moose Jaw, Saskatchewan

A: Log calibration normally requires the use of a measured mile, which is always clearly marked on charts. Many new logs are self-calibrating or have an optional manual calibration, while some use a GPS to get speed-over-ground values. This Speed Log Calibration formula is extracted from my book, "The Marine Electrical and Electronics Bible," (Sheridan House, 420 pages). Perform the calibration run at slack water to prevent any influence and inaccuracy from tide or current, as well as during calm, wind-free conditions. Prior to making a run, ensure

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that the correct magnetic course has been worked out to ensure the vessel takes the correct course, and this means making appropriate corrections for variation and compass deviation. An autopilot, if the boat is so equipped, is better than hand steering as weave distorts the actual reading. Locate a measured nautical mile. Make the runs under power at a constant engine throttle setting. Run 1 is direction 1; Run 2 is return that averages out any slight tidal sets, etc. Ensure that transits used are accurately observed at the start and finish of each run. The formula for determining log error is:

Runs 1 + 2 (True Speed) = Correction K

Runs 2 + 2 through water (log speed)

The resulting figure will show either under- or over-reading, and this is used either to calibrate log or correct readings.

Average true speed = (Run No. 1 true speed + Run No. 2 true speed) / 2

Average log indicated speed = (Run No. 1 log speed + Run No. 2 log speed) /2

Per cent error = ((Average log indicated speed - Average true speed) X 100 %) / Average true speed

Note: The error is positive when the log speed is greater than the true speed. The error is negative when the log speed is less than the true speed.

Bridging a Flex Coupling

Q: I installed an R&D flexible coupling and, unless I install a bridge across the bolts, I now have no ground. How critical is the ground provided via the motor through the propeller shaft to the water?
Chip Lohman, "Whispering Swan," Quantico, Virginia

A: PYI (Tel: 425/670-8915 Web: www.pyiinc.com)is the distributor for the British-made R&D couplings. I spoke with president Frederic Laffitte and his reply follows. "Installing any flexible coupling results in an isolator between the engine coupling and the shaft. This effectively isolates the shaft entirely from the boat grounding system. In some cases this is good and in some cases it's bad, depending on the location of the sacrificial anodes (zincs) on the boat and whether or not these anodes protect other parts of the boat. For example, if the boat has a shaft anode only and bonded bronze thru-hull fittings, then having the anode isolated from the bonding system is bad. If there are multiple

anodes on the boat, then the shaft anode protects the shaft and prop, while anodes on the hull (or rudder) protect the rest. When in doubt, bridge the flexible coupling to restore the engine ground. To do this, run a wire between one bolt each on the engine coupling bolt and shaft coupling. This way an electrical current can run from the engine to the shaft and vice-versa.
— Frederic Laffitte, PYI

Resupplying a 32-Volt System

Q: My 14m (46') Bertram has a 32-volt power system comprised of four 8-volt batteries for each engine. Since I need to replace the batteries, is it possible to use one 8-volt battery and two 12-volt batteries? Three batteries totaling 32 volts per engine would weigh less and certainly cost less than the present set up.
Marvin Kessler, "Noteworthy," Glen Cove, New York

A: Reliability is a problem when you install mixed battery types and sizes as they have different characteristics. A better option is to have one dedicated starting bank of the cranking-type batteries and one house bank consisting of four, 8-volt off-the-shelf batteries.
— John Payne

No Twist, then Shout

Q: My Forespar adjustable tiller extension no longer locks; it simply turns without any friction. Is there an easy fix for this?
André Caron, "Détente Totale," Montréal, Quebec

A: We contacted Art Bandy at Forespar (Tel: 949-858-8820 Web: www.forespar.com) and he suggests that you send the unit to them for repair or replacement. These are sealed units and cannot be repaired in the field. Twist-Lock extensions are warranted for three years except where dented, bent, oiled or modified.
— Jan Mundy

Replacement Fridge Options

Q: My boat's small Norcold refrigerator, a dual voltage unit that runs mostly on 110-volt AC, no longer works. Assuming the fridge is not easily and economically repairable (probably needs new-type refrigerant), one option is to purchase a small 110-volt AC bar fridge for about 20% less than the cost of a dual voltage fridge. When at anchor, it can be powered by the boat's 1,000-watt inverter. What are the drawbacks of using a conventional bar fridge as opposed to a dual voltage marine-grade refrigerator.
Gary Way, "Cardinal," Point Roberts, Washington

A: One reason the dual voltage marine fridges are so pricey to fix or to buy is because they include a built-in inverter that changes the boat's DC power to the 115-volt AC the fridge compressor actually runs on. As you already have an inverter, replacing the AC/DC unit with an AC-only household unit is a viable option but there are some differences. Most marine fridges have a front air vent (and fan) to cool the condenser grill. A typical bar fridge has a back grill and is designed to be cooled by convection. When installing, be careful not to block off airflow to the grill. A typical small household bar fridge has a lot more cooling capacity than a marine unit, approximately 1,000 BTU versus 350, which means more power consumption. This is probably within the range of your inverter but check the power consumption wattage specified for the bar fridge and assume it will momentarily draw three times that amount at start up. More important, is battery capacity and charging capabilities. Do a worst case energy budget to figure out your power consumption in amp hours and assume the fridge will be running at least 50% of the time. Plan to start charging your batteries when they are down to 50% of their rated capacity. Remember a battery that reads 12 volts on a digital meter is already at or beyond that point. You may need additional batteries and/or a bigger alternator.
— Nick Bailey, Bristol Marine

Wiring EI in an Old Merc

Q: My boat's port engine, a 1978 Mercruiser 454 with electronic ignition, lost spark. Because all the ignition components were old, I bought a new electronic ignition (EI) from Ebasic Power, which consists of a coil and distributor to replace the existing coil, distributor and black

box. In the new EI set up, the positive wire to the black box wire now connects to the positive side of the coil. Following the instructions, I attached the positive wire to the distributor and the voltage regulator wire to the coil "positive" but this wire got hot to the touch as soon as I started the engine. On the coil "positive" is a hot wire, which on the starboard motor goes straight to battery positive. On the negative side of the coil, is a wire to distributor "ground" and tachometer. What wiring problems do I have here? Also, shouldn't the positive wire be wired to the ignition switch, so it's only hot when the ignition is switched on?
John Formica, Stevensville, Maryland

A: I have seen these drop-in distributors (usually Presolite) typically used to upgrade breaker point ignitions to a breakerless distributor. Ignition advance is still controlled by springs and weights under the pick-up coil plate in the distributor. Early 325hp 454 Mercuisers used Mercury's Thunderbolt 1 ignition system, a system wired very differently from most conventional ignitions. In order for your new ignition to work correctly, I recommend wiring it in the following manner. Connect the wire that supplies power to the new ignition system directly from the ignition switch "I" terminal (usually a purple wire) to the ignition coil "positive" terminal with no drops. Remove the voltage regulator lead removed from the coil "positive" and connect it to the protected side of the 50-amp circuit breaker on the engine. This leaves a distributor pick-up coil lead and tachometer lead to connect to the "negative" side of the coil. Some of these drop-in distributors use a dedicated ground lead that must be connected to a good ground on the engine block. If the voltage regulator wire still gets hot after rewiring, it's not because of your new ignition system but a failure of the voltage regulator itself. If your engine uses an electric choke it's best to run a dedicated wire from the ignition switch "I" terminal to the electric choke thermostat terminal on the carburetor.
— Steve Auger
Ed: Never install any gasoline engine accessory that is not ignition protected. Equipment purchased from automotive parts suppliers is not likely to have this vital protection. Parts for marine applications (gasoline engines) must bear the marking, "Ignition Protected." If they aren't marked, assume they're not protected.

Surveying Used Fuel Tanks

Q: I'm considering the purchase of a 1988 Prowler. The boat has two aluminum diesel fuel tanks encased in fiberglass. These contained a considerable amount of water a few years ago, resulting in expensive engine repairs and a hefty insurance claim. I don't know how long the water sat in the tanks nor have I been able to find any information on the condition of the tanks. Is there a significant concern that the tanks are damaged and require expensive removal and replacement? How does one go about checking tanks? Obviously, I would like to know as much as possible before putting an offer on the boat.
Laura Jensen, Burnaby, British Columbia

A: Presumably, the water got in by condensation, contaminated fuel or by someone mistaking the fuel fill for the water fill. This becomes a freshwater problem and I would be surprised to find serious pitting from corrosion on the inside of these fuel tanks. Nonetheless, it's a possibility, however remote (saltwater corrosion damage can be more extensive). There is no way to be sure without an inspection. Attempt to get permission to inspect the tanks internally if possible. If they are not fitted with a removable inspection/clean-out port then the only access is through the small 12mm (1/2") diameter hole cut for the fuel gauge sender, which likely won't show much. If the tanks are mounted with fiberglass in contact with the outside of the tank, I would be concerned about external corrosion, particularly if the tanks are mounted low enough in the boat to get wet from bilge water.
— Nick Bailey

TECH TIPS

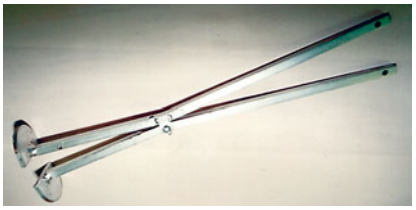
SPOT-FREE SHOWER: A boat wax applied twice yearly to the walls of a fiberglass (or painted) shower stall makes cleaning easier and reduces water spots.

REMOVING PAINTED GRAPHICS: To minimize gelcoat damage when removing painted-on graphics, dab on some rubbing compound and rub lightly to remove just the raised paint.
Bill Macklin, Stratford, Ontario

LIQUIDFYING 5200: Next time you need to dissolve 3M 5200 adhesive, squirt on some Lestoil, the one sold for cleaning floors. Apparently it won't damage fiberglass or Plexiglas surfaces but I would first do a spot test.
Hexan Zales, Fajardo, Puerto Rico

SALT-PROOFING TRAILERS: Boat trailers used in saltwater are commonly galvanized for corrosion protection but springs, hubs, winch gears and swivel jack soon start to rust. A product generally referred to as "open gear lube" can prevent this. Used by marine salvage and construction industries, this almost tar-like lube is sprayed on clean metal. It contains a carrier that penetrates the spring leaves and then evaporates leaving a flexible, waterproof, lubricating coating. Available from many industrial cleaning suppliers, particularly around ports and industrial areas, I purchased a 397ml (14oz) private label brand spray can (US$5) from Savannah Brush and Chemical (Tel: 912/232-4446). It's a mess to put on but one application has lasted five years, so you'll at least double the life of your trailer parts.
George Thomas, Savannah, Georgia

BELLOWS: Replacing a cracked transom bellows is a job best left to the pros but, with a bellows tool, some mechanical skill and an



engine service manual, you can likely do it yourself. Ask your local yard or dealer for the tool (about US$70). My yard owner disliked doing this job so much he was very happy to sell me one.
Ben Owen, "Dolphin," Oshkosh, Wisconsin

PASS THE SHAVING CREAM: When drilling or scraping any material that contains or is coated with hazardous material such as fiberglass or toxic bottom paint, squirt a wee bit of shaving cream on the work surface. This method is used by professionals in large shipyards to keep any airborne dust and particles on the surface and makes cleanup easy. Use whatever brand of cream you like. It's non-toxic and the white is non-staining.
Woody (Gerald) Woodside, "Salmagundi," Port Orchard, Washington

A SIMPLE CHIP FIX: When you need to repair a few small gelcoat chips and nicks and you're not near a marine store, try sink and tub touch-up available at hardware stores in a wide assortment of white tints for easy color matching. Before applying, wipe the repair area with solvent to remove any wax, then apply several coats to build thickness, allowing drying time between coats. This product's viscosity makes for a clean, easy application using the brush on the bottle lid. Sink and tub repair products are sold for use on both fiberglass and porcelain. I mistakenly used the porcelain repair, which looks great, though I'm not sure how either product weathers UV.
Mike Holden, Ajax, Ontario

ANCHOR COUNTDOWN: To help determine how much anchor chain is payed out, mark the links with Plasti-kote Orange Glow 140

or other reddish fluorescent paint. To space the marks at 7.6m (25') intervals, paint one single mark at 9m (30'), which includes, for example, an extra 1.5m (5') deck height above the water. Paint two marks at 16.7m (55'), the next mark, a triple, at 24m (80) and so on. Apply lots so the marks are visible from the flybridge.
Dwight Powell, "Wiking," Orillia, Ontario

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DIESEL

DEMYSTIFYING THE *FUEL INJECTION SYSTEM*

Engine stalling, lack of use, corrosion, water, polluted fuel and other contaminates all contribute to injector and injection pump failure.

STORY AND PHOTOS BY LARRY BLAIS

In the early days of the internal combustion engine, igniting the fuel once it was in the combustion chamber was a major hurdle faced by designers. When Rudolph Diesel noticed that, in refrigeration systems, the temperature of the medium would rise when compressed, he theorized and patented the idea that the heat generated by compression could ignite the fuel. Five years later, he proved his theory but his design revealed another major problem inherent in all high compression engines. Once ignited, the fuel might burn so rapidly that the gasses inside the combustion chamber would be forced to expand faster than the speed of sound, generating a shock wave that would leave a path of destruction in it's wake.

Engines had to be very heavily built to survive this shock wave and thus, large and slow turning. It wasn't until the development of the high-pressure fuel injector by Bosch that the full potential of the compression ignition engine could be realized. By injecting the fuel in precisely shaped and sized droplets that would ignite and burn off the surface of each droplet, the rate of burn could be controlled and the creation of shock waves avoided.

Engines could now be built much lighter and produce more power. As the years passed, the fuel and the engines have been even more refined. A modern diesel engine is a truly marvelous piece of machinery. Let's do the math. Inside an engine turning 3,000 rpm, each piston starts moving from a dead stop at one end of the cylinder bore, accelerates to the midpoint, decelerates to a complete stop at the other end of the bore and then does the same thing going the other way; 6,000 strokes per minute. That's 100 strokes per second! In a four-stroke engine, the fuel injector would have metered and injected 25, 50, 75, 100 times in those same four seconds. That's 90,000 injections in an hour. If the engine has four cylinders and burns only 3.78L (1 gal) of fuel an hour, each injection would deliver the minuscule amount of .945/90,000 of a litre (1/90,000 of a quart).

Rx for Injectors

All modern fuel injectors are pretty much the same internally. At the tip is a valve seat and valve that is opened by fuel pressure generated by the injection pump against the little piston and held closed by the spring. Some fuel leaks past the little piston, lubricating it, and is then returned to the fuel tank. The amount of pressure required to open the valve is often called pop pressure. The direction and intensity of the spray is called "pattern." The pattern must match the shape of the combustion chamber to burn properly. This is sometimes called "indirect injection" and this injector is pretty much self-cleaning.

Note how the detonation shock wave has literally pulverized the top of this piston.

Pre-combustion chambers were developed in an effort to help engines suppress and/or tolerate stronger detonation shock waves by moving the initial combustion area away from vulnerable parts such as pistons, rings, valves and head gaskets. Forming a small, reinforced, swirl chamber deep in the heavy casting of the head did this quite effectively. The down side was harder starting. The air being heated by compression would have to travel past so much cold metal that enough of its heat was absorbed by the cold metal that it could no longer ignite the fuel. This problem was solved by the installation of little electric heaters, commonly called "glow plugs," in the pre-combustion chambers. How long

The above injector is designed for an engine where the fuel is injected into a pre-combustion chamber.

Don't For Cold Starts

Never, ever use starting fluid in marine diesel engines. Extensive (and costly) engine damage may occur should the starting fluid ignite on top of the piston before the piston is fully up.
— *LB*

these little heaters are activated before starting is attempted depends on the actual temperature of the engine more then anything else. In colder climates, other starting aids may need to be incorporated such as block heaters or air intake heaters. Since engines with pre-combustion chambers are built with lighter pistons, valves and head gaskets, NEVER use starting fluid in these engines. The starting fluid may ignite on top of the piston before the piston is fully up, causing extensive damage.

The tip of this injector is different, as it's designed to inject fuel in a broader pattern into the main combustion chamber of a direct injection engine. The little discharge orifices on this injector can easily become clogged by soot.

All diesel engines will accumulate some soot in the combustion chamber while being warmed-up. The gasses inside the combustion chamber need to reach almost 538°C (1,000°F) to sustain complete combustion of the fuel. A diesel engine idling at the dock will rarely ever attain these internal temperatures, even when the water temperature gauge reads 76.6°C (170°F). Nor will it get warm enough internally while idling at the dock in gear, so the longer it idles, the more soot it accumulates. To help keep injectors clean, idle at the dock just long enough to dependably, without stalling, put the engine under the load required to maneuver out of the berth. [Ed: I prefer an engine warm up of at least 10 minutes, rather than chance a stall.] Once past the breakwater, slowly increase the throttle as the engine continues to warm up until cruising speed is attained. Sailors should refrain from hoisting their sails until after their engines have had a chance to burn out the soot under load for 15 to 20 minutes. Doing this will go a long way in preventing many expensive soot related problems later. A word of caution: diesel engines should never be operated at high throttle if they are over-propped or the boat bottom is dirty enough to lug the engine.

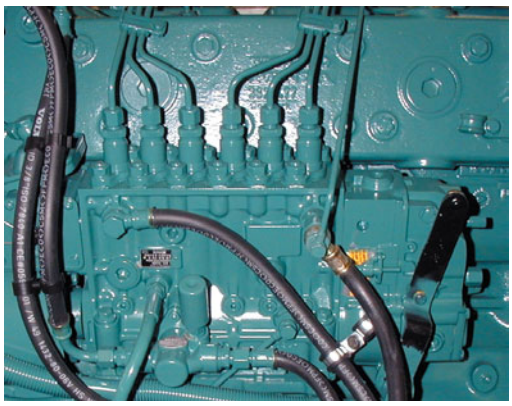
"Sailors should refrain from hoisting their sails until after their engines have had a chance to burn out the soot under load for 15 to 20 minutes."

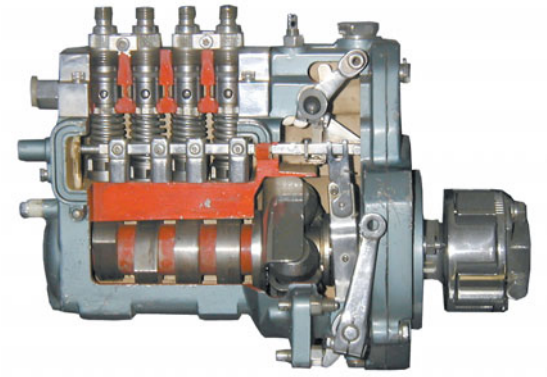
Fuel Supply

Two types of injection pumps, the other major component in the fuel injection system, are most common on modern marine diesels. Pipes to the injectors being all in a row distinguish a multiport jerk pump. The crankshaft through a set of reduction gears drives a small camshaft. The lobes on the camshaft push the little pistons up against the springs forcing fuel through the pipes connected at the top to the injectors. The governor and the throttle linkage determine how long fuel is sprayed into the engine during each injection. By pulling the throttle back, the duration of each injection can be shortened to the point that the engine can idle under no-load. Each little jerk pump

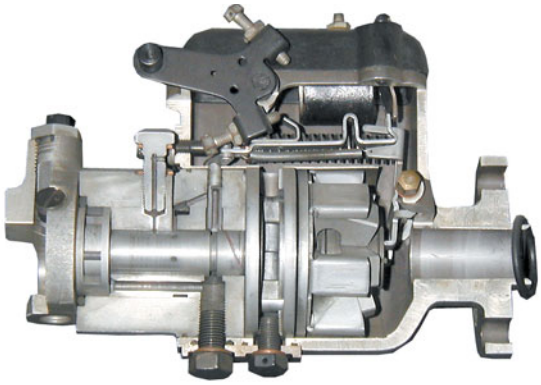
SHERYL SHARD

Injector removed from a 1986 Volvo diesel shows signs of corrosion and soot build-up. Calibrated to very close tolerances, injectors are easily plugged by polluted fuel, water, corrosion and other contaminates. Always wear gloves or hold the injector with a rag when servicing as moisture from fingers or hands can destroy them.





