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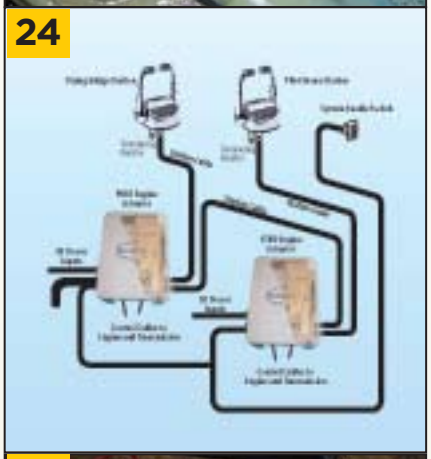


Currents

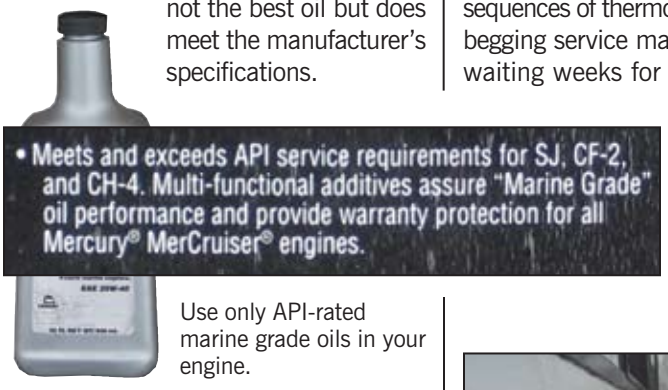
Edited by Jan Mundy

Straight Oil Facts

Just read the Q&A titled "Straight Oil Facts" in DIY 2005-#4 issue and it's not quite clear that multigrade automotive oil is not an option. You do make reference to "marine grade oil". I have twin 4.3L Mercruisers and was wondering if a straight weight quality 30W oil, such as Pennzoil or Quaker State is acceptable?

Brian Hicks, Thunder Bay, Ontario

Steve Auger replies: Mercury Marine has issued a service bulletin that specifies the recommended engine oil for Mercruiser engines as listed here in order of preference: Mercury Synthetic Blend 25W40, Mercruiser 25W40 Marine engine oil or SAE 30 HD automotive engine oil. This means that a Quaker State or Pennzoil straight 30 weight is not the best oil but does meet the manufacturer's specifications.



Use only API-rated marine grade oils in your engine.

All oils are rated according to their flow capability and viscosity. The first number identifies the oil's flow capability at 0F (-18C). The lower the number, the lighter the oil. For example, a 5 weight 30, written as 5W30, flows faster than a 20W30. The second number rates the oil's protection or viscosity at engine operating temperature. The lower the number, the lighter the oil so 5W30 oil gives the protection of 30W oil when the engine is at operating temperature. As most of us use our boats in warm rather than sub-zero temperatures, marine engines require an oil with a slower flow rate and higher viscosity for better engine protection, such as 25W40 oil. Despite the double-digit oil ratings of the first and second oil choices listed above, they are all straight weight not multigrade oils. Marine grade oil, such as 25W40, consists of equal amounts of SAE 25 weight and SAE 40 weight blended together. Furthermore, all marine oils should meet or exceed the American Petroleum Institute (API) ratings of SJ for gasoline engines, CF-2 for two-stroke diesel engines and CH-4 for four-stroke diesels. Be certain that the oil you put in your marine engine meets these specifications.

Winter Dynamics

The answer to off-season cabin fever is to go on the boat during the winter months, inspecting everything inch by inch, grooming and tending to every detail and dealing with marine technicians for needed repairs when they are happy to see me. Come April 1, the boat's ready to launch. I subsequently observe owners arriving at their boats for the first time since November to find the cover torn or loaded with an immoveable pool of water or various and sundry other manifestations of the laws of the unintended consequences of thermodynamics. Instead of begging service managers for parts and waiting weeks for delivery, I'm on the Bay (Chesapeake), enjoying spring. My winter boating activity has every joyous and energizing psychic feature of a successful Easter egg hunt — finding the hidden flaw is exactly like finding the $50 egg!

Dr. Dan McDougal, "Dry Doc," Baltimore, Maryland

Scott Fortier, Grand Haven, Michigan

Prep your boat during the off-season and you won't be caught high and dry come spring.

More Diesel Alternates

Further to your article on sailboat repowering in DIY 2005-#4 issue, I'd like to point out that, for most C&Cs stringer modification is irrelevant. These boats have the standard medium-sized diesel engine stringer spacing of 16" (40cm), even in boats fitted with Atomic 4 engines. To drop in a new diesel with the standard mount spacing in a C&C, just raise the stringers 3/4" (19mm) with a wood strip and redrill the angle iron brackets, about a two-hour job. Even on boats that need modifying or moving the stringers, it's simply a matter of cutting out the old stringers with a grinder, making two pieces of wood the right size (i.e. for a Catalina 27 add 4"/10cm) and installing them with some epoxy resin and fiberglass cloth and then painting them.

Robert Hess, Atomic Four Engine Service (www.atomicfourengineservice.ca).

Not a Certified Anchor Light

Further to your comments on the Davis Mega-Light in DIY 2005-#4 issue, page 2, I installed one on my Ericson 32 in 2002 thinking the less than 1-amp draw would be worthwhile. During a rigging survey last year, I was informed that it was not a legal anchor light so I had it replaced. So much for savings. Davis confirmed that it's not an anchor light and offered to send me a higher voltage bulb.

Chip Lohman, Whispering Swan, Quantico VA

Jan Mundy replies: You're absolutely correct. We checked with Davis and the Mega-Light is not certified for use as an anchor light though it does make

Rising Costs

The DIY team is committed to providing you with the very best reference manual, the only magazine for boaters that is totally dedicated to helping you maintain and upgrade your boat. Every new issue of DIY is packed with technically accurate "how to" that is supported by extensive research and reliable facts and figures from proven boating experts. In order to maintain this DIY standard for excellence in editorial and print quality and to keep pace with rising production, printing and mailing costs, single issue and subscription prices have increased effective March 15, 2006. We value all our readers and hope you'll continue to enjoy DIY. We also invite your input. Please email comments to *info@diy-boat.com.*

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

UPDATED

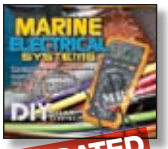
Plumbing 101

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

DIY Mechanic

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

AC/DC Electrical Systems



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

UPDATED

Painting & Refinishing

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

Launch & Haulout

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

UPDATED

Marine Equipment Installations

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

UPDATED

Fiberglass Boat Repair

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

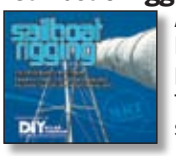
Nautical Necessities

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

Better Boats

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

Sailboat Rigging



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

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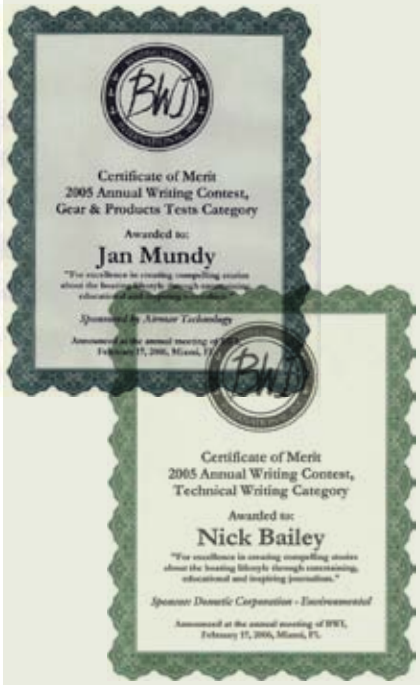
Kudos for DIY



DIY author's Jan Mundy and Nick Bailey were each awarded a Certificate of Merit by the Boating Writers Association.

In the annual writing contest conducted by Boating Writers International (BWI) two DIY writers received a Certificate of Merit: Editor Jan Mundy for "Better Handling the QL Way," published in DIY 2005-#4 issue, in the Gear and Product Tests Category; and Nick Bailey for "Core Doctor," DIY 2005-#1 issue, in the Technical Writing category.

DIY magazine made Coastal Sailing's Top 10 Magazine list. In fact, DIY rated fourth, which is a special honor when you consider the competition from the big publishing houses. To quote Coastal Sailing (www.coastalsailing.net): "DIY…has the most amazing coverage of the things we all have to deal with onboard: things to fix. And even if we don't do it ourselves, it's worth it to learn what is supposed to be done so we can avoid those hugely frustrating experiences with boat yards."

an excellent cockpit light for use when you're onboard or when away and need to find your boat in a crowded anchorage.

Caution When Fastening

The article on the hazards of swimming in marinas (DIY 2005-#3, page 5) brought to mind a similar case of 120-volt leakage from a neighboring boat in the marina where we keep ours and luckily no one was injured. In this case, the leak of AC power to the 12-volt DC system was found to be a mounting screw for a 12-volt device that was screwed into the cabin bulkhead and penetrated an AC power cable. The installation predated the current owner. There is a lesson in this for us do-it-yourselfers and professionals alike. Fastening anything on boats requires special care to make sure that we are working on a surface that is not concealing AC wiring.

Chris Groundwater, Calgary, Alberta

Boatbuilding Guide Back in Print

West System recently released the fifth edition of "The Gougeon Brothers on Boat Construction". With more than 400 pages, this new version includes an updated color photo section and hundreds of step-by-step illustrations. Reflecting 35 years of building with West System epoxy, the book features chapters on lofting, safety, tools and construction methods. It's a valuable resource for amateur or professional boat builders. Cost is US$36.40. Order by phone (866/937-8797) or web (www.westsystem.com).

West System

Gear Lube Installation Dilemma

Regarding the article titled "A Simple Approach to Lube Diagnostics" in DIY 2005-#4 issue, I would like to point out a problem with the instructions, although the weakness actually originates in Mercruiser's instructions. The problem is with the location of the thru-transom hole that must be drilled for the tube that runs from the reservoir on the inside to the outdrive. Mercury provides a template, which positions the hole at a certain distance relative to the top edge of the sterndrive housing. The difficulty is that, on some boats,

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Contributors: Steve Auger, Nick Bailey, Susan Canfield, Tracy Croll, Jim Grant, Lee Mairs, Roger Marshall, John Payne

this results in the hole being below water level. My own boat, a 1984 Doral Citation, is a case in point. Following the template, I wound up with that hole just below the waterline and further below when carrying a moderate load. Because you install the kit when the boat is out of the water, it only becomes apparent that this is the case after launch, when the damage is done. I filled the hole with sealant around the tube and then around the fitting and I check it regularly but it would have been an easy matter and, in retrospect, far safer to simply have located the hole slightly higher and the reservoir correspondingly higher on the inside. There is plenty of flexibility in the kit and tubing provided to accommodate such a modification and no reason I can see to have to adhere to the precise point relative to the sterndrive that the template dictates. The result would have been to avoid an unnecessary compromise to the integrity of the transom.

John Harding, Ottawa, Ontario

Steve Auger replies: As each boat produced differs in transom design, there is no way that one set of instructions covers the ideal installation of any accessory on every boat. Each manufacturer tries to provide instructions that work well with most applications but there are always issues with specific boat designs. Equally, such installation manuals are, by and large, written for trained service personnel, not the do-it-yourselfer, and there is a presumed ability factor. [Ed: Case in point was the installation of Volvo BTS detailed in DIY 2005-#4 issue. It's only because of my 30 years of messing about in boats that I was able to provide such installation details not contained in the instructions.] Your observation on ensuring the fitting is above the waterline was Mercury's oversight and DIY appreciates knowing about such omissions, albeit the design of the thru-hull fitting for the gear lube hose should prevent any water leakage into the boat. In addition, make sure to use a marine sealant at all fasteners.

Top 10 List of Stolen Boats

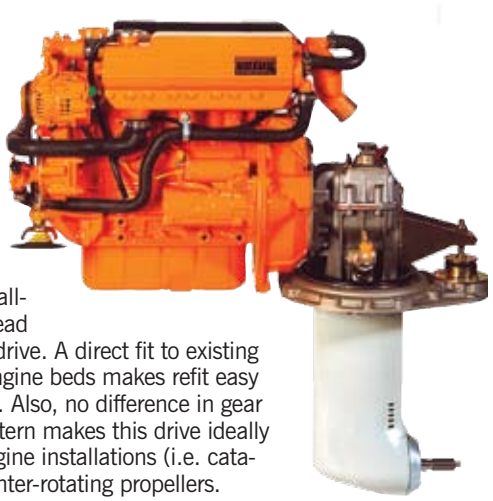
Albeit boat theft is not as well organized as auto theft, it's still big business with 20' (6m) trailerable boats being the most desirable. Below are the top 10 most frequently stolen boats by brand and the chances of their being stolen as compiled in "Seaworthy," the damage avoidance newsletter from BoatU.S. Marine Insurance. It's no surprise that the most sought after boats are personal watercraft.

Manufacturer	Chances per 10,000
Yamaha (PWC)	15.30
Kawasaki (PWC)	12.80
Bombardier/Sea Doo (PWC)	8.19
Mako	7.00
Chaparral	5.22
Regal	4.92
Wellcraft	3.70
Boston Whaler	3.36
Four Winns	3.06
Chris-Craft	2.80
Bayliner	2.5
Sea Ray	2.25

Rebuild Versus Replacement

As our sailboats are getting long in the tooth, coupled with the type of inboard propulsion of the day, many are confronted with the decision of your article titled "Rebuild Versus Replacement," in DIY 2005-#4 issue. It was especially rewarding to read words of a possible can of worms if one does not do one's homework and heed the advice to go for the full meal deal: cleaning, preparation, preservation and a complete overhaul of the entire engine compartment. With all that could go wrong with alignment, I'm wondering if one of the new saildrive engines, providing more power per pound with an integral folding prop, is a reasonable alternative replacement in applicable configurations.
David Bakody, Dartmouth, Nova Scotia

Nick Bailey replies: The choice between a conventional shaft drive versus a saildrive is more often a designer or builder's decision when choosing an inboard engine for a new boat. Despite alignment issues, when repowering it's usually easier to make use of the existing infrastructure of shaft log, bearers, strut, etc. Obviously, a saildrive is designed for a fin keel and spade rudder configuration (not a full keel) where the hull between the keel and rudder is relatively flat or a shallow vee. Nonetheless, there are situations where the old engine and transmission configuration can't be used and a major rework of the bearers, shaft log, shaft angles, strut, etc. is needed just to get enough propeller clearance. In that circumstance, a saildrive could be a better alternative. Saildrives are usually 10% to 20% more expensive than the same engine with a conventional transmission but can certainly be simpler to install due to the absence of alignment issues. Some makes are easier than others. Volvo has a ready-made fiberglass bed available but Yanmar expects the installer to make one. I'm not sure whether saildrives have any efficiency advantages over a shaft drive with a similar prop. Generally, saildrives have proven to be reliable; one concern, in saltwater particularly, is that the aluminum saildrive is vulnerable to stray current and galvanic corrosion. This requires regular monitoring of anodic protection (a.k.a. "zincs") and maintenance of the saildrive paint coatings to avoid more serious repairs.



New Vetus (www.vetus.com) saildrive, developed by ZF-Hurth, is available in two models with transmission ratios of 2.16:1 and 2.52:1. Reversing the outdrive by 180° enables installing the engine ahead or behind the saildrive. A direct fit to existing Volvo saildrives engine beds makes refit easy in this application. Also, no difference in gear ratios ahead or astern makes this drive ideally suited for twin-engine installations (i.e. catamarans) with counter-rotating propellers.

Recording Bilge Water Levels

A bilge pump cycle counter tracks how often an automatic bilge pump is activated but keeping track of how much bilge water a manually switched pump moves is a different issue. On many small boats, the user must remember to pump out the bilge and constantly monitor water levels. Since many people are in the habit of turning on the pump to dewater the bilge as soon as they come aboard, the question arises, "How much water am I pumping out and how much did this boat leak while I was away?"

To get a handle on leakage rate and directly measure how much water goes out, it should be possible to hook up a meter to the bilge pump outlet hose. This reduces pump efficiency and can involve an investment in an expensive Navman electronic fuel flow sensor and display for the job or a smaller investment in an inexpensive little mechanical water volume counter device sometimes fitted on a garden hose. Another way to measure water volume pumped is to time how long the pump runs. Assuming a constant flow rate, a digital kitchen timer mounted near the pump switch could serve as the manual timer. This requires initially calibrating the outflow rate in gallons (or liters) per minute by collecting water in a measuring container over a measured time period. If your goal is to meter the actual bilge water level, say from full to empty, just adapt a tank level sender with float to read out the bilge level on a meter at the dash. (Some clever person should market a float switch that does just this.) There are lots of high water alarms on the market that let you know when bilge water reaches the alarm trigger float switch. Three or four of these float switches could be set up at different levels with indicator lights to show low, mid, high and dangerous bilge water levels. A big siren and strobe could be rigged to go off at the "danger" level and could page your cell phone or send an email alert by wireless Internet.
— Nick Bailey

Trojan Battery Specs Revised

If you plan to use 6-volt Trojan T-105 batteries on a boat, you need to be aware that the standard T-105 battery now has a short terminal post and a short threaded terminal. Much too short to properly attach two cables on the threaded terminal, such as needed to connect them in series to supply 12-volts, and impossible to attach three cables on one post. Also, the round post is too short to use an adapter. According to Trojan, to use the T-105 batteries in a marine application, specify the marine dual terminal or APW terminal, which supposedly has longer terminals. My dealer didn't know this and I didn't notice the difference in the posts until I went to install the batteries. This may be old hat to some but it's a change since I bought Trojans two years ago.
Tex Hill, Pensacola, Florida

Pat Kearns comments: Threaded terminals use wing nuts to secure the cable connections. These nuts tend to vibrate loose, creating a high-resistance connection. Use only the bolt type terminals for battery cable connections. In the day-to-day course of my survey practice, I find 50% of the wing nuts loose on boat battery terminals.

(top) Good practice for connecting to the battery stud fittings but corrosion will defy their integrity. (bottom) A mix of good connections (bolts) and bad (wing nuts). Loose nuts result in a loss of power.

Patricia Kearns

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River Queens Wanted

DIY reader Mike Wolfe has launched a River Queen registry on his website (www.mikewolfe.us/The_River_Queen_Registry.htm). Owners complete an e-form, send a few favorite photos of their boat's profile, bow, stern and interior and Mike posts the information, organizing the boats by hull numbers. "Like a family reunion, this gives us an opportunity to see all River Queens still in existence, learn their configurations and interact with their owners all in one location," says Mike.

River Queens owned by (top) Scott Fortier, Grand Haven, Michigan and (bottom) Mike Wolfe, Stockton, California.

Is Insurance Available for Boats in Rehab?

When a DIY reader contacted us after a fire destroyed the nearly completed boat he was building in his backyard only to learn later that he had no insurance coverage, we decided to investigate. Years ago, a DIYer could insure their boat at various stages of building provided a surveyor reviewed the value at each stage. It can still be done but it's not easy and it's very expensive in today's insurance market. In the case of rehab boats, their condition at the point of acquisition often means they are not insurable. As progress is made, a surveyor can verify the increase in value but it must be a defensible and substantial increase in value.

According to Al Golden of International Marine Insurance Services (www.imiscorp.com), Builder's Risk policies are available for refit projects but because commercial marine departments typically underwrite them, they have rather high minimum premiums. A rare boat, valued at big dollars, even at the earliest stage of a refit, is probably a likely candidate for this kind of coverage as replacing it, at any stage of the refit, would far exceed the investment in a year or two of insurance premiums. I suspect that, for most refits undertaken by DIYers, the cost of builder's risk coverage could significantly compromise the money saved by doing it themselves. This kind of coverage is readily available to professional boatbuilders and it protects their under construction inventory.

The main risks involved could extend to storm damage and the other usual risks associated with a boat under construction, being refit, etc. while on land or dockside but not those risks associated with using the boat. A DIYer could also look into "port risk" coverage (boat cannot be used), which is an indemnification against perils that could be suffered solely while in port. There is still the option of insuring a boat "as is" provided it can be insured and later update the coverage and value of the boat with a survey and appraisal for current market value, either at the end of the project or along the way at intervals, which requires that a surveyor affirm the boat's condition and value at every waypoint. In any case, DIYers needing to protect themselves against the loss of their project should shop carefully for the right coverage product. It won't be found in the usual options for boat insurance but it's out there and the same kind of coverage that a big builder can get may be adapted by special underwriting to cover a single boat project. It may be elusive and/or expensive, and the latter is a very subjective call cloaked in the adage, "penny wise, pound foolish."

— Pat Kearns

Meter, meter on the hull, who's the driest of them all?

When evaluating the health of a fiberglass hull, it's important to remember a moisture meter is just another tool and getting reliable results require intelligent use of a meter in conjunction with other diagnostic tests and a knowledge of how boats are built.

By Patricia Kearns

Patricia Kearns

"Relative" differences in meter readings of a fiberglass hull at the (top) waterline and then just (bottom) below.

In my day-to-day practice, I'm often asked "how wet is it?" I hear of or see reports of a surveyor who has proclaimed a boat bottom, in terms of moisture content, as "wet" in an arbitrary percentage. "The moisture content of the laminate is XX%." If you're hearing that from a surveyor, run, run, run and seek a second opinion.

A modern moisture meter, used in marine applications, is not a complicated device. These meters were originally developed for use in the construction trades, where knowing the moisture content (relative wet/dry condition) in lumber, roofing materials and concrete is a key to the success of a given material's performance in its integration within a building structure. Meters operate on a relatively simple technology that "measures" moisture content in a material, in this case, a fiberglass laminate, some of which is a composite sandwich of two or more materials. The oldest and most common meters use the resistance principle that reads a resistive electrical current as it passes between two contact points. Other meters use radio frequency to conduct a signal.

The true good that these meters can do is to non-destructively alert us to areas of moisture entrapment on our boats, places where water, if it gets stuck, can do a great deal of damage to the laminate. Besides a boat's hull, these meters are very useful in detecting potentially damaging moisture on decks, bulkheads, stringers, transoms, engine bearers and anywhere where microscopic pathways allow water to migrate into encapsulated wood or other materials used in a laminate panel. Here's where a quick check with a meter can spot problems around deck-mounted cleats, winches, hatches, sailboat chainplates or anything else that is screwed, bolted or otherwise fastened. In these applications, finding the symptom can stem the damage long before a tiny water entrance point becomes a soggy mass of deck core that results in a big repair bill.

When the meter sounds its telltale "beep," it's alerting the user to the fact that it's detecting the presence of moisture in the laminate. Being able to quantify how much and how deep into that laminate structure the moisture goes is in the skill of the meter user. No meters give readings that can be related to anything other than the arbitrary scale on the meter itself and that depends on what the meter maker has established as its reference for a moisture level. That reference point still has to be correlated to an area of the hull laminate that has not been exposed to immersion.

When attempting to assess the health of a fiberglass hull, these non-invasive diagnostic tools are reliable only when their results can be corroborated by other widely used field testing methods that, unfortunately, at this point in survey technology, often means invasive tests and/or laboratory analysis of laminate samples. The surveyor starts with a visual overview, taps with a hammer (percussion sounding) and applies a moisture meter. If one or more of these techniques suggests problems, such as laminate debonding, blisters, moisture intrusion into the laminate and/or suspected wet core, he can speculate on the cause, nature and extent of the condition (not a good idea) or recommend further testing (the best approach) by a qualified repair facility. X-ray, though possible, is very expensive and may be inconclusive. Infrared themography, which uses a special camera that detects temperature variations in a tested material, has proven useful but is very, very expensive and is reserved for quantifying and qualifying the most mysterious and elusive symptoms. What is often the most practical option involves physically invading the structure by destructive means to reveal the laminate, layer-by-layer, for a surgical view to complete a diagnosis and prognosis.

Nick Bailey, a DIY contributor and the service manager of a busy repair yard, says yards use meters to establish the "cut line." "Because we fre-

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quently get to follow up the moisture readings with surgery we have a pretty good idea of what to expect inside a laminate that pins the meter at full scale deflection," explains Nick. "Nonetheless, we are not inclined to cut unless the whole story of what the meter reads is clear to us. When we can trace ever-higher readings to a plume of moisture at a deck fitting, we know exactly what we are facing. When the meter pegs on a cored hull below the waterline and the hammer gives a sickly dull thud, there is not much doubt in our minds what is happening."

For those of you who want to get into meters, Jonathon Klopman, a marine surveyor colleague of mine, has published several fine articles on moisture meters, including comparative tests of their performance, on his website (www.jklopman.com).

The most important thing to remember about moisture meters is that they can howl foul and the needle can peg the scale but nothing verifies just how much water there is in the laminate being metered without conducting other testing. Even so, moisture meters and their readings are important diagnostic tools for surveyors and repairers who use them judiciously. "A meter reading is not enough to make a final judgment but it can sure be a good start," says Nick. "It is the only tool that will give a clue to insidious seepage into a core, especially at deck hardware mountings, early enough to address the problem by simply rebedding the fitting." This ability alone makes a moisture meter indispensable as a preventive maintenance tool.

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

ASK THE EXPERTS

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Head Connections

Q: My new electric toilet has a macerator with the outlet nearly level with the inlet spigot on the holding tank. Do I run the connecting hose straight into the tank from the toilet?
Jim Ciceri, Penetanguishene, Ontario

A: I don't see any reason why you can't plumb the toilet straight to your holding tank. A full holding tank should not allow sewage to flow back into the toilet because there is usually a one-way choker or duckbill valve on the toilet flush pump to prevent back-flow. You might eventually have problems with this if any debris gets caught in the valve, causing it to stick open. If your system is set-up with a diverter valve to discharge overboard where legal, you will need to route the discharge hose up as high above the waterline as possible and connect to a vented loop. The vented loop will allow air into the line to stop siphoning of seawater (via the discharge thru-hull) that could sink an unattended boat.
— Nick Bailey

Install anti-siphon devices in all overboard discharge hoses to prevent siphoning seawater that could sink your boat.

Optimal Diesel Running Temp

Q: My 1985 O'Day is in very good condition and I maintain it as best I can. The M12 Universal diesel engine is reliable and has never been a problem, although I did replace the exhaust system last fall. It rarely operates over 140F (60C). Even against a 2 knot current or 40 mph head wind the highest it ever gets is 155F (68C). Some sailors say that it's running too cold. Is it?
Pete Pierson, Albertson, New York

A: If your engine is raw-water cooled, then it's operating correctly. In fact, if you use the boat in saltwater you might want to reduce the operating temperature by replacing the thermostat with one with a lower temperature setting. There is a lot of myth surrounding the durability of raw-water cooled versus freshwater-cooled engines. A lot of folks think the former may operate more efficiently at higher temperatures. The only way a raw-water engine running in saltwater clogs up is if it's running too hot. Many older raw-water cooled diesel engines live long service lives while chugging along at 110F (37.7C). Problems start when over-zealous owners replace the OEM low temperature thermostat with a high temperature thermostat so they can create a hot water supply. The unintended consequence is salt precipitating out of solution if the temperature gets much above 140F (60C) and encrusting the cooling water passages in the engine. Eventually, the operating temperature keeps rising until the overheat alarm ends a great weekend of sailing.
— Lee Mairs

Pollution Fighters

Q: More and more attention is being given to fuel spills. In marinas and at fuel docks, fuel spills are the responsibility of the property owner who can be charged for clean up costs and be subject to a fine. The fuel gauge is certainly not an accurate enough alert to a filled tank and neither is waiting for the sound from the air vent to cease. It's electronically very simple to make an alarm that sounds when the tank is full. Are you aware of any such device in production or being installed by manufacturers?
A. Kirk, Salt Spring Island, British Columbia

A: We're not aware of any electrical devices but there are a few mechanical devices to prevent vent line overflow of gasoline or diesel from contaminating the environment during refueling. Racor Lifeguard is an inexpensive device that is easily installed in the fuel tank vent hose. It separates air from fuel, venting the air and returning fuel to the tank. For larger boats, Vetus Splash Stop (refer to DIY 2001-#4 for installation particulars) routes excess fuel back into the fuel tank from the fuel intake line and eliminates deck spills. There's also Davis No-Spill, a simple device with suction cups that you stick to the hull at the tank vent to capture fuel spilled exiting from the vent while refueling, which is better than nothing at all.
— Jan Mundy

Various mechanical fuel recovery systems to stop fuel spills while refueling range: (top right, clockwise) the US$22 Davis No-Spill; US$90 dual-purpose Vetus Splash Stop; US$95 Racor Lifeguard.

Cure for Low Speed Stalling

Q: My 1990 Cadorette Holiday 280 is powered by twin 5.0L V8 engines with approximately 850 hours. Lately, after running the boat for about one hour, the port engine quits when throttling down to neutral or idle in preparation for docking (really bad timing). It idles fine when first started and continues to run smoothly with the boat on plane or even at 1,500 rpm. Water temperature is normal but I have noted that the oil

pressure drops below 40 psi and the engine seems to be having difficulty idling. I notice small rpm fluctuations on the tachometer when throttling down to idle. This engine also stalls when I shift into neutral or reverse, unless I rev the engine while still in gear. The engines were tuned last year (points, plugs and condenser). The PVC valve appears fine and the spark arrester has been cleaned recently. Someone suggested the fuel filter or fuel pump. Any ideas?
John Latulippe, Amellasburgh, Ontario

A: I would try to duplicate the symptoms again and, when the engine stalls, turn the key off and inspect the spark plug tips. If they are black and wet you likely have a flooded carburetor, which I think is your problem. With a fuel filter or fuel pump problem the engine would run fine at idle but with decreased power at speed and the spark plug tips are white. Also your 1990 Mercruiser should not have points in the distributor as Mercury has installed electronic ignition on all V-8 models since 1985. This electronic system does require the correct voltage and low voltage causes a weak spark and in turn stalling. Using a multimeter on the 12-volt DC scale, ensure that, with the key on, you have a minimum of 12 volts at the positive connection on the coil (purple wire). If you have the required 12 volts, I would be taking a serious look at the carburetor.
— Steve Auger

Black and wet plug tip suggests flooded carb condition.

Longevity Linked to Engine Hours

Q: I am searching for a used 200-hp outboard motor. I have located a few that claim to be well maintained; all have over 600 hours on them. I have located others that claim to have as little as 200 hours and their price reflects this. What comprises "high" hours? Do engine manufacturers set limits for the maximum operating hours of an engine's life?
Lyle Pare, South Hadley, Massachusetts

ASK THE EXPERTS

Help line info@diy-boat.com

A: There is no cast in stone limit on engine operating hours but historical data suggests that a well maintained and properly operated two-stroke, carbureted outboard has a service life of around 1,000 hours; EFI outboards a little longer; four-stroke, EFI outboards a little longer still. Gasoline inboards and those with sterndrives should run around 2,000 hours before requiring major engine service. Since most pleasure boaters in northern regions only put 40 to 60 hours a season on their engines, an average 5-year old engine would have around 200 to 300 hours. If the engine hours don't jive with the engine age, the engine may have been used in commercial service, a much harder life than recreational use.
— Steve Auger

Diesel Rebuild Time

Q: We have just returned from 5 years sailing in the Caribbean and are now on the hard. Our boat's 3GM30 Yanmar

engines with saildrives have about 1,500 hours on them. During the last 200 to 300 hours, one of the engines has been leaking oil out from the breather. This condition is worsening progressively. There is also white smoke exiting the exhaust. There has been no loss of power and the engine sounds great. The breather has been taken off and doesn't appear to have any problems. What next?
Donald Pole, "Polecat," Wilmington, North Carolina

A: Oil around the breather is a pretty sure sign of piston blow by and crankcase pressure. This coupled with white smoke would lead me to believe that this engine has either a damaged piston or rings. Many times this type of damage is the result of a leaking injector. I suggest that you do a lube oil analysis on the oil in both engines. If my suspicions are correct, you'll find fuel in the crankcase as well as some wear metals from pistons and cylinder. There is the slight chance that the white smoke signals a cold running engine.
— Bob Smith

Blister Fabrication

Q: I am thinking of purchasing a Grampion 34 but the survey says that the hull has some blistering. I approached a marine repair shop concerning the repair and was told that the repair is not guaranteed and that it can develop into a major problem if the boat is taken to a warm climate for a year or so. Another source tells me not to worry as it is only cosmetic and redoing the hull with gelcoat most likely solves the problem and that it's caused by changes in temperature. I like the boat and the price is right. Who should I believe and is stripping and repainting the hull the answer?
Bruce Penn, Toronto, Ontario

A: Blistering may or may not be a big deal. It all depends on how severe the problem and the opinions you have heard reflect opposite ends of the spectrum. I disagree that blistering is caused by temperature changes. If you boat in regions where boats are hauled out for the off-season, blisters may never develop into anything that threatens the boat structurally. You could repair minor blisters with gelcoat and it's true that only a few highly skilled repairers with extraordinary reputations for the success of their repair work will warrant a blister repair. Why should they? They did not build the boat or manufacture the original materials or the repair materials. The most important factor in preventing new blisters after a repair is done is to ensure the hull is very dry and that all the degraded laminate has been removed before relaminating and applying any barrier coating. Hauling out every winter does seem to retard the development and/or progress of blistering. (For complete step-by-step blister repair refer to DIY's MRT Series "Fiberglass Boat Repair" CD-ROM.)
— Nick Bailey

Here's how to survey, repair and help prevent osmotic blistering of the wetted surface (hull bottom) of a fiberglass hull. Available on CD-ROM for US$19.95.

[Ed: Blistering causes and cures have been a topic of debate among boat builders and repairers for decades. The temperature of the water in which a fiberglass boat is used is a known and accepted factor in the development of and the extent of damage to the bottom laminate from blistering. Warm freshwater is the environment in which blisters are most likely to form on fiberglass. Warm, saltwater is the next most blister friendly environment and there are degrees of the effects of both the former and the latter. Blisters do not seem to form or propagate as readily in cold water (fresh or salt) and boats sailed in these waters, while not immune from blistering, are the least likely to suffer the problem. The fact that they spend a substantial percentage of their life in off-season storage is an aid to deferring their development. The big variable is that boats move around and a boat kept in Maine for 10 years without blistering can become a blister nightmare after a few seasons in tropical waters or on a southern freshwater lake or river. The chemistry and physics of fiberglass blistering is an arduous study in molecular engineering and a true understanding of the topic is usually something the average boater tackles. The black magic and myth that surrounds blistering no longer needs to be suffered by boaters. It's a science that has been thoroughly researched and the methods and materials used by builders of new boats today will likely spell the end of blistering as we have known it.]

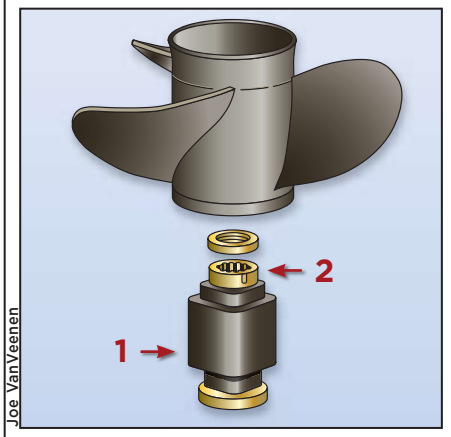
Prop Hub Service

Q: I have 13-year-old stainless steel propellers mounted on two Evinrude 175-hp outboards with approximately 600 hours on the props. The boat cruises at 27 knots and is capable of 40 knots. When do I have to worry about the rubber breaking down in the hubs and winding up with a spun hub at a bad time. As you know, you can only inspect the outside, which doesn't let you know what is going on inside the hub.

Larry Cole, Mississauga, Ontario

A: There is no set time for rubber propeller hub replacement. I would inspect the rubber hub for cracking. If the prop has been slipping on the hub, check the large prop thrust washer that sits on the taper of the propeller shaft for wear marks on the taper of the prop shaft and the thrust washer. Most modern props use a square shaped composite hub that does not require a large press to change the hubs, such as the Mercury Flo-Torq II prop hub system. These modern props allow the operator to change a damaged hub with simple hand tools. Another option is to purchase an inexpensive spare prop to keep on board for emergencies.

— Steve Auger



Joe VanVeenen

Components of a propeller hub: (1) cushioned rubber hub, round or square; (2) inner splined bushing.

Patching Aluminum

Q: I purchased a 32' (9.7m), aluminum Marinette. In applying Trilux on the hull, I discovered that, at some point in the boat's 40-plus year history, it hit something hard causing a major dent in the aluminum. Someone filled it with what looks like automotive putty. I need to grind out all the filler and knock out the dent but in doing that, I'm afraid I might actually put a hole in the aluminum where there is not a hole now. What filler should I use and how best to apply it?

Richard Dugger, "Brenda Gale II," Gulf Shores, Alabama

A: If the previous dent filler is in good condition and well adhered I would not feel compelled to remove it. I also agree that there is some risk trying to hammer out the dent. If you want to replace the old filler, proceed as follows. First use a grinder and 36-grit disc to remove the old stuff and abrade the underlying aluminum to that legendary clean-sanded

surface the coatings guys refer to as "bright metal." Clean off any dust and degrease the area with a solvent. Next, most paint systems recommend a primer wash, for example, Vinyl Lux Primewash 353/354, and follow up with an epoxy anti-corrosion barrier primer (Interprotect 2000E) and then an epoxy filler (VC Watertite), followed finally by more epoxy barrier primer and then Trilux anti-fouling.
— Nick Bailey

Odorless Plumbing

Q: I would like to replace a 12' (12mm) 1-1/2" (38mm) hose from the head to the holding tank. I have been reading about the merits of hard plumbing. Will PVC pipes calcify as much or as fast as sanitation hose does? Should the pipe be mounted in sections so as to replace or clean as needed?
Marshall Harris, "Ka Honu," Key West, Florida

A: PVC Schedule 80 pipe, the common black or white pipe used for domestic plumbing and available at hardware and home improvement stores, is now the recommended "hose" for sanitation use. The lone benefit of the pipe is that it's completely odor impermeable. Since this pipe is vulnerable to damage from vibration, you'll need to support the pipe every 18" (457mm) and use smooth walled, flexible hose at bends and sharp angles. Over time, calcification will occur inside this pipe just as it does inside any hose.
— Jan Mundy

Tips to Weld Stainless

Q: I want to replace the stanchions on my boat and I'm looking for tips on welding stainless-steel tubing.
Victor Camaiore, "Joyful," Harrison Township, Michigan

A: Stanchions, more so than rails, require strong welds that won't fail since there are no other supporting structures. The only thing between you and the deep blue sea is a single tube on a base. Believe it or not, it's comforting to see a bent stanchion after impact because that means that the weld (and the deck) has survived the trauma. When professional shops repair stanchions, they sleeve the pieces to be joined and leave a gap between the two parts for welding with filler rod. The same technique applies to bases. The welds must have sufficient filler rod and good heat penetration on both the tube and the flat stock to insure a strong weld. Sanding, blending and polishing takes real talent and a lot of practice to make the weld invisible. If it's done with the correct tools and lots of patience, a respectable job will result. Do-it-yourself-ers are best advised to take a welding course.
— Jan Mundy

Weld strength is key if stanchions and bases are to withstand an impact.

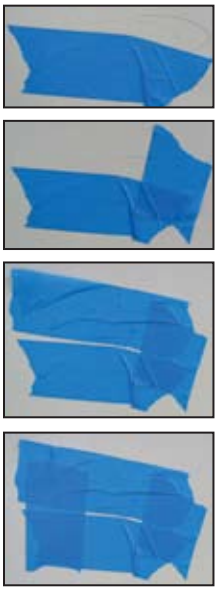
Leak-Proof Hatch Seal: To seal hatches against the freeze-thaw-damming and leaking problems we have in our harsh Michigan winters, we press (as demonstrated

in the photo by my 14-year-old son) some 3/8" (9mm) foam rope sealant, available at Lowes for about US$10 for 50' (15.2m), into the bow hatch, three aft hatches and under the slider doors.
Scott Fortier, "Mon Ami," Grand Haven, Michigan

When Appearance Matters:

Duct (not duck) tape, a.k.a. handy man's solder, may be convenient to use but looks unsightly onboard boats. You can now hide the gray by using 3M Marine's new transparent duct tape that virtually disappears when applied. It results in a more esthetically pleasing, temporary repair and also lasts six times longer compared to other heavy-duty duct tapes.

One-Pull Tape Trick: Next time you tape around something to isolate an area for repair, paint, etc., lay the tape down in a clockwise (or counterclockwise) fashion, overlapping the ends, so that, when it comes time to remove the tape, simply pull up the first tape strip applied and all the other pieces will follow.



Friction Sand: If your work is moving around when hand sanding and there are no clamps or a vice handy, a sheet of non-slip material placed underneath the woodwork provides a high-friction base.

Painless Sealant Stripper: Removing sealant residue with the 3M Stripe Off Wheel is faster and easier than solvents or adhesive cleaners and the residue comes off without scratches or damage to gelcoat or painted surfaces.

Anchor Rest: We spend many weekends on the hook at Southern

California's offshore islands and our powerboat would rock-and-roll all night just like the other boats in the anchorage until I installed a Magma Boat Stabilizer. Now the boat rests relatively still.
Frank Roberts, Calabasa, California

Nut Chooser: When you need to drill a hole for a bolt, use the nut to test bits for the proper size.

Straight Lines: The easiest way to get a nice, straight tapeline is with a laser level and then taping along the projected line.
Scott Hartill, Keswick, Ontario

Scale Remover: Normally, it takes a lot of scraping with a plastic scraper (or metal one if you're careful) and elbow grease to remove hard scale off bronze propellers. This job will progress faster using the mechanical advantage provided by a Scotch-Brite Purple Clean 'n Strip XT Roloc Disc (part number 03171NA or 03172NA) inserted in a drill and soaking the prop in CLR, a household cleaner.

Simple Tank Repair: To repair a polyethylene holding tank, purchase an epoxy made for radiators and plastic and available from automotive stores. Thoroughly clean the area with solvent and then lightly sand to give it some "tooth." Mix and then apply the black epoxy on the inside and outside of the tank, working fast as it sets up quickly.
Don Williams, Waterdown, Ontario

Rust Blocker: To keep tools corrosion-free in a boat's damp environment, place them in a gasketed toolbox lined with a chemically impregnated rust-inhibiting paper, such as Bull Frog Blocker Shield. Also slip some of this paper inside electrical panels or enclosed electronic devices to protect them from corrosion. Be sure to replace the paper annually.

TECH TIPS WANTED

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The Perfect(ion) Solution

Interlux claims that any do-it-yourselfer can match a professional spray paint finish with its newest two-part paint. This amateur puts Perfection to the test and discovers that it's worth the marketing hype.

Story and photos by Jean Paul Vellotti

Author's boat sat neglected at the back of a yard for years and the hull was coated with mildew, which came off with a power washer.

When Interlux released a new two-part polyurethane paint, dubbed Perfection, it opened up a whole can of expectation in the marine industry. Perfection is the replacement product for the highly successful Interthane Plus and aims to be the choice of the do-it-yourself crowd. Still, with an average price of US$60 per quart, many backyard boat-builders may scoff at the cost and choose a single-part polyurethane paint.

Interlux claims the real secret to Perfection is that you can achieve boat yard quality work in a DIY setting. That level of appearance is elusive with a single-part paint unless you plan to spray on the finish. (Interlux strongly advises against spraying Perfection unless you can follow stringent safety standards.)

Perfection is formulated with special flow additives that give the finish applied with a brush and roller the look of a professional spray job. My own test paint job resulted in a smooth gloss and smoothness that compares well to the factory gelcoat finish on my father's center-console fishing boat.

In fact, due to the effect of rolling versus spraying the coating, I would argue that the finish on my boat is thicker and harder than the sprayed gelcoat, which should translate to a more durable and longer lasting finish. According to Interlux, the added polyurethane resin in Perfection improves durability and resistance to finish damage from inevitable topside abuse. Interlux suggests that the paint can also be used on masts and decks. The coating for decks will need the addition of Interlux Interdeck No-Skid 2398c and a flattening agent to reduce glare.

As with most projects, the secret to success is in the preparation. The final painting portion of my project took only a few hours but, after days of sanding and filling, seeing the professional quality results was encouraging.

Temporary Quarters

I tested Perfection on a 1962 24' (7.3m) Schroeder sloop that I had my eye on for several months. This boat sat neglected in the back of a local boatyard for over 10 years and different colors of peeling paint told me it had already been painted several times. After negotiating with the owner, the boatyard released the boat and I had it hauled to my home. There, safely in its cradle, I assembled a 10' by 20' (3m by 6.1m) canopy that I bought at a national discount club for around US$150. I felt the canopy was a justified expense for the painting project because a backyard is not exactly the most sterile environment.

The canopy also helped me control the sanding dust, a consideration that helped keep the friendship of my neighbors. I did worry that someone might call the Environmental Protection Agency, so I laid a plastic sheet on the ground. I felt environmentally friendly after capturing about a gallon of sanding dust, something you certainly wouldn't want to leech into the ground.

Hull Prep

As much as I wanted to grind away the old paint, I first had to remove the wooden rubrail, an outboard bracket, a swim ladder and various vinyl letters and numbers. The vinyl letters were easily removed with a plastic putty knife and some patience. They had been on the boat so long that their outlines and sticky reside still remained. This residue came off easily once I got to the sanding phase of my project. [Ed: A better method to remove vinyl letters and graphics is with a Ferro Stripe Eliminator. It safety "erases" the vinyl, there's no risk damaging the hull and it leaves no sticky residue.]

The wood rubrail and caprail were held in place with bolts covered by bungs, which meant removing the bungs to access the fasteners. To do this, I drive an ice pick into the center to cause a crack in the bung and then I use the tool to pick out the debris. Removing the bolts was trickier as I had to remove some interior trim work to get to the nuts. Although I had a helper for the majority of the project, I was able to remove the bolts myself by attaching vise-grips to the nut and working the bolt loose on the outside of the hull.

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The worst of the paint, near the top rail aft. I had to remove this rail so the paint could flow underneath. This section required 60-grit paper, followed by 80, 120 and a final sanding with 220-grit paper.