(top) Pipes in a row leading to the injectors indicates a multiport jerk pump. (bottom) This inside view shows the cam across the bottom driven by the crankshaft through a set of reduction gears. Cam lobes push the pistons up against springs forcing fuel through the pipes to the injectors.

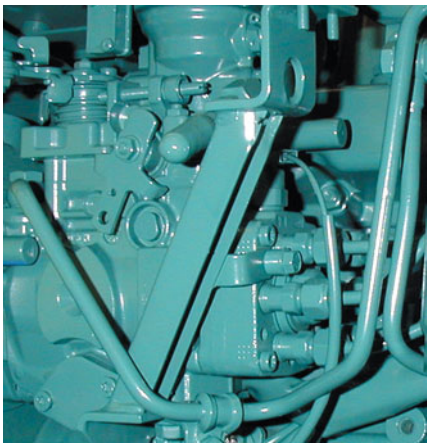


This is what a rotary injection pump looks like inside. Instead of a separate pump piston for each cylinder, it has one main high-pressure pump and a rotating selector valve that delivers the fuel to each injector.

piston can be adjusted so that each cylinder does its equal share of the work. If these are out of balance, one or more cylinders may be over-fueling and trying to do most of the work, causing them to lug and even damage themselves.

A rotary pump can most easily be identified because all the injector pipes come out of the pump in a circular pattern, instead of all in a row. One of the few benefits of sulfur in diesel fuel was that it acted to maintain the uniformity of lubricity in the fuel. Because the

rotary-type pump utilizes numerous seals and sealing rings, it has suffered the most from the advent of low sulfur diesel. New materials have been developed for these pumps to help them tolerate low sulfur fuels.



On some engines, especially older, larger engines, the injector pump is actually part of the injector and is mechanically actuated through a linkage by a lobe on the engine cam. A throttle rack connects the throttle linkage and governor to each of the injectors to control injection duration and thus engine speed.

Regardless of what system is utilized, one thing holds true, these are very precision, close tolerance parts that can be damaged very easily by abrasion from contaminants in the fuel or from galvanic corrosion or etching from acidic by-products of a microorganism in the fuel. They can rarely be serviced in the field and should be serviced by a qualified technician. Keep them healthy with clean, fresh fuel and run the engine long enough, hard enough and frequently to burn out the soot.

About the author: A master mechanic, master shipwright and marine surveyor, Larry Blais has operated boatyards for more than 30 years. He teaches classes for the United States Coast Guard, Havorn Marine Survey and Shipwrights's School, University of Washington's Sea Grant program, and hosts workshops in diesel care for the Northwest School of Wooden Boatbuilding.

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STEPS TO A SMOOTH FINISH

Filling and fairing are the final and perhaps the most important steps in a repair before applying paint or gelcoat. How this is done determines the outcome, either a mirror-like finish or an uneven bumpy surface. By using the proper tools, materials and procedures you can obtain professional results.

STORY AND PHOTOS BY NICK BAILEY

Everyone wants a good-looking boat. Even back in the days of Bartolo Ptolemeus, a bad tempered Roman boatyard foreman in 122 AD, fairing with an adze was Job One. He taught it to the new guys (some of them slaves) with the end of a rope. You didn't want to rile him, so you learned the trade quickly. Unfortunately the adze was a mean tool to master. They didn't have any "filling" back then. All your mistakes remained in public view for the life of the boat.

Filling came along much later, around the same time as the first durable paints. As soon as it was possible to create a smooth paint surface, good fillers became a necessity. Today's buyer expects a near-perfect finish. But therein lies the rub. The shape beneath must also be near perfect because high-gloss paint or gelcoat reveals every tiny flaw.

This essential boatyard skill has been passed down from the plasterers of ancient times and is used in almost all major exterior repairs as well as custom boatbuilding in all types of materials. Achieving a fair shape has always been much sought after, labor intensive and can be very expensive. Beauty is not the only hallowed goal. There is also speed. Below the waterline form follows function and perfect form yields that precious extra boat speed derived from an optimized hull, keel and rudder.

Filling and fairing is the process of applying and sanding a putty to manually create a surface that is not only smooth to the touch but also smooth on a larger scale, without the bumps and hollows that reveal themselves so boldly under a gloss surface. This requires a durable putty or fairing compound. It must have desirable working characteristics such as simple mixing, buttery smoothness, good spreading ability, resistance to sagging and air entrapment, light weight, quick cure time in cold weather and long pot life in hot weather. After the compound hardens, you want durability, ease of sanding, minimal shrinkage and paint-ability. Unfortunately, many of these desirable characteristics are mutually exclusive and can't be found in one product, so a job often requires different products at different stages.

Materials

Modern fairing compounds are putties made by mixing a two-part resin, either epoxy, polyester or vinylester, with a powdered filler. Epoxy is used in most big fairing jobs because it's waterproof and very durable. It's expensive, can be difficult to sand and tricky to use near its temperature minimum of about 10°C (50°F). Polyester is prone to osmosis blisters, making it a risky choice for below waterline service. It shrinks more than the others but is easy to work with over a wide range of temperatures. Unlike other resins, the catalyst ratio can be adjusted to suit the circumstances. Polyester compounds are cheap and easy to sand. They work well for finishing glass repairs above the waterline. Vinylester compounds have a durability approaching epoxy and a sand-ability approaching polyester but most won't work below 15°C (59°F) and can be as expensive as epoxy.

The powdered ingredient is what makes the compound thick and viscous and includes: microscopic, hollow spheres of glass (Q-Cell); phenolic (microballoons); colloidal silica powder (Cabosil, Aerosil, Wacker) or a mixture thereof. Resin and filler are mixed together or you can purchase it premixed. On small jobs a pro will usually mix up a custom-tailored "mud" using a mix of spheres for lightness and sand-ability combined with colloidal silica for smoother spreading. A big job, like fairing the hull of a custom boat, may call for premixed two-part fairing compounds compatible with the final paint coating. These are available in a variety of grades from coarse putty, designed to be applied 25mm (1") thick upside down, to fine buttery compounds designed to spread thinly and fill small imperfections.

Tools of the Trade

There are tools used for gauging the shape of the surface, for applying wet putty and for sanding dry putty.

Before the fairing process begins it's important to know how far from true the surface is. To gauge curved hull surfaces lay a long flexible batten against the hull. A batten placed fore and aft will touch at the highs and bridge over the lows, allowing them to be marked for filling. The idea here is to fill the lows and at the same time cover the highs with just a thin layer of putty. A straight edge of appro-

priate length is also useful where the surface has a straight vertical element such as the side of a keel or a slab-sided powerboat. In demanding applications, such as hulls and foils of one-design racing sailboats, the shape may be required to match a template. In this case, it's possible to clamp a plywood copy of the template into place as a fairing guide.

Applying the fairing compound to the substrate is simple and employs a wide variety of conventional putty knives and trowels. The next immediate step is the accurate spreading and leveling or "screeding" of the compound. This requires a carefully chosen tool, often a homemade one. Screeding is the critical first step towards creating the desired shape and, if done skillfully, minimizes the laborious sanding that follows. A good screeding tool has the largest spreading edge possible, is stiff enough to hold its shape yet is flexible to conform to the curved surface you're working.

Shaping a curved leading edge with a flexible plastic spatula.

"Screeding" is physically easier and less time consuming than sanding.

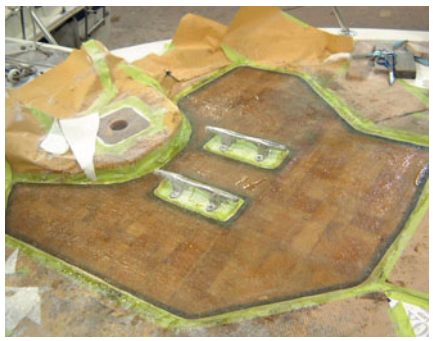
(top left, clockwise) Detail sanding to fair a flat surface requires a sanding block; 3M Fairing Board uses special self-adhering Hookit paper; Low-speed sander/polisher fitted with a 20cm (8") foam pad and 60- to 80-grit self-adhering sanding disc for coarse sanding; Dual-action sander with 15cm (6") foam pad and 80- to 120-grit Velcro disc for fine sanding.

On small jobs, a large drywall putty knife works well. For larger jobs, a scrap piece of 6mm (1/4") Plexiglas may be perfect. With a really big job, like fairing a megayacht hull, it's not unusual to see several men working a single screeding tool several meters (feet) in length.

Sanding tools are divided into manual and power varieties. The manual spectrum ranges from sandpaper wrapped around a flat piece of wood, to the handy 3M Fairing Board and ultimately to the multi-man long boards moving slowly back and forth on a megayacht hull. Manual sanding creates the most accurate shape, particularly on a relatively flat surface but it's painfully slow and exhausting work. Power tools include giant circular sanders to take the place of long boards for fairing megayachts. On a smaller scale, the advent of powerful dual-action, random orbit sanders, 20cm (8") low rpm sanders with foam pads and hook-and-loop attached sandpaper, means that power tools, in the hands of a skilled worker, are now capable of producing good results quickly, particularly on curved deck surfaces.

Surface Prep

Solvent wipe the substrate to



Deck repair ready for sanding and filling.

Keel repair prepped for initial putty application.

remove contaminants, sand to 80 grit or coarser, then blow free of dust and solvent wipe again. It's important the substrate be at a workable temperature for the fairing compound in use especially with epoxies. Should the temperature drop below the recommended minimum before epoxy has fully cured, the cure stops and can't be restarted regardless of warmer temps.

Mixing

Good mixing is important. Failures often occur due to inadequate measuring or improper mixing of two-component products. Pros often use a slow-speed power mixer for large batches and scrape around the bottom edge of the mixing container with a putty knife to ensure all ingredients are thoroughly mixed. Good mixing technique is not so vigorous that air bubbles get into the mix. Many products also have an induction time that must be observed between mixing and use. The batch size is dictated by the pot life of the product. Mix only enough to use before cure sets in. The larger the batch, the shorter the pot life due to heat build up in the batch.

If a custom fairing compound is called for, the powdered combination of spheres and colloidal silica goes in a bit at a time after the two resin components are thoroughly mixed and have inducted.

Application

Ladle from the mixing pot two or three scoops of putty with a 10cm (4") putty knife onto a non-absorbent board such as Masonite, Formica, Plexiglas, etc. Spread this small batch using the putty knife to turn and work it over to remove all air bubbles and achieve a smooth and even mix.

(left) Working the fairing compound to get even consistency. (right) Coarse filler is mixed to a peanut-butter consistency for applying to vertical surfaces.

Once the working batch looks satisfactory, use the knife to scoop and transfer the putty to the repair surface and spread it out. Continue this until the repair substrate is more or less evenly coated with putty. The idea here is to fill the lows and at the same time cover the highs with just a thin layer of putty. The next step, screeding, removes any excess putty.

Screeding

Use a dry wall putty knife or custom screeding tool to pull the putty across the substrate in a smooth, even layer. After each pull, clean the tool with a trowel to remove putty build-up. If you are good (or lucky) the shape will be nearly fair after the first pull. A pro knows when to quit; fussing over wet putty increases the chance of undoing what looks passable. On small repairs, it's ideal if each end of the screeding tool rests on the original unrepaired surface. Screeding larger repairs benefit from "ramps," pre-formed using guide battens. If things go well, the screed brings the fairing filler up to a uniform level. Additional filling is required if the first pass is not satisfactory.

Keel repair after two fills.

Sanding

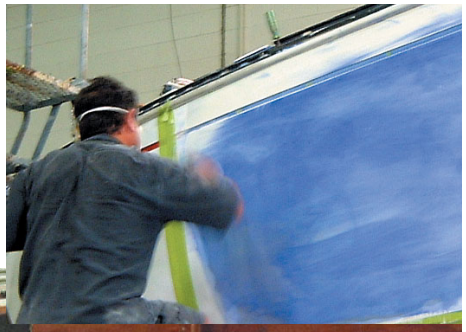
Coarse leveling of the lumps and ridges in the cured filler is done with an 20cm (8"), low speed (1,500 rpm) sander and a foam pad with a 60- to 80-grit Velcro disc (e.g. 3M Hookit or Skikit system). Be careful with this tool as it's easy to badly scallop the surface. A skilled professional uses this method to complete much of the heavy sanding on a repair. Larger jobs

(continues on page 22)

Leveling or "screeding" filler with a piece of scrap Plexiglas. Also touch ups with a small 10cm (4") putty knife.

(left) 3M Fairing Board in action. (right) Coarse sander in action. Tool must be kept nearly flat to prevent swirl marks in finish.

Fine sanding a deck repair with a 15cm (6") dual-action sander.



(top, below) Blue dye applied as a visual aid to filling and fairing. (bottom) Blue dye patchwork remaining on this hull after preliminary board sanding indicates many low spots requiring more filler.

(continued from page 20)

with flatter surfaces often require more manual block or long-board sanding. Use a 15cm (6") dual-action sander for the final sanding stage. Prior to sanding, coat the cured filler with machinists' blue dye. This provides a clear, visual indicator of the low spots left behind after sanding. These require another filling. Don't try to sand down to them.

Outlook

Apply second, third or more fills as required using finer, less viscous compounds and sanding between coats. The shape gradually gets closer to the target and the man-hours mount up.

(top) Deck repair after fairing is almost ready for new non-skid but not ready yet if gloss paint were to follow. Note residual blue dye indicating low areas. (bottom) Keel repair now ready for primer and antifouling.

The dilemma facing any fairing job is deciding when it is "good enough." True perfection is impossible to achieve (ask an optician). Until the surface has, at least, a semi-gloss coating, you really can't judge it visually.

Every fairing job reaches a point of diminishing returns where achieving that final percentage point of perfection will require as much labor to complete as all the work up to that point. Most boat owners won't pay professionals to do that but, as a DIYer, you can put as many hours into the job as you see fit and get as obsessive as you like. Been there; done that. It's fun to be able to say "Look upon my works, oh ye mighty, and despair."

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

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BOTTOM PROTECTION

10 most frequently asked questions about antifouling paints and solutions for professional results.

BY NICK BAILEY

For many boaters the major item on the spring "To do" list every year is bottom painting. This task can be pretty simple if a quick overcoat is all that's needed or it can be a big dirty job if the old paint needs to be removed. Judging from the questions I get every spring, antifouling paints and related bottom maintenance are still areas of confusion and mystery.

"Why does my boat need bottom paint?"

This isn't as much of a rookie question as it might sound. In some locales, such as cold northern lakes, growth is so slow that you can actually get away without antifouling paint. If the boat spends most of its idle time on a trailer or hoist, antifouling is obviously unnecessary. During their first season at a wet mooring in any coastal and most inland locations many unprepared boaters are surprised by the relentless fecundity of Mother Nature. Depending on where your boat is moored a variety of organisms will quickly gain a foothold, ranging from animals (shellfish, barnacles) to vegetables (grasses and seaweeds) to primordial algae and slimes. As these organisms, hard shelled and soft bodied, thrive in the new environmental niche you have generously provided, not only does the boat get slower and fuel consumption rise but the biochemical attachment mechanism of barnacles and mussels etches into the gelcoat. Before long the build up of biology becomes so overwhelming that a powerboat no longer planes, a sailboat barely moves and both may prove impossible to steer. In extreme cases of neglect, the boat becomes physically tethered to the bottom by a forest of underwater vines or an outdrive is reduced to an unrecognizable ball of zebra mussels.

Zebra mussels infest an outdrive left unused for the season.

The only way to avoid this mess without antifouling is to frequently scrub the bottom clean. I have tried this experiment myself as documented in DIY 1999 #1, page 24, "Alternatives to Copper." I admit vanity and access to a good boat hoist led me to endure it far longer than I should have. After a few sessions scrubbing, you will find that a lot more time is spent cleaning than you would have spent had you painted the bottom in the first place. I eventually gave up and reapplied antifouling.

"How does antifouling work?"

Antifouling paints prevent marine organisms from attaching themselves to the bottom of the boat. These days, this is done two completely different ways: the traditional (and still most effective) method is to incorporate a "biocide" (a compound that repels or is toxic to marine life) into the paint. The newer alternative method is to apply a bottom coating so slick or hard that marine organisms cannot adhere to the bottom, sometimes called the "bio-release" method. The bio-release approach is being driven by the quest for a more environmentally friendly solution to the age-old problem of fouling. These new coatings will still allow soft slime and even weeds to grow unimpeded but they can't attach themselves firmly to the bottom. Theoretically any growth is easily removed with a sponge or by the movement of the boat through the water, so the bottom in effect becomes self-cleaning.

"What is antifouling made of?"

Biocide-based antifouling paints consist of a binder, biocide, pigments and solvent.

A binder is the base resin that gives the dried paint its mechanical properties and acts as a medium to carry

the biocide. Many different binders are used, ranging from soft rosins (from trees), to alkyds, one-part epoxy esters, to hard vinyl and Teflon plastics.

Biocides over the years have included every toxic heavy metal available but, thankfully, environmental and health concerns have narrowed the field to copper and copper oxides. The most effective and corrosion friendly biocide of all time, tributyltin (TBT) was banned in 1987 for use on all vessels in North America, Europe, Australia and Norway, except in certain licensed applications (on aluminum boats). [Ed: There is now a 76-country ban on the application of TBT, effective January 1, 2003, and complete removal or overcoating by January 2008 on all vessels.] Copper is only with us still because it's not very toxic, acting more as a repellant than a killer. There are a few exceptions to the rule of copper. Epaint's "No Foul" products are based on zinc and hydrogen peroxide biocides. Recent anti-slime additives from Interlux (Biolux) and Pettit (Irgarol) also represent a different approach by blocking photosynthesis with a kind of sunscreen based on zinc pyrithione, the active ingredient in many anti-dandruff shampoos.

Pigments give the paint color (sort of), though the copper biocide limits these to dark colors in most paints. There is no such thing as a high-gloss white antifouling.

Solvent keeps all the solids in suspension until it evaporates away as the paint dries. In the past many solvents have been used, some more volatile than others. They ranged from the usual petroleum distillates, methyl alcohol and even, in the case of early versions of VC-17, chlorofluorocarbons. Nowadays, with environmental regulations restricting the release of volatile organic compounds (VOCs), to say nothing of banned ozone-depleting gasses, the paint manufacturers are introducing water-based antifouling paints.

"There are so many kinds, how do I choose the best paint?"

It may seem like a bewildering variety of biocide antifouling paints on store shelves but, in reality, there are only two general classes: soft and hard, based upon whether or not the paint is designed to wear off.

TIP PAINTING REFERENCE

Detailed instructions covering the removal of antifouling paints or preparations for new hulls plus step-by-step application of a new bottom finish appear in DIY 1999-#1 issue. This information is also contained on DIY's MRT "Painting and Refinishing" CD-ROM (US$19.95/ CDN24.95). To order, use the form in this issue, call toll-free 888/658-BOAT (2628) or order on DIY ONLINE at www.diy-boat.com.