I removed the swim ladder and outboard engine bracket and I was able to parlay them at a marine salvage yard for a pair of cowl vents to be installed later.

I rented a power washer for US$45 per half-day and that effort paid off by taking off all the grime and mold and blasting away lots of the peeling paint. Be sure you wear safety goggles when power washing.

Sanding by the Numbers

Interlux recommends using Fiberglass Solvent Wash 202 or Fiberglass Surface Prep YMA601 to remove all wax and mold release agents prior to sanding. I was confident that, since this hull was painted and hadn't seen wax in years, I didn't need to follow this step but just to be safe, I washed the hull with 202 and let it evaporate before sanding.

I used two different sanders for the project, both variable action adjustable models. One was a 5" (127mm) and the other a 6". I had used the larger sander on a wooden boat with good results but worried that it might not give me enough control to prevent gouging the fiberglass, though both tools had foam backup pads. I found that, as long as the variable speed was set to low, I had no problems. The benefit of the 6" model is obviously a faster work time. The detriment, however, is that it weighs more and it doesn't work well on the curve of the hull.

My workflow was to use the larger model in the flats of the hull and the smaller where the other wasn't effective or when my arms were tired, which was often. On a worn boat like mine, it took nearly a full day to sand the transom, so plan accordingly. I learned that the best way to prevent gouges is to put the sander on low, make contact with the hull, then raise the speed gradually.

The paper that I found worked best was 80-grit open cut. I was able to buy this at the local hardware store in packs of 10 and I would estimate I used at least 50 discs for the project. I also used 60 grit in areas that were incredibly stubborn. When all the paint was removed, I went back with 120-grit paper to smooth out the surface and then finished up with 220 grit before applying the primer.

A major reason the sanding took so long was that Perfection is a two-part paint and can't be applied over a one-part finish so all traces of old paint must be removed. To be sure of this, I tried using the recommended primer, Epoxy 404 Barriercote, over a sanded area of single coat

The 6" (152mm) orbital sander that I used for most of the project. The residue of the vinyl letters came off easily with the sander.

Various states of sanding progress before I applied InterStrip. The gray areas are where all the paint has been removed. Once the paint remover dried, the paint flew off the hull with my sander, saving me hours of work.

paint. The primer bubbled the underlying paint within hours. Keep in mind that my boat had multiple old layers of paint. Boats with gelcoat rather than paint finishes sand more easily and should require a finer grit paper.

I was able to get some relief during the sanding phase after time on the excellent Interlux Technical Support Line (800/468-7589 in North America). A rep recommended I apply InterStrip paint remover. I bought a gallon at West Marine, put on my protective clothing, and used a throw-away brush to apply a thick coating of the product. The gallon of remover was just enough for my boat.

I kept my eye on the progress of the stripper but, after 24 hours, nothing peeled away. Had I been swindled out of US$85 and a day's work? Amazingly, when I went back to sanding, the paint flew off the boat. My recommendation is to use InterStrip first, then attack the sanding part of your project. Finish up by washing the hull with 202 solvent and let dry.

Filling and Fairing

Once the fiberglass was bare, I needed to fill and fair the hull to create the smoothest possible surface. In particular, I needed to fill several gouges, a few deep sanding marks and the bolt holes where the swim ladder and engine bracket had been mounted. For filling, I chose to stay with the Interlux family and used Interfill Epoxy Filler, which is a two-part product that dries extremely hard.

A little of this product goes a long way, so you don't need to mix very much of it. After incorporating the two parts in a mixing pail, I used a plastic putty knife to force the filler in the cracks. For the bolt holes, I put blue masking tape on the inside of the hull to prevent the filler from seeping through.

The filler dried hard within hours but I waited 24 hours before sanding it flush using 80-grit paper. In some areas, I needed to apply a second coat of filler, which added another day to the project.

I felt Interfill wasn't the best choice to fair the hull for several reasons. In my opinion, it's too thick and sticky to be spread out with a wide fairing board. It also dries too hard to sand with a fine grit paper and, considering how many cans it would take to fair the hull of my boat, it would cost a fortune. My solution was to use Interlux Epiglass Epoxy 9000 with Epiglass 450 Lightweight Filler Powder.

To accomplish this, mix a small amount of epoxy as normal in a 4:1 ratio and then slowly mix in the 450 powder. The more powder you add, the thicker the compound. This takes a little practice but the best mix is one that can flow very easily on the hull surface with a wide putty knife. It should be the consistency of soft butter. If you have mixed the two correctly, it will sand effortlessly using 220-grit paper.

Primer Coat

Interlux recommends their Epoxy Primecoat 404, which comes as a two-part kit that makes a quart. It's also available in a gallon kit. The primer dries bright white, which makes it easy to spot areas that need fairing.

Once the hull was smoothed with 220-grit paper, I washed the residue off with Brushing Reducer 233N. I then mixed and applied the Primecoat, thinned with Brushing Reducer 233N by 25% per the manufacturer's recommendation. After drying overnight, I applied the fairing compound and once dried, sanded the entire hull by hand with 220-grit paper. I repeated the priming, again reducing the paint by 25% with 233N. When dry, I used 320-grit paper on a block and sanded the hull, followed by a wash with 233N. At this point, the hull was ready for the final topcoat.

Roll and Tip Method

Interlux recommends using the "roll and tip" method to apply Perfection. The idea behind this method is for one person to roll the paint in one direction, say vertically, and a second person to follow closely behind and gently brush ("tip") the paint in the opposite direction, in this case horizontally, with a high quality brush.

I tried several different roller covers, including those designed for foam adhesives, mohairs (generally pink) and any short nap cover I could find. The results were all poor because the roller loaded with too much paint and caused runs when you put pressure on it. The exception was the mohair, which wouldn't hold any paint at all.

I then found a foam roller designed to paint behind steam radiators and in tight spaces. These are available at Home Depot and are about 4" (101mm) long. The small design of the roller head allowed just enough paint to be applied, and the foam pattern didn't leave any marks. In fact, it worked so well that I could do the roll and tip method by myself. I used a badger-hair brush to tip but also had good results using a 4" (101mm) China bristle brush.

I ended up needing four coats to make my boat look perfect. In between coats, I sanded by hand with 400-grit, wet-dry paper and washed the residue off with 233N. I applied Perfection when the outside temperature was 75F

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The small roller that worked best, along with the badger hair brush (rear) and the China bristle brush (front). You only need to lightly tip the surface with the brush after you roll it. You can tell you are doing it correctly if the brush is barely covered with paint, as seen with the China bristle brush.

(23.8C), which seemed optimal. I was able to use the paint without the need to thin it, a common issue with two-part paints. The pot life of the paint is two hours, which was ample time to cover my boat.

DIY Bill Of Materials

To paint my boat, which has an average topsides height of 3' (91cm), materials cost approximately US$715. (Interlux provided some materials for this project). That works out to about $30 per linear foot (304mm). Considering that yards charge an average of US$75 per foot (for hulls in good shape) to professionally spray a boat, painting a boat with Perfection is a cost-saving method.

4 quarts/3.78L 404 Primer	$130
4 quarts/3.78L Perfection	$220
2 cans Interlux 202 Solvent wash	$30
2 cans Interlux 233N Brushing Reducer	$40
Epoxy and fillers	$75
Interstrip	$85
Sandpaper	$40
Tape, trays and rollers	$25
Badger hair brush	$25
Power washer (rental)	$45
Total	**$715**

Prices based on West Marine, January 2006

(top) Transom shows just how nice the final result was. Compared to the sides of the hull, which were still in progress, the transom looks like new. Once I launch the boat, I plan to measure the correct height for new gold-leaf style lettering. (bottom) Here you can see just how deep the Perfection mirror finish can be.

Results

My overall impression with Perfection is that it's a quality product that performs as advertised. After three months in weather conditions that included an ice storm, the paint is showing no signs of fading or failure. In bright sunlight, you can see some blemishes from my fairing job but I doubt others will notice, once the boat is sailing again. The dark Mauritius blue hides a lot of imperfections.

The paint beads water well and has a deep mirror finish. I had expected to wax the boat but Interlux doesn't recommend this. Instead, they claim that a good wash with boat soap will restore the mirror finish.

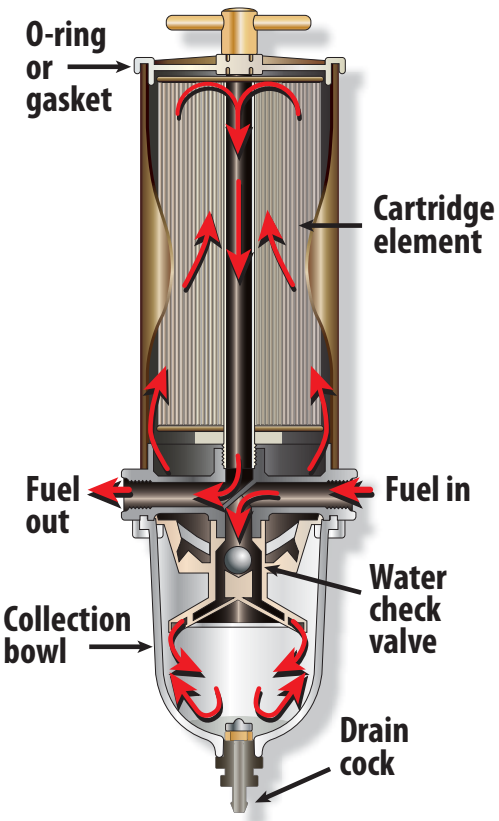
About the author: Former technical editor of PC Magazine and in charge of testing at PC Magazine Labs, Jean Paul Vellotti is a freelance writer and photographer with work published in National Geographic, Traveler, Bon Appetit and Conde Nast Traveler. Boating is his passion, perhaps building and fixing even more than the sailing.

Cleaning Fuel

Proper cleaning and filtration of diesel fuel improves engine performance and repays you with trouble-free service.

By Lee Mairs

Figure 1 Anatomy of a Water Separating Fuel Filter



Joe VanVeenen

As fuel enters the filter, it moves around, spinning off asphaltenes, gums, rust, varnishes and other solids, tiny particles of dirt, algae and water droplets. Being heavier than fuel, these solids drop to the bottom of the collection bowl. Water droplets collect on the filter cartridge element and fall into the bowl.

Clogged fuel filters and an engine gagging on contaminate fuel can turn the perfect day on the water into a nightmare. Your engine's fuel injection equipment requires incredibly precise machining and immaculate fuel to deliver reliable performance. The tolerances necessary are easily ruined with even the slightest amount of contamination in the fuel. If you don't have at least one spare filter element onboard, you are really testing fate and one spare is the bare minimum. As far as diesel engines are concerned, cleanliness is next to godliness.

It's little wonder that most diesel engine problems are directly related to dirty fuel. Tiny, virtually invisible, dirt particles can score pump cylinders and seize injection pump plungers. To run well, the diesel engine relies on precision delivery of fuel to each cylinder. Uneven fuel distribution causes the power load to be carried unevenly. Rough running, noise and excessive vibration are just the first symptoms of the failures that can occur.

Your fuel tank is like Club Med to a whole variety of bacteria. Your fuel supply occasionally delivers unwanted water. Water also can enter the tank via the deck fill fitting if the cap is loose or its gasket seal is degrading. Snow and ice accumulating on top of the filler melt and the melt water slithers into the fuel tank to create the perfect environment for these bacteria to become the smelly, filthy slime that plugs fuel hoses, filters and plungers. You can get biocides to kill the bacteria but you still have to get rid of the dead bodies.

Sheryl Shard

When inspecting injectors, never handle the tip (nozzle) with bare hands, as the skin's moisture is sufficient to destroy them. Inspect the nozzle body's end and sides for carbon build-up and corrosion and replace if badly corroded. Carefully wash the nozzle in clean diesel fuel and, holding the body upright, lift the nozzle about one-third of it's length and release. If it drops smoothly it's in good condition. Otherwise, replace the nozzle. Unless you have the expertise, this is one job best left to the experts.

Water in the fuel not only hosts the bacteria, it is incredibly destructive when your fuel-injection pump attempts to compress it to 2,500 to 3,000 psi. Even a tiny water droplet can turn to steam and blow the tip off a fuel injector when it hits the hot compression chamber. The space left in the cylinder when the piston is at top dead center is virtually gasket width thin. It doesn't take a very big chunk of injector tip to tear up valves, cylinder walls and a piston. At this point, you are but a few strokes away from needing an expensive spare parts kit (a.k.a. a new engine).

Engine manufacturers recognize this and install an on-engine fuel filter but this simple on-engine filter is not sufficient protection for your engine. You should install a primary fuel-water separating filter between the fuel tank and the engine's fuel lift pump. The on-engine filter then becomes the secondary filter.

Filtering in Microns

The primary filter's purpose is to remove water and sediment. Incoming fuel hits the filter element and centrifugal force separates the heavier water and dirt particles to separate from the lighter fuel and fall to the bottom of the bowl (**Figure 1**). A small ball that floats on the water but sinks in diesel

Filter Replacing

Changing a primary filter/separator is straightforward. Due to the many different types of filters, use the steps below for general guidelines. Refer to the instructions included with your new filter element for exact procedures.

1. Clean the outside of the filter housing with a clean cloth.
2. Open the drain in the collection bowl base and drain off accumulated water and solids. Place a large plastic container or small bucket underneath to catch the fuel and eliminate fuel spillage.
3. Unscrew the handle or nut holding the top lid and extract the filter element. Have a plastic bag or bucket handy to hold the used filter.
4. Insert a new element of the recommended size. Fill the chamber with clean diesel fuel to prime the system. (See "Product Update" on page 23 for a new product that eliminates this step.)
5. Check the lid's sealing O-ring for wear and replace as needed. Be sure the gasket is positioned correctly and refasten the lid. Do not overtighten.
6. Bleed the fuel system if necessary.

fuel acts as a check valve to prevent water from entering the top of the filter unit where it could recontaminate the fuel. If there is a lot of water in the lower bowl, the water check valve floats up and blocks its passage. When both water and fuel are eventually cutoff, the engine stops. This will never happen at a good time. How will you describe that day when your engines quit just before a critical turn in a crowded marina?

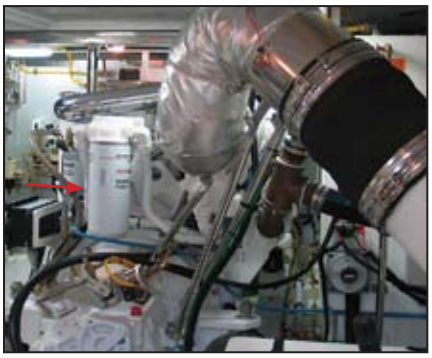
Good quality primary filters also include a course element in the top part of the unit to further filter dirt particles. These elements come in a variety of sizes generally between 2 and 30 microns. (A micron is approximately 40 millionths of 1"/25mm.) The lower the micron rating, the finer the filtration. The primary filter should be no small-

Injector Nozzle and Pintle

Lee Mairs

This is a cross section view of a typical fuel-injector nozzle and pintle. It has been ground in half with a milling machine so you can see the fit. The thin silver colored piece is called a pintle. When the fuel injection pump delivers fuel to the injector, the pintle is forced off its seat in the nozzle allowing a fine mist of fuel to spray into the cylinder. The resulting explosion is what gets you the go!

Hold a new fuel injector pintle in your hand for just a few seconds and see how your body temperature causes the metal to expand enough that the pintle will not fit back into the nozzle. Injectors have a very finite shelf life. While a good fuel shop can extend shelf life by packing the nozzle and pintles in a magic preservative, you can pretty much count on them not working direct out of the container if they've been stored for several years.



(top) Fuel from the tank passes first through a combined water separator and fuel filter, in this case, a duplex setup. (bottom) The engine manufacturers provide a secondary, spin-on type fuel filter mounted on the engine before the injector pump.

er that 10 microns. This way most of the big pieces are removed from the fuel before the engine lift pump, extending the life of the much finer secondary filter. I prefer a 2-micron, on-engine secondary filter but it's best to follow your engine manufacturer's recommendation. Remember that the engine's lift pump or the external electric fuel pump has to be able to suck fuel through all the in-line filters. One primary off-engine fuel filter should be sufficient for most small sailboat engines; powerboats with larger engines will benefit from two.

Just about everybody favors a plastic or glass see-through bowl on their primary filter so they can readily see if water has collected. I've noticed that fuel filters, particularly on sailboats, are mounted in the far corners of the bilge or in the deep recesses of a locker, where it's usually too dark to tell if there is even fuel in the bowl. Owners like to have a petcock or valve at the bottom of the bowl so that water can be drained off. In my opinion, if you have that much water in the fuel tank, draining the filter bowl is not likely to give much relief. Similarly, if you have a quart of water in your fuel tank, there is nothing that you can put into the tank that will remove that water. (Caution: never put alcohol in a diesel fuel tank.)

Availability of replacement elements is the most important criteria for a primary fuel filter. A previous owner equipped my boat, a 1982 Passport 40, with an absolutely wonderful, high tech, primary fuel filter system. It even had a small vacuum gauge to indicate when to change the filter element. Element life is a function of how much dirt is in the element, which

Locate primary and secondary filters on your engine and note replacement filter part numbers in your maintenance log.

restricts the flow of the fuel through the filter. Unfortunately, it took three weeks to get replacements from the manufacturer. I replaced the system with a Racor unit because filters are readily available from most marine stores.

Why do you need quick access to elements if you only change them once a year? One bad load of fuel from the fuel dock and you can go through a dozen filter elements in short order, though, one or two spares may be sufficient to get the boat back to the marina on a Sunday afternoon. If changing the elements requires you to twist your body like a pretzel and work in the dark, a bad time will quickly become a horror story.

• TIP •

Gasket Replacement

It's good practice to replace the gasket during routine element replacement. An ill-fitting seal causes the filter/separator to suck air into the system, causing rough running or engine stalling.

Three Additive Rules

The effects of suspect diesel fuel are complicated by some government's environmental requirement to lower the sulfur content. A good idea for the environment but it's that sulfur that lubricates your diesel engine's fuel injection pump. If you don't replace it with another substance, the expected long service life of the injection pump, which is designed to last 20,000 hours or more on a diet of clean fuel and non-abusive operation. The cost of replacing or rebuilding an injection pump is a heavy penalty for failure to use the right additive.

There are only three things you should put in your fuel. A lubricating substance to replace the lost sulfur (Lubricity is one recommended by Yanmar), a cetane booster to raise the octane level (Plus Eight is a commercial product) and a biocide, such as BioBor or Kill'em. Check your favorite marine supply store and you'll probably find one product that accomplishes all three tasks. Make

Additional Reading

Fuel System Modifications	DIY 2005-#4 issue
Diesel Fuel Filtration and Polishing Systems	DIY 2005-#1 issue
Fuel Additives and Additive Testing	DIY 2001-#3

Product Update: Reprimer Pump Solves Messy Filter Changes

An innovative solution to the messy job of changing filter elements, Racor's new FilterPump kit (RKP1912, US$465 for 12-volt version) eliminates having to refill the filter/separator with fuel after changing the cartridge element. Available on all Ford diesel pickups for the past five years, the marinized version was launched at the Miami boat show in February where it received a new product Innovation Award. Easily retrofitted in the field on existing 900 and 1000 Racor units, the kit consists of a prescreen filter, flow bypass circuit, 12 and 24-volt gear rotor, positive displacement pump and a new lid with an air vent. To install, simply drain the filter, remove the screws holding the collection bowl, insert the pump, refasten and wire to a power supply. Fuel flows through the filter as normal without restriction until the pump is activated. After changing the element, just press, "Push to prime" and it reprimes the fuel system downstream to the engine. As soon as fuel starts to come out the top vent or the pump starts to labor, the system is fully primed. By filling the cylinder and pressuring the injection system, there's no chance of air locking your engine. Any contaminants in the fuel are trapped by the prescreen before it can clog the pump.

Racor

Racor RKP1912 fuel filter primer pump retrofit kit for Racor 900 and 1000 models.

sure to thoroughly wash your hands after using these products, as the biocide is toxic.

The bottom line is that you have to be careful about where you purchase fuel. Find a place that pumps a lot of fuel. Find out where the commercial boats refuel. A day spent draining tanks and changing fuel filters cuts deeply into their profits, so they are especially careful.

Maintenance 101

Next time you visit the boat, jot down the make and model numbers for your primary and secondary fuel filters and add this data to your maintenance log. Run your hands along the fuel line out of the lift pump and along the injector pipes to check for tiny leaks. Spend 30 minutes tracing the fuel lines from the tanks to the engine. Surprised that you found an extra line from the fuel tank to the engine? This is the fuel return line from the engine to the tank. Its purpose is to recycle the extra fuel not needed by the injection pump and the injectors. Make a diagram indicating the location of fuel shut shut-off valves and identifying the return line. Keep the diagram at the navigation table, or put it in the back of your maintenance log. Remember, "A pencil stub is better than the longest memory."

About the author: Lee Mairs is a graduate engineer and a retired Navy commander. His company, Security Marine Services, conducts seminars on a variety of boating topics including diesel engine systems and marine electrical systems. He holds a 100-ton ocean license for both sail and power.

Electronic Propulsion Control

Today's digital electronic control systems offer unparalleled smooth shifting, fast throttle response, effortless control and reliable performance and can be retrofitted to older gasoline and diesel engines by competent boat owners.

By Chuck Husick

Unless your boat is fairly new or has a new engine, it's likely that your boat's throttle and marine gear controls are managed mechanically, using two-way or push-pull cables, hydraulics or pneumatics with an air cylinder. If your boat has more than one control station, such as lower helm inside plus a flying bridge or, on a sportfisherman, a set of aft cockpit controls, you may have encountered problems keeping all of the various control points working. These types of installations and the adjustment and maintenance challenges they present were one of the motives for the development of the first electrical electronic controls.

The electric-electronic controls introduced in the 1980s were straightforward electrical servomechanisms. What looked like a conventional throttle-shift unit housed a potentiometer that provided the varying DC voltage needed to control engine speed and switches that signaled the gearbox shift control. A servomotor moved the engine's throttle or the diesel engine's speed governor control arm in direct response to movement of the bridge controls. A similar system moved the gearbox control lever. Since only a few electrical wires were needed to connect the control station to the engine compartment, the installation was easier than with cables or hoses. Multiple control stations were easily managed with the addition of changeover switches and relays. Mathers introduced the MicroCommander, a microprocessor based control system in 1987. This was a significant advance in control system technology for the boat and yacht market.

In general, these systems worked well, although the absence of a back-up power supply could create some interesting situations when a power failure left the engine running at its last power setting with no easy way to change its speed or the position of the gear selection. Fortunately, the electronic control systems being sold today provide for backup power and reasonable access to direct mechanical control of the engine and marine gear.

Enter the Digital Age

The control systems installed today are overwhelmingly digital, mostly using a communication system called a CANbus (controller area network, a very robust technology developed for the automobile industry). Many of the

Electronic control systems utilize CANbus technology to provide responsive control for single, dual or triple mechanically controlled engines, mechanically or electronically controlled transmissions or outboard engines: (from the top) Glendinning Smart Actuator EEC3, Teleflex Morse KE4, Twin Disc EC300, Vetus-Rexroth, Volvo EVC and ZF Marine MasterCommand 2000.

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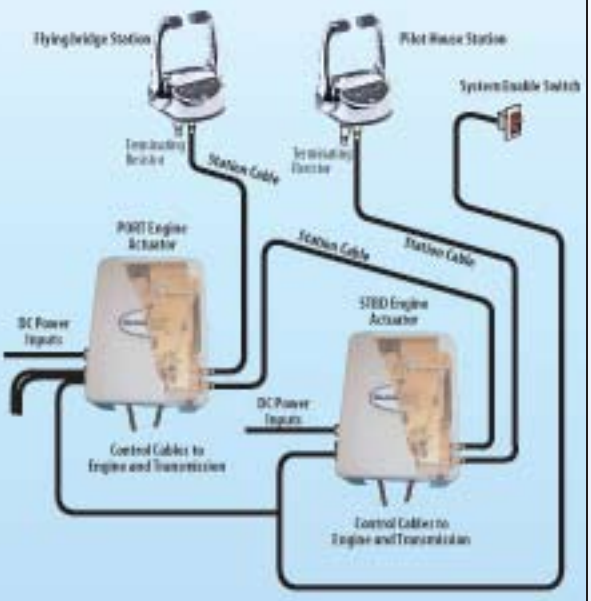
Sample twin engine, dual station installation



Sample twin engine, dual station installation of Glendinning Smart Actuator system with mechanically controlled engine and electrically controlled transmission. Features include a single handle to control both boat speed and direction, seven idle settings, power inputs from two battery sources, ability to transfer control between stations while underway and, in the event the system should fail, an optional, mechanical back-up control.

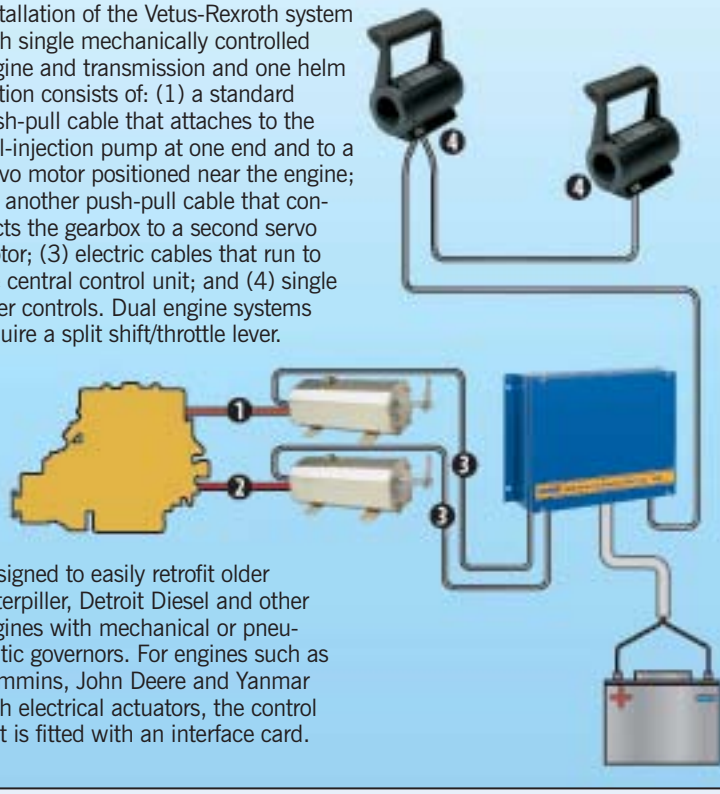
control systems use proprietary coding systems, based on the SAE J1939 SAE specification. The relatively new NMEA 2000 CANbus system has not yet been widely adopted by the engine control community for throttle and gear control, in large measure because of the high value engine manufacturers and boat builders place on control integrity and on the physical separation of the propulsion control system from all other electronically transmitted data on the boat.

At this time, NMEA's 2000 role in the engine compartment is primarily limited to engine monitoring. The engine gauges may look no different from the conventional round analog displays that have been used on instrument panels ever since internal combustion engines were first installed in boats, however it's likely that they are all identical digital devices using whatever software is needed to provide the appropriate display format, oil pressure, temperature, voltage, rpm, fuel flow, etc. It's also likely that the gauges may have morphed into an LCD panel, possibly with user selectable display formats, in some cases with provision for recording an operating data log.

There are no mechanical adjustments, no screws to turn. The idle speed and most of the other engine adjustments are controlled by code stored in the control computer. The same situation applies to increas-

Sample single engine, dual station installation

Installation of the Vetus-Rexroth system with single mechanically controlled engine and transmission and one helm station consists of: (1) a standard push-pull cable that attaches to the fuel-injection pump at one end and to a servo motor positioned near the engine; (2) another push-pull cable that connects the gearbox to a second servo motor; (3) electric cables that run to the central control unit; and (4) single lever controls. Dual engine systems require a split shift/throttle lever.



Designed to easily retrofit older Caterpiller, Detroit Diesel and other engines with mechanical or pneumatic governors. For engines such as Cummins, John Deere and Yanmar with electrical actuators, the control unit is fitted with an interface card.

Joe VanVeenen

ing numbers of marine engines. Almost all new marine fuel-injected gasoline and diesel engines rated above about 100 hp are computer controlled. Many new outboards rely upon sophisticated computers to comply with increasingly challenging emission standards and to provide the acceleration and fuel economy performance required to meet market demands. Autopilots have always relied upon computers, analog at first, digital in the more recent models.

Intrinsic Value

You don't have to buy a new boat or a new engine to enjoy the advantages of electronic propulsion control and the ease of adding an additional control station, more precise control of engine speed and, when desired, automatic engine synchronization. While crash stops are not a part of most voyage plans, improved vessel control for emergency maneuvering is one of the most valuable attributes of digital electronic engine-transmission control. This is achieved by programming the microprocessor to automatically reduce engine speed at the maximum achievable rate to a speed that allows the transmission to shift into reverse, followed by maximum application of power, all achieved by rapidly moving the throttle lever from forward to full reverse.

There are other attributes of electronic power system controls that make routine boating operations easier and more pleasant. The combination of throttle and gearshift control software can ensure smooth clutch engagement when maneuvering around a dock. When trolling speeds are desired, the engine throttle and gearbox trolling valves bring another bonus into play by providing variable propeller speeds while the engine speeds remain constant.

System reliability has been addressed by the manufacturers with the incorporation of self-checking command codes, redundant power supplies and/or automatic switching to alternate power sources and a number of "limp home" modes similar to those used in automobiles to deal with failures of sensors or control computers while ensuring continued engine operation, albeit at reduced power.

A benefit of the new electronic control technology is apparent every time you have your vehicle serviced and the technician extracts computer readout of the operating history and current condition of the engine and related systems. The same facility is available in many of the new marine control systems. The result is more precise knowledge of events that might have led to a malfunction or performance problem and a precise record of engine operation that can help resolve warranty questions.

Retrofit Options

Control systems for electronically controlled engines are normally specified by the engine manufacturer. However, the control systems that currently appear most amenable to retrofit installations on conventional engines include the Glendinning Smart Actuator, Kobelt (for larger boats with 24-volt DC power), Teleflex Electronics i6000 system, Vetus-Rexroth, Volvo Penta EVC/MC and ZF Marine MicroCommander. The choice of control is generally independent of the size of the vessel. The systems listed above are available with mechanical actuators, making them suitable for use with virtually any gasoline or diesel marine engine, regardless of vintage. [Ed: Caterpillar, Cummins MerCruiser, Mercury Smartcraft and Volvo Penta IPS offer systems generally applicable only to specific electronically controlled engines, though Smartcraft can be retrofitted on some outboards and DIY plans to cover this refit in an upcoming issue.]

A number of safety, convenience and performance features are practical only

Optional handheld remote control (Glendinning unit shown) allows control of both the throttle and transmission from almost anywhere onboard.

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with these digital electronic control systems. A typical feature list includes: single lever control of gear and throttle; gear lock-out, allowing control of engine throttle but keeping the gear in neutral; push button transfer from one control station to another or selective lock-out of selected stations; precise adjustment of engine idle speed, including, depending on the engine, a selection of unusually low but stable idle speeds; operation from dual battery supported power sources; and the ability to bypass the system's control computer in the event of an unrecoverable failure. Some systems offer the option of a hand-held control that, when paired with a portable autopilot control, allows maneuvering a boat from anywhere on board. Some autopilot manufacturers offer remote, integrated autopilot and engine control units.

The throttle and shift control levers at the helm of a boat usually provide few hints of the fact that the only connection between them and the engines and gearboxes is a series of electrical pulses on a pair of wires. You may unknowingly find yourself at the helm of an electronically controlled boat. Many of these systems require the user to engage a self-check routine, possibly including verification of the availability of the back-up power source. As always, if in doubt, read the manual. In most systems, placing the power levers in the neutral position and/or depressing the neutral button assures that the transmission is in neutral, allowing a normal engine start. If multiple control stations are installed, it will also be necessary to press a "Select" button to transfer control to the station you wish to use.

The capability, complexity and cost of these systems vary widely. The component cost, for example, of the Glendenning Smart Actuator system for mechanically controlled engines is approximately US$4,900, plus US$350 for automatic engine synchronization. A trolling valve control adds about US$1,800 for the additional actuator needed to control the transmission. Component cost for a Vetus twin engine electronic control system, where mechanical control of both the engine throttle and the transmission (marine gear) is required, using a dual, single lever control unit and providing automatic engine synchronization is approximately US$8,400.

All systems are amenable to do-it-yourself installation by a skilled boat owner with access to a machine shop for fabrication of the brackets that are required to mount the throttle and shift actuators. The installation, checkout and operation manuals for these control systems are necessarily detailed, often 80 pages and more. The extent and detail are fully justified by the critical need for reliability in your boat's propulsion control system. A thorough setup and checkout procedure must be precisely followed to ensure that the system performs properly, including a check of any and all degraded performance and emergency provisions.

About the author: Award-winning writer Chuck Husick is an electronics engineer who has held many positions with aircraft and marine companies including serving as the chairman of Chris-Craft. He is a commercial pilot and flight and instrument instructor, holds a USCG masters license and sails a 46' (14m) Irwin ketch.

Making the Sailboat Trailer Road Ready

A "trailerable" sailboat? Sure, why not.

Many trailers that are fine for yard storage are a long way from being roadworthy. Here's how to repair, replace and upgrade the running gear, brakes and hitch plus towing tips to ensure a safe road campaign. Once the trailer is road ready, your yard bird sailboat can head for the launching ramp as a roadrunner.

Story and photos by Nick Bailey

One of the undeniable advantages of owning a trailerable sailboat is the ability to take your sailing lifestyle on wheels, expanding your horizons to include distant regattas in summer and tropical harbors in February. With a good trailer and tow vehicle and plenty of gas money, it's all yours without special licenses and permits or the costly services of a professional trucking company.

Cruising your boat on the road is not without its own set of cautions and it requires careful preparation to ensure both you and the boat arrive in one piece sans "road rash."

Robertson & Robertson Insurance

The road has hazards of its own and careful preparation is needed to ensure both you and the boat arrive intact.

If your boat was originally designed and marketed as "trailerable," chances are it was originally sold as a package deal complete with a road-ready trailer, including tie-down straps, winch and a mast cradle kit. The boat itself would often have a centerboard or swing keel to allow easy ramp launching and retrieval, much like a powerboat. Good examples at the cruising end of the spectrum are Com-Pac, boats built by Hunter and Catalina, a water-ballasted

Centerboard or lifting keel sailboats, like powerboats, are designed for easy ramp launching.

MacGregor and, on the racing side of things, the Melges 24. Things get a bit trickier when the boat has a fixed keel, as do most one-design racing keelboats. These boats were not conceived with trailability as the primary design focus but, to save precious wet mooring space, many do end up spending their downtime on trailers in sailing club or marina "dry-sail" yards. Launched and retrieved by crane or forklift trucks, these dry-sailed keelboats range from trailerable J-22s to not so trailerable J-105s and 35s. Unfortunately, many trailers that are fine for yard storage and trundling back and forth to the drysail crane are a long way from being roadworthy.

Pity the poor yard trailer suffering from neglect. Its fenders are covered with blobs of epoxy filler and spilled paint. It's stripped to the bare bones. Essential components, the forward keel brace for example, are missing ("Pretty sure it's in the garage"). License plates have vanished, lights are broken, spare tires and safety chains have been "borrowed" but not returned. Such items are vital or legally required to put the

A deep fixed keel usually requires a crane or forklift.

trailer on the road. Here are what to look for in assessing the condition of your trailer and some ideas for upgrades to consider.

Trailer Structure

Catastrophic structural failures are surprisingly common with old or poorly built trailers. Just because a yard trailer has low mileage does not exempt it from the ravages of time and neglect. Corrosion takes a steady toll. Be prepared to crawl

Forward section of a full keel is held securely by a fitted brace.

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(top) Where is the forward keel brace? (bottom) There it is! This piece can make all the difference as to whether or not the boat remains stationary under emergency braking or in a minor collision.

beneath the trailer (or at least use a mirror) to inspect the metal frame and especially any rusty welds. Use a welder's chipping hammer to knock off all loose rust and to probe suspicious looking metal. Grind off the external rust and apply new paint. Corrosion inside a hollow frame channel is a challenge. Doubler plates or a section of replacement channel may need welding into place. Be very cautious of an old trailer that has been subject to immersion in saltwater at launch ramps. Corrosion could be severe enough to render it unrepairable.

Beware also of borrowing creatively engineered home-built trailers. And if you're not convinced, read "True Travels" on page 33.

Running Gear

Assuming the basic structure of the trailer is good, the running gear, namely axles and bearings, wheels, tires and brakes are the next area of concern.

If a trailer has been sitting around for years or has been subject to frequent immersion at ramps, storm surges or extra high tides (as happened last summer to our Thunderbird trailer at the Savin Hill Yacht Club in South Boston, Massachusetts) you should expect

Bearing protectors are a convenient way to ensure good lubrication provided the grease seals in a brake-equipped hub can take the extra pressure. They are not recommended for retrofitting on a used trailer.

to service the wheel bearings before taking it on the road. This is a fairly straightforward procedure. Remove each bearing, clean and inspect the race and bearings (usually roller type) for wear or pitting due to corrosion. Replace any bearing that is anything less than perfect before reassembly and repack with medium viscosity, water-resistant grease. While the bearings are out, carefully clean the axle spindle and inspect for any cracks, scoring or unusual wear. Henceforth, at the very least, once a year or more frequently if you are ramp launching, externally regrease the hub by removing the outer bearing cap and packing in the grease. Periodic regreasing can be a lot easier if the hubcap is fitted with a bearing protector, such as a Bearing Buddy. These spring-loaded grease reservoirs have a convenient grease nipple (zerk fitting) in the center. This style of bearing protector, however, is not recommended as an upgrade for older trailers. The constant 3lb or 4lb (1.3kg or 1.8kg) pressure they apply to the hub grease can force grease past the inner seal and out onto the brake drum. The result of a well-lubricated brake drum is no brakes.

Good tires are of critical importance. Replace any worn, cracked or dubious tires with a tire specifically designed for trailer use (type ST) and of the maximum load rating for the rim size you are using. Trailer tires are designed differently from automotive tires in that they require a stiffer sidewall to minimize sway and are usually rated for higher air pressures. Traditional bias ply designs are still popular due to their inherently stiff sidewalls but new radial ply models tend to run a bit cooler and have better wear properties. Correct inflation is the most critical factor in tire safety, road handling and getting maximum tread life. An under-inflated tire overheats. This causes excessive wear but can also lead to a tire failure. You'll find the recommended inflation embossed on the sidewall of the tire. Always check the tire pressure when tires are cold, in other words, before starting out. A good tire is not much use if the bead won't seal against the rim. Slow leaks occur here and are caused by a rough surface or corrosion on the bead area of the wheel rim. To avoid dangerous slow leaks, replace any wheel that shows corrosion in the bead area. Use fabric tire covers when the trailer is stored to extend tire longevity. Last but not least, make sure you have a good spare tire plus a jack, wood blocking, a tire iron and pressure gauge as well as a 12-volt air pump with an extra long power cord to reach back to the trailer tires.

The law now requires new trailers designed to exceed a gross vehicle weight (GVW) anywhere from 2,000lb to 4,000lb (907kg to 1,814kg), depending on the jurisdiction, to be equipped with brakes. Adding brakes to an older trailer may require the replacement of not only the wheel hubs but also the axles and making the decision whether surge or electric brakes are most suitable.

Surge vs. Electric Brakes

Each type uses a different way of actuating a traditional drum brake and each has its pros and cons. Surge or more properly, hydraulic, brakes are actuated when the tow vehicle begins braking. The deceleration force compresses the hitch assembly that, in turn, pushes on the piston of a hydraulic master cylinder connected to the hitch. From the master cylinder down, the system works on the same principal as an automotive brake system: the piston pressurizes the brake fluid in the master cylinder. This

The master cylinder for hydraulic surge brakes is an integral part of the hitch and tongue assembly.

hydraulic pressure is transferred, via the fluid in the brake lines, to actuate slave cylinders that push the brake pads against the drum (or disc). Alternatively, electric brakes use an electromagnet to force the brake pad against the drum. The actuation power is supplied by the tow vehicle's 12-volt electrical system.

Surge brakes work automatically and in proportion to the increasing deceleration forces of increased braking. Electric brakes also engage automatically and, in their most basic form, they are either off or on. One advantage is that they are controlled independently of the tow vehicle brakes. The trailer brakes alone can be engaged via a lever on a small control box mounted near the steering wheel, an especially useful feature should the tow vehicle suffer a brake failure. The controller also has an adjustment thumbwheel to tailor the braking power to suit differing loads and speeds. The full power setting is used at highway speeds but can be dialed down to avoid lurching and jerking in stop-and-go traffic. Full power is not used when pulling an empty trailer to avoid locking up the wheels and flat-spotting the tires. A momentary engagement of the manual trailer brake trigger is also a very effective way to damp out sway before things go divergent in all axes. There are more complicated automatic electric brake controllers with pendulums to sense G forces and even pressure sensors that tap into the tow vehicle

An electric brake controller. Note the brake power adjustment thumbwheel and manual override slide.

brake line, all to provide proportional electric braking, but the simple manual control box is reliable and versatile.

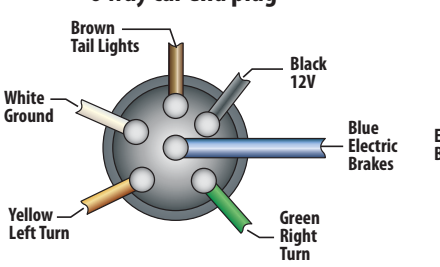
Surge brakes work independently of the tow vehicle's electrical system and require no special wiring. This is an asset if the trailer is towed by many different vehicles (e.g., a rental trailer) or if you are borrowing or renting the tow vehicle. On the other hand, installing the tow vehicle side of the wiring harness for electric brakes is usually no big deal. It's already prewired on many late model trucks and SUVs, especially if the vehicle was ordered with a tow package option. The hook-up of the controller is as simple as plugging it into the open socket that is ready and waiting under the dash. The aft end of most prewired trailer light harnesses includes a power supply wire for the electric brakes. It's just a matter of following the industry standard color code (shown below) when connecting the plug and then mounting the plug under the back bumper. The trailer side of the electric brake harness adds just one wire to the standard lighting harness. All other things being equal (presuming the correct hub or brake drum assemblies can be found), retrofitting surge brakes to a brake-less trailer is a bit more difficult than installing electric brakes. Instead of running just one wire, installing surge brakes usually involves changing the entire hitch mechanism as well as plumbing high pressure hydraulic lines, filling and bleeding the brake fluid, adjusting the system, etc.

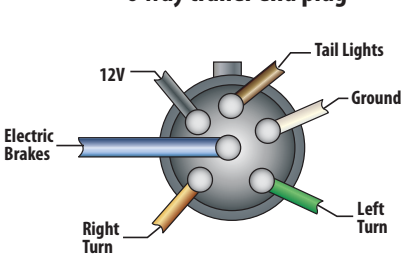
Electric brakes have a bad reputation on boat trailers. The established opinion is that water and electrical equipment don't go well together so surge brakes have traditionally been the only way to go on a ramp-launched trailer. However, today's electric brake manufacturers say this is hogwash and point out that many electric brakes available today are designed for marine use with electrical innards sealed. Internal springs and other moving parts are now made of stainless steel.

Regardless of the type of brake system fitted, if you ramp launch into saltwater, the best way to minimize corrosion on the bare steel brake drums of either system is to flush them thoroughly with freshwater. Brake flushing kits that hook up quickly to a garden hose are available as an aftermarket accessory.

Tie Down Engineering

Trailer brake flush kit, part 81107, from Tie Down Engineering adapts to all trailers.





Joe VanVeenen

The industry standard wiring color code for lights and electric brakes.

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The surge brake breakaway lanyard is designed to be connected from the tow vehicle to the locking actuator lever on the master cylinder.

A breakaway kit for electric brakes (lanyard and pin not shown).

Trailers do occasionally come unhitched. This is more commonly due to human error than mechanical failure. Nonetheless, according to my friend Winston, there is nothing quite like the experience of looking out the passenger side window, wondering whose sailboat is passing on the right and then, in horror, recognizing it as your own. The last defense against this has traditionally been the mandatory safety chains or cables. What if someone forgot to hook them up or they fell off? To address this possibility the U.S. government now requires all new trailers equipped with brakes have a mechanism that triggers the brakes and keeps them engaged in the event the trailer breaks free of the tow vehicle.

Breakaway systems for surge brakes use a lanyard attached to the tow vehicle connected to a mechanical lever at the master cylinder. Before it's finally torn off in a breakaway situation, the lanyard pulls hard enough on the lever to actuate and then lock the master cylinder at full pressure to initiate and maintain braking. Breakaway systems for electric brakes consist of a small 12-volt battery mounted on the trailer designed to apply full power to the brakes. This unit is also triggered by a lanyard attached to the tow vehicle. In a breakaway, the lanyard pulls out a safety pin at the battery allowing current to flow to the brakes. Installation of the small box containing the electric breakaway kit is simple enough; it bolts to the frame with a single electrical connection to the brake circuit. The hydraulic kit may require changing the hitch and cylinder assembly.

A typical weight-distributing hitch with spring bars. As the bars are tensioned by means of the adjustable chains and lever brackets, the rear of the truck is jacked up. This shifts tongue loads towards the front of the tow vehicle.