COMPATIBILITY CHART

NEW ANTIFOULING / OLD ANTIFOULING	SOFT-SLOUGHING	SOFT-ABLATIVE MULTI-SEASON	SOFT-ABLATIVE SINGLE SEASON	HARD-MODIFIED EPOXY	HARD-VINYL	HARD-TEFLON	HARD-EPOXY	ALUMINUM BOATS (e.g. Trilux)
SOFT-SLOUGHING Bottomkote Bottomkote XXX KL990 Komposition Sikkens Ruwa	Lightly sand & apply	Sand well & apply	Sand well & apply	Lightly sand & apply	Lightly sand & apply	Remove	Sand well & apply	Sand well & apply
SOFT-ABLATIVE MULTI-SEASON ACP-50 Awlstar Gold Label Horizons Micron CSC/Extra Micron Optima Ultima SR West Marine CPP	Remove	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Remove	Lightly sand & apply	Remove
SOFT-ABLATIVE SINGLE SEASON Fiberglass Bottomkote ACT Tropicop	Remove	Sand well & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Remove	Sand well & apply	Sand well & apply
HARD - MODIFIED EPOXY Boat/U.S. Coppercoat KL990 Super KL Fiberglass Bottomkote Neptune Trinidad /SR Ultra Plus Ultra-Kote Unepoxy Unepoxy Plus West Marine Bottom Pro Plus West Marine Bottom Shield	Sand heavily & apply	Sand & apply	Sand & apply	Sand & apply	Sand well & apply	Sand well & apply	Sand well & apply	Sand well & apply
HARD-VINYL Baltoplate Sikkens Vinyl 2000 VC Offshore Vinelast Vinylux	Remove	Remove	Remove	Remove	Sand well & apply	Remove	Remove	Remove
HARD-TEFLON SR-21 VC 17M / VC 18	Remove	Remove	Remove	Remove	Remove	Clean & apply	Sand well & apply	Remove
HARD-EPOXY Copperpoxy West System w/additive	Remove & Clean	Remove & Clean	Remove & Clean	Remove & Clean	Remove & Clean	Remove & Clean	Remove & Clean	Remove & Clean
ALUMINUM BOATS Micron 66 Trilux	Remove	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Lightly sand & apply	Remove	Light sand & apply	Remove

Within these categories there are a handful of sub-classifications based on the type of binder. (See "Biocide Antifouling Groups" beginning on page 30.)

Different types have different strengths and weaknesses and the choice of paint will be based on the marine life in your local waters as well as how you use your boat.

"This boat already has antifouling, do I need to do anything now?"

This depends on the type and condition of the existing coating. If the bottom paint is a multi-season ablative copolymer you are in luck. If not, assume you will need to re-coat. If the coating is worn so thin you can see the underlying primer coat or actual hull showing through, then you should recoat even if it's multi-season paint. For a bottom that has thick layers of old chipped and flaking paint, you have extra work to do before you recoat. Scrape or sand off the loose paint prior to beginning the overall prep-sand and recoating. Paints in really bad shape should be stripped. Otherwise, any new antifouling you apply over this mess just disappears as the old stuff flakes off.

"When I don't know the original paint type what product should I apply?"

When painting a new or not previously antifouled boat all the various bottom paint options are open to you. Recoating an unknown antifouling, however, has an element of risk. It's often difficult to identify the paint on a boat in the yard because some soft paints seem pretty hard until they are immersed. There are some general guidelines.

Hard epoxy ester antifouling paints like Fiberglass Bottomkote are the most common paints in the boat yard. Look for characteristic signs of a lot of paint build-up as well as random chipping and flaking. It can be overcoated by almost anything (except VC 17/18 and vinyl) and will go on top of almost anything, even VC17/18, provided any softer paint being overcoated is given a heavy sanding first to the point of nearly removing it.

Old worn-out paint should be stripped before recoating.

Soft sloughing antifouling is easy to spot because it's chalky and wipes off on your hand. It makes a poor base coat to anything except more of the same, but can be applied on top of most paints (except VC 17/18 and vinyl).

Teflon (VC 17/18) is identifiable by dark gray or blue color (on rare occasions red) and a satin sheen. It feels like a slick Teflon-coated frying pan. VC 17/18 should only be overcoated with itself. The only other paint it successfully overcoats is hard vinyl.

Hard vinyl can sometimes be mistaken for VC 17 especially if it has been burnished to a racing finish. It can be overcoated by, but can't overcoat, other paints. A light prep sanding will be required.

Most ablative copolymer paints are not easy to identify. The dark colors and flat finish are similar to most hard epoxy ester paints. Look for signs of gradual wear along

Badly chipping paint indicates poor original prep, as hull surface is still glossy! Needs to be stripped.

Typical epoxy ester shows some paint build-up and chipping. Scrape loose paint and lightly scuff sand to prep for recoat.

VC 17 is easy to identify, as evident by sheen on keel.

Waterline wears but the otherwise good condition of this paint means it's an ablative type, most likely multi-season copolymer.

Refueling No Casual Job

Gasoline Has Been Pumped Into Water Tanks, Diesel Tanks, Fish Rod Holders, Holding Tanks…And Bilges

The aftermath of pouring gasoline into a fish rod holder: After mopping up the gasoline in the bilge, the skipper of this sportfisherman in Texas thought it was safe to start the engine. What he failed to account for were the fumes that remained.

Cliff Steele, a BoatU.S. member in Illinois, recounted for BoatU.S. an incident that happens all too often. Before leaving for a weekend on the water, Cliff pulled his 24-foot boat around to the gas dock to be refueled. While he and his wife, Sandy, were busy securing the boat, the dock attendant, a new employee, stepped aboard with the gasoline nozzle. A few seconds later Sandy noticed him starting to pump gasoline into the fish holder. She yelled "No!" but not before the attendant had pumped two gallons of gasoline into the bilge.

Cliff used to be a fireman and knew that even a half-cup of gasoline in the bilge is enough to blow the boat to bits. He immediately shut off the engine and called the fire department. He then ran water into the bilge and arranged to have the boat pulled immediately.

Once the boat was out of the water, Cliff pulled the drain plug and ran the water/gasoline mixture into a 55-gallon drum. He'd painted the bilge earlier that week with epoxy paint, which probably meant that less gasoline was absorbed into the fiberglass. By the next day, the bilge was free of odors, and life for the Steeles returned to normal.

Others haven't been so fortunate. A few years ago, after an almost identical incident with a dock attendant, the owner of a boat in Texas used a sponge to clean up the gasoline and then opened all of the hatches to dissipate the fumes. About two hours later he decided the fumes must be gone, started the engine, and the boat exploded. All of his crew was aboard and one was badly injured.

Several things to remember if gasoline is spilled into the bilge:

- Do not operate the bilge's exhaust blower. It cannot remove liquid fuel and could make matters worse by creating a more explosive air/gas mixture.
- Evacuate anyone near the boat.
- Be sure the vapor-proof master battery switch is OFF so that no equipment can start automatically.
- Notify the marina manager. If a professional manager is not available to take control of the situation, notify the fire department.
- Open all doors and hatches to encourage evaporation.
- The automatic bilge pump bypasses the battery switch. The pump should be disabled *if it can be done safely*. You can disable the pump by placing a weight on the float switch or raising the pump above the fluid level.

If fuel is pumped overboard, the spill must be reported to the National Pollution Response Center at 1-800-424-8802. Failure to report a spill will subject the owners to fines.

- Arrange for a mechanic or salvage contractor to remove the fuel. BoatU.S. insureds should immediately call the BoatU.S. Emergency Response Hotline at 1-800-937-1937 to get the proper assistance.

— By Bob Adriance

National Fire Protection Association — Fueling Procedures

Before Fueling:

- Stop all engines and auxiliaries.
- Shut off all electricity, open flames, and heat sources.
- Check bilges for fuel vapors.
- Extinguish all smoking materials.
- Close access fittings and openings that could allow fuel vapors to enter the boat's enclosed spaces.
- Get everyone off the boat except the person handling the fuel hose.

During Fueling:

- Maintain nozzle contact with fill pipe.
- Fuel filling nozzle must be attended at all times.
- Wipe up fuel spills immediately.
- Avoid overfilling.

After Fueling and Before Starting Engine:

- Inspect bilges for leakage or fuel odors.
- Ventilate until odors are removed.

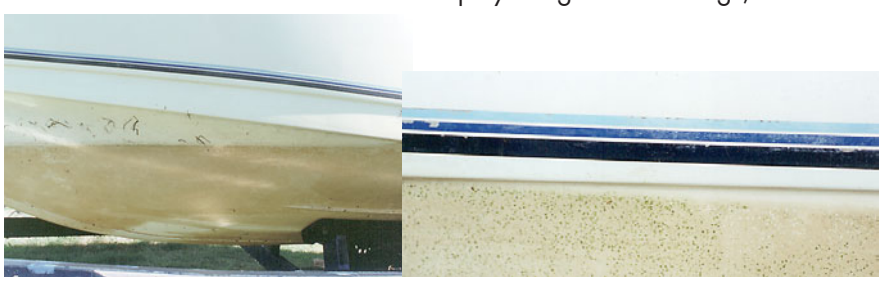
leading edges and the waterline. Heavy build-up isn't visible unless there is old hard paint underneath it. They are happy overcoating or being overcoated by most other paints that look the same including other ablatives and most hard paints (with prep sanding). They won't overcoat soft sloughing paints and some specialized ablatives containing TBT. Most TBT copolymers are no longer marketed in North America so it's not likely to be an issue but beware of an imported used boat.

"As TBT is banned, what can I apply to my aluminum boat?"
Some TBT-free products that contain copper cyanate, such as Micron 66 (Micron 55 in Europe), are compatible with aluminum hulls. The antifouling contains less than 10% of the copper ions found in cuprous oxide. All copper-biocide paints should be used with a primer when applied over aluminum. Better yet, is to coat the bottom with an epoxy barrier coat. Some paints can be applied to an aluminum outdrive with some form of isolation barrier between the coating and drive. Check product labels before applying copper-based paints on aluminum.

"Is there a wax that lets me keep my white hull and delivers antifouling performance?"
Waxes for hull bottoms have been around for a while but the ones that DIY editor Jan Mundy has tested don't seem to work very well. Waxes fill the porous gelcoat with a hard, slick coating. As they don't contain any biocide, the idea is that fouling cannot stick to the bottom but this assumes that the boat is always moving or is berthed in fast moving water. In past tests, all it took was a few weeks in a slip before slime coated the hull bottom of the test boats. Waxes likely work best on trailered boats in freshwater but are not recommend for any use in brackish or saltwater.

(left) Transom of DIY's test boat coated with a bottom wax shows build up of slime. (right) Always water test the hull after cleaning to ensure all wax is removed. Repeat the cleaning on any areas where water beads.

"What products will remove a bottom wax?"
With all bottom waxes tested by DIY, algae adhered to the hull, absorbed into the porous gelcoat. Even pressure washing didn't remove the slime or stains. An effective all-purpose cleaning and wax-stripping product is TSRW Quick Strip. Actually sold to remove acrylic polymer gelcoat coatings, Quick Strip is diluted 3:1 with water, sprayed on the hull and after a three-minute wait scrubbed with a white Scotch-Brite abrasive pad. Rinse well to remove all residue. Though not as noxious as acid-based cleaners, always use in a well-ventilated area and wear protective clothing, eyewear and gloves. Highly corrosive, it can damage painted surfaces and gelcoat, if left to dry.



Multiple coats of QuickCraft bottom wax didn't prevent slime growth along the waterline and hull bottom after four weeks in freshwater.

COPPER ALTERNATIVES

The concept behind a biocide-free antifouling, sometimes called "bio-release," is to apply a bottom coating so slick or hard that marine organisms cannot adhere. Bio-release coatings still allow soft slime and even weeds to grow unimpeded but theoretically any growth is easily removed with a sponge or by the movement of the boat through the water. The bottom in effect becomes self-cleaning. Examples of ultra-slippery coatings include Veridian by International Paints, which is also available as a spray coating for aluminum outdrives. There are also slick, hydrophilic coatings from Dolphinite, Hyspeedkote, Quick Craft and others. Certain new ultra hard coatings show some promise as well. Ceramcoat, an industrial epoxy paint loaded with ceramic and new polyflourethane high gloss topcoats are reported to shed marine growth as well as survive underwater without blistering. These new coating technologies may be the way of the future but are not yet generally available in the marketplace.

"What's the easiest and fastest way to remove bottom paints?" While you can grind, scrape or use messy and sometimes-toxic chemical strippers, this tip comes from DIY's editor Jan Mundy, based on a test conducted at the 3M Marine product testing facilities. A sample panel coated with Interlux Bottomkote XXX was first sanded with 3M Fre-Cut Green Corps 24E, a paper designed especially for heavy bottom paint removal, then 60-grit to refine the scratch, followed by a final sanding with 80. These sandpapers are free-cut types, which results in little or no paint loading on the paper. They are designed to be used with either the Hookit and Skikit pad systems and a dual-action sander operating at less than 3,000 rpm. Sanding residue is toxic and requires wearing a particulate mask and protective clothing and eyewear. If working outside you need to sheet the boat and contain the dust. Though messy, it's fast. The trick is to move quickly with the severely abrasive 24-grit paper, no longer than 30 seconds in one spot or you risk removing the gelcoat as well. Cost for a 9m (30') boat is about $150 in sanding supplies plus a dual-action sander – you'll need one anyway to professionally refinish gelcoat topsides and deck.

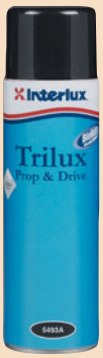
(counter clockwise starting at the top) Test panel with coats of soft antifouling (Bottomkote XXX); Surface is lightly skimmed over with 3M Fre-Cut 24E on a 3M Skikit pad and dual-action sander running at 3,000 rpm; The trick is not to dwell — it took less than 10 seconds to break the paint adhesion on the 61cm (2") square test panel and expose the original white surface; Remaining paint residue is removed with 60 grit; Final finish with 80-grit sandpaper is similar to a primed surface, though some paint systems may need to be sanded finer with 120 grit.

"Is there a bottom paint for wooden boats that is effective against toredo worms? "

According to Jim Seidel of Interlux, any antifouling that contains copper will work against toredo worms, the trick to successfully repel them is in the paint application. Rather than apply a primer, let the copper biocide in the paint act as a primer and wood preservative. Over bare wood, thin the first coat by 10% to 15%. This soaks some of the copper biocide into the wood, then follow with two coats at full-strength. Also, apply antifouling to the seams before caulking. Seidel also recommends applying a copper preservative in the bilge before painting, especially on boats with wet bilges.

CURE FOR SALTY OUTDRIVES

With TBT banned and none of the copper-containing paints compatible with aluminum there are few antifouling options to protect an aluminum outdrive. Now there is a solution. Trilux Prop & Drive (US$24.95) is a TBT-free aerosol antifouling paint specially formulated with Biolux for aluminum outdrives. When applied over properly primed aluminum, this spray provides good antifouling protection in fresh, salt and brackish water.



No antifouling means excessive drag, slower speeds, increased fuel consumption and a difficult to clean drive.

BIOCIDE ANTIFOULING GROUPS

TYPE 1 SOFT ANTIFOULING

Includes most expensive and lowest cost antifouling. Won't accumulate dead paint layers. Divided into three subtypes.

Sloughing

Traditional paint with soft rosin binders, for service over a short season.

Advantages: Low cost. Should be removed by power washing at haulout. Will overcoat most existing antifouling.

Disadvantages: Too soft for planing boats. Rubs off if you brush against the bottom while swimming. Must be applied within a few days of launch. Limited colors.

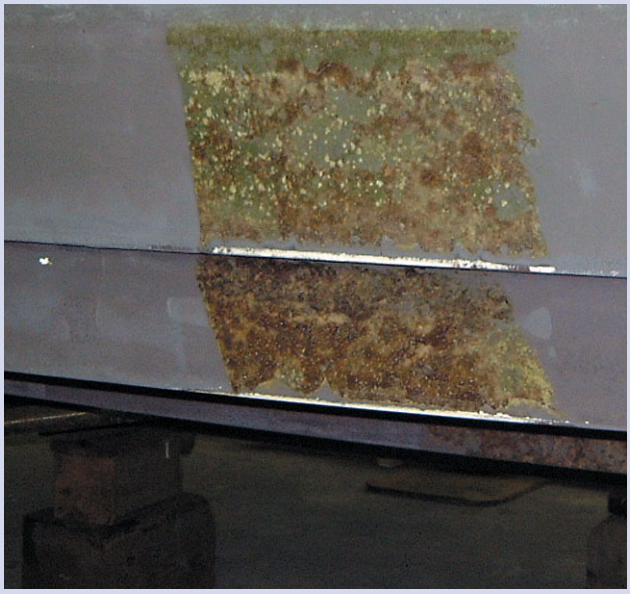
Examples: Bottomkote and Bottomkote XXX, KL990 Kompostion, Sikkens Ruwa.

Multi-season Ablative Copolymers

Top of the line ablative antifouling. Soluble; designed to slowly wash away as boat moves. New products , such as Micron 66, mimic TBT self-polishing copolymers with performance equal to TBT systems.

Advantages: Multi-season. Paint binder and biocide are chemically bound together so any paint remaining is still effective antifouling, as fresh biocide is continually exposed by ablation. No dead paint build up requiring eventual stripping. Will overcoat many other types. Better color selection; some brands available in white. Life span is based on mileage versus original coating thickness.

Disadvantages: High initial cost. Some versions may not ablate effectively on slow sailboats and end up flaking off. Used up by mileage, not time in water, so



Slime sample left behind the travelift sling on this multi-season copolymer bottom shows typical soft growth some copper biocides allow. It washes off easily though.

may not suit world cruiser. Care must be taken to avoid excessive power washing at haulout, which can waste good paint.

Examples: ACP-50, Awlstar Gold Label, Micron (CSC, Extra, Optima, 66), West Marine CPP.

Single Season Ablative

Lower cost alternative to multi-season but more durable than sloughing antifouling. Combined leaching and ablation expose fresh biocide.

Advantages: Will overcoat most types.

Disadvantages: Like sloughing type, should be stripped by power washing at haulout, otherwise dead layers will build up.

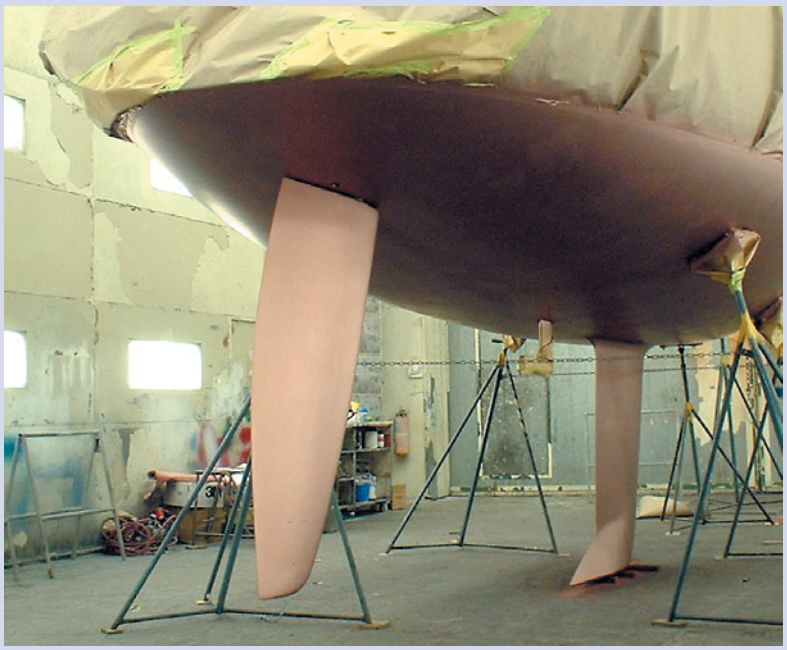
Example: Bottomkote ACT.