Weight and Hitches

Minimal tongue weight is convenient when moving a loaded trailer around the drysail lot but is a real hazard on the road. If you have ever towed a trailer with a tendency toward uncontrollable sway you know how frightening it can be when the "tail wags the dog." The

Reese

The jacking effect of a weight distributing hitch transfers load forward on the truck chassis and helps compensate for high tongue weights, which are always preferable to low tongue weight anyway.

recommended tongue weight is between 5% to 10% of the gross vehicle weight (GVW) of the loaded trailer. Single axle trailers need more tongue weight than dual axles do. For example, a 3,000lb (1,360kg) GVW single axle trailer should carry a tongue weight in the 200lb to 300lb (91kg to 136kg) range and a 6,000lb (2,721kg) GVW dual axle trailer should tow happily with 300lb to 400lb (136kg to 181kg) of tongue weight. Proper tongue weight can cause "stern down trim" on many tow vehicles as well as a tendency for the whole rig to "hobby horse" on uneven pavement. This situation, as well as the overall stability of the tow, can be much improved by upgrading to a weight-distributing hitch. These hitches use steel spring bars that connect between the hitch ball mount and the trailer. When tensioned by means of a lever bracket at the trailer end of the spring bar, the hitch and receiver, together with the back end of the tow vehicle, is torqued upwards. This forces the front wheels down and redistributes weight more evenly fore and aft on the tow vehicle. Installation is just a matter of swapping the standard ball mount for the new weight distributing version and then mounting the tensioning bracket assembly on the trailer A-frame or tongue. The brackets often just drop over the frame rail and are clamped in place with a simple setscrew.

Anti Sway Devices

Large loads may need some additional help to control sway. The major hitch manufacturers (Draw-Tite, Equal-i-zer, Reese) offer various options. All are designed to stiffen the hitch connection to add friction or resistance to any turning action of the trailer. To allow the rig to still go around corners, the sway controllers are designed to slip if pushed beyond a certain angle. Always remove a sway bar before backing up. If you use a sway bar and have reversed even once, consider it broken and replace it. A sway bar might have saved "Dawn Ellen," an S&S 35, had the rig been so equipped. Her skipper had sailed his boat twice across the Atlantic but it did not survive the road trip to winter storage. On that day, shortly after getting up to highway speed, the trailer developed a violent sway and pitched the boat off the elevated expressway to its destruction 90' (27m) below. Except for the heartache of the boat's loss, no one was hurt.

Reese basic friction sway control unit. Note: Always remove the sway bar before backing up.

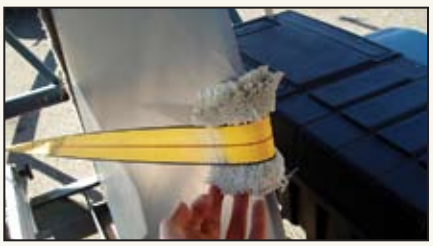
Reese

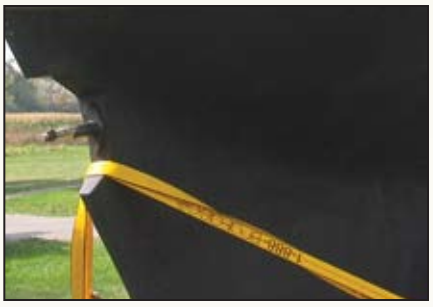
Putting it all Together

Once the trailer, hitch and tow vehicle are ready to go, the next challenge in transforming a sailboat from a yard bird to a road runner is to develop efficient methods of keeping the boat on the trailer and transporting the mast and all your gear safely with a minimum of fuss and bother. All this ancillary stuff is already sorted out for you if you have a centerboard boat originally sold with a complete trailer package. If (like me) you have a fixed-keel sailboat taking to the asphalt for the first time you have to start from scratch. Where does the mast go and how do I support it? How do I strap the whole show down without damaging the boat? Your technique evolves as you get more experienced. I found out that strategically placed padeyes for the tie-down straps are nice but not essential. (The trailer frame itself is probably more secure). The prefab wooden mast supports I made to carry the mast on deck worked well enough but someday I will add mast support brackets to the side of the trailer itself for less hassle loading and securing, better access for enroute checks and adjustments.

The first few miles at freeway speeds confirmed I had two minor aerodynamic problems. First the 55-knot slipstream was slowly pushing the boat back on the trailer despite the tight rear strap. This did not bode well because

(top) Conventional welded eye for tie-down straps. (bottom) Ad-hoc tie-down strap attachment is just as secure as a welded eye but isn't as tidy.





(top) In addition to the fore and aft tie-down straps, a tight ratchet strap to the trailing edge of the keel helps to keep the boat from creeping aft on the trailer. (bottom) On a full-keel boat you'll need to engineer the strap to pass through the propeller aperture.

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(top) Primitive anti-chafe strap covers were later replaced with (bottom) advanced technology anti-chafe strap covers.

any reduction in tongue weight would soon start to mess with the handling. A quick side trip to the hardware store produced one more ratchet strap. This one went from the front uprights to the aft edge of the keel and back. When ratcheted tight it provided all the rearward restraint necessary. The other problem was that the main tie-down straps were vibrating enough to chafe the hull even with the recommended half twist in the strap. This is not good for the Awlgrip finish. So I jury rigged

A good storage box is a great convenience.

chafe protection by wrapping towels around the straps. The towels have since been replaced by purple swim noodles (the noodles and the color were both Wendy's idea.) They work beautifully of course!

An often overlooked item but one that is really the finishing touch to a well-organized road campaign is a good-sized storage box mounted on the trailer. When the boat is in the water or in the drysail yard this is the place to stow all the road stuff: the massive ball mount, spring bars and lever brackets, ratchet straps, launch lifting strap, tool box, tire jack and iron, pressure gauge, air pump, tire blocking, keel and rudder covers and license plate. With luck, there will be enough room somewhere on the trailer for the ladder, mast stepping gin pole and spare tire.

With the right equipment and careful preparation, a long road trip towing a sailboat (even a deep-keel sailboat with an 11'/3.3m vertical clearance) can be safe and fun.

About the author: After years of making short scary trips with dubious yard trailers Nick Bailey and his wife Wendy upgraded a trailer and took their Thunderbird from Toronto to Boston for the Marblehead NOOD Regatta and T-Bird Worlds where they finished first and second respectively. They then returned unharmed with

On the road. "No worries mate."

Additional Reading

10 Best Trailer Options	DIY 2000-#2
Trailer Capacity	DIY 2000-#2
Trailer Maintenance and Repair	DIY 2000-#2
Trailer Wiring Troubleshooting	DIY 1996-#3
Wheel Bearing Repacking	DIY 1995-#2

True Travels

Once upon a time, I talked a friend into moving "Looney Tunes," a 4,000lb (1,814kg) 26' (8m) Thunderbird (T-Bird). He had an old Chevy Suburban and we had arranged to borrow his brother's well-used "custom" T-Bird trailer. It was just a few miles to the winter storage shed and this particular trailer had carried his brother's boat all the way from the West Coast without any problems. In rush hour on one of Toronto, Ontario's busy expressways, one of the four "creative designs" by a guy in San Diego, cantilevered stub axles broke. The wheel assembly and stub axle rolled drunkenly across three lanes of slow moving traffic to careen high off the center guardrail and wobble back across all three lanes again without hitting anything else. Fully aware that there are up to $50,000 in fines for losing a wheel off a trailer, my friend pulled over, jumped out, retrieved the errant wheel (the evidence) and slowly, carefully, with what was now a three-wheeled trailer, made his escape down an exit ramp. The remaining three wheels, apparently now loaded in excess of their structural limits, continued to break off in rapid succession. A pair of wobbling wheels, enjoying their new independence, followed the grinding, sparking, stricken trailer down the ramp and out through the underpass, like new hatchlings reluctant to stray too far from mother. At about this time, my friend, being an old racing sailor and a man of decisive action, used an emphatic right foot to awaken the 454 lurking under the Suburban's hood. The secondaries on the Rochester 4-barrel carburetor burst open with a sudden moan and with the V-8 at full bellow, the ancient Suburban at last gathered some momentum, dragging the heavily laden and almost wheel-less trailer the last few hundred yards by brute force to Noah's, a marine supplier and boat repair yard. The last wheel broke off in a shower of sparks on the curb at the yard entrance. As the dust cloud cleared the yard's proprietor, regarded the scene with a weary eye. To everyone's amazement "Looney Tunes" came through it all without a scratch but it was no surprise that the trailer was written off and scrapped. — *NB*

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Charting the Wrong Course

First, a little history: Starting with the wreck of the *Delight* in 1583, at least 350 ships have been wrecked off Canada's Sable Island, a 27-mile-long sandbar in the North Atlantic. The last ship to be lost there was the *Manhasset*, a freighter that ran aground in July 1947.

It's easy to understand why so many ships like the *Manhasset* were lost; in those days the skipper was probably relying on a sight that had been taken with a sextant many hours or even days before. The only way to get safely beyond the tricky currents that swirl around the fog-shrouded island was by dead reckoning and a little luck.

That changed abruptly after World War II, with the availability of RDFs (Radio Direction Finders), sonar, and radar. Those innovations, followed later by Loran, Sat Nav and then GPS, have enabled large ships, hundreds every year, to now pass safely by the island in any weather.

The very same electronics that were once found exclusively on larger oceangoing ships are now commonplace on small recreational boats. Professional navigators on large ships, however, spend years learning and continually practicing their trade. Learning to be vigilant and have a healthy respect for the sea often only comes later with hard-won experience.

Early in the morning of July 27, 1999, a 41-foot sailboat was attempting to sail across the Atlantic when it was stranded on the south side of the island. Seas were rough, with rain, wind and fog. The three men aboard made it safely ashore and then spent several hours on the beach waiting for daylight. They were picked up later that morning by some scientists who happened by. Zoe Lucas, who lives on the island for 11 months each year, told *Seaworthy* that the men didn't seem to know where they were.

Coast Guard Canada was notified, and later in the day the three were transported to the mainland by an offshore industry helicopter. During the next few days station personnel removed hazardous material (e.g. fuel, oil and batteries) and equipment from the yacht.

A few days later, the owner made an attempt to free the stranded boat with a tug that came out from the mainland. A hole where the keel had been was patched and the tug pulled and pulled but the boat could not be refloated. The effort had to be abandoned and the boat eventually broke apart and was scattered along the beach.

Run aground on the shores of Sable Island, this sailboat's owner and crew got safely ashore, having no idea where they were. It turns out they were using inadequate paper charts that did not even have 27-mile-long Sable Island marked on it.

The boat's stranding was something of a mystery: How could a navigator with ready access to the boat's GPS position not know where he was?

After the photos were originally published, a BoatU.S. member, Emanuel Laufer, wrote to *Seaworthy* saying he had taken his own boat, *Ceol Mor*, to Sable Island three times and has seen the stranded boat's sad remains. He also said there was more to the story and suggested we contact Gerry Forbes, who lives on Sable Island.

Gerry said that the boat's skipper had a lot of charts onboard, all of which were neatly rolled up and stowed. Instead, he had been using a small hurricane plotting chart of the North Atlantic that omitted many details, one of which was Sable Island. The skipper had plotted a course that passed directly through the island. That explains why when he made it safely ashore, his first question to islanders was "Where are we?"

It's a dramatic example of why it is important to carry *and use* the proper charts.

Go to greenhorsesociety.com/Shipwrecks/Shipwrecks.htm to see more images of the stranded boat on Sable Island.

—By Bob Adriance

Subscriptions to the quarterly magazine Seaworthy *are $10 per year. For more information go to BoatUS.com/Seaworthy or call 703-823-9550, ext. 3276.*

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Tips to Stretch your Gas Dollar

Are you getting the best fuel economy that your boat and engine package can provide? With fuel prices soaring, it pays to do a little tweaking and dieting to get the most miles for your money.

Story and photos by Steve Auger

Chances are that, if your boat or engine is older than three years, it's already consuming more fuel than when it was new. An awareness of the conditions that effect fuel economy and how to rectify them ensures your boat and engine combination is providing you with the best fuel economy.

Most gasoline marine engines operate on two-cycle or four-cycle type technology. Two-stroke engines have a very high horsepower-to-weight ratio. When combined with computer-controlled direct fuel injection (DFI), such as Mercury Optimax, these engines are low emission but do consume typically more fuel than an electronic fuel-injected (EFI) four-stroke engine of the same horsepower. In contrast, four-stroke engines have a very low horsepower-to-weight ratio and are usually much heavier than two-stroke engines of the same horsepower. Both EFI and DFI two or four-stroke models, however, are more fuel-efficient than carbureted versions of the same engine.

When factoring fuel costs for two-cycle engines, oil consumption must be taken into account as this type of engine consist of a total loss oiling system. In this system, the oil and gasoline are mixed together and burned off during engine combustion whereas a four-cycle engine has oil that remains in the crankcase separately from the fuel. The quality and type of oil or lubricants used in marine engines, transmissions, generators, etc. can also affect fuel economy. Many technicians employ the use of products, such as Royal Purple lubricants, that claim to provide the best in fuel economy. I always advise using only the engine manufacturer's minimum or better recommendations for lubricants as specified in your engine service manual.

Trim it right. Be sure rudders are aligned and trim tabs are working correctly.

Diesel engines, which utilize a mechanical fuel injection system, have always been the best choice for sailboats and large motoryachts. The addition of an electronic processor or computer to modern diesel engines dramatically increases the engine's drivability and fuel economy. Most gas and diesel marine engines that have an engine processor or computer can supply the operator fuel consumption numbers through a shop tool called a Scan Tool or a laptop with the correct diagnostic software.

Don't rely on the "fill 'er up, run and fill her up again" method to guesstimate fuel consumption. Consider installing a fuel flow meter, such as FloScan, to monitor fuel consumption. [Ed: Installation and on-water testing of the FloScan fuel flow computer appears in DIY 2002-#3 issue.] Just set the throttle at the most fuel-efficient speed. A flow meter also displays fuel remaining so you can carry less fuel and you'll not fret about running out. Considering that gasoline weighs 6.1 lb per gallon (2.7kg per 3.78L) and diesel a pound (.45kg) more, cruising with less than full tanks reduces boat weight, which translates into better fuel economy and money saved. Included in Mercury's SmartCraft system for EFI engines is fuel consumption information that displays a variety of fuel economy or consumption values, including gallons per hour based on engine rpm and how far you can travel on the fuel in your tank at present speed.

Get a tune-up: routinely inspect spark plugs and wires. Fouled plugs and worn wires burn more fuel.

Engine Checks

The quality or the state of engine tune has the most direct effect on fuel economy. Engine parts, such as distributor caps, spark plug wires, spark plugs and filters, need inspecting annually and replacing every three years or every 300 hours, whichever comes first. After three years, the performance of the boat drops off so gradually that it's not noticeable to the owner or operator. Be assured that, in order to get peak fuel efficiency from your engine, it must be in tip-top running condition.

More throttle means more fuel! Most marine gasoline engines have a maximum engine rpm in the 5,000 to 6,000 rpm range. This high rpm range, obviously, is not within the engine's best fuel efficiency range. On average these engines get their best fuel efficiency in the 2,500 to 4,000 rpm range. An engine operated at 75% throttle versus operation at 100% throttle uses approximately 50% less fuel regardless of which fuel management system the engine utilizes. Further, an EFI engine is approximately 30% more fuel efficient

Tune your prop. Cracked or bent blades, dings and nicks or untrue blades and chunks out of the skeg all increase drag so the boat uses more fuel.

when run within the normal duty cycle of 2,500 to 4000 rpm range compared to that of a carbureted engine of the same horsepower and design.

Duty cycle is the amount of running time and engine speed that the manufacturer recommends when operating an engine and the information is available from the manufacturer. Most pleasure craft gasoline engines have a duty cycle of no more than 75% throttle for up to three hours continuous operation and then the engines should be shut down and allowed to cool off. Commercial engines obviously have much more vigorous duty cycles and can be run continuously for greater lengths of time. Ensuring your engine is well maintained and operated within the engine's duty cycle promotes good fuel economy and long engine life.

Fuel Stats

This boat with Bravo 3 drives and timed props maximizes propulsion efficiency.

When considering a new engine, pay special attention to the fuel economy information supplied by the manufacturer. As well, most boat companies should be able to provide you with approximate fuel consumption values for their particular boat and motor combinations. You could compare this data to your current consumption values to determine if moving up to a computer controlled EFI or DFI engine is cost effective. For example, a 32' (9.7m) express cruiser with twin 350 cid carbureted engines consumes around 16.5 gallons (62.4L) per hour. The same 350s with EFI use 14.5 gallons (54.8L) per hour at 3,500 rpm. Be aware, though, that there is no way to accurately predetermine the fuel consumption of any boat and motor package due to changes in the boat's operating environment. A boat run at the same engine speed in saltwater on a cool, clear day has better fuel economy than that same boat operated at the same speed in freshwater on a hot, humid day due simply to the operating conditions.

Shed the Weight

Does your boat need to go on a diet? How can I be delicate here? Boats are like old acquaintances, when you meet them they're fresh and spry and everything works well. As time goes on they gain weight, wrinkles appear and generally it's a slippery slope toward declining fitness. Ensuring that your boat is physically fit also adds to fuel savings. Most boats that I have worked on over the years have three times the "stuff" socked away onboard than needed for comfortable cruising. Put your boat on a diet and get rid of any excess cargo, debris, old lifejackets, mildewed and soggy lines, "stuff" you haven't used in years and any other non-essential equipment that doesn't compromise any safety standards.

Cover up. Fiberglass hulls absorb water from inside and out and a well-fitted cover will protect the boat in storage.

Another common problem with maturing boats is they tend to hold more water both during operating season and while in storage. Functioning bilge pumps with automatic float switches keep the boat bilge dry when the boat is afloat and a cover or shrinkwrap during layup are essentials if you want to keep the fiberglass hull dry. Another common area where boats gain weight is the flotation foam, typically used on runabouts. These lightweight foam

Monitor fuel consumption. Install a fuel flow meter to run your boat at the most fuel-efficient engine speed using real time data.

blocks are often discovered to be water saturated and very, very heavy.

Once you have ensured the boat is as light as possible, try to lower the center of gravity. In the case of planing hulls, position gear and equipment so that a minimum of the hull's bottom is in contact with the water to reduce drag. Loading two weeks worth of vacation supplies in the bow will not be in the best interests of trimming the boat for fuel economy. Try to keep the boat balanced bow to stern and side to side. Correct use of power trim systems on sterndrives and outboards also reduces fuel consumption by reducing hull drag. Less drag means more fuel economy. That also means keeping the bottom of the boat free of marine growth (barnacles, zebra mussels and vegetation) is essential. Inspect propellers for bends, nicks and any other damage and check skegs, struts and rudders for proper alignment.

Scan tool can provide fuel consumption numbers for computer-controlled engines.

Displacement hulls such as large cruisers and sailboats under power also benefit from a clean hull, correct propeller selection and placement of loads to encourage a low center of gravity and a level attitude afloat.

Trolling tabs/plates and trim tabs should be checked for proper operation to ensure the tabs can be lifted when not required, ensuring minimum drag.

Dial in Thrust

Correct propeller applications are essential for peak fuel economy. As a rule of thumb, propellers with multiple blades provide better acceleration than two-blade props but a two-blade prop is more efficient and produces higher top speed than a five-blade one. Determining whether your boat works best with a three, four or five-blade propeller is a trial and error process. An experienced propeller selector service can usually get pretty close to your boat's theoretical best pitch and diameter for a given prop of any number of blades.

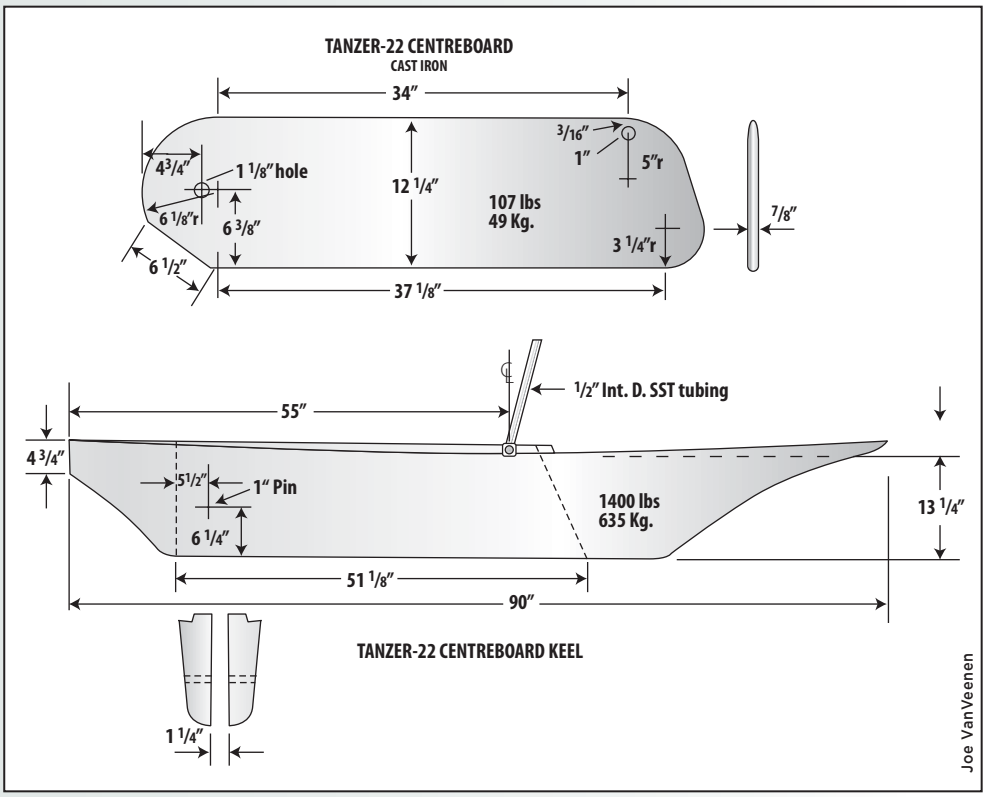
Don't let high fuel prices stop you from going boating. Get smart about maintenance and your driving habits and stretch your fuel economy not your wallet.

About the author: Steve Auger has over 35 years experience servicing all makes of outboard and sterndrive engines. He is DIY's engine technical advisor and a service training instructor/ Mercruiser product support specialist at Mercury Marine.

SAILBOAT RIGGING

Replacing A **Tanzer 22** Centerboard

When his boat's centerboard unexpectedly sinks, this owner weighs the options and settles for a steel replacement.



Story and photos by Ram Sudama

Centerboards are "out of sight, out of mind" and without any attention to their attachments and other maintenance needs, these key appendages are problems waiting to happen.

The two worst things that can happen to a sailboat's centerboard occur when you cannot lower it or if the board drops completely out of the boat. The former problem can often be remedied by the judicious application of brute force with a pry bar wedged as a lever between the trailing end of the board and the bottom of the boat. You might just get lucky here but, failing that, lots of frustrated sailors have left the board in its stuck position, accepting the new limitation on the boat's sailing performance. My experience with my 1981 Tanzer 22 involved the latter "worst."

The Tanzer 22 was designed by Johann Tanzer and originally built in Canada, with later production extended the U.S. in North Carolina and Washington. The shoal keel version of this sloop has a slot in the keel that houses the 107lb (48.5kg) cast iron centerboard. The board pivots on a stainless steel pin that runs entirely through the keel. A hole at the aft end of the board accepts a cable or pendant that runs up through a tube to a small winch at the forward end of the cockpit. Because the board is carried completely within the keel, it doesn't intrude into the cabin space as is often the case with a centerboard that is raised into a trunk inside the cabin. Other than the tube that accepts the pendant, there are no openings in the hull related to the centerboard. The techniques for replacing the board that will be described in this article can probably be adapted to other swing keel or centerboard designs fairly easily.

I was sailing with friends when we heard and felt a sudden thud, as if we had struck rock. I was sure I was in the channel but, within a few seconds, there was a second thud. I later surmised that the first thud hailed the pin failing, allowing the front end of the board to fall out with the second thud signaling the pendant's parting. Charging that off to "whatever," the bottom line is that I lost the board in the deep, cold, dark waters of Boston Harbor and there was really no hope of retrieving it.

Board Games

Although the builder ceased production in the mid-80s, many parts for Tanzers are available through the owner's association. A replacement centerboard listed for US$500. Unfortunately, the person who had the molds to cast the iron centerboard had died and all I could get was drawings for the original boards.

I considered various options for building a board. One approach was to make a new one of fiberglass, cored with some material such as plywood that could be easily cut and shaped. It might also be possible to shape a board from aluminum. Because the Tanzer centerboard serves as ballast, those approaches were not safe alternatives. When I calculated the area of the board and the

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weight of the materials required to achieve the design weight of 107lb (48.5kg), it was clear that the only viable options were cast iron or steel.

I contacted local iron works to find out if it was feasible to have a board fabricated to the drawings. The shape is relatively straightforward; a rectangle of about 12" x 48" (30cm by 122cm), with a thickness of 7/8" (22mm). The only complications were variously rounded corners, tapered edges and drilled holes for the pin and pendant. Most of the shops I called didn't even want to talk to me about such a job, so I focused on smaller shops that were capable of doing custom work such as those fabricating iron and steel handrails, fire escapes and such. I was told that doing a one-off in cast iron was fairly expensive, as a mold has to be made for the casting. Using 7/8" (22mm) steel plate for the replacement now seemed the obvious choice.

I finally found Eliot Metal Works, a small shop in Roxbury, Massachusetts, that was willing to do the job for US$200. Given the complexity of some of the measurements on the drawings, Dana, the shop manager, requested that I provide a full-size template to reduce any risk of error on their part. I got some poster board and spent an hour or so reproducing the board from the dimensions provided in the drawings. The unfinished board, cut to my specs and with holes in all the right places, was ready in less than a week.

Metal Prep

Donning goggles, gloves and earplugs, I set about rounding and tapering the edges and cleaning off all the surfaces oxides on the steel plate with a 4-1/2" (11cm) grinder. This took a couple of hours and the board looked mighty nice when I was finished even though I never achieved the full taper on the trailing edge as shown in the drawings.

The finished replacement steel centerboard with five coats of Interlux Primocon followed by two coats of bottom paint.

It's practically impossible to completely prevent corrosion from developing on a steel part that is totally submerged in saltwater. With a centerboard, this problem is exacerbated because the board rubs against the sides of the well when raised and lowered and, sometimes, comes in contact with "external" objects as well. It's considered good practice to barrier coat the steel for protection and it's very important to do this immediately after grinding since oxides begin to form immediately. I used Interlux Primocon, a formulation designed to be applied directly on bare metal. I chose Primocon partly because I use Interlux Fiberglass BottomKote ACT antifouling on the hull and I see a benefit in using coating systems from one manufacturer. If I had been willing to spend more money, I could have had the metal shop do the grinding (or better, blasting) and coat the board for me. I could even have had it

galvanized but there is a diminishing return on the investment. I figured that the board was already likely to outlast the rest of the boat.

I applied the manufacturer's recommended five coats of Primocon, followed by two coats of bottom paint. The most tedious part of the process was the wait between coats for the specified drying time (8 hours for Primocon, 16 hours for ACT), processes that, of course, had to be done on both sides of the board. All in all, this part of the project took several days with scrupulous attention to the clock.

Pins and Needles

During my down time waiting for the board to be fabricated and paint to dry, I turned my attention to the pin. First, I had to remove whatever was left of the original stainless steel pin from the keel. I located the hole, chopped through the fairing compound with a screwdriver and discovered nothing. All that was left of the original pin was a piece of rust the thickness of tissue paper. No wonder the board fell out.

The parts for the custom centerboard pin: Delrin tube and washers, brass rod and nuts and stainless-steel cotter pins.

Another Tanzer owner suggested that I use a thru-bolt instead of a stainless-steel pin. Having a bolt extend all the way through the keel allows for easy removal of the board for the inevitable and desirable access for maintenance. Some purists might complain that the end of the bolt and the nut, protruding through the keel, introduces additional drag. You can see from the pictures of my keel that it isn't exactly fair anyway and, as I'm more interested in safe cruising than in high-performance racing, I didn't really have an objection to this compromise. I'd rather be able to service the centerboard and monitor the condition of the pin.

I wasn't able to locate a 6" (15cm) long stainless-steel bolt of the required 1" (25cm) diameter, so I fabricated a new pin of the following components: 12" (30cm) long, 3/4" (19mm) bronze threaded rod with two silicon bronze nuts; 6" (15cm) long, 1" (25mm) OD, 3/4" (19mm) ID, Delrin tube, Delrin washers and large stainless-steel cotter pins. All of these components were ordered from McMaster-Carr (www.mcmaster.com). The total for all these parts was about US$80. The idea was to have the board pivot on the Delrin tube, supported internally by the bronze rod and held in place by the Delrin washers and bronze nuts.

Why go to all this trouble? Part of my goal was to provide as much galvanic isolation of the components as possible to reduce the potential for corrosion. Cast iron and raw steel are pretty low on the galvanic scale compared to stainless steel and silicon bronze. When two materials this far apart are placed in close contact in an electrolytic solution (saltwater), corrosion is accelerated. This may be one of the reasons why the original stainless-steel pin disintegrated. I reasoned that insulating metallic components of different materials from one another using the Delrin tubing and washers would help minimize future corrosion problems.

(top) The Tanzer 22 keel and (bottom) close up of centerboard pin hole.

(top) Positioning the board and then climbing into the boat to (middle) winch in the pendant and then back to ground to (bottom) jack up the front end.

It's also possible that, with this design, most of the wear will be on the Delrin tube. I can remove that fairly easily when the boat is hauled and replace it periodically at very little cost when necessary. To facilitate maintenance, I drilled holes through the nuts and the ends of the threaded rod to accept the cotter pins. This secures the nuts from turning and, even if corroded they are relatively easy to break loose for maintenance.

Two-Handed Installation

Finally, we get to the fun part of putting it all together. I would certainly have hoped to have two or more helpers to do this job but, as it turned out, my boat was due to be launched and I found myself at the yard alone with all the pieces. Never fear, I had a plan.

My first step was to position the centerboard beneath the keel. It's worth noting that the keel supports need to be positioned high enough to allow the

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The finished job.

board to enter the well straight up on edge. In my case, that was at least 12" (30cm) off the ground. In addition, supports must be far enough apart to allow the full length of the board to enter the well. The yard foreman moved the aft hull blocking back a few inches to open the slot completely. I was ready now to insert the new pendant through the hole in the board and push it up through the well and into the tube that leads up into the cockpit. I wedged it in place temporarily so it wouldn't fall out and went aboard the boat to attach it to the winch and then I cranked the board up until the back end just touched the bottom of the keel. Next, I went under the boat with a car jack. I lifted the front end of the board just high enough to get it positioned on the jack and started cranking up the front end.

Once the front end was a few inches above the back end I went aboard again and cranked the back end the rest of the way up into the well. (With an assistant I wouldn't have had to climb in and out of the boat multiple times.) At this point, I could jack the front end of the board the rest of the way up into the well. Since the back end was hanging on the pendant I had some maneuverability fore and aft, and I was able to look through the hole in the keel and line up the hole that had been cut in the centerboard exactly. I greased the Delrin tube (again, thinking of maintenance and corrosion) and pushed it through the keel and the centerboard. I then inserted the bronze rod (also greased) through the tube, attached the washers and nuts and secured them with the cotter pins. I lowered the jack out of the way and went aboard to test the winch and make sure I could raise and lower the board with ease. Everything worked fine.

All in all, this was not a terribly difficult job. I spent more time painting than just about anything else. The actual installation was done in less than half an hour and I have the full use of my boat and my centerboard back for an overall investment of less than US$300. That's money and time well spent.

— Ram Sudama is a marine surveyor living on Vancouver Island. He cruises his Tanzer 22 "Savitri" on the Straight of Georgia.

Additional Reading

"Don't Be Foiled by Foils" in DIY 2002-#2 issue discusses how to remove, repair and reinstall swing or lifting centerboards.

Sewing With Sailrite

Make your Own Boat Cushions

Part 1: Selecting, Patterning and Cutting Foam

Story and photos by Jim Grant

Every cushion project begins with the selection and purchase of the foam. I am sitting at my desk looking through all the sample cases sent to Sailrite by foam manufacturers. It's very confusing. First, there is a mind-boggling array of polymers: cellular rubber, polyurethane, cross-linked polyethylene, cross-linked polyolefin, expanded polyethylene and a silicone and neoprene blend rubber. Each one of these polymers can be concocted to yield many different physical properties. There are literally hundreds of foams from which to choose to make boat cushions.

Let me bring order to this cacophony. There are just three kinds of foam used in contemporary boat cushions and one newcomer that we will begin to see next year. All the other foams, in all their variations, are rendered inappropriate for use in a marine environment either because of their properties or their price. I'm going to ask acceptance of that fact as a sufficient argument for us to not consider them here.

Foam Selection

The foams of choice for use in boat cushions are first, flexible polyurethane, then polyvinylchloride nitrile and, last, reticulated polyurethane. The newcomer is "memory" foam, which is a relatively new concoction of polyurethane. The most common is flexible polyurethane, which Sailrite sells as Reflex Plus foam (part #100160-82; US$114.80 for a 4"/101cm thick sheet, 48" by 81"/122cm by 206cm). It's relatively inexpensive and used almost universally in new boats (as well as in automobile seats and household upholstery). Unfortunately, it tends to collect moisture (not as much as a sponge but in a similar fashion). This tendency encourages the growth of mold on the surface of the foam where any dirt accumulates. Mold will not attack the foam but it feasts upon that "dirt." If you remove your cushion covers and noticed that the foam is black or spotted with black, mold is growing there. The result is the common musty smell associated with many boats. In order to minimize this problem, Sailrite's Reflex Plus foam is treated with a biocide that inhibits the mold growth. Reflex Plus breathes rather poorly and air does not circulate freely through it. When this is coupled with the slightly moist condition that it encourages, sleeping on it can be hot and sticky. Even so, this foam has been used on boats for years and it continues to make very good economic sense.

Preferred boat foams (bottom to top) are the flexible polyurethane Reflex Plus (very small cell structure); 4" (101mm) Dry Fast and 2" (50mm) Dry Fast reticulated polyurethane; 1-1/2" (38mm) Ensolite closed-cell; and .83 oz. (23.5g) polyester batting used to give cushions a plump, full look. Branded foams offer consistent and high durability results over generic products.

Like a sieve, water streams through Dry Fast.

Polyvinylchloride nitrile foam is sometimes referred to as closed-cell foam and Sailrite stocks the Ensolite brand. It doesn't absorb water at all. Indeed, it's often used in life preservers and the cushions made from it can be so employed in an emergency. By its very nature, it's extremely firm and is best used for relatively thin cushions or as a base layer in laminated assemblies. Moreover, because it doesn't breathe at all, it can be hot and sticky but it's excellent for cockpit cushions and is widely used in this capacity. It's relatively expensive. Sailrite stocks it in 1/2" (12mm) and 1-1/2" (38mm) thicknesses, 56" (142cm) wide, which sell per running foot for US$10.95 and US$28.95 respectively.

Reticulated polyurethane is sometimes called open cell, although this term is also used to describe flexible polyurethane as well since it, too, is open but just to a much lesser degree. To avoid confusion, Sailrite labels this foam as Dry Fast. It's available in two thicknesses, 2" and 4" (50mm and 101mm) and sold in 48" by 60" (122cm by 152cm) sheets costing US$108 and US$173 per sheet. Dry Fast foam is, in my opinion, the most appropriate choice of foam for boaters. When this foam is placed under a faucet, water runs right through it. It's cer-

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Visco-cel recovers slowly from a hand press, making it the ideal mattress topper for optimal comfort.

tainly more expensive than Reflex but it doesn't collect moisture and it breathes nicely so sleeping on it during hot, humid nights is not a torture. My wife, Connie, and I have been perfectly satisfied with this foam, used exclusively on our boat and at our Clear Lake, Indiana, cabin.

The memory foam Visco-cel is a slow-recovery foam with special shape conforming properties that provide pressure point relief to virtually any bedding product. I still have a good deal to learn about it but I do believe that it can be used to good effect as a "stow away" top layer on a bunk that is made up of two or more separate cushions. A 1" (25mm) thick version of this foam, 60" (152cm) wide, costs US$35.95 per running foot. I fear that thicker Visco-cel foam would be hot and sticky on board a boat since it breathes very slowly.

Choosing Foam Properties

Each of the foam types has density and compressibility values that effect usability and durability.

Density is a very simple measure of the weight of a block of foam one cubic foot in volume. Thus, a block of foam 12" by 12" by 12" (30cm by 30cm by 30cm) that weighs 1-1/2lb (680g) would be said to have a density of 1.5 pounds (680 grams) per cubic foot (PCF). This says nothing about the compressibility of the sample since foam with the same PCF can vary over a wide range of hardness or compressibility.

There is a widely accepted test of compressibility. A 50 sq.in. (4 sq.cm) plate is pressed into the foam block with sufficient pressure to compress the foam to 75% of its original thickness. The weight in pounds to accomplish this is referred to as its indentation load deflection (IFD). If 35lb (197kg) were used to accomplish this task, it would be 35 IFD foam.

Usability and Durability

What do you look for when selecting foam for cushions? Generally speaking, the lower the PCF number for any given foam type, the more quickly it will soften or "fatigue" in use. You may have experienced an old bunk cushion that was very soft in the center while still firm on the sides. This kind of breakdown in foam occurs more rapidly when the foam is lighter per cubic foot. There are other factors, such as special manufacturing techniques, that will improve the resistance to softening.

The polyurethane foams discussed above (all but the Ensolite) should have a PCF between 1.4 and 2.5. It doesn't seem helpful to go beyond this range for cushion foam, although for gasket foam a PCF of 6 is not uncommon. I suspect that the need for flexibility in use accounts for this. Ensolite closed-cell foams are by their nature denser. A PCF range of from 3 to 4.5 is appropriate when employed as cushions.

Patterning for a V-berth platform has masking tape under basting tape on the sides; pattern material in place and roughly trimmed.

Unfortunately, finding foam within the appropriate PCF range doesn't guarantee foam durability. Further assurance of durability cannot be derived from inspection of the finished foam, either. Instead, durability is dependent on trust in the supplier and, ultimately, in the manufacturer.

Even after durability has been assured, the foam must provide comfort over time or "usability." The IFD number can be helpful in this regard; however, comfort is a highly subjective thing that leads people to prefer firm or soft foam for no apparent reason. We have all learned, in the course

of buying mattresses, sitting or lying on a sample is not at all the same thing as sleeping on it night after night. Even when presented with a number of different firmness samples, it's difficult to select the best one.

This realization led to some rather arbitrary decisions at Sailrite, which stocks and sells foam of just one IFD, depending on its type and thickness: 4" (101mm) thick Reflex Plus foam has an IFD of 40; Dry Fast in the same thickness is IFD 35; 2" (50mm) Dry Fast is IFD 70 and both thicknesses of Ensolite foams are IFD 80. One sheet of foam of a given type and thickness from Sailrite should be just like the next. It also ensures that customers do not make mistakes when confronted with an array of choices some of which are not likely to yield good results. By offering a quite firm 2" (50mm) Dry Fast, for example, and nothing else, customers are ensured the right choice in thinner cushions where the higher IFD makes "bottoming out" less likely.

Patterns for Cushions

Once the foam has been selected, it must be cut to shape and that is carefully done with proper patterns. Almost anything that is dimensionally stable can be used to pattern cushions. My patterning material preference is a heavy (4 mil or better), clear, 10' (3m) wide polyethylene film. (Sailrite part #6789, US$1.95 per running yard.) Aside from the fact that it will not stretch (under normal stress) in any direction, it also is clear so positioning is easily determined and it's easily written upon with a marker allowing notations viewed from both sides. Other patterning options are butcher paper, paper grocery bags or heavy Kraft paper available from craft or office supply stores. If these materials are insufficient in width, tape together on a flat surface with masking tape as necessary.

One final advantage of plastic film over paper is that it can be "basted" in place with double-sided tape or with 3M Super 77 or other spray-on contact cement. Such adhesives also act as a third "hand." While you can use adhesives with paper patterns as well, there is a distinct risk that the paper will tear when you separate it, whereas the film easily pulls away intact. If using double-sided tape, be sure to put a strip of masking tape down first to facilitate removal. Otherwise, it's necessary to rub the adhesive off the mating surface, a very slow process.

To create a pattern for a berth cushion with a flared side, take a small piece of the cushion foam placed 90° to the bottom surface, measure offsets at arbitrary intervals and transfer measurements onto your pattern.

Pattern Creation

The actual process of creating the pattern depends on the shape of the cushion. Below are pattern considerations for six different cushion shapes.

Square sided foam cushions with all edges 90° to the top and bottom surfaces are very simple to pattern. Fortunately, these cushions are the most common. All that is required here is to lay the pattern material down on the cushion platform and mark all the corners. If the platform edges between these corners are straight, a straight edge can be used to join the corners after the pattern material is removed. If there is a curve on one or more edges, it's generally best to put down a series of dots 2' or 3' (30cm or 91cm) apart to be joined with a fair curve made along a guiding batten later rather than drawing in the curve freehand along the platform edge itself. Cut the pattern to the actual shape of the platform. We will increase the size of the foam by 1/2" (12mm) on all sides when it's cut (more on this below).

Patterning a cushion with one or more outward flared sides, such as is normally found in a forepeak veeberth or quarterberth, requires a bit more time. Start with the same procedure used above for the square-sided cushion. There is an additional task to indicate on this pattern how to cut the slope or slopes into the foam. We will do this by drawing five or six hash marks more or less equally spaced on the edge of the pattern and writing offsets to the wall at what will be the top of the foam over each mark. To do this accurately, find a block of wood the same thickness as the foam or better yet a small piece of the foam itself. Place one edge of this block that is square (90° to the bottom surface) on the top of the pattern at each hash mark and align it against the crease at the bottom of the slope. Now measure the gap from the top of the block to

Using the pattern to mark the foam for cutting. Notice the pattern is cut 1/2" (12mm) oversized all round. The batten and push-pins ensure a fair curve.

The second line defines the flair in this forepeak cushion. Note the offsets at the hash marks on the pattern.

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the boat's flared side. Technically, this surface is called a "ceiling" if it's a separate layer of material that is furred out from the hull or attached over frames. If it's secured directly to the inner side of the hull, it is a hull liner. In the absence of either, it's simply the inner side of the hull. Indicate this measurement on the pattern material over the appropriate hash mark. The final pattern will be exactly the shape of the smaller foam surface (usually the bottom of the cushion) with hash marks and offsets along the sides that are to be flared towards the top.

In the case of a cushion that flares towards the bottom, such as a seat back, cut the pattern for the larger (bottom) surface and then place a line on the pattern to indicate the edge of the foam at the smaller (top) surface along each edge.

More complicated foam shapes, such as helmsman's chairs or rounded settees, are usually patterned using the techniques above if the shapes are broken down into flat segments or "facets." Foam can be shaped or "sculptured" when necessary but it's easier to build parts of the structure separately using the patterning techniques described above and then assemble them using a contact adhesive to make the more complicated shape. Keep in mind that sculpting cannot be applied to cushion covers; they will, of necessity, be structures made up of flat segments.

(top) A sharp knife cuts about 1" (25mm) of foam per stroke, often resulting in kerfs along the edge. (bottom) Foam edge run along a disk sander removes kerfs and results in a smooth edge (as shown near the author's hand); unsanded foam edge with kerfs is visible below the hands.

Fine Elements

Foam edges are trimmed to round them when the radius of the cut is small (less than 6"/152mm or so) but it's better to build larger rounded surfaces by wrapping a thin foam

sheet, 1/2" to 2" (12mm to 50mm) thick depending on the radius, around a roughly shaped block of foam to create a smooth and fair surface. Here, patterns need be little more than an indication as to how wide, deep and high the area occupied by the foam will be. The creation of the foam structure to occupy that area is largely a matter of trial and error.

To give cushions a plump, full look like upholstered furniture, full sized (or nearly so) pieces of square cut foam are wrapped with several layers of polyester batting. The thicker the batting (the more layers), the more rounded the corners of the cushion and the more plump it appears.

Cutting Foam

Now you're ready to cut the foam. Using the pattern, transfer cutting lines on the foam. A permanent marking pen with a fine point leaves a clear, sharp line on the foam. Though the pattern was marked to fit the cushion platform, it's good practice to cut the foam 1/2" (12mm) oversize in all directions. Since the fabric cover is built to actual size, this ensures a good tight fit. So, put your cutting line down 1/2" (12mm) outside of the pattern edge or, to prevent mistakes, I prefer to cut the pattern oversize. In the case of cushions with flared sides, put a second line on the other side of the foam sheet that exactly matches the position of the first and then, from this second line, measure out (or in as required) at the hash marks and place a dot to indicate the offset measurement (don't forget the extra 1/2"/12mm). Join these dots in a fair curve with a long batten as a guide.

A professional jigsaw foam cutter.

(top) A reciprocating carving knife provides excellent shape control for cutting foam, especially wedge cuts, and (bottom) leaves a smooth, clean edge.

A band saw gives a quick, clean edge. Tilt the table for accurate wedge cuts.

Once all cutting lines are on the foam, you can cut it with a number of simple tools. When a side is flared, make the cut on both lines, top and bottom, to put the proper angle on the edge. Keep in mind that the foam edges do not have to be perfectly smooth. Indeed, kerfs with ridges 1/4" (6mm) or so deep are not likely to show through most cover fabrics. Sunbrella and Naugahyde are especially good at hiding such roughness in foam. Even so, a clean, smooth edge is possible with just a little care.

A simple sharp knife requires the most care in cutting. It's necessary to move the knife back and forth in a sawing action to make it cut and this tends to leave kerfs. A second set of hands to separate the cut portion of the foam makes the work go faster. Follow with a

Additional Reading

Selecting Boat Covers and Cushions DIY 1998-#4 issue

Whether you're planning to make your own cushions, dodger, bimini or awning or use a professional, here's what you need to know when purchasing materials.

DIY's "Better Boats" features 200 plus do-it-yourself projects to customize your boat. Included on this new CD-ROM are instructions for making interior cushions, sewing fitted sheets, bunkboards, boom covers, bag holders and other canvas projects.

Using 3M Super Trim Adhesive to glue two pieces of foam together.

disk sander to remove the unevenness resulting from this cutting technique.

Professionals often use a specially made reciprocating saw that ensures a 90° cut and that can also be used freehand for flared edges. Here, a single blade moves up and down alongside a stationary one. The latter keeps the foam in position while the former does the actual cutting.