HOW MUCH PAINT DO I NEED?

Use the formula below to determine your surface area, then refer to the paint category for an estimate of the amount of paint required when applying by brush or roller. Purchase enough paint to apply two or more coats.

LOA x Beam x .85 = Area of bottom

Multi- Season	400-450 sq. ft. per gallon
Hard	400 sq. ft. per gallon
Aluminum	275-375 sq. ft. per gallon
Teflon	300 sq. ft. per gallon
Vinyl	300-350 sq. ft. per gallon



New VC 17m Racing Bottom. The copper color darkens after immersion.

TYPE 2 HARD ANTIFOULING

Excellent choice for ocean-going boats because biocide will "contact leach" at a steady controlled rate so paint is effective for a given time span regardless of sea miles. Dissolves like a bar of soap. Opposite of copolymers, it may time expire but won't wear off. When biocide is gone inert paint binder is left behind. As release rate is less controlled, often contain high copper levels. Most types eventually require a brutal stripping job done mechanically by sanding (a big dusty mess) or chemically with paint strippers (a big gooey mess). Life span is nominally a single season (6 to 18 months in the water). As biocide oxidizes after few weeks' exposure to the air (except for VC 17), launch boat not long after painting. Divided into four subtypes.

Epoxy ester

Uses a one-component modified epoxy binder and includes some of the best selling antifouling paints.

Advantages: Low cost. Versatile, they overcoat almost anything. Works well on planing powerboats, is hard enough to withstand trailer contact and can be burnished to a smooth finish.

Disadvantages: The classic single season paint that builds up over time and eventually crumbles.

Examples: Epoxycop, Fiberglass Bottomkote, Neptune, Trinidad, Ultra-Kote, Unepoxy.

Dry Lubricant, Thin-Film

Advantages: Gives a slick durable finish right out of the can. A favorite among racing sailors, powerboaters also claim increased speed and better fuel economy. Very easy to clean. Easiest of all antifouling to reapply, no sanding required. Ultra thin coating does not build up dead flaky layers. Unaffected by exposure to air, launch time is not critical. Good alternative for rack stored and trailered boats.

Disadvantages: Previously not the best antifouling properties in salt water. Subject to soft slime build-up in all waters but now available with Biolux (Interlux) or Irgarol (Pettit) slime inhibitor. Limited colors available. Generally can't be overcoated with other paints, won't overcoat much either.

Examples: Interlux VC 17m, VC 18, Pettit SR-21 (freshwater only).

Vinyl

Advantages: Very durable antifouling that can be wet sanded and burnished to a slick racing finish. Can be overcoated, after prep sanding, by almost all other antifouling.

Disadvantages: Will not overcoat anything other than vinyl-based paints.

Examples: Baltoplate, Sikkens Vinyl 2000, VC Offshore, Vinylast, Vinylux.

Permanent Epoxy Antifouling

Uses 100% solids two-part epoxy resin combined with a copper-biocide powder and is close to being a permanent antifouling. Application is similar to an epoxy barrier coat.

Advantages: The ultimate hard bottom paint. Long-term protection with low maintenance. Possibly lower lifecycle cost. Also acts as a barrier coat.

Disadvantages: Low leaching rate may reduce antifouling effectiveness against soft growth. High initial cost. Applied only to new, never coated hulls. Eventual renewal or repair also likely costly but can always be over-coated with regular antifouling.

Examples: Copperpoxy, West System epoxy resin with copper biocide additive.

ENGINE TROUBLE SHOOTING

4-STROKE OUTBOARD MAINTENANCE

Follow these seasonal maintenance procedures and a few storage tricks to keep your four-stroke outboard humming and provide years of trouble-free operation

STORY AND PHOTOS BY HARRY SWIECA

As a long time service tech, I still learn new tricks when it comes to servicing outboards. Recently, I spent time with a local dealer and discovered there's a lot I didn't know about the routine maintenance of four-stroke outboards.

Reliability, performance, increased fuel economy and longevity are the key benefits of four strokes. Mechanically, all four-stroke outboards are more or less the same. The difference is in the electronics, fuel systems and lower unit designs. Advances in fuel injection systems, electronic timing and computer-controlled carburetion means some engine servicing is beyond the scope of the average owner.

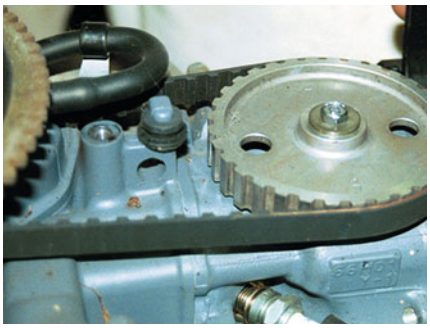
"An owner with some mechanical ability can easily perform the majority of service on 25 horsepower and smaller engines," explains Steve Hannum, owner of Skokie Marine, a Mercury Platinum dealer in Skokie, Illinois.

"An assortment of specialized tools are required to service larger outboards, one of which is an electronic vacuum gauge," says Hannum. "Be sure the servicing dealer has the knowledge and the proper tools needed to service these high-tech machines."

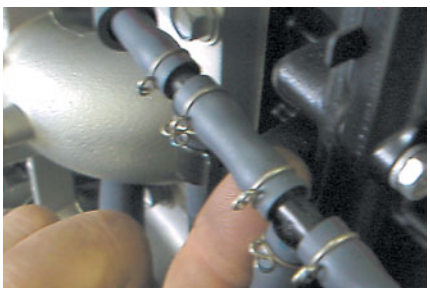
Steve directed our attention to a Mercury 9.9-hp four-stroke Sailpower outboard being prepared for service. I watched as he performed routine seasonal maintenance on this engine. The following guidelines are based on this sample engine. Before performing any service, purchase the appropriate engine service manual and review the procedures for your particular engine. Gather the necessary lubes, filters, gaskets and oil as specified by the engine manufacturer and a socket set and you're ready to start.

Routine maintenance begins with an inspection of the motor cowling and lower unit for any damage. Repair any paint chips or dings as needed. Check the air-intake passageways on the cowling and clean if needed. These vents are not usually screened but still can trap debris that can clog the air-intake slots. Large four-strokes often have screens on the powerhead assembly, which need to be cleaned. Remove the cowling, and check for loose parts, chafed wires and hoses.

Visually inspect the powerhead assembly. Starting at the air intake, look for debris or any damaged components. On lower horsepower outboards, remove the air chambers on the carburetors and examine for debris. To lessen the chance of fire, keep the powerhead assembly free of oil, fuel and debris.

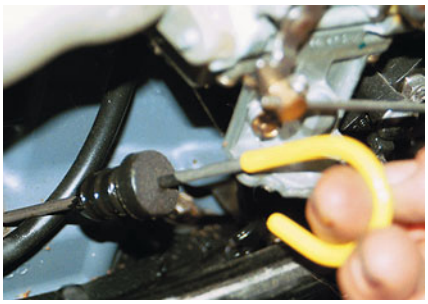


Any cracks or wear are reasons to replace the timing belt. Follow the steps in your service manual, paying especially careful attention to the proper gear alignment. Be sure the arrows on the pulleys line up with the appropriate markings and that they are in the correct rotation sequence. Then, simply slip off the old belt and slide on the new one. No adjustment is required. The belt is a positive cog system that eliminates slippage.



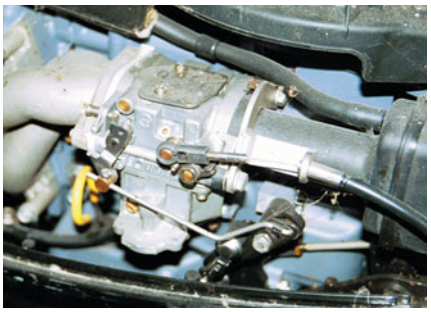
Inspect fuel system hoses for leaks or dampness. Check that all hose clamps are tight. Inspect the portable fuel tank (if equipped) and replace if the bottom is worn or sides are visibly damaged. Be sure the fuel cap vent opens and closes and is not clogged. The rubber fuel line from the tank should be pliable and free of abrasions. Disconnect fittings should be secure and dry. The primer bulb, if installed, should be soft and pliable. Replace any suspect components. Monthly, inspect all fuel lines that are exposed to sunlight.

The most critical component on all four-stroke outboards is the timing belt housed under a plastic cover. An easily removable two-piece plastic cover protects the timing belt. Inspect the belt for cracks and wear on both sides.



To determine the condition of the engine oil sump, remove the oil dipstick and wipe it on a clean rag. Water beads, rust on the stick or silver flakes indicate internal damage and require servicing by a qualified dealer. Smell the oil. If it smells rancid, the motor has been overheated because of a cooling system problem. Refer to your service manual for details on cooling pump replacement.

Check the condition of spark plugs. Mark the upper spark plug lead with tape to aid in correct reinstallation. Remove the plugs one at a time with a quality spark plug socket. Inspect the electrode. It should be light gray in color and free of heavy carbon build-up. Carbon is the result of poor quality fuel and/or extended running at low speeds. Small silver specks on the electrode indicate internal cylinder damage and the engine must be inspected by a dealer before proceeding. When replacing the plug, set the gap on the new plugs to the recommended setting. Apply a thin layer of anti-seize compound on the threads before installing. Be sure to tighten the plugs to the recommended torque. Apply dielectric grease to the external tips of the plugs and install the wire caps.

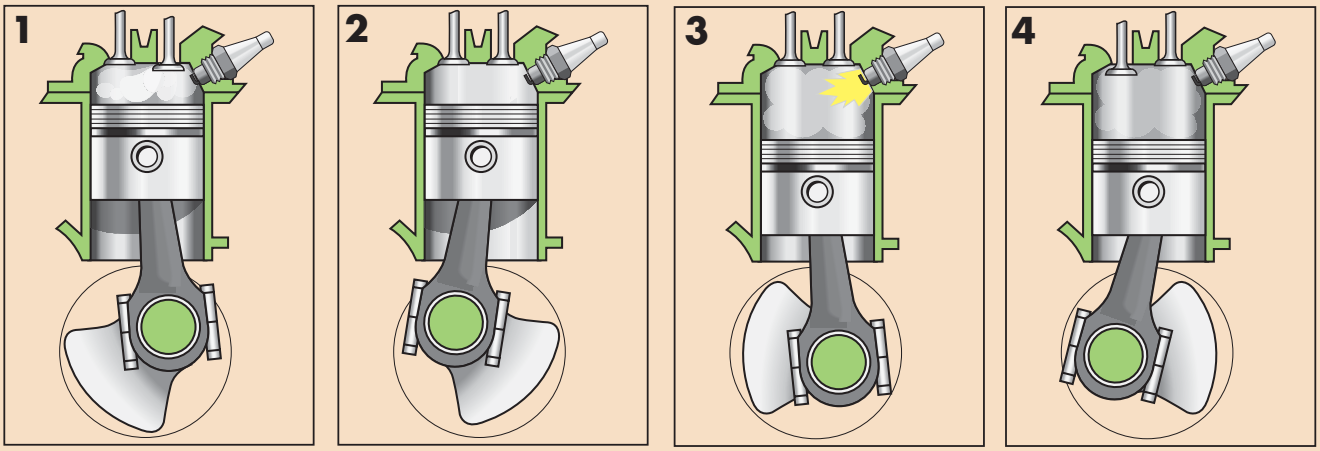


Inspect the control cables and the shift linkage for wear. On this engine, the shift linkage is located below the powerhead assembly between the motor mounting bracket and lower housing. Confirm that the shift linkage locknuts are secure. Check and lubricate all end caps and moveable parts as recommended. Difficult shifting requires dealer adjustment.

Inspect the propeller for nicks and dents and repair as needed. Grease the propshaft splines with the recommended grease. Inspect the lower housing sacrificial anodes for wear and replace them if they are 50% dissolved. Outboards can have one or more anodes. Use your manual to locate them.

HOW A 4-STROKE WORKS

A four-stroke engine completes one combustion cycle in four strokes. In other words, the piston travels four times from top to bottom in the cylinder. The four strokes are intake, compression, power or ignition and exhaust.



GARRY LAW

1 Intake stroke The piston starts at the top of the cylinder or TDC and, as it moves downward, the intake valve opens. This draws in a mixture of air and fuel to "charge" the chamber. When the piston reaches the cylinder bottom or BDC the intake valve closes trapping the mixture.

2 Compression stroke The piston moves upward, compressing the air-fuel mixture.

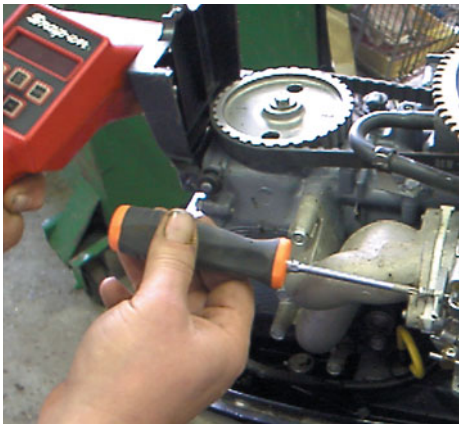
3 Power stroke Just before the piston reaches TDC, the ignition system sends a high voltage charge to the spark plug that ignites the compressed air-fuel mixture. The resultant pressure drives the piston down.

4 Exhaust stroke
When the piston reaches BDC, the exhaust valve opens at the top of the cylinder, releasing the pressure and allowing combustion gases to exit the cylinder. The piston moves upwards pushing the burnt gases into the exhaust system. When it reaches TDC, the exhaust valve closes, the intake valve opens and the four-stroke cycle repeats.

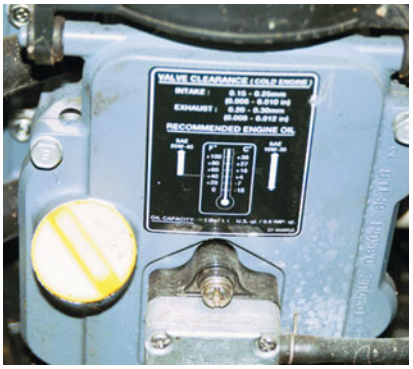
The next step is to drain the crankcase oil. Do this by either draining it through the drain plug or use a manual suction pump. Be sure to install a new plug seal.

Replace the oil filter as outlined in your service manual. Slide a plastic bag under the oil filter to lessen the mess. Be sure to carefully remove the old filter gasket from the filter housing. Dabbing a little clean oil on the new filter gasket (shown by the pen tip) before installing helps it to seal.

Insert the pump's suction tube into the dipstick hole until it bottoms out. Operate the pump until all oil is removed. Two styles of suction pumps shown.



Assemble the engine belt covers in reverse order. Grease all fittings and clamps. Install the cowling and apply a coat of protective wax. Because of EPA restrictions, the only adjustment available to the consumer is the engine idle. Use a digital tachometer and follow the instructions outlined in our service manual.



Select the correct oil as recommended for your engine. Fill the crankcase through the oil fill cap up to the required level as outlined in your manual. Install a new inline fuel filter following the directions in your service manual. Service the fuel-water separating filter, if equipped.

TIP Weekly Storage

If your engine will not be run for longer than one week add the recommended fuel stabilizer at a ratio of 30ml (1oz) per 22L (6 gal) of fuel to insure proper fuel system operation. Before leaving the boat, disconnect the fuel line and run the engine until all fuel is consumed and it stalls.

ELECTRICAL

Troubleshooting Engine Electrical Systems

When your engine won't start, a systematic approach to diagnosing your often-ignored engine's electrical system can often get you underway again. Here's how.

STORY BY JOHN PAYNE

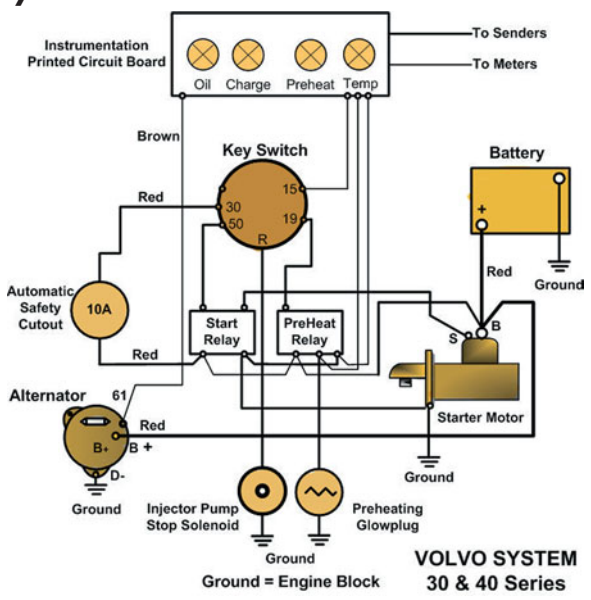
At first glance, a circuit diagram appears to merge into a mass of wires and components. This looks intimidating when you're trying to troubleshoot problems and failures. Before you can troubleshoot, you need to know the sequence of electrical functions that take place to start an engine.

In some engines, the key is turned to a preheat position and the preheat time is either automatic through a timing relay or at the user's discretion. When the key switch is then turned to the "On" position, the engine control circuit is energized. When the key switch is turned to the "Start" position, the start solenoid is energized and pulls in to supply current to the start motor.

The starting circuit is frequently cited, along with the associated control circuitry, as the main cause of engine failure. Other systems that take the blame include instrumentation and monitoring and charging and are not discussed in this article. This system comprises the starter and the preheating system and the control system for starting and stopping the engine. Various subsystem components and sub-systems that make up a starting system include a starting battery, engine control panel, wiring loom, preheating system and starter motor.

In the average starting system there are up to 16 possible single failure points. Failure of any single point brings down the entire system. A typical starting circuit consists of the DC positive circuit, which includes the battery, the battery connections, the battery isolator or a changeover switch, the cables from battery to engine, the solenoid connection and solenoid contacts, the starter motor and the various starter motor components such as the brushes, brush gear, commutator, bearings and windings. The DC negative side of the circuit also includes the battery connections, the engine block that is often part of the return path, the cable back to the battery and an ammeter shunt, if installed. The engine control system from the panel includes the key switch, stop and start buttons, wiring harness, harness connectors, control system fuses and engine stop solenoids.

Image of a typical Volvo engine electrical system



Fault: Voltage Drop

High resistance that results in excess voltage drops in starting circuits is the most common fault. In most cases, this is caused by loose connections or, less commonly, corrosion at cable terminations. Battery changeover switches are also a big cause of starting problems with contact problems resulting in high resistance. Installing high quality switches is important to avoid failure.

The main start cables should be rated to have minimal voltage drop at full rated current. The starting cables should be kept as short as possible and as large as possible to minimize power losses and maximize the power availability to the starter. As an indication of the start current levels, the instantaneous stalled condition short circuit currents can be up to 3,500 amps in large engine starters before the load drops to a few hundred amps. Even very small values of resistance and resulting voltage drop can have significant effects and prevent starting.

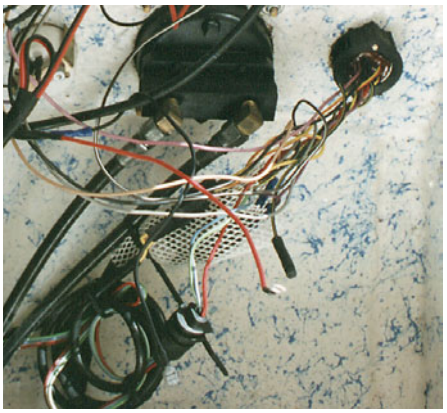
Fault: Key Switch

There is nothing quite so unnerving as that deafening silence that follows when the key is turned and nothing happens. Failure to start is usually caused by circuit failures

rather than reduced voltage conditions. Key switch connections and start buttons are not actually a frequent cause of problems, although, on some boats, water ingress and corrosion can cause failure. The terminal connecting the circuit from the key switch to the solenoid is a common failure point. They are relatively small and tend to work loose or even break. Some are actually slide-on connectors that can vibrate loose. Some circuits may also have a fuse protecting the ignition circuit and, in some cases, this may have poor connections or even blow and prevent starting.

Fault: Relays and Harnesses

Some engines use relays for operations and all relays should be checked. It is not uncommon to have relays work loose and they also may be affected by vibration that causes poor seating of contacts in the relay base. Several multi-pin plug and socket assemblies usually connect the main engine control wiring loom to the control console extension loom. As these are usually prone to heat and vibration, they should be disconnected and reinserted to ensure a good pin contact. Corrosion of pins is also a possible failure point, although it is less common.



Loose or corroded main engine fuses, multi-pin plugs, socket assemblies and engine control wiring loom harnesses are the most common reason for engine electrical failure.

Fault: Low Voltage

Low voltage at the battery starter terminals is the most common reason why engines crank over slowly without reaching the needed rpm to start. The usual assumption is that the starter battery is at fault, however starting batteries are generally less the cause than might be expected. This can be easy to verify by checking the voltage with a meter.

If the battery reads 12 volts and above, then it can be presumed to be charged, although some batteries may fail under load. Under starting loads a battery voltage should not drop below 9.5 to 10 volts. The principal failure mode is the battery connections and is the very first place to look if the voltage is correct. Taking off, refastening and tightening a battery terminal is usually enough to rectify the problem. This is only half the circuit and the negative terminal also must be checked. In poor connections with high resistance, it is not uncommon to simply feel the connection and it can be warm or even hot. In some cases, smoke can be seen rising after a start attempt.

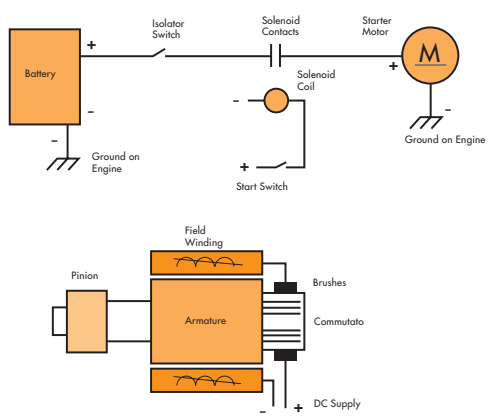


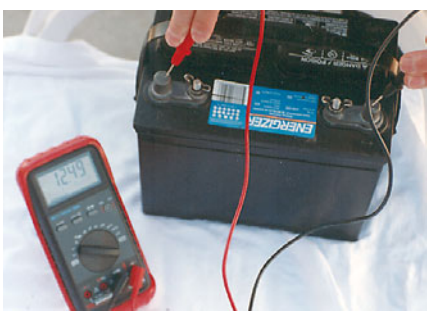
Image of typical single engine starting circuit layout.

Fault: Start Terminals

The ominous click when an engine fails to start or the start solenoid chatters away without a start signals trouble with the starter motor and solenoid. Terminals often work loose or make inadequate contact. Many people try and torque the connections up with an adjustable spanner; however, there is no substitute for a socket or ring spanner to do it properly.

Fault: Engine Negative

A final electrical area to check is the engine negative connection. Loose



Use a voltmeter to test the start battery and replace if voltage drops below 9.5 volts under starting loads.

bolts are a common cause of failure and must be tightened onto a clean surface to avoid high resistance. Remember the negative side of the circuit is as important as the positive and voltage drops occurring in both sides of the circuit will cause voltage drop and cause the starter to crank over slowly.

Fault: Glow Plugs

Partial or complete failure of the pre-heating glow plugs on direct injected engines is also a reason for slow starts. In most boats, the plugs are interconnected and even the loss of a single plug can cause problems. The connections on plugs need to be inspected and damage is often a cause of failure. Bad connections also cause voltage drop to the plugs with reduced heating.

Fault: Motor Failure

It's common to burn out starter motors from too many starts or excessively long start attempts, causing the overheating of starter windings. The bearings in starter motors may seize up causing slower rotation, although this is comparatively less common. [Ed: A step-by-step diagnostic guide and bench testing of starter motors and solenoids appears in DIY 2000-#1 issue.]

Maintenance Tasks

Preventive maintenance is essential to the reliability of your engine's electrical system. The first task is to ensure that the starter is mechanically secure. Engine starters on boats are, by default, generally located relatively low down towards the engine bilges. They are subject to leakages from seawater cooling systems; seawater injection points into exhaust elbows as well as any unexpected high bilge water level. Also check that the attached cables are of the correct rating and that the terminal nuts are properly torqued so that they do not work loose.

Faulty wiring connections are the most common reason for failure. Regularly examine every wiring connection, remove and check them, clean and refasten. Check loom connection plugs for damage. Visually check the cable looms and look for signs of chafe or damage. Check the pre-heating glow plug connections. Check that the plug connections and the insulators around the connections are clean and not causing tracking to ground.

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.

ENGINE WIRING COLOR CODES

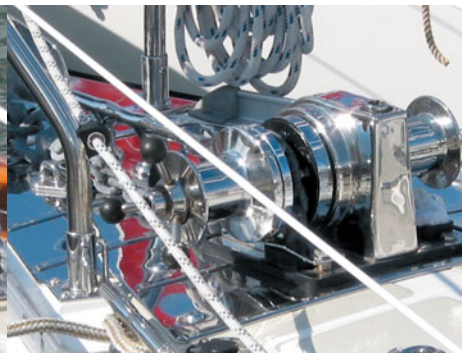
Some engine manufacturers use standardized color codes, such as that from ABYC, while others have their own standards. When troubleshooting, refer to the color codes marked on the engine schematic in your service manual. For practical purposes these markings are rather small. It's a good idea to laminate a copy in plastic to ensure a working copy is ready to use when troubleshooting. Even better is to have a copy with the charging system marked out in colored pens or highlighters, the same for the charging system and the instrumentation. The following table gives equivalent color codes between various makers, although check your own drawings for your engine.

Purpose	ABYC	Yanmar	Volvo	Perkins	Mercruiser
Ignition Start	yellow/red	white	red/yellow	white/red	yellow/red
Ignition Stop	black/yellow	red/black	purple	black/blue	
Preheat		blue	orange	brown/red	
Negatives	black or yellow	black	black	black	black
Alternator	Light orange	red/black	brown	brown/yellow	
Tachometer	gray	orange	green	black/brown	gray
Oil Press Gauge	light blue	yellow/black	light blue	green/yellow	light blue
Oil Warning Lt		yellow/white	blue/white	black/yellow	
Wtr Temp Gauge	tan	white/black	light brown	green/blue	tan
Wtr Temp Lt		white/blue	brown/white	black/light green	

GETTING HOOKED

If you enjoy anchoring, using a windlass to retrieve ground tackle is an essential tool. Here's what you need to know to select, install and operate a windlass system for your boat.

BY NICK BAILEY



Serious cruising in a powerboat or sailboat arguably infers the ability to be relatively independent of shore support. "Getting away from it all" assumes dropping anchor in a secluded cove. Setting and retrieving an anchor then becomes an essential cruising art and, on any boat over 9.1m (30'), requires some essential equipment unless you plan to include weight lifting and "tug of war" as part of your daily cruising workout.

A windlass serves three functions: provide freedom from the physical strain of ground tackle retrieval, stow the rode and land the anchor aboard. Ideally, a true "hands-free" system with remote push-button operation is best. This means no one should need to manually intervene during anchoring operations and everyone is more likely to return to shore with limbs and digits attached. In reality, complete hands-free operation is not always possible or even desirable but safety demands that manual handling of anchors and heavily loaded rode is kept to a minimum.

Windlass Selection

There are two basic windlass styles: horizontal (**Figure 1**) and vertical (**Figure 2**) as defined by the position of the axis of the drive shaft. Either type is available with a "capstan" (a drum winch similar to a sheet winch) for handling rope rodes or a "gypsy," a narrow drum notched to *(continued from page 40)* handle a specific size of chain and often configured to carry rope as well. Many windlasses are available with both a capstan and gypsy.

Most capstans are not self-tailing and none are designed to automatically feed the rope through the hawsehole into a locker below deck. The rope must be tailed and coiled on deck to be put away later. If there is chain on the end of the rode, it must be manually transferred to the gypsy under load, a tricky procedure at best.

The gypsy, however, provides a method of handling the anchor rode without manual intervention. No tailing is required and the rode auto-

(continues on page 42)

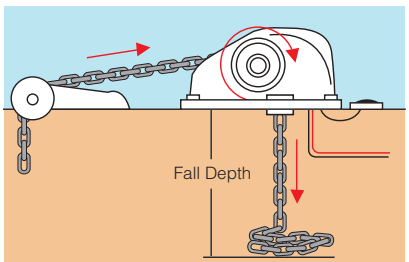


Figure 1
Example of horizontal windlass operation.

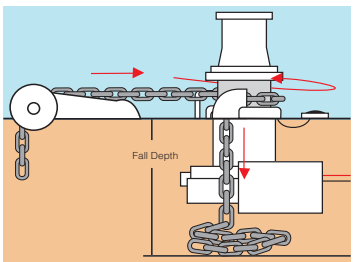
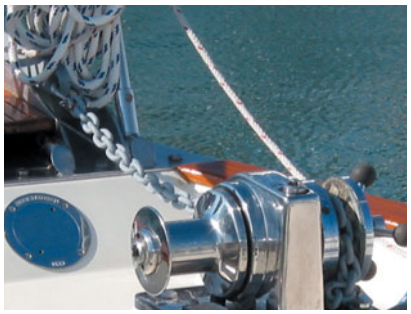


Figure 2
Example of vertical windlass operation.



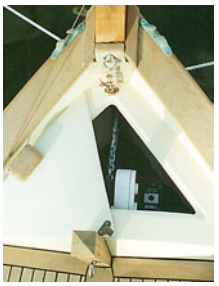
(left) Winch-type vertical windlass for rope-only anchor rodes. (right) Horizontal windlass features both a rope capstan and chain gypsy. Note covered foot switches on deck.

Self-tailing chain gypsy automatically feeds chain or rope anchor rode down the hawsehole. (inset) Hands-free operation demands a proper rope-to-chain splice.

Vertical windlass requires a deeper rode locker to make room for the windlass drive and anchor rode.

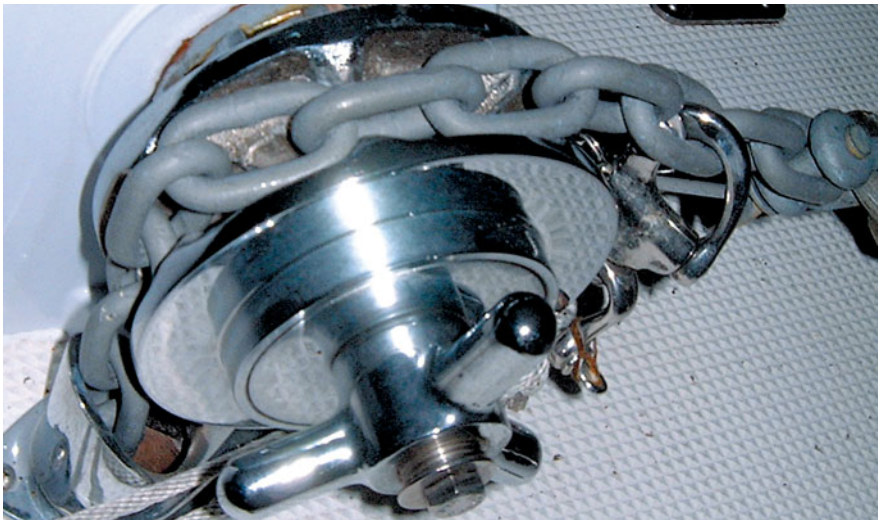
Low-profile vertical windlass on small cruiser easily manages chain (or rope) anchor rode to provide secure anchoring with less scope.

A stern windlass? If it fits, why not!



A horizontal windlass easily fits in the anchor locker and is simpler to install and maintain.

A vertical windlass mounts the electric motor and gearbox on the underside of the deck.



Anchor chain on horizontal windlass drops off the back of the gypsy and down through the hawsehole.

(continued from page 42)

matically peels off the gypsy and down the hawsehole. This self-tailing and stowing mechanism is most reliable with an all-chain rode but also works with a rope-chain gypsy. For a rope-chain combination to work in "hands-free" style, the rope must be spliced to the chain properly. Shackles won't go through without jamming.

There are many small boat windlasses designed to automatically handle (mostly) "all rope" rodes, but on larger boats, most experienced cruisers prefer an all chain set-up. Chain handles easily with a good windlass, is resistant to chafe, won't rot and allows secure anchoring with a little less scope (5:1 versus 7:1 for rope). Unfortunately, chain is expensive, heavy and drags all kinds of muck on board.

Since a horizontal windlass has the motor and gearbox fully enclosed in a housing on deck, it doesn't require as much space in the anchor locker (underside of the foredeck) and is simpler to install and maintain. It's popular on powerboats but less so on sailboats where bulky equipment on the foredeck can interfere with sail handling.

A vertical windlass mounts the electric motor and gearbox on the underside of the deck. The drive shaft and mounting bolts pass through the deck and clamp the gypsy capstan assembly to the deck surface. This results in a tidy, low profile installation, particularly with a "gypsy only" model. The hawsepipe is often integrated with the mounting of a vertical windlass because the rode is guided around the gypsy a full 180° and then peeled off by a stripping mechanism to make a 90° turn through the deck at the hawsepipe. This controlled feeding of the rode is in contrast to the horizontal windlass where the rode makes a single 90° turn and drops off the back of the gypsy and down through the hawsehole. A vertical windlass requires a deeper

Size Matters

Windlass manufacturers provide guidelines based on boat length and displacement but the final determining factor in how much pulling power is required is the weight of the ground tackle you plan to use. Every windlass will have a maximum pull rating and a safe working load. The safe working load is usually 1/3 to 1/4 of the maximum pull rating. In most cases the safe working load should be about the same as the required pulling power which is usually recommended to be three times the dead weight of the entire ground tackle complement. This three times factor allows a safety margin for other factors such as windage, current and the unexpected.

In this example, we have a hypothetical 11.5m (38') trawler yacht with a displacement of about 8165kg (18,000lb). Ground tackle is adequate but not extra heavy and consists of a 19kg (35lb) plow anchor and 61m (200') of 8cm (5/16") high-test chain weighing 99kg (218lb). This gives a total ground tackle weight of 114.7kg (253lb).

Recommended pulling power is 3x ground tackle weight = 344kg (759lb)

Recommended windlass peak power rating is 3x recommended pulling power = 1,032kg (2,277lb)

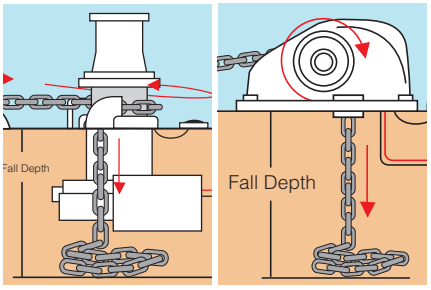


Figure 3
(left) On vertical models, fall is measured from the top of the chain pile to the underside of the deck; to the center of the gypsy on horizontal units (right).

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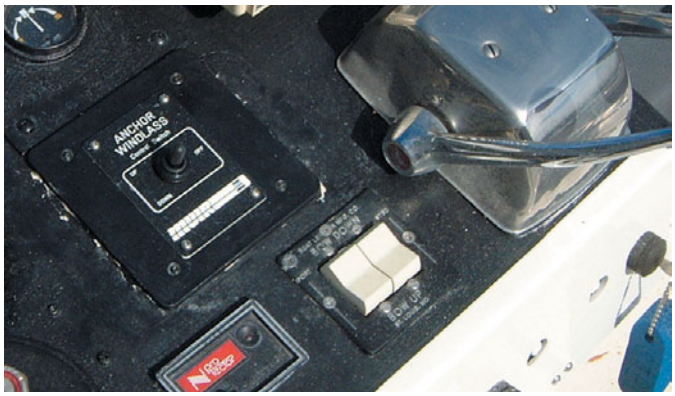


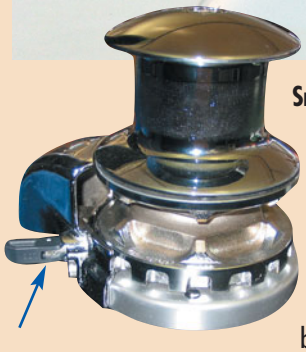
Panel at the helm (top) and foot switch (bottom) nearby the windlass transfer absolute hands-free control.

Anchoring package complete with up/down/off switches all neatly stowed in foredeck locker.

rode locker to make room for the windlass drive and to provide sufficient "fall" so that the rode doesn't pile up in the locker and jam the hawsehole. Typically, 30.4cm (12") of fall is considered the minimum, measured from the top of the chain pile to the underside of the deck for vertical models, or to the center of the gypsy on horizontal units

TIP Proper Anchor Retrieval

Most boaters slowly motor up to the anchor while the rode is retrieved. A better technique is to retrieve the rope or chain rode until the boat is directly over the anchor, then pause to let the momentum of the boat break the anchor out. In this way, the maximum pull effort is only rarely and momentarily encountered when trying to break a stubborn anchor loose from the bottom.
—NB



Snubbers and Chainstoppers

No windlass is designed to carry the loads of the anchor rode while anchored so you must install a chainstopper or snubber to spare the windlass and the deck the stresses and strains of a buried anchor. A snubber consists of a hook to snag the chain just outside the bow roller and a rope to transfer the load to a bow cleat. This also reduces the nocturnal clunks and clanks generated by loaded chain passing through the bow roller. The chainstopper is bolted through the foredeck and brackets the chain between the windlass and the bow. It has a flip-down trap door that carries the anchor strain and also blocks the chain and anchor from accidentally deploying while underway. Quick windlass (left) has an intregal snubber on the drum.

Bow Rollers and Sprits

Smooth and safe ground tackle launching and retrieval also depends on a proper anchor roller and bowsprit. A bowsprit or anchor platform will keep a swinging anchor away from the hull. Otherwise you are required to watch like a hawk as the anchor clears the surface, fending it off the hull and guiding it manually into the bow roller; not exactly a hands-free retrieval. If a bowsprit is impractical, one alternative is to install bow armour made of 1.5mm (1/16") polished stainless-steel sheet. A pivoting bow roller also facilitates retrieval by converting the wicked 90* turn at the bow roller into two 45* bends. This means less likelihood of a jam (and popped breaker) as the anchor shackle and shank arrive home.

Wash-down Pumps

One frequently overlooked accessory is a raw-water washdown pump with a deck fitting on the bow for attaching a hose and spray nozzle. While you're standing on the "up" switch, you can give mucky chain a good rinsing as it comes aboard. Stowing clean chain keeps the rode locker from becoming a very nasty place.

(**Figure 3**).

Prior to selecting a windlass, it's important to check the configuration of your deck and anchor rode locker (if equipped) to determine which windlass design fits best. If using chain, it's also important to know exactly what size and type of chain so that you order the correct gypsy. These components must match perfectly to work.

Control Options

Most windlasses power up and down with the option of dropping the anchor by "free fall" to save time. This is done manually by releasing a clutch or pawl on the winch. Some new models offer "automatic freefall" where the (electric) clutch is remotely released by actuating a switch. This is the ultimate in "hands-free" anchoring and perfect for single-handing. Be sure to remember to release the anchor tie-down beforehand.