A similar job can be accomplished with an electric carving knife that has reciprocating blades. These knives are handy for professionals when there is freehand work to be done, such as along a flared edge.

Shops that cut foam on a mass basis generally use band saws with special knife edged blades. A standard wood cutting band saw works just as well if it has sufficient depth and height to accomplish the work. The depth of the throat in a band saw is a limiting factor so, to avoid this limit, cut pieces roughly to shape before using the band saw to do the finish cut.

There will probably be wasted foam and likely some cutting errors. In either case, it's good to know that you can piece foam together with contact cement. Use Sailrite's contact adhesive (part #100351, US$19.50 per quart/3.78L) or 3M Super Trim Adhesive (part #08090, US$17.95 per 18oz/29ml spray can) to adhere the foam. Just apply the adhesive to both sides, wait three or four minutes, and "book" the pieces together for an hour or so. It will be possible to peal the joined sections apart (especially in the case of the Dry Fast foam) but there will be more than enough strength to keep everything together inside a cover. Use these adhesives to also secure polyester batting to foam so the batting doesn't slide out of place.

Covering the foam with fabric or vinyl is the next step. That is a task we will put off until the next issue.

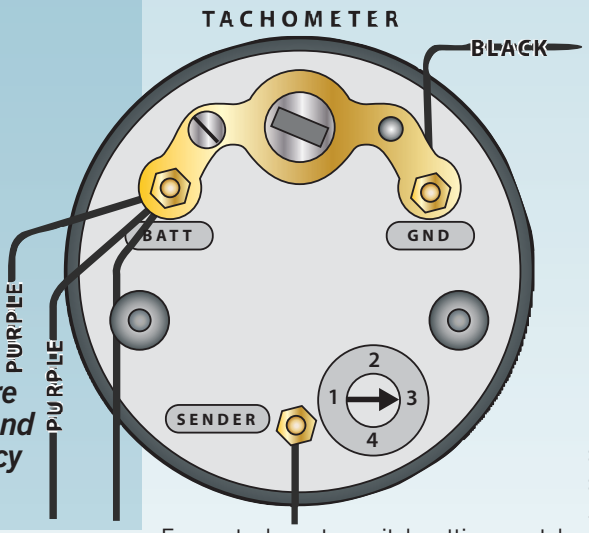
About the author: Jim Grant founded Sailrite in 1972 to supply specialty marine fabrics, component hardware and tools, sewing kits and sewing machines for boaters to build or repair canvas and sails. Headquartered in Indiana, the company has satellite stores in Fort Lauderdale, Florida, and Annapolis, Maryland.

(Ed: All of the supplies discussed here and many more are available through Sailrite (Tel: 800-348-2769; Web: www.sailrite.com).

POWERBOAT RIGGING

Troubleshooting tachometers

Age and electrical problems caused by vibration, moisture and corrosion all take a toll on a tachometer's function and reliability. Here's how to verify your tachometer's accuracy and troubleshoot a non-functioning tachometer.



Joe VanVeenen

Ensure tachometer switch settings match your engine configuration.

Story and photos by Steve Auger

An electronic engine tachometer measures your engine's crankshaft speed in revolutions per minute (rpm). As the engine rpm increases, power and fuel consumption rise along with boat speed. Engine longevity, boat speed and fuel economy all depend on operating the engine at the most advantageous rpm for the prevailing conditions of its duty cycle.

When correlated with a speedometer, a tachometer also helps you recognize engine or hull performance problems. For instance, if under normal conditions your boat makes 20 mph at 3,500 rpm and then, on your next trip you had values outside that range, such as only 15 mph at 4,000 rpm, you can presume you have a problem.

Outboard vs. Inboard Tachs

The tachometer signal from most carbureted inboard and sterndrive engines comes from the negative terminal of the ignition coil. The tachometer signal from most outboard engines comes from the rectifier/regulator component of the outboard alternator. For example, Mercury tachometers have switch settings on the back of the instrument that allow the same tachometer to be used on both outboard and inboard applications. Most marine aftermarket tachometers are of similar design unless your boat was produced prior to the 1960s where anything goes from battery CD systems to mechanical cable driven tachs, a discussion for another time.

Verify that you have the required operating voltage.

Basic Set up

An electronic tachometer is simply a pulse counter. When the tachometer on an eight cylinder inboard engine receives four pulses from the ignition coil, it registers one rpm on the tachometer. On a six cylinder, it's three pulses, a four cylinder, two pulses and so on. On an outboard, the tachometer counts the pulses that come from the charging stator. Because different outboards also have different numbers of bobbins on the stator, there are different switch settings for different engine applications. The tachometer signal is transmitted from the engine to the instrument at the helm panel via the gray colored wire in the instrument harness on inboards and the remote control harness on most outboards. The power supply to the tachometer comes from the "I" (ignition) terminal of the key switch and should have over 12 volts with the key in the on position. (ABYC guidelines for wiring states this wire should be purple). The ground for the tachometer is battery negative and is usually a black wire that connects to the instrument harness. Use the tachometer ground wire as the negative connection when making your voltage checks. Power supply for the tachometer can be checked with a standard volt-ohm-amp (VOA) multimeter. Verify that all electrical connections are clean and tight. In short, there are three wires that have to be connected correctly and a switch must be set in the correct location.

Tach Types

Electronic tachometers used on inboard and outboard engines for the past 40 years have traditionally been analog-type gauges with readings seen as a needle position on a scale. These days, the computer driven, digital tach has become popular. Instead of using the signal from an ignition coil or alternator, a crankshaft position sensor sends a digital signal to the engine management computer, which provides a digital display of the computer's rpm information. The problem with a digital tachometer for old-school boaters like me is that, when idling, the display number never sits at exactly one number, say 600. Instead, it continually scrolls up and down as an obsessively accurate readout is displayed. I prefer the analog needle and gauge type of readout that sits steady at 600 rpm. Various tachometer manufacturers offer something for everyone, which allows the use of analog or digital computer-driven display and digital-driven analog displays or a combination of both.

How Accurate Is Your Tach?

Tachometers are typically designed as reference type instruments. By this I

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TACHOMETER TYPES

(top, clockwise) Standard analog tach; modern digital tach; Smartcraft digital-driven tachometer with analog readout; tach with both analog and digital displays.

mean that, at 3,500 rpm, my boat will typically perform the same on each outing. Any change in that status is a clue to a problem with the boat. The tach does not have to be extremely accurate, which is another reason why an analog type instrument is adequate to the task. To find out if your tachometer is providing an accurate readout, you'll need access to a digital shop tach. This is the same shop tach the professionals use, though some modern VOA multimeters have this shop tach feature built-in and most modern marine engines have a gray-colored test lead on the engine wiring harness that allows a direct connection with the shop tachometer.

Most modern engines have a shop tachometer lead.

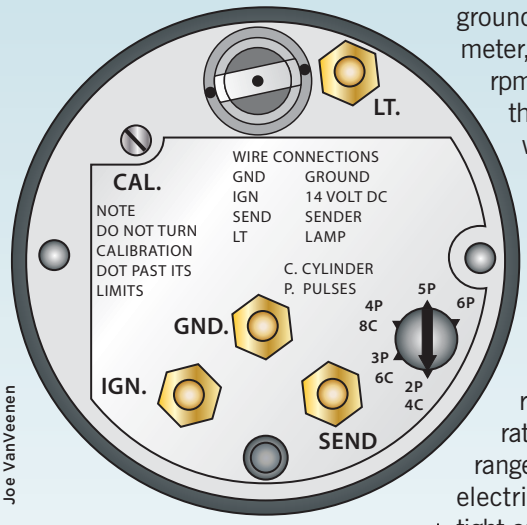
Verifying onboard tach with a shop tach. This particular instrument is a Mercury Marine combined DMT 2000 digital multimeter and tachometer.

Caution: Safety First

Electrical test procedures are provided in detail in your engine's service manual. Comprehending the wiring diagrams and carefully following these test procedures are essential to conducting these tests safely. The instructions contained within this article have been generalized to apply to all marine outboard and inboard products. Your personal safety requires that you always refer to your original equipment manufacturer's (OEM) service manual for the special precautions applicable to your engine. Energizing an incorrectly wired electrical circuit can cause damage to the electrical systems of the engine and/or boat and can be a fire and/or explosion hazard.

Shop Tach Settings

Before continuing, set the shop tach for the correct number of cylinders and the correct frequency cycle setting. On four-cycle carbureted engines, the red lead goes to the shop tach test lead on the engine, if so equipped, or to the negative terminal of the ignition coil. The black lead from the shop tach goes to engine ground. Start the engine, turn on the meter, advance the throttle to 1,000 rpm on the shop tach and compare the readout to your boat's tach. It would be considered acceptable if the display on the boat tach was within 10% of the readout on the shop tach display. This means that if the shop tachometer is displaying 1,000 rpm, your boat tachometer could show between 950 to 1,050 rpm and still be considered accurate. If the display is outside of this range, verify that all your tachometer electrical connections are clean and tight and the switches on the boat tach are correctly set. If the boat tach is set as a six cylinder and it's connected to an eight-cylinder engine, you'll get an inaccurate readout.



Joe VanVeenen

Shop tach settings differ depending on what engine you're testing. Switches must be set specifically for each engine type and number of cylinders for the shop tach to function correctly. These instructions are generalized. Refer to your shop tachometer instructions for correct tool switch settings.

Most two-cycle carbureted engines use the charging system to supply the tach with an engine speed signal. Modern carbureted and electronic fuel-injected outboards also have a gray tachometer test lead wired the same way for testing. If there is no signal,

the outboard's charging system (carbureted models) needs checking. Modern EFI outboards use the engine computer to supply the tachometer signal.

Inductive Clamp Usage

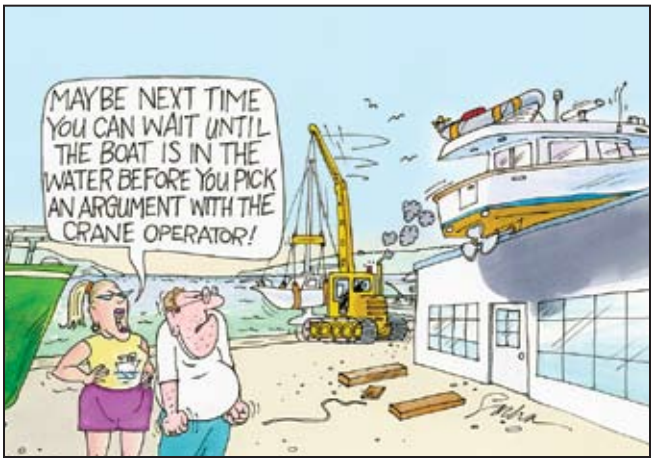
Some engines don't allow for the use of the frequency function and it's in these cases only that you would use an inductive clamp that measures engine rpm off the number one spark plug lead. With the engine off, set the shop tachometer to the inductive clamp tachometer position and install the clamp over number one spark plug lead and plug lead into the shop tach. Ensure the shop tach is correctly set on two or four cycle and the correct number of cylinders.

EFI Scan Tool

On electronic fuel-injected engines (EFI), a scan tool can also be used for tachometer accuracy tests. Start the engine, advance the throttle to 1,000 rpm and compare the reading on the shop tach to your boat tach readout. As with carbureted engines, a 10% difference is acceptable. Any higher and you'll need to check electrical connections and switch settings. If your tachometer is outside of the acceptable range, check the gray wire with your VOA meter for a high resistance between the tach and the engine. There should be less than 1.0 OHM resistance.

EFI engines require a scan tool to verify tach accuracy.

About the author: Steve Auger has over 35 years experience servicing all makes of outboard and sterndrive engines. He is DIY's engine technical advisor and service training instructor/ Mercruiser product support specialist at Mercury Marine.



Delight in Restoring a **Trojan F-26**

A suggestion to replace the galley countertops lead to restoring, replacing, updating and upgrading during the off-season. "It just made sense!"

(top) Beautifully restored 1978 Trojan F-26 looking dandy on the hook at Crystal Bay near Amherstburg, Ontario, on the Detroit River. A custom radar arch for mounting antennas and a searchlight crown the original hardtop while topsides sparkle with Interlux Brightside applied using the roll and tip method. (bottom) Foredeck details show windlass, primary anchor on roller, secondary anchor and washdown.

Story and photos by Paul Drouillard

As a youngster, boating for me was a 12' (3.6m) aluminum fishing boat. As a young man, my 18' (5.4m) Doral runabout was my summer home, waterskiing with my buddies or beaching it for the night. Fast forward to middle age and boating now requires creature comforts so, in 2000, we purchased a 1978 Trojan F-26 hardtop model. It was clean and in fairly good shape with a recent interior redo but in need of repowering. Margaret, my wife and first mate, had convinced herself there wouldn't be much work needed. It was easy to let her think that.

At haulout that first fall, we were inspired by sunsets on the water as we sat in the cabin with our friend Gary, the "woodworker." "It would be easy to make a new countertop," said Gary. Soon, the dark faux oak wood grain Formica counter and table were refaced and the cabinet and head doors were replaced with custom mahogany. Suddenly, the carpet looked worn, the upholstery looked tired and it was all Gary's fault. We replaced them both and it snowballed from there.

Of course, once the boat was empty, it simply made sense to upgrade the electrical systems and plumbing. I patiently explained to my wife about maximizing these kinds of opportunities in doing a job right. She bought it.

Plumbing Perks

The boat originally came with a cold-water only freshwater system that I upgraded with new plastic plumbing and hot water capability. I chose a Seaward 6-gallon (22.7L), 120-volt water heater and the new engine's heat exchanger makes hot water while under power. A spot behind the freshwater tank in the engine compartment was a perfect fit for the water heater. With the old engine removed, the installation was easy and all we needed to complete it were a couple of mounting pads. A wet bar-style sink and gooseneck faucet replaced the

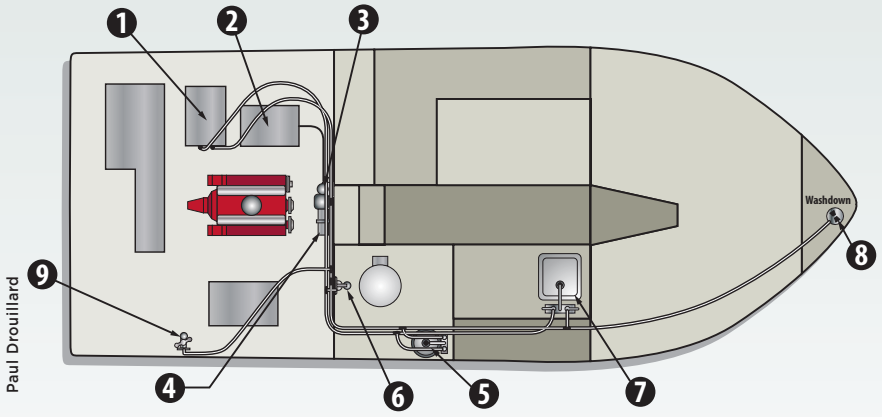
Hot showers are now possible with water heated by a tank mounted in the engine compartment.

standard shallow sink and faucet and fitting both into the new countertop was no problem.

I added a Jabsco model 30573-000 accumulator. This involved spliting the hose from the supply pump and installing a tee fitting with the supplied hardware and then bolting the

New hoses and poly holding tank secured with tie-downs made of stainless-steel wire and eye screws.

unit to the forward bulkhead in the engine compartment. This particular model, equipped with a bladder, allows installation horizontally and vertically as space available dictates. To help justify the need, I decided to install cockpit and bow washdowns solely for my wife's happiness. Swabbing the deck is so much easier for her now. The bow washdown came in a kit that included a flush-mount faceplate and a coil hose housed in a sealed tube beneath it. A hole was cut in the foredeck with a jigsaw and, before inserting the washdown tube, I sealed the



Schematic of freshwater plumbing upgrade: (1) Seaward F600 water heater, (2) 20-gallon (76L) freshwater tank, (3) Jabsco water pump, (4) Jabsco 30573-000 accumulator, (5) head sink, (6) shower, (7) galley sink, (8) bow washdown and (9) cockpit washdown.

hole perimeter with epoxy resin and mat to prevent water from migrating into the core, then I bed the tube in Lifeseal. The cockpit washdown is simply a chrome-plated spigot, available at any hardware store, to which we attach a potable water hose and nozzle when needed. This allows us to store the hose when not in use. Both washdowns attach to the freshwater system, as are the shower and sinks, so that supply is fully drained often to ensure fresher water. Water supply for the head was originally connected to the freshwater system but I transferred it to lake (raw) water supply. The original holding tank was a 4-gallon (56L) bladder type that I replaced with a rigid 20-gallon (76L) polyethylene tank with new transfer and pump-out hoses.

Power to Spare

Electrical upgrades included a TrueCharge battery charger, AC electrical panel and a stereo amplifier (shown on the bottom left in the photo).

I prefer to isolate the start and house battery banks as opposed to setting a switch. The 12-volt system has two separate panels: one for operating systems only and the other for accessories. Stereos, water supply pumps, TV, lights, etc., are all dedicated to the accessory system. Only essentials, such as the engine, running lights and anchor windlass operate off the panel fed by the start battery. Some would argue that a windlass is an essential; ask my first mate how essential it is.

To maintain the batteries I added a TrueCharge 10-amp, multi-stage battery charger. This micro processing "smart" charger ensures maximum charge but prevents damage due to overcharging and is correctly sized for the battery bank. Since we spend a lot of time on the hook, the house bank was upgraded to a pair of 6-volt T105 Trojan batteries wired in series to provide a capacity of 225 amp hours. We now have sufficient power to run the fridge, water supply pump, lighting, TV, DVD and stereo over the course of three days without drain-

(top) Before: Galley and vee berth prior to restoration. (middle) During: Interior under construction. (bottom) After: Author's home away from home with new galley, upholstery, carpet et al!

ing the bank by more than 40%. The existing 70-amp Delco marine alternator was modified with a smaller pulley thereby increasing alternator rpm at a lower engine rpm, yet still putting out proper charge. The alternator lead was upgraded to 4-gauge cable coupled to a Powerline battery isolator and then from each end of the isolator to corresponding battery banks. Both batteries get the required charge from the alternator while the engine is running but are not linked when the engine is shut down. The battery master switch is set on the start battery or "1" position but can be easily switched to the house bank if needed. The 120-volt electrical system remained mostly original except for updating the outlets to ground fault protected receptacles.

Buoyed by Optimism

While this work was going on, the first mate was refinishing all the wood. Every piece was removed, stripped and sanded using a combination of orbital sander, finishing sander and then hand sanding with 240 and 320-grit paper. Two coats of Cetol Marine Matte and three coats of Cetol Marine Gloss were applied to all but the swim platform and hull step pieces, which were stained only to reduce slip risk. New brass screws and nails fitted pieces back into the interior. The result is outstanding. I didn't laugh when Marg first took on the job and estimated she'd be done in three days. It took three months.

Bilge Resurfacing

New bilge stringer was laminated of plywood and covered with roving saturated in epoxy resin then scarfed into the existing good wood.

We discovered a soft starboard stringer on lifting the engine. A reciprocating saw cut out the old stringer and an angle grinder cleaned up the area in preparation for replacing the bad wood. Since the entire stringer was not replaced, lap joints at each end of the old stringer were tied into the new section and then bedded to the hull with West System epoxy and covered with fiberglass roving. Three layers of plywood were laminated together with hardwood inserts added where the motor mounts would be bolted. Before painting the engine compartment with two coats of Interlux Bilgecoat, my wife and a friend worked countless hours scrubbing 25 years of dirt and oil with Mean Green super strength cleaner degreaser. They scrubbed and rinsed and scrubbed and rinsed for weeks. More dirt came off with each session so they kept at it. Again, I patiently explained to the first mate about maximizing opportunities for doing a job right. She's beginning to get it.

In the Engine Room

The existing Mercruiser 305, 228 hp made way for a 350, 300-hp Chevy (right-hand rotation) with all required marine components. AquaPower manifolds replaced original exhaust manifolds, including risers and elbows. New OEM cooling lines replaced all the old ones. The motor and transmission mounts were also replaced and all external fasteners are now stainless steel, socket head cap screws. The original distributor and carburetor were rebuilt and the carb had to be jetted up because engine displacement increased. In order to ensure clean fuel delivery to the carb, a Racor water separating fuel filter was added to the fuel system. Because the engine is mounted low in the bilge, changing the oil required the body of a contortionist so I installed a Moroso remote filter kit mounted in a more accessible location. Connecting this filter involved removing the factory bypass, installing an adaptor plate in the original filter location, adding two 4' (122cm) long braided stainless-steel hydraulic lines and attaching the ends to the remote filter mount. It was important to use a filter with a bypass to ensure the relocated remote filter doesn't restrict oil flow to the engine since I removed the original bypass to make the relocation happen.

Of course, since the engine bay was empty, it just didn't make sense not to have the transmission rebuilt. A 1:1 ratio Velvet drive is now coupled to a new Aquamet shaft. Instead of a straight key coupler I used a taper coupler for better lock. Cooling lines

(top left, clockwise): New 350 Chevy sits in cleaned and painted engine compartment. Lasdrop shaft seal eliminates stuffing box drips. Moroso remote oil filter kit allows relocating an oil filter to a readily accessible location. Racor water separating fuel filter threads onto the original filter location and has a drain with a drip catching bowl at the base to spot check for water.

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are now also braided stainless. The shaft passes through a dripless Lasdrop shaft seal (www.lasdrop.com) and the other end of the shaft swings a cupped Michigan 13" by 10" (33cm by 25cm) Nibral propeller. After trying a few different props that didn't seem quite right, I went to the experts at Michigan Wheel (www.miwheel.com) and gave them details regarding my boat displacement, waterline length, beam, draft and maximum engine rpm. They sized a prop for me that is right on the money, performing well both getting on plane and at cruise. Cruising speed is 18 to 20 mph at 3,500 rpm.

Helm Re-creation

We were finally ready to put the cockpit floor together and start working on the helm. Again, it made sense to replace instrument gauges. I took this opportunity to rearrange the instrument panel, relocating the trim tab switch, making room for the VHF radio and raising it all above the steering wheel for a better line of sight. The new textured Formica-covered Plexiglas panel complimented the new white-faced Faria gauges. To ensure correct wiring connections on the new instruments, I reattached the old gauges to their respective wires after I dismantled the old panel. I had an Impulse 2830 loran/fishfinder combo on my Doral and wanted to keep it. Since I had to create a new space for this anyway, I decided to create a panel capable of housing all the navigational toys of my dreams. Since this would be a custom piece, it made sense to install a new Garmin 240 Blue depthsounder and Garmin GPS Map 162 with the loran now. At this point though, Marg anticipated my every move and just rolled her eyes.

Box design began with a cardboard model of the new overhead console, making a pattern for cutting the 1/4" (6mm) plywood. Since boats are not like houses with square corners, the base of the console had to be curved where it met with the front edge above the windshield. I cut several slits into the wood through all but its bottom layer. I then steamed the bottom layer of wood to make it pliable and then bent and clamped the piece overnight to dry. Once dry, the slits were filled with epoxy and allowed to harden before the clamps were removed. Next, the face and sides were bonded with epoxy and dried. I laid a pattern of required holes and cut them out with a jigsaw, covered the box with light foam and white vinyl and fitted the instruments. It looked great but made the Formica cockpit panels look not so great. So, we covered these with foam and new white vinyl as well. It just made sense.