Control options range from remote up-down switches to deck mounted foot switches and handheld remote controls. Power-boats use a dual-station control set-up with the up/down/off panel at the helm or flybridge and foot switches on the foredeck near the windlass. In most aft cockpit sailboats it's difficult to see the bow so foot switches near

Windlass is best mounted mid-deck rather than adding uncalled-for weight on the bow.

Delamination caused by improperly caulked windlass fasteners and hawsepipe hole results in a costly foredeck repair.

the windlass are the norm. Even with relatively hands-free anchoring, it's a good idea to watch proceedings closely and be able to stop the windlass if a jam develops. Having nearby foot switches is important in these circumstances. Another important caution is that foot switches can be unintentionally activated. Equip them with covers to prevent activity on the foredeck, unrelated to anchoring, from lowering an anchor in an untimely manner.

Mounting Basics

Bolting a windlass to the foredeck is straightforward in theory but the typical installation, including those done by the boat manufacturer, is fraught with peril. A windlass won't pull a deck apart; however, the opening cut for the windlass and the forces exerted by the windlass on the deck laminate structure are a notorious source for water intrusion into a cored deck, eventually leading to costly delamination.

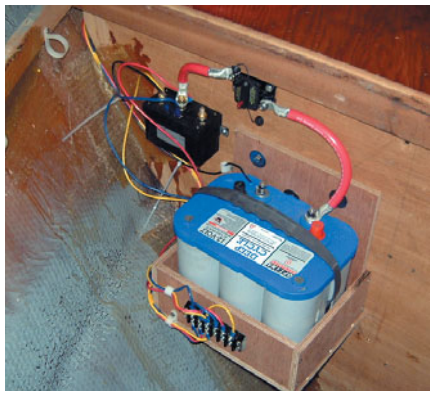
A windlass installation involves simply lining the unit up carefully for the best rode angle and ground tackle stowage, marking and drilling the mounting holes plus a larger hole for the shaft of a vertical windlass (or the wiring to a horizontal model). These holes are hidden under the windlass itself and require the normal attention to good caulking procedures. Then comes the job of using a holesaw to drill the opening for the hawsepipe. Here is where things go wrong. Most existing installations have exposed balsa or plywood core at the hawsepipe hole. This exposed core soaks up moisture every time a wet chain rattles past, it rains or a wave splashes the foredeck. (It's a small detail perhaps, but very good for the boat repair business.)

Installation involves excavating the core and filling the cavity with thickened polyester or epoxy and chopped glass fibers. While you're at it, dig out and fill all other holes too.

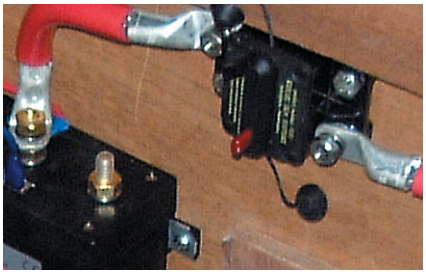
Power Supply

Motors on 12-volt windlasses are rated anywhere from 200 watts for an entry-level unit to 1,500 watts for the most powerful. Normal draw at the rated power would be 16 to 117 amps respectively. If the windlass bogs down and begins to stall the motor can draw two or three times the rated amount. Large cables are required to minimize the effects of voltage drop, especially on long cable runs, and the possibility of excessive resistance causing the wiring to overheat and cause a fire. A small unit will need 1 or 2 AWG cables and larger windlasses often need 4/0 cable. To determine the cable size required, measure the total power cable length (positive plus negative) and assume the maximum potential amperage drawn by the motor. [Ed: Tables to determine wire size requirements based on voltage drop are found in DIY 1998-#4 issue and MRT "DC Electrical Systems" CD-ROM.]

There are two ways to provide power. The simple method is to run power cables from the windlass and connect them to the house battery bank. This simplifies charging but routing pushing 4/0 cable (garden hose size) through mysterious and inaccessible places in the boat. The other approach is to install a dedicated battery in the forepeak to serve the windlass. This minimizes long, high amperage wiring routes. In the past, this set up still demanded fairly heavy cable just to charge the battery. Some new equipment has made this option more practical. The Heart Echocharge is an automatic battery paralleling device originally designed to provide a current-limited trickle charge (15 amps) from a house bank to an otherwise isolated starting battery. Each Heart inverter includes an Echocharge as standard equipment. It can also be bought



Dedicated battery mounted in the bow reduces wire size. Battery must be installed in a sealed case and away from any ignition sources.



Breaker mounted near the battery protects the circuit from overload.

separately and provides an ideal means to charge a dedicated windlass (or bow thruster) battery. The 15-amp current limitation means you can use modest size cable to connect to the house bank for charging through the Echocharge unit. As a bonus, the dedicated battery approach often turns out to be less expensive — 15m (50') of 4/0 cable is more expensive than the combined cost of an Echocharge and a battery.

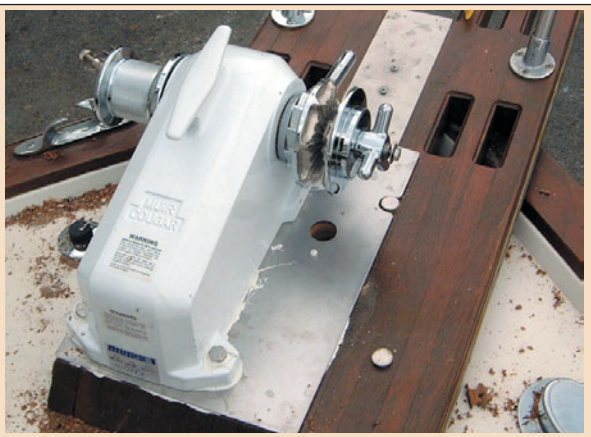
Regardless of the approach, protect the circuit with a fuse or breaker large enough to carry the maximum motor load and located as close as practical to the battery. The heavy, crimped connector lugs on the cable ends should be insulated as much as possible and, in the case of a vertical windlass, where the motor connections live in the rode locker, protected from any possible contact with the anchor chain.

Switches

Most windlasses are sold as kits that include the necessary switches and solenoids. Kits vary depending on whether the unit is "powered up" only or "powered up and down" and whether there is a second station or hand-held remote control. Follow the supplied circuit drawing. Foot switches are usually designed to handle the full draw of the windlass, while remote and hand-held controls are designed to trigger a relay, a remote switch actuated by a solenoid. When cutting foot switches into the deck, caulk them well or seal the opening as previously described.

About the author: Nick Bailey began his professional marine career with C&C Yachts more than 25 years ago. He is general manager of Bristol Marine, a full-service yard in Mississauga, Ontario.

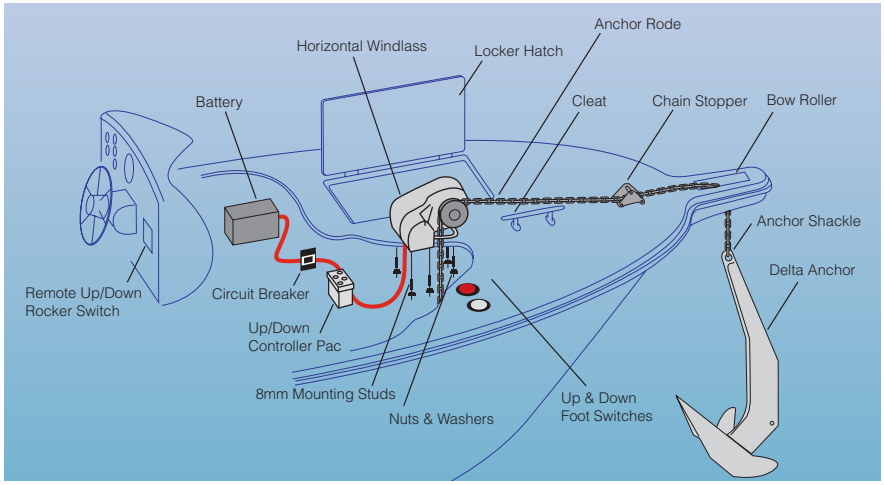
Installation Costs



If you're considering having an electric windlass installed professionally, here is an example of the cost to install a horizontal windlass on a 11m (36') tri-cabin cruiser including a dedicated battery in the forepeak and a Heart Echocharge unit. Prices are in Canadian dollars.

Parts	
Muir HR1200 Cougar (List $3476.35)	$2,781
Optima D900M battery	*$299
Heart Echocharge	*$275
12.8m (42') 1/0 boat cable	*$393
Custom stainless steel mounting plate	$123
Misc. supplies and electrical including, breaker, wire, etc.	$391
Subtotal	$4,262
Labor	
35 hours @ $80/hr	$2,800
Added Accessories	
Anchor, 61m (200') all-chain rode, chain tensioner	$1,273
TOTAL	**$8,335**
(converts to approximately US$5,556)	

*Note: Without a dedicated battery in the forepeak, the cable run would require 24m (80') of 4/0 cable for $1,280. This method is more practical and saved $313, assuming the labor is about the same either way.



SIMPSON LAWRENCE

Sample installation of horizontal windlass on powerboat shows placement of battery, cables, circuit breaker and helm controls.

SAILBOAT RIGGING

CHANGING GEARS WITH MAINSAIL TRIM

Unintended tacks and gybes can and do happen, sometimes with fatal consequences. Good mainsail trim with the proper deck hardware will help keep you in control.

STORY AND PHOTOS BY NICK BAILEY

In a good breeze the forces generated by the mainsail become difficult to handle and managing sail shape is critical to sailing well and in control. The easy "out" is to reef but such a gross trim change may leave the boat under-canvassed and bobbing about unable to power through waves. Proper management of mainsail shape will keep your boat powered up without being overpowered, at least until you run out of trimming options and really do need that reef.

Unfortunately, the sail controls on many small boats are so marginally rigged that making adjustments for optimum trim as conditions change is difficult or impossible.

The minimal boat is equipped with a mainsheet but no traveler or one that can't be easily adjusted; a main halyard cleated at the mast; a clew outhaul tied at the end of the boom with no adjustment possible while underway. Often, there is no boom vang fitted so, when the mainsheet is eased, the boom jumps up in the air and the main loses a controllable airfoil shape. The whole idea of good sail control hardware is to allow you to easily maintain an aerodynamically efficient mainsail shape in both light winds and breezy conditions.

Short of tucking in a reef as the wind speed increases and the cloth of the mainsail stretches, the power generated by the mainsail can be decreased in small increments by first flattening the sail and adjusting the draft (max depth of the airfoil) position, then later by gradually reducing the angle of attack of the sail to feather it slightly into the wind. In a dying breeze, the process is reversed. Racing sailors call this process depowering (**Figure 1**) or powering-up (**Figure 2**) a mainsail. The techniques are equally applicable to cruising sailors.

Good rigging and deck hardware allow gear changing, including big changes like putting in or shaking out a reef, to be done without leaving the safety of the cockpit. It's essential if you sail short-handed or single-handed. It's not a difficult job to upgrade a bare bones boat to one where you have all the necessary controls at your fingertips.

Primary Mainsail Controls

Most boats have an adequate mainsheet, usually a 4:1 or 6:1 tackle with a convenient self-contained cam cleat. Travelers are another issue. Many boats, if they have one at all, have worn-out units that jam under load and have stops instead of a proper cross haul system so they can't be easily adjusted. Sailing to windward requires a traveler with a good cross haul. This allows the entire mainsail to be eased down to leeward, depowering the sail, while leaving the mainsheet tight. Otherwise, when the mainsheet is eased, it initially regains draft and power, just the opposite of what you are trying to achieve. Continue to ease the sheet and the sail depowers completely and starts to flog. It's a gross trim change when what you really want is fine trim. Letting the traveler down instead of easing the mainsheet preserves the flattened shape of the main and depowers it incrementally by changing the angle of attack of the whole airfoil.

FIGURE 1
A depowered main. Note minimal draft due to full outhaul, cunningham and halyard tension, lots of backstay to bend mast and pull sail flat also eases the leech plus significant backwind due to eased traveler.

FIGURE 2
A powered-up main has deep draft, straight mast, tighter leach and very little backwind.

A good traveler will have a smooth ball-bearing car that slides easily under heavy load and a powerful cross-haul system (at least 3:1) with the cross-haul cleats within reach while you are perched on the weather rail. (**Figure 3**). [Ed: DIY 1996-#2 issue and/or the MRT "Sailboat Rigging" CD-ROM feature additional traveler layouts and upgrade options.] Installation is simple. Lay out the hardware positions

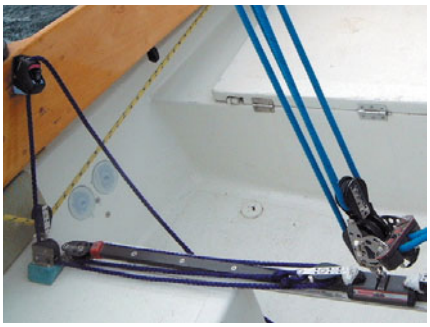


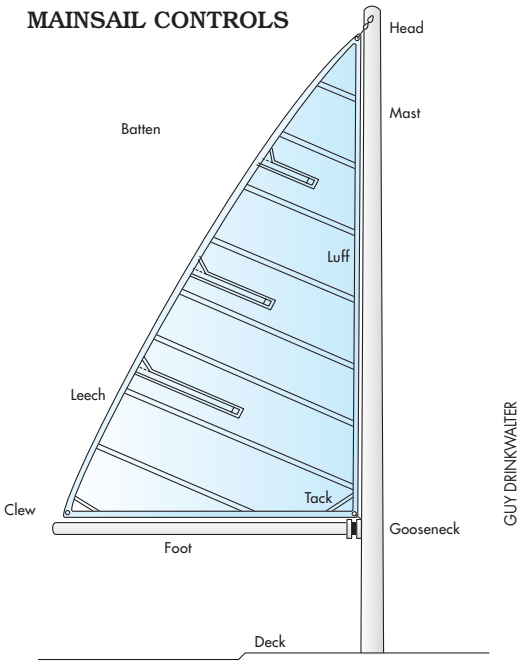
FIGURE 3
Ball bearing traveler with 3:1 cross-haul cleated on the coaming.

carefully, drill the mounting holes and through-bolt it all in place with some marine polyurethane sealant (e.g. 3M 4200). Be careful to use good bedding techniques especially when installing hardware through cored laminates. [Ed: DIY 2000-#3 issue details the proper techniques for mounting deck hardware.]

Secondary Controls

The halyard, cunningham and outhaul are used to stretch or ease the sailcloth at the luff and foot of the mainsail. This controls the fullness of the sail and also the draft position. Used in conjunction with changes to mast bend (rake), which are done primarily with an adjustable backstay, it allows maintenance of an efficient low drag airfoil shape as the wind speed changes.

The clew outhaul tension controls the fullness of the mainsail, particularly the lower half. It can be the biggest challenge to upgrade. Many boats have no hardware on the boom to lead the control line forward to the gooseneck and down to the cabin top aft where you can comfortably reach it. To accomplish this improvement, it is necessary to install blocks at the fore and aft ends of the boom to bring the outhaul forward to the mast. From there, the outhaul line goes straight down to a block near the base of the mast and aft along the cabin top to a cleat or rope clutch (**Figure 4**). This is complicated by the tendency of the outhaul line to be inadvertently tensioned or eased by the action of the boom swinging on its gooseneck. To minimize this, keep the vertical portion of the outhaul line between the gooseneck and deck as close to the axis of the gooseneck pin as possible. The neatest installation has the outhaul line internally led through flush-mounted blocks and exiting from the boom on centerline just under the gooseneck (**Figure 5**).



You may have to cut and file some metal to install these. (**Figure 6**) Thru-bolt or drill and tap for machine screw fasteners. [Ed: Instructions for drilling and taping aluminum appear in MRT "Sailboat Rigging" CD-ROM.] Pop rivets are for lightly loaded fittings only.

Since the outhaul can be under heavy load, it's advisable to lead it aft to a rope clutch and a halyard winch or have a multi-purchase tackle set up internally in the boom. Use only large low friction blocks for the tackle; otherwise the outhaul won't ease if the wind dies. I like the robust (some say brutal) simplicity of

FIGURE 4
(left) Keep-it-simple outhaul and main halyard lead to a rope clutch and winch. (inset) Deck organizer in action.

FIGURE 5
(left) Basic internal outhaul. Red line is the first reef. (right) Ideal set-up: Integral sheaves in casting at forward end of boom provide exit for outhaul and first reef. Empty sheave is for second reef; not rigged.

the rope clutch and winch combo. It's a simple system that always works.

An easily adjustable main halyard allows ongoing changes to luff tension over the top half of the main. The cunningham, invented by Briggs Cunningham, famous America's Cup and sport's car racer of the early '50s, does the same thing for the lower half of the sail. Luff tension controls the draft position. As the wind increases and the sail stretches, the draft will tend to sag aft, which increases drag and weather helm. Tensioning the halyard and cunningham moves the maximum draft position forward again.

To bring the main halyard aft requires a turning block at the base of the mast, a cheek block or deck organizer to guide it around the companionway and, finally, a clutch and winch combo mounted aft on the cabin top.

It's important that the main halyard tail is long enough to reach, particularly if you like to secure the halyard shackle, all the way down to the toerail when the boat is moored.

The cunningham usually ties to a pad eye on the mast; leads through a sail cringle above the tack and can include a tackle for extra purchase. The tail end goes aft in the same way as the main halyard (**Figure 7**).

Specialized Controls

Over the years, I have come to appreciate more and more the power of a backstay adjuster and vang, often-misunderstood controls.

The backstay bends the mast. This stretches and flattens the sail and at the same time eases the leech. It tensions the forestay, reducing sag and improving pointing. A racing boat "dialed in" upwind, carrying all the power it can handle, often keeps the main balanced on a knife edge by trim adjustments to the backstay alone. It's an excellent fine control for the overall power output

FIGURE 6
When sheaves are not integral, flush-mount the block by cutting and filing an opening in the base.

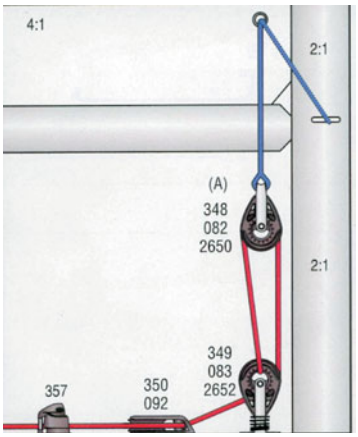


FIGURE 7
A cunningham arrangement with 4:1 tackle.

of a mainsail.

Admittedly backstay control is more of a racing concern. It took me a long time to finally change the backstay controls on my Thunderbird "Looney Tunes" to a double-ended set-up that I could keep in my hand while perched on the weather rail on either tack upwind. (My wife, Wendy, is the helmsperson.) This simplified the whole process of powering the main up and down, particularly in puffy conditions.

There are many different ways to rig an adjustable backstay. My boat, as shown in **Figure 8**, has a 6:1 double-ended tackle in the lazarette, connected to a 2:1 cascade on the backstay, passing through a block cut into the back deck. Each end of the tackle follows the cockpit outer perimeter through turning blocks to cam cleats on both coamings. This gives me 12:1 at my fingertips on the rail but it does let some rain water into the boat.

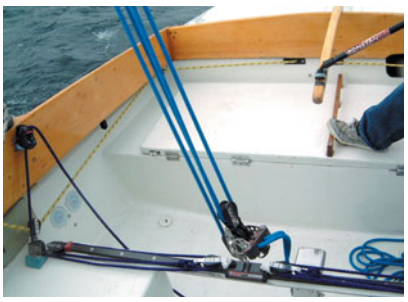


FIGURE 8
Rigging a backstay: (clockwise, top left) Backstay attaches to 6:1 double ended tackle in the aft locker; 2:1 wire cascade enters deck at block; Yellow line exits the aft locker and follows the cockpit perimeter (both sides); Secures to a cleat on both port and starboard coamings.

The boomvang, a multi-purchase tackle that connects between the mast and boom below the gooseneck, is an important piece of hardware that is often ignored. The primary function of the vang is to keep the boom from rising while sailing downwind. This prevents the leech of the main from sagging and spilling air. Racing boats find a powerful vang can also be useful in breezy conditions to help flatten the mainsail upwind, particularly if the boat doesn't have a backstay. In this case (along with mainsheet tension) it becomes a primary control for mast bend.

In extreme situations, the vang can supplement the traveler keeping the mainsail shape when the sheet is eased, a technique known as vang sheeting.

A 4:1 vang with a self-contained cleat is adequate for most small cruising boats. The attachment fittings on the boom and mast must be extra heavy-duty because the long lever arm of the boom multiplies loads on the vang. Large bails bolted through the center of the mast and boom work well on smaller boats. Boats longer than 9.1m (30') may need custom hardware. Leading the vang control aft is optional but can be handy in a bad knockdown where the boom hits the water and the only way to spill power is to let the boom kick up into the air as the main is eased.

Installing Hardware for Aft Controls

Some planning is required. Make a deck layout drawing (**Figure 9**) to make sure of your hardware requirements. All of this is easier to sort out when the mast is stepped and you can see exactly where the lines and blocks need to go. Tape also works to plan the layout (**Figure 10**). If you have multiple items to bring aft, it's tidier to use deck organizers (**Figure 11**) instead of individual cheek blocks to bypass the companionway. Lightly loaded items, such as boom topping lift and lazy jacks,

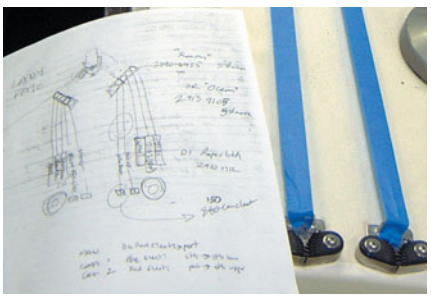


FIGURE 9
Plan the deck layout on paper first.

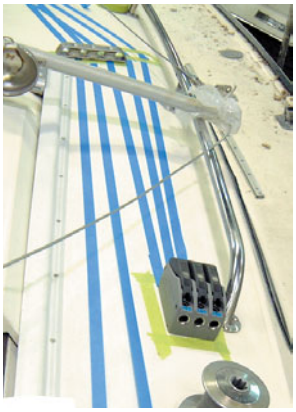


FIGURE 10
Using tape to plan a deck layout.

FIGURE 11
Triple organizer has a shim to compensate for deck camber cut from King StarBoard.

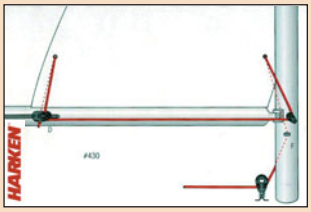
can be brought back through a simple fairlead. When positioning multiple clutches make sure to align the center of the clutch assembly with the right hand loading side of the winch drum. This will minimize excessive rope exit angles and reduce side loads on the clutch. [Ed: DIY 2001-#1 issue provides options for coping with interior liners when installing deck hardware.]

Ideally you should attach as many of the turning blocks at the mast base to the mast itself using drilled and tapped machine screws and strap-eyes or to the mast step with shackles (if deck stepped) or to a mast collar. [Ed: Refer to DIY 1998-#1 issue for step-by-step details on hardware installation on masts.] It's not a good idea to transfer loads formerly carried on the mast to the deck or mast collar unless there is some kind of deck tie-down at the mast collar or the underside of the deck. This is particularly true with halyards.

About the author: Nick Bailey is a 26-year veteran of the boat repair business. He and his wife, Wendy Loat, competitively race "Looney Tunes," a classic Thunderbird.

TIP Single Line Reefing

One of the best things to lead aft is a single-line reefing set-up. This is a great boon to sailors because the entire reefing procedure can be done from the safety of the cockpit. Just ease the mainsheet a bit, ease the halyard, and crank in the single reef line. Retension the halyard and sheet in. No more staggering around at the mast trying to pop the reef cringle over the tack hook while the main flogs. Harken has a nice kit for this but it's also possible to put one together yourself.



WATER-TIGHT FITTINGS

Every hole in your boat located below or at the waterline has the potential to sink it. Read on to find out why you may need to upgrade and what to purchase.

[BY JAN MUNDY]

Seacocks, thru-hulls and valves are names that identify an opening in a hull and though they are related, by definition, they serve different purposes.

According to the American Boat & Yacht Council (ABYC) under Standard H-27, a thru-hull is "a fitting designed to accept pipes, hoses or valves to allow the passage of water in or out of a vessel." A seacock is a "type of valve used to control the intake or discharge of water through the hull giving a clear indication of whether it is open or shut." That last part of the description is the key to whether a "valve" is a "seacock." A gate valve, for example, is not a seacock because the operating handle's position does not give any indication as to whether the valve is open or closed. You can see the wheel but you don't know whether the valve is open or closed unless you turn the wheel. The seacocks we see most often have a lever-type handle that moves through a 90° arc to operate the valve. When the valve is "open," the handle tip typically is inline with the body of the valve. In the closed position, the handle is 90° to the body of the valve.

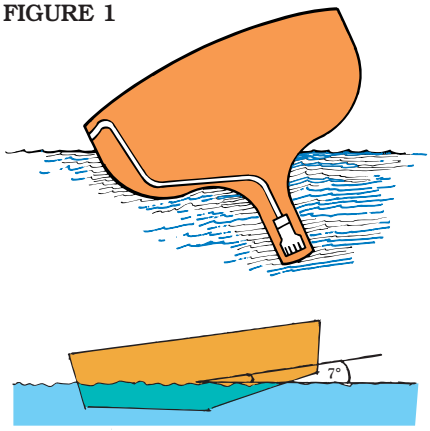
Why Seacocks?

ABYC further states that all thru-hulls shall be equipped with a seacock when installed below the maximum heeled waterline, under normal conditions of trim and heel. The key here is the definition of maximum heeled waterline. For powerboats, this is defined as line reached by the water when the boat is heeled 7°; on sailboats, that line goes all the way up to the rail." (**Figure 1**) Normal conditions of trim" includes weight from all additional gear. For example, a powerboat loaded with fishing tackle and filled livewells sits lower in the water, especially when heeled. The 7° factors plays out in, for example, a rolling motion due to wave action or even when the boat is in its berth and the hull is subject to rolling from wake action nearby. There are three exceptions to this standard: boats with level flotation; boats with self-draining cockpits that discharge above the static (not underway) waterline; and when the thru-hull serves an exhaust system.

TIP EMERGENCY CORKER

Attach a tapered soft wood plug to every seacock and thru-hull fitting to seal the valve opening in case of failure.

FIGURE 1



Maximum heeled waterline as defined by ABYC is rail down for sailboats, 7° for powerboats.

Rarely do boat manufacturers comply fully with the ABYC standard. Thru-hulls only are especially common on cockpit, LPG locker and anchor locker drains, galley and head sinks, air-conditioning system circulating water discharges and bilge pump outlets. Livewell drains present another situation on powerboats. Just power down in reverse or be out on rough water with a following sea and watch the livewells fill and possibly swamp a smaller boat.

Buyer Beware

Many freshwater boats were equipped with all brass thru-hulls and seacocks and, in some cases, a bronze body but brass valve, sometimes with a pot metal (ferrous) handle, or brass or stainless-steel nut. There is no way of telling the difference visually between metal fittings of hardware quality (contains zinc) and those acceptable for marine use. However, if it's a stem-style valve, it's likely brass; if it's a brand-name seacock like Apollo, Groco, Perko or Wilcox, among others, sold in a marine store, it's likely bronze. If you're planning to use a boat so equipped in saltwater, you must replace all valves. Corrosion will inevitably cause them to fail.

Be suspicious of low-priced seacocks when purchasing new ones. Look for an all bronze body, non-corrosive handle and chromed-bronze ball. When in doubt, buy a recognized brand name. When purchasing composite "plastic" fittings look for the UL-1121 stamp of approval. Acceptable plastics include reinforced nylon, such as Marelon, a fiberglass-reinforced nylon. Advantages of installing these composite fittings are obvious: corrosion resistance being the main one; no need for electrical bonding and they can be installed in metal hulls without needing to isolate. Don't mix metal and plastic fittings. Their expansion coefficients are very close but a male metal fitting mated to a female plastic fitting could be a bad marriage. An example of this is coupling a bronze thru-hull with a Marelon valve. Never use ABS, PVC or polycarbonate thru-hulls or seacocks for marine applications.

To Bond or Not

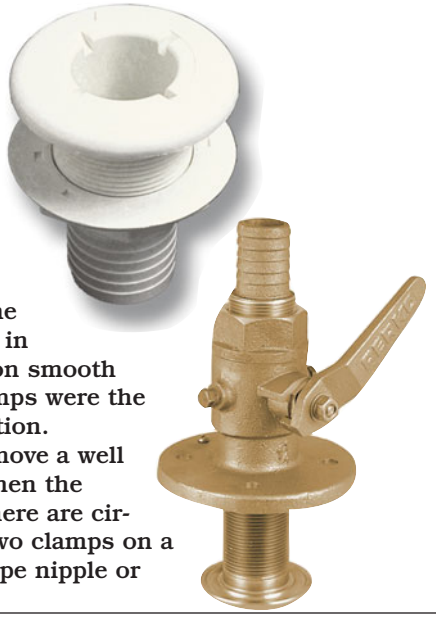
Most experts don't recommend the bonding of electrically isolated metal thru-hulls and seacocks. The only exception is where fittings are below the normal bilge water level to protect against stray current corrosion. Of course, it's not necessary to bond composite thru-hulls or seacocks.

TIP IN-WATER SERVICING

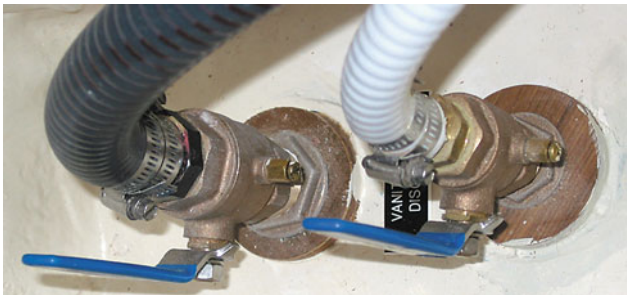
Stow a plumber's "helper" onboard or a suction-cup handle used by glass installers in case you need to service a below-waterline seacock and don't want to haulout. Just cover the hole and push in on the handle. Keep a tapered soft wood plug and a mallet near at hand as a back up to seal the thru-hull.

ROUTINE MAINTENANCE

- Open and close all seacocks at least monthly. This "lubricates" the valve stems and self-affirms that they are not obstructed by marine growth. If the handle doesn't turn easily, stop immediately and disassemble. Never over torque or you risk shearing the handle.
- Inspect for water leaks around seacocks and hose connections.
- Inspect handle and nuts (sometimes cotter pins) for corrosion.
- Regularly lubricate composite (e.g. Marelon) valves with the manufacturer's recommended lube. Forespar recommends water pump or winch grease.
- Identify all seacocks with water resistant nametags secured with wire ties.
- In cold climates, add "Open seacocks and drain plugs" to your winterizing "To-do" list.

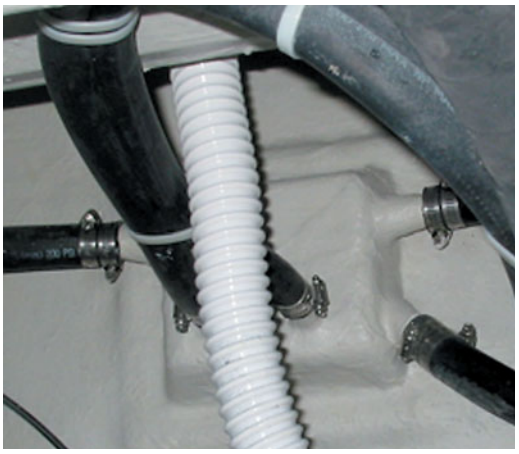


Tail pieces on thru-hulls and seacocks must be barbed, not smooth, to hold hoses securely and, ideally, should be long enough to curb two hose clamps. Contrary to popular belief, there is no standard that requires two hose clamps on thru-hull fittings but it's a good and well-accepted "marine practice," which is, in itself, something of an unwritten standard that causes no harm and creates some peace of mind. The practice is rooted in the times when hoses were secured on smooth pipe ends (no barbs) and the two clamps were the key to a belt and suspenders installation. Nowadays, you'd be challenged to remove a well fit hose from a barbed fitting, even when the clamps are removed. Be aware that there are circumstances where trying to secure two clamps on a hose can injure the hose when the pipe nipple or barb is short.



On all below-waterline hoses, providing the seacock's hose barb is long enough, a double-clamped hose provides peace of mind. Screws should be opposed as shown. Note tags to identify usage and drain plugs for winterizing.

Install only approved composite fittings. A UL label on this Marelon ball valve assures quality.



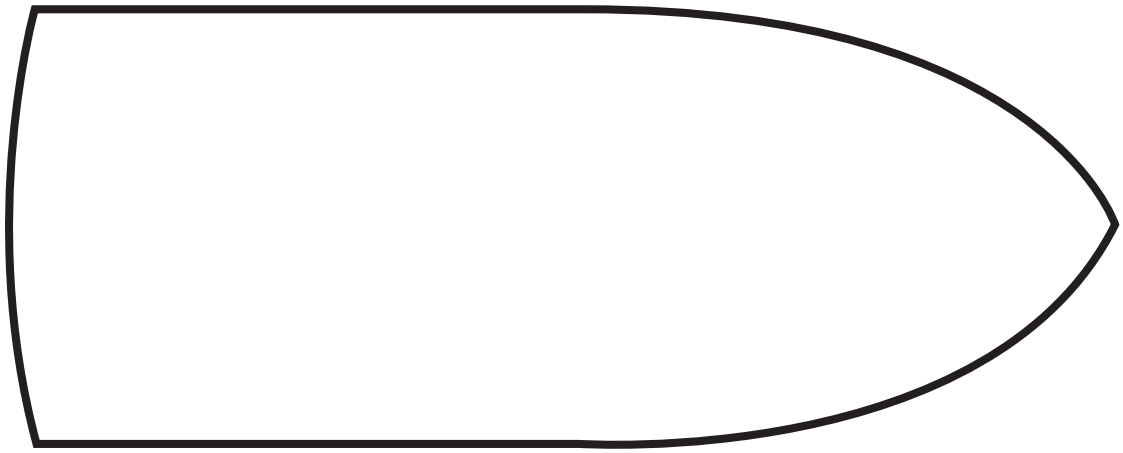
These sample installations have the potential for a sinking should a clamp or hose fail unless equipped with seacocks: (left) Mid-size sailboat's cockpit drain hoses lead to a fabricated manifold and to a single thru-hull, that when inspected, was installed just at the waterline when the boat is stationary. Once heeled, the thru-hull would surely be submerged. (right) Cockpit drains exit the hull at the waterline, which doesn't allow for heeling or extra payload if there is an emergency need to stop water from passing though the opening.

(left) Red-White brand stem-style valve is likely hardware store quality brass. (right) Marine grade seacock is most likely bronze.

Lower priced gate valves don't belong on any boat. Most are made of metals that can't stand the corrosive nature of the marine environment; are slow to operate and you never know if they are open or closed. Their mechanisms are easily obstructed by marine growth, which results in incomplete closure.

(above) Bad: Thru-hull fitting connects to an in-line valve that connects to a threaded hose barb, then to a hose results in an inherently weak installation and one that doubtfully withstands the ABYC test that requires: "A seacock … mounted so that the system will withstand a 500 pound static force ("lead weight") applied for 30 seconds to the inboard end of its connecting fitting, at any point in its most vulnerable direction, without the system failing to perform as intended." (right) Best: Single-piece seacock assembly mechanically fastened to the hull distributes torque loading and stress across the entire cast base. Note that clamp screws are inline instead of opposed.

DIAGRAM YOUR THRU-HULLS



COURTESY OF DAVID MCKIE, MARINE SURVEYOR

Should you open the hatch and see a bilge filling with water, knowing the location of your boat's thru-hulls may save it from sinking. For safety's sake, diagram your below-waterline thru-hulls on paper, laminate the diagram and hang in a conspicuous location. Be sure to revise if you add any thru-hulls.

Sample Codes:

EI	engine intake
PG	packing gland
GEN	generator
GI	generator intake
HI	head intake
HE	head exhaust
SD	sink drain
WI	water intake
CD	cockpit drain
DP	drain plug
TD	transducer
SC	seacock

In our next issue we'll cover the proper procedures to install a thru-hull and seacock in both solid (uncored) or balsa and foam cored hulls.

PROJECTS

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

1 —— 10

RETROFIT A SWIM PLATFORM

How do you add a swim platform to an older boat? This owner purchased an OEM platform, direct from the dealer.

9

We purchased our 1997 Regal 242 used, and like many compact cruisers of that era, it had a standing-room-only swim platform. As we wanted to retrofit a full-size platform and I wasn't keen on building one, I called Regal and learned the company makes swim platforms for older models. I placed my order and eagerly awaited delivery. To save on shipping costs, I picked up the 36kg (80lb) fiberglass and plywood platform from Regal's plant in Valdosta, Georgia, a four-hour drive north of my home.

"The toughest part of the entire project was ensuring all parts were on-hand. The actual installation was tedious but relatively easy."

Functional but not enjoyable, the author's out-of-the-box 1997 Regal 242 Commodore has a small platform integrated with the stern.

"Boating is now a party! I've fallen asleep too many times on the platform and ended up with sunburn. But I just roll off the back to chill without a concern of hitting the sterndrive and prop."

Once back home, the first order of business was to double-check the parts list and carefully review the installation instructions as I visualized each step of the project. As I matched each part to each step of the installation process, I discovered that the installation guide referred to the parts' list for a Regal 2000 Commodore. A call to Regal resolved the problem but I had to wait another nine days before receiving the correct parts.

"With each part, I also had to make sure I had the correct tools."

Prep Work

Some of the tools this job required included: powered drill, socket set, ratchet extensions, heat gun, caulk gun, Xylene (for adhesive cleanup), gelcoat patch kit with color tints, Dremel kit with cutting and sanding wheels, coping saw, extendable magnetic pick-up (to retrieve parts that fell into the bilge), rubber mallet and the usual tools found in any DIYer's toolbox. The adhesive came with the platform parts. Otherwise, I usually rely on 3M 5200.

Twelve bolts secured the existing ladder to the hull and removal involved first securing the nuts on the inside so I could back out the bolts. This involved crawling into the

engine compartment, putting a Vise-Grip on each nut, and then going back outside to the stern to remove the bolts. Since I was doing the job by myself, I made several round trips until all the bolts were out. Following that exercise, I scraped all the old adhesive bedding compound away, being careful not to scratch the gelcoat. A quick wipe with Xylene removed any remaining residue. Bolt holes were then filled with filler. [Ed: 3M Marine Premium filler is highly recommended for hole filling.] Once dried, I mixed gelcoat to the proper color and covered the filler. Following the instructions, the gelcoat was sanded with 800 then 1200-grit wet-sandpaper to a shine. Rubbing compound was the final factor in getting a uniform finish.

Platform Mods

I set up a support for the platform by placing a ladder on each side of the stern with a plank laid on the ladder rungs across the stern just below where the platform would be installed. I put the platform on top of the plank and adjusted it to fit snugly against the stern, so I thought.

This 2000 model platform was not an exact fit for my 1997 boat as it butted-up against the trailer tie-down U-bolts. Do I jeopardize hull integrity by moving the hooks or do I modify the platform? I decided to cut notches into the platform. When purchasing an OEM platform, be sure to ask if attachment requires any modifications.

Measurements for the cutouts were transferred onto both ends of the platform but I hit another snag in the plan. The three pre-marked support bracket holes were in the middle of the notches slated for cutting. This meant moving the support bracket holes as well once I determined that moving the holes would not compromise the support structure.

Using a coping saw, I cut notches into the platform at the marked locations. The platform was pushed up against the hull several times to ensure the tie-downs were accessible and the platform fit was snug. Any deviations or space between the hull and platform would not ensure a good fit. A Dremel tool with a sanding wheel was used for the finer cuts and finishing.

One last step before the final mounting was to fill the existing bracket holes with fiberglass filler and finish with white gelcoat sanded smooth with 200, then 400-grit paper. Using the support brackets as a pattern, I measured for the new holes and drilled the platform.

The installation instructions fixed the internal center support for the platform within the engine compartment. After measuring the space above the sterndrive from within the engine compartment, I cut a 15cm by 30.4cm (6" x 12") piece of 19mm

(3/4") pressure-treated plywood. This was glued to the inside of the transom where the center of the platform would be aligned on the stern. Two holes were drilled through the platform. Bolts through the transom and plywood backing plate would support the platform by distributing the weight across the board.

The platform ladder handhold also required adjusting. The hole was cut perpendicular to the platform but it needed a 45° angle. The Dremel with a fiberglass reinforced cutting wheel made the rough cuts. Adjusting cuts were made until the handhold fit flush against the top of the platform. Not much wood existed in this portion of the platform, so I applied gelcoat and sanded the surface smooth.

Drilling and Sealing

The platform was now ready to transfer the mounting hole pattern to the transom. Again, I positioned the platform but this time it rested flush against the hull. The pattern for drilling the holes for the six-support bracket holes (three per side) and the two sterndrive support holes was transferred to the transom and I removed the platform from the plank.

I was filled with dread at the prospect of putting holes in my boat. My courage depended heavily on the instructions as I nervously drilled all eight holes. Adhesive was applied to the support brackets and

welded bolts, pushed into the drilled holes, and secured with locknuts and washers. As this was done from inside the engine compartment, a ratchet extension simplified tightening. I applied the adhesive to fill each hole and squeeze out from the sides of each bracket as insurance against leakage.

With a little persuasion, the platform mated perfectly with the support brackets. I immediately applied adhesive, grabbed the supplied support plates, washers and locknuts and secured the platform to the brackets.

The sterndrive support was next. Again, lots of adhesive was applied before inserting the bolts and washers. The plank held the platform while I attached the washers and locknuts from inside the engine compartment. Vise-Grips secured the locknuts while bolts were tightened from underneath the platform. I had to be especially careful going back into the boat as the platform was not ready to bear any weight yet.

Stanchion Installation Component

I followed the installation instructions for the stanchions almost to the letter. Measuring just slightly inboard from the trim tabs and high enough to fit for access within the engine compartment, I transferred the drill holes pattern to the transom and platform. This was nerve racking as the three transom holes were below the waterline. Lots of adhesive squeezed in and around each hole made for a watertight fit. Tightening the platform bolts was fairly easy; securing the transom bolts was the toughest part of this project. Reaching the bolts from my position wedged aft of the engine at the lowest part of the transom took a lot of effort. I used a magnetic wand to put the washers on the bolts. Next, a socket with ratchet extension was seated onto the locknuts. Vise-Grips were again used to hold each locknut while tightening.

Four Steps Up

It was now time to install the telescoping ladder. I carefully measured the hinge locations on the ladder and its hatch cover, and then drilled the mounting holes, filling them with plenty of adhesive before inserting the bolts and tightening the locknuts. The final touch to the platform was attaching the weight limit (226.8kg /500lb) warning label supplied with the kit.

Wrap up

The supplied rubrail was more than enough to cover the entire platform perimeter. I used a heat gun to bend the rigid plastic rail to fit the curves of the platform. (Tip: Don't hold the heat gun too close or for too long in one spot or you'll overheat the plastic and cause it to blister.) Though

small, the plastic rail was actually quite cumbersome; my ladders helped to support the extra weight. The rail screw holes were positioned 15cm (6") apart. On reaching each hole, I'd synchronize the heat gun, drill and screwdriver, drill into the platform and secure the assembly with a supplied screw. Heating, bending, drilling and securing the remainder of the rail was fairly easy. Starting at one end, I positioned the rail insert over the plastic grooves and hammered the insert into place with a rubber mallet. I used the heat gun and a flat-head screwdriver to widen the groove in places where it's width did not quite accommodate the insert. A bead of adhesive laid along the top of the rail helps to prevent water from getting between the drilled holes of the rail and platform. [Ed: A better installation involves applying sealant to every hole before fastening the rubrail.] A quick wipe to remove any markings on the platform and hull and the job was complete.

Since I already had all the tools, my total cash outlay was US$950, the cost of the platform. Installation labor breakout included two hours for plan and instruction review and parts' inventory; two hours to dry-fit and fudge the measurements to fit my boat's transom and 12 hours to complete the installation for a total of 16 hours.

[Ed: The new platform will be a tempting place to gather for a swim. Make sure the party doesn't turn into a sad event by making sure that you never have the gasoline engine(s) or gen-set running when people are on or near the platform. These platforms can form a shell under which carbon monoxide (CO) vapors build to highly dangerous levels. There are documented cases of CO sickness and fatalities from exactly these exposures. Party safely! Shut down all gasoline engines before the party starts.]

About the author: Eugene Kachele hails from Marietta, Georgia and tows his 1997 Regal 242 Commodore with a GMC Yukon.

LOCATING A RADAR DISPLAY

So, you've decided to install radar on your boat. Have you thought about where to mount the radar display unit?

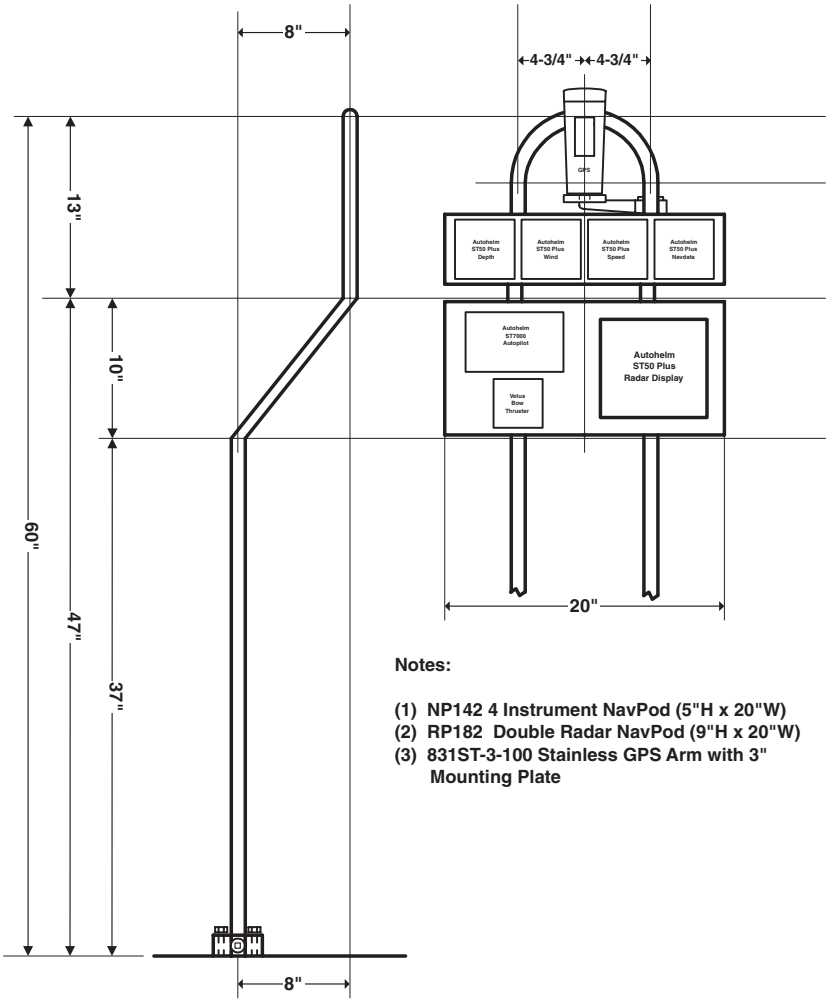
8

Many boat owners spend a great deal of time considering the installation options for the radar antenna. A radar arch or helm hardtop makes the choice a no-brainer. What about a sailboat? Attach it to the mast? On a pole? Gimbal it? These issues are the topic of the great debate but what about the display location? It often ends up at the navigation station by default as the easier part of the system installation.

In my opinion, of the three common mounting locations, the nav station, companionway or the helm, the latter is the best choice. Helm mounting provides instantaneous and constant access for the helmsman for purposes of collision avoidance and offers the best opportunity to expand one's familiarity with and knowledge of the capabilities of the system. On the other hand, the nav station location has several significant disadvantages. Information gained from the radar display must be communicated to the helmsman. This can impair position confirmation and collision avoidance tasks. This out-of-sight mounting also greatly diminishes the opportunity for continuous learning. The companionway is a better choice than the nav station but still limits the opportunity for continuous learning. In most cases the location is too far away to be operated or read easily by the helmsman. Also, helm installation oftentimes requires some major surgery.

Helm mounting requires a suitably sized instrument housing on

Notes:
(1) Fabricate offset pedestal guard from 1.25" OD 316 SS Tubing.
(2) New Guard Feet (2) with SS Mounting Bolts will be required



Notes:

(1) NP142 4 Instrument NavPod (5"H x 20"W)
(2) RP182 Double Radar NavPod (9"H x 20"W)
(3) 831ST-3-100 Stainless GPS Arm with 3" Mounting Plate

DAVID ANDERSON

which to mount the display unit. NavPod (Ocean Equipment, Tel: Web: www.navpod.com) makes a series of UV-resistant marine housings with a watertight silicone O-ring seal for this purpose. Models fit two tube sizes for pedestal guard or rail mounting. If your existing pedestal guard is a straight 2.5cm (1") OD tube with a width of 24cm (9.5") you may be able to use the CP10, the RP41 or the RM71 NavPod units. For boats with a wide Angle-Guard, you could choose the RP182 or perhaps the RM71 NavPod unit.

On "Stand Sure," our Catalina 42 MK1, we decided to replace our existing pedestal guard with a larger 3.1cm (1.25") OD Angle-Guard. Not only is this size a much sturdier piece of hardware, but the increased tube diameter greatly facilitates routing the numerous instrument and power cables from the cockpit sole to the NavPod unit. Though NavPod makes such a guard, the AG10, which accommodates one instrument and one radar or chart plotter NavPod, we decided to design our own to accommodate specific space requirements in our cockpit (as shown in the diagram on the opposite page.) Using a wiring terminal block beneath the cockpit sole facilities both installation and maintenance.

About the author: David and Arlie Anderson took a year's sabbatical, and sailed "Stand Sure" with a fleet to Newfoundland, then headed south down the Intercoastal Waterway to the Caribbean. David's company, Stand Sure Enterprises, designs and builds innovative boating equipment.

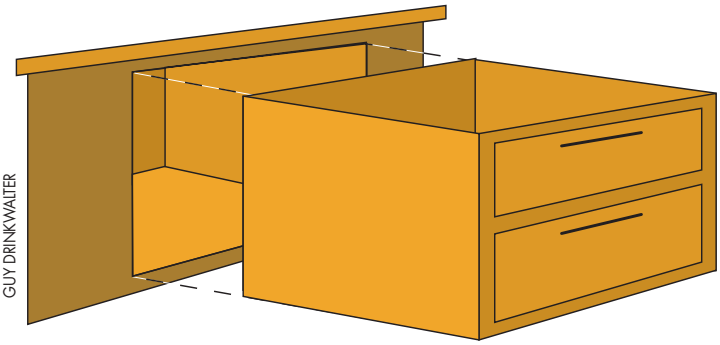
ICE BOX CONVERSION

A galley refit becomes high priority when digging for a cold one involves reaching across a hot stove.

7

Our boat was equipped with the traditional icebox in a far aft corner behind the stovetop. Reaching into the dark, deep caverns of the icebox is nearly impossible not to mention hazardous when the reach exposes your

BEFORE



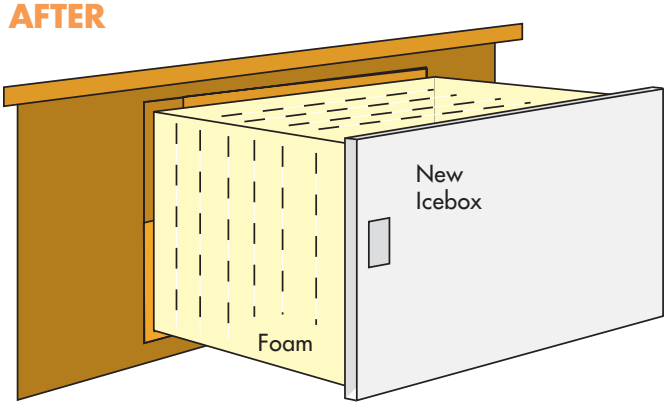
GUY DRINKWALTER

armpit to a hot burner underneath. Having to get supplies for my wife on one occasion when the stove was on moved this project to the top of my modification list.

A two-drawer cabinet assembly presently occupied the only alternate location in the galley area. This spot could accommodate an icebox of roughly 66cm high, 45.7cm wide and 51cm deep (26" by 18" by 20). Finding an icebox to fit this space turned out to be a problem. Though this location was well suited to an electric refrigerator, I didn't want one because it uses too much power to suit my needs and we didn't always have a dockside power supply. No one I spoke with in the marine or RV industry could suggest a supplier. Then I discovered JC Whitney Co., an automotive supply outfit (Tel: 815/667-7700; Web: jcwhitney.com) that also has a great selection of 12-volt appliances. Its latest catalog lists two suitable icebox models in the RVs and vans section. List prices are under US$100.

Installation of the new icebox was rather simple. The teak drawers were removed, and then the four retaining screws and the entire drawer assembly pulled out of the hole and set to one side. Later, I mounted this drawer assembly in another location. After very carefully measuring to find the exact location of the hole to accommodate the new icebox, I cut the liner using a small reciprocating saw. As I made the cut, my wife held a vacuum cleaner hose next to the saw blade to collect the fiberglass dust and lessen the mess in the cabin.

AFTER



GUY DRINKWALTER

Rather than run the icebox drain tube directly into the bilge, it was routed into a large plastic container. From here, another tube connects to a foot pump to pump the melted ice water into the galley sink. This reclaimed water is useful for doing the dishes, washing hands etc.

Granted our new icebox doesn't hold the same amount of food as the original one, it's much more accessible and safer. The original icebox cavity makes an ideal long-term food storage area.

About the author: Donald Boone lives aboard his boat and is an avid DIYer from Sequim, Washington.

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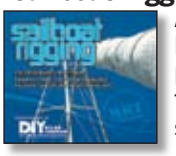

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Good Boatkeeping

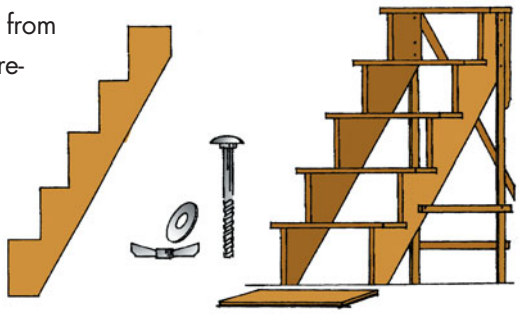
[BY DAVID AND ZORA AIKEN]

BOATYARD GANGWAY

You probably spend a fair amount of time in a boatyard if you enjoy working on your own boat. Boarding the boat when it's hauled and blocked usually intilizes a ladder propped against the hull. It's an obvious solution as long as you tie the ladder to the boat to keep it from slipping and you cushion it to prevent scratching the hull. Easy enough but it gets risky when you're carrying heavy tools and parts and supplies for the job in one hand. Boarding now becomes a balancing act on the narrow, sometimes slippery ladder and you cannot get secure footing. Here's a suggestion for a better boarding device that becomes even more attractive if you're planning a major job.

At the local home-building-supply store, look for stair frames made of pressure-treated lumber. The frames should be tall enough to reach a height where you'll have a comfortable, safe step from the top of the ladder onto your deck. Determine the desired width of your stairway and buy enough pressure-treated planks for the planned number of steps. For example, a 61cm (2') width for the stairs is a convenient measure for dividing the longer planks. Attach the step planks to the two side frames with stainless steel deck screws. In order to make the stairway self-standing, build the back-leg framework with pressure-treated 2x4 studs. Use bolts and wing nuts to attach that framework at the top and back of the step frame. Brace the structure with more studs and more fasteners. Using wing nuts lets you disassemble the back framework easily for more compact storage later.

Where the ladder touches the hull, cushion it with carpeting, some foam rubber or an old fender. At the bottom of the stairs, keep a sample-sized piece of carpet or any kind of footpad for wiping shoes before ascending. Some folks choose to



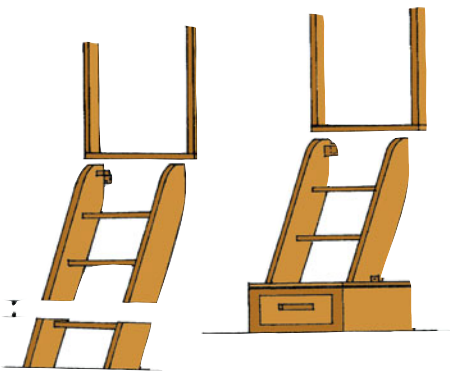
leave their shoes at the bottom of the stairs; in this case, a substantial ladder is most important. Mark the ladder clearly with your name or the boat name and run a section of chain or wire, like that used to lock bicycles, around the top step and through some piece of deck hardware. Secure the chain or wire with a lock. Otherwise, someone might assume it belongs to the boatyard.

A GRACEFUL DESCENT

As companionway ladders go, the original design of ours was not the best. It has only three steps but something about their placement or size makes visitors very hesitant to go below. Even when cajoled into descending, people are overly cautious about each step.

An easy DIY fix made the entry more accessible and provided added space for storage, always a welcome benefit. We always kept a toolbox under the last step but now there is room to stow a larger box or more stuff. A custom-built box now is the last ladder step. As the box top is larger than the original step, it is set further out (forward) from the ladder vertical, making it easier to see or find with a searching foot. Where space permits, you can build the box to fill the full width of the space where the ladder now stands. On our boat, this is the space between the under-sink galley locker below and galley sink to starboard and a separate, narrow storage locker to port. Make the box so the entire top lifts off or you install a drawer into a framed front panel, although this does compromise a bit of the storage space you might otherwise gain. Another option is to hinge or inset a portion of the box top, like a locker hatch.

No matter which design works best on your boat, make the bottom step before cutting off the bottom of the existing ladder. Once the step is finalized, cut the bottom of the ladder so it rests squarely on the step top. Install cleats or other retention devices like hook and eye or slide bolts on top of the box where the ladder legs rest to ensure that the ladder can't slip.



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" published by International Marine.