(above) Helm under construction. (across) More functional helm station with vinyl-covered plywood instrument box overhead and a new Formica panel with Faria gauges relocated above the steering wheel.

Topside Style

I really like the look of a radar arch so I made one. I started by drawing an arch design on a picture of our boat that copied to a sheet of paper. Once I had the look I wanted, I sent dimensions to a local furniture builder who had a pipe bender to bend the 1-1/4" (31mm) diameter 304 stainless-steel tubes. At home, I cut the tubes to the required lengths and welded them together. A die grinder and then emery paper finished the process. Flanges were welded to the feet of the arch and used to screw it to the roof of the boat. The arch holds a Glomex TV antenna, GPS antenna and a Jabsco Remote Control searchlight.

The hull was then painted from the rubrail down. To prepare the hull, we cleaned with Mean Green and scuffed with ScotchBrite pads. We applied Interlux Brightside with the roll and tip method, using a West System foam roller and a foam brush for tipping. [Ed: A natural China bristle brush typically nets the best results.] The weather has to be perfect for doing this job outdoors as high humidity and morning dew will mar the finish. It takes a least two peo-

Custom designed and built tube radar arch.

ple to carry a wet edge so I rolled and Marg tipped. We applied three coats and wet sanded with 600-grit sandpaper between coats. Boaters often talk about Imron for a quality result but the cost is often prohibitive. I wondered how the economical Brightside would look but the result was excellent. Most people don't believe we did it ourselves much less with a roller and brush. We painted the boot stripe with Interlux Super High Gloss enamel and, like most detail work, taping took longer than painting. We replaced the old plastic vents with shiny new stainless ones and added screens to keep out the critters.

A Dink to Match

A few years before buying the Trojan we bought a 9' (2.7m) Achilles inflatable that we used for short trips across the Detroit River to Peche Island. It was a great boat but didn't look that good on the back of our newly restored "Cruise Control." Marg practically forced me to buy a new Mercury Air Deck inflatable to complete the new look. She refers to our new tender as "No Control." Women!

I knew I could design a davit system better suited for our boat than I could buy. I wanted a system that would lift and secure the inflatable without removing the motor or blocking access to the transom-mounted fenders, so I created a vertical-lift system. In doing the design, I kept in mind the weight of both the inflatable and motor, the weight distribution on the transom, the distance between determined by length and lifting points on the inflatable as well as keeping it out of the water, wake and following seas while under way. We can now secure the inflatable and motor and launch it in a matter of minutes. The davits themselves are easily removed with tools when the inflatable stays home.

New inflatable rests in the fully removable custom davits.

More than Sunsets

We spent winters restoring, replacing, updating and upgrading. We were bruised, broken and sore and we were happy. We truly get as much pleasure working on our boat as we do floating around in it. We often talk about the restoration, remembering incidents and recalling injuries. We are grateful for the help of local chandleries and I'm certain they are grateful to us for our financial contribution. Thinking of all the work involved in restoring your boat can be as overwhelming as it is satisfying but we think it was definitely worth it — every nail, every screw, every detail. We'd absolutely do it again. Shhhhh, don't tell my wife.

Winter projects are my favorite way to spend time while waiting for the new boating season to start. This year's project is just now getting under way: installing a Kohler 2.5kW generator. Did I mention that I left room for it when I put in the new fuel tank two years ago? I've acquired two identical used units and will integrate the best parts of each in a complete overhaul. Even though these units are at least 35 years old, parts are still readily available. I plan to use a more modern exhaust and switch system. Of course, it just makes sense.

About the author: For Paul Drouillard boating is not a pastime but a passion. A design engineer with a machine shop in Windsor, Ontario, Paul and his wife Margaret are found most weekends from June to October aboard "Cruise Control" touring their favorite haunts on the Detroit River, the islands of Lake Erie and the calm waters of Lake St. Clair. They've spent the past 20 years docked at Westport Marina in LaSalle, Ontario, and since purchasing "Cruise Control," have spent winter weekends there too.

DIY Bill Of Materials

Rather than itemize all components and purchased parts involved in restoring "Cruise Control," the author provides cost totals, grouped by task. Prices were converted into U.S. funds using a 1.12 exchange rate with Canadian currency noted in brackets.

Dismantling supplies	$302.16	($338.42)
Transmission and drive	$2,162.11	($2,421.56)
Engine build	$3,930.81	($4,402.51)
Hull, machinery and accessories	$5,776.66	($6,469.86)
120-volt DC upgrade, electronics and accessories	$3,271.37	($3,663.94)
120-volt AC upgrade	$374.72	($419.69)
Plumbing upgrade	$1,073.54	($1,202.49)
General interior	$3,560.60	($3,987.88)
TOTAL:	**$20,451.97**	**($22,906.20)**

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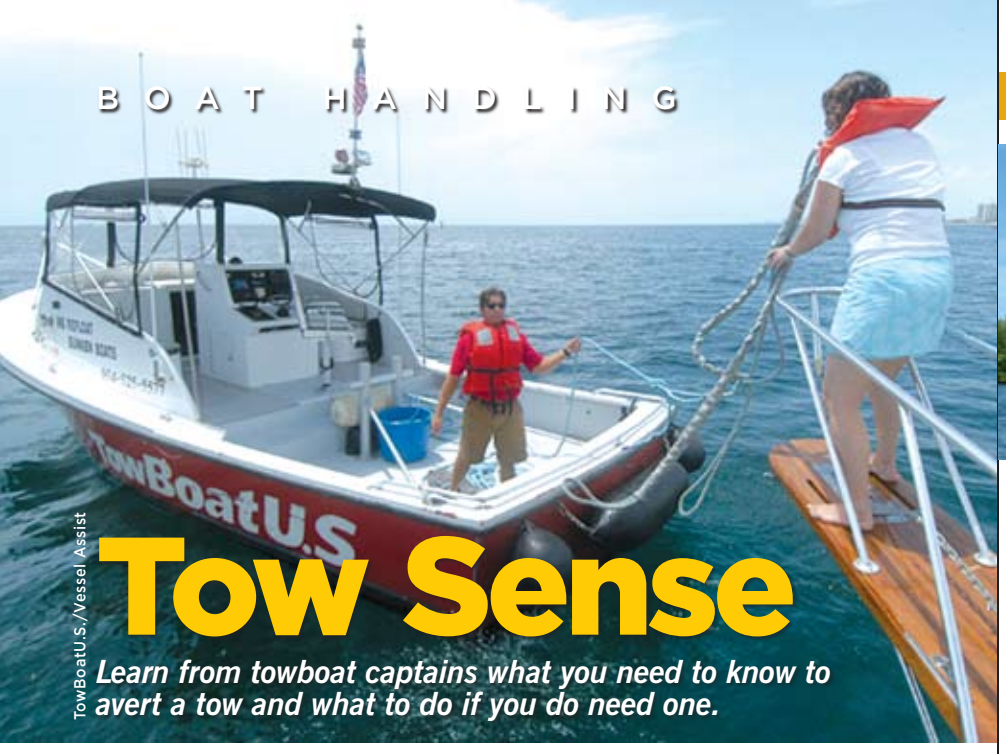

TowBoatU.S./Vessel Assist

Tow Sense

Learn from towboat captains what you need to know to avert a tow and what to do if you do need one.

By Scott Croft

Sometimes things don't go the way you like. One moment it's a great day on the water, your boat is running fine, guests are happy and the warm sun is in your face. The next moment you're dead in the water, your guests are wondering when they'll make it back to the dock and you're frantically hailing your local towing service for a pull home and, oh yes, it starts to rain. What happened?

In my recent mishap, it was a spun prop but it could have been anything: a mechanical or electrical problem, operator error or just plain bad luck. If you don't have a towing plan with TowBoatU.S., Vessel Assist or other commercial towing company, calling for help could be expensive. My incident would have cost $400 or more if I didn't have my TowBoatU.S. Unlimited Plan. At BoatU.S. Towing Services where I work, our TowBoatU.S. and Vessel Assist towing captains see the many reasons for needing a tow and they aren't shy about sharing their knowledge so that others can learn and avoid a hefty bill.

Sweat the Small Stuff

Sometimes, the simplest things can foul your time on the water as I learned from captain Charles Meyer of TowboatU.S., Lake of the Ozarks, Missouri. Meyer says that one of the most common reasons he's called out on the lake is because of the simple engine ignition cutout or "kill" switch.

"The first thing I do when I get the call, is ask about the kill switch," he says. "Are you familiar with it? Did you bump it or trip it accidentally? Frequently, they have no idea what it is or how to reset it. Not having a basic familiarity with how your boat works is probably the number one reason why we get called."

In the Pacific Northwest, captain Chris Conti of Vessel Assist Seattle/Tacoma, Washington, says boaters frequently don't understand how their boat's electrical system works.

"If a vessel is dead in the water, the first thing we often do is pop open the battery caps and then check the cells," says Conti. "We often find lead-acid batteries have lost their water due to overcharging, exposing the lead plates and reducing charging capacity. The boater didn't understand that they needed to be periodically checked and topped off," he continues.

"Batteries don't last forever," warns Conti, a lesson boaters unfortunately only learn after they have left the dock. What happens, he explains, is that an owner starts the engine at dockside while connected to shorepower with the charger on. After leaving the dock, the boat spends a long day anchored or rafted up while running the stereo, fans, fridge or other electronics but now, "off the grid," the battery just won't have the juice to start the engine.

Meyer says he sees more boaters carrying mobile battery "jump packs" aboard but wiring or battery terminal corrosion reduce the unit's effectiveness. "It's very difficult to get a good connection," he says.

Another tip to help avert a tow is not to trust your gas gauge. "They are notoriously inaccurate," says captain Jim Reynolds of TowBoatU.S. Bayshore, on New York's Long Island. "The information comes from a float inside a tank, which goes up and down with the boat thousands of times, often slamming pretty hard. How accurate a reading can you get?" Reynolds suggests using some basic math and an engine hour meter to reduce your reliability on a potentially inaccurate fuel gauge.

"Fill the tank with fuel and run for four or five hours like you normally would, then fill up again, taking note how many gallons were burned in that time," he explains. "For example, if you burned 6 gallons (5L), write that down in your logbook. Now divide 6 gallons (5L) by the number of hours and you have a good number to work with to plan your trips."

Conti also says that the wires connected to the tank's sending unit frequently corrode. "In fact, we replace the towboat tank sender wires nearly every year," says Conti.

Reynolds also believes that water separating fuel filters should be replaced more often than once a year. "And if your fuel contains ethanol or if you frequently get down to a quarter tank full or less, the fuel system can pick up water and debris off the bottom of the tank." If you have a diesel-powered boat, make sure you know how to bleed the lines.

Reynolds has also noticed that, with high fuel prices, some boaters are penny pinching and are heading

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out without enough fuel. “Nothing ruins a nice dinner at a marina restaurant better than running out of fuel on the way home in the dark, so always follow the rule of thirds. A third of a tank for going out; a third for returning; and a third always in reserve.”

Another reason the 24-hour dispatch centers receive requests for assistance is for overheating problems. With most engines you’ll want to remedy the situation by shutting the engine(s) down before you attempt anything. Next, check the water intake, hoses and sea strainer as you may have ingested debris via the seawater intake. Surprisingly, our captains sometimes find seacocks in the closed position. Slipping or broken belts for the raw-water pump or the pump’s impeller can also be the source of the problem.

All three captains agree that lack of routine maintenance is the biggest culprit that leads to a tow. Conti remembers one case where an aluminum sterndrive corroded so badly that oil leaked into the sterndrive’s bellows, out of sight. The boater found out only after the gearcase “blew up” a few miles from port. Simple, periodic replacement of zincs would have prevented the problem.

“Don’t wait to fix it until it’s broken,” says Conti. That includes regular replacement of the raw-water pump impellers and engine hoses, as well as ensuring the proper coolant/water mix if your boat has a closed cooling system.

Meyer sees quite a few calls for assistance in the spring related to improper winterization and cautions that engines should be idled for a while before any inaugural cruise. “Perhaps the owner did a poor job of winterizing and left some water where it shouldn’t have been, which then froze and a crack developed somewhere. For a few minutes after the spring startup everything looks fine but the owner doesn’t realize he has a problem until the boat’s a few miles from the dock.”

Halt First and then Call

Preventive maintenance won’t always take care of “Murphy.” If you call for a tow, here are some tips that can help the situation.

Reynolds says the first thing to do is to set an anchor as quickly as possible. “An anchor is your parking brake,” says Reynolds, “and if you stay in one place, I’ll be able to find you faster. The last thing you or I want to do is waste time

on a game of Marco Polo or Hide-n-Seek while your boat drifts."

In the case of running aground, anchoring may give you some much needed breathing room time to fully access the situation. An extra minute or two can provide clarity to the situation. He recounts the time a disabled boat hailed for assistance, then while waiting for help to arrive, the tide rose sending the boat adrift further into shallows, causing major damage.

One time a large sailboat had gone aground at the edge of a narrow channel. Instead of taking stock of the situation, the skipper attempted to quickly back off under power and promptly wrapped the dinghy painter around the prop.

Powerboat engines can overheat after ingesting bottom debris into engine cooling intakes, so the first thing towers always advise is to stop everything, assess the situation and identify and record your location.

Calling Frequency

The best way to get immediate help in an emergency is via your VHF radio as local towing captains monitor channel 16. On the West Coast, Vessel Assist uses a unique series of VHF radio antenna locations that increase VHF communication range along the Pacific coast and on Catalina Island.

Many boaters may use cell phones to call their local tower directly. To find the one nearest you, go to: www.BoatUS.com/towing/guide. Dispatch centers, located in Virginia or California, are open 24/7 and can be reached at 800/391-4869. Post these numbers onboard your boat so they are handy when needed or, better yet, add them to your cell phone roster of important numbers.

Position Pointers

If you can't tell a tower where you are, it delays a response and, if the weather is rough, could potentially expose your family and guests, as well as the towing crew, to dangerous conditions. You need to be specific.

"When someone says, 'I can see the lighthouse,' that's great, but it's meant to be seen 22 miles (35km) out," says Reynolds with a chuckle. "So I ask them, how well can you see it? When looking at it, will a fist on the end of your arm completely cover it or does it tower over you? Using your compass, can you tell me which direction it lies from you? The best one I've ever had was the boater who told me he was right under the moon to the left."

Learn how to take bearings using multiple landmarks and understand on-the-water signage and markers. "A boater said he was anchored right next to the lighthouse. The boat was found hours later next to a 2' (61cm) high channel marker, miles from any lighthouse," says Reynolds.

Those with sophisticated electronics need to know how the equipment operates. Reynolds says he asked distressed boaters for their latitude and longitude reading on their GPS, and they said, "S-O-G… ."(speed over ground). "Another time I had a gentleman give me a waypoint location 15 miles (24km) from his actual location," he says.

Ultimately reducing your chances of having to call for on-the-water assistance is probably proportionate to the amount of preventive maintenance you perform, as well as your knowledge of your boat's systems and local waterways. If you do have to make the call, stopping

drift and providing an accurate location will increase safety and speed response times.

On my own boat I'll have some work to do before I go out in the spring. In addition to my own schedule of routine maintenance, I'll be looking at my 10-year-old fuel tank wiring and I know I need to get up to speed on using the new chart plotter I received for Christmas. Perhaps I'll rig my anchor so I can deploy it quickly and easily.

Just in case, I've added my local TowBoatU.S. port to the speed dial on my cell phone.

About the author: Scott Croft is an assistant editor at BoatU.S. magazine and director of public affairs for the 630,000-member association. Scott recently sold his sailboat for a 28' (8.5m) power cruiser in order to take advantage of the "great" fuel prices. He currently cruises on the lower Potomac River in Maryland.

Towing Costs

Hourly towing charges, which generally apply from the time the towing vessel leaves its home dock to the time it returns, average about US$200 per hour. In 2005, the average towing bill for those who didn't have a TowBoatU.S. or Vessel Assist towing plan was about US$600.

BoatU.S. and other companies offer various levels of towing plans. If you cruise a lot or go offshore, unlimited plans are best and average about $140 year. If you generally don't stray far from port, you may be fine with a lesser plan that offers up to $150 or $300 payment per incident and that costs less upfront. For more information, go to www.BoatUS.com/towing or call 800/888-4869.

On-the-water towing companies generally provide two basic services to recreational boaters: towing and salvage. The majority of jobs today fall under towing and either paid for by a towing service plan or out of pocket. Generally, BoatU.S. defines a pull off the soft bottom with one towing vessel using no special equipment, with the boat in no imminent danger of peril to the vessel or passengers, as a towing job. Other examples include fuel drop offs, battery jumps or towing a disabled boat back to port.

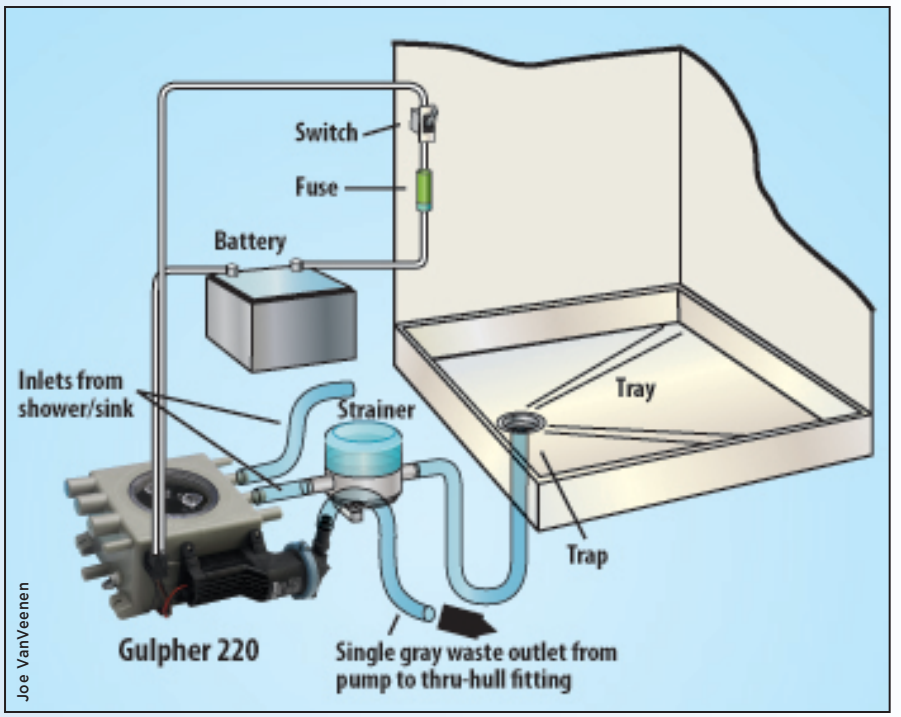
Salvage is more serious as it brings a higher level of "peril" into play, can be much more expensive and is covered by an insurance policy or out-of-pocket. Salvage jobs sometimes are based on a percentage on the post-recovery value of the vessel and the level of peril can affect that percentage. Charges are usually in the thousands of dollars.

When in doubt about what kind of job it is, always ask the towing captain first and have a copy of the BoatU.S. Open Form Salvage Contract aboard in case you are in a salvage situation. To print your own free copy, go to BoatUS.com/salvage. Details of what you need to know about towing versus salvage appear in the next issue (2006-#2). — *SC*

Shower Project

Common problems plaguing shower sump systems are easily resolved with an alternative keep-it-simple custom installation for trouble-free performance.

By John Payne



In the custom made shower water collection arrangement, the shower water drains down from the shower base to a collection sump. Water passes through the lowest point in the sump tray that employs a 1" (25mm) or larger trap to a common washdown strainer to the inlet side of a diaphragm pump and then to a gray water holding tank, or use a combined Whale gray water holding tank and Gulpher 220 pump as shown, or discharged overboard. When routing hoses, eliminate sharp hose bends to avoid kinks. Sloping the base of the sump to one corner allows draining of all water especially when the float switch is replaced with a single waterproof toggle switch panel that allows manual control of the pump action. There's no residual water which keeps the sump cleaner and reduces maintenance.

Shower sumps, sump pumps and the associated control systems are often a problem on boats. Shower wastewater is also known as gray water. Many modern boats have a plastic water collection sump that contain a small centrifugal bilge pump and a float switch that automatically controls the pump as water rises and falls in the sump. With this arrangement, the shower drains to the small sump and the float switch activates the pump that discharges overboard.

In the custom made shower water collection arrangement, the shower water drains down from the shower base to a collection sump. There is a separate pump to pump out the sump, with a float switch to activate the pump. This is the arrangement on my own boat, for what should be a relatively simple system; it's been a constant source of problems.

The principal problem with shower sumps is that the pump fails to go on and/or off because the float switch is stuck. If a stuck switch prevents the pump from activating, the sump will overflow. If a stuck switch keeps the pump running unnoticed, not only will the sump be dry but also a battery will be drained. Even with a shower pan drain strainer, hair will escape into the sump along with the soapy (gray) water. This gooky mess eventually collects around the float switch and binds the mechanism that allows the switch to hinge freely. Once this mixture gets into the pump intakes strainer, it can block the flow and, even if it gets past that, it can wrap around and bind the impeller of a centrifugal pump.

Pump Selection

Now that we know the problems "gray" water can cause, lets look at how to make the system a little more bullet-proof. The typical shower drain system has a submersible centrifugal pump that consists of an impeller or rotor. When this spins at normal speed, the gray water discharges through the outlet port. These pumps are not self-priming so there has to be some water around the pump suction to allow priming and, when the pump is submerged, this occurs by simple gravity. These pumps are usually reliable and require little maintenance and they are capable of running dry without damage and they all have easily removable strainer bases. While they are fairly resistant to clogging, debris can and does enter the strainer and jams or damages the impeller and prevents rotation. The challenge of keeping soapy hair and other icky things that go down shower drains out of the impeller and from around the float switch has resulted in many home grown remedies that include enclosing pump and switch in fine mesh and other creative strum box arrangements. While centrifugal pumps are inexpensive to replace, it's the inconvenience and irritation that we are trying to resolve here. It's worth noting that several models of integrated pump and float switch are available but all require regular checking and cleaning to keep them healthy.

My solution to keeping the flow going was to install a diaphragm pump. These pumps have a one-way valve that controls the water input and discharge as the diaphragm flexes in and out. While the valves can become clogged with debris, these pumps do handle hair and soap residues well. They are also self-priming and the Whale Gulper pump I installed can be mounted up to around

12' (3.6m) away from the drain source. Like centrifugal pumps, they can operate dry. The typical capacity is around 3.5 gallons (13.2L) a minute, which is a mixture of water and air.

Pump Controls

The float switch is often the Achilles heel of shower sump systems. The mechanical float is the most common device used for automatic bilge and shower sump pump control. They incorporate a mercury, or as is more common these days, a mercury-free switch inside the float mechanism. An important consideration is to ensure that the float switch wires are taken outside the sump and terminated with care to ensure that the wires cannot foul or otherwise restrain the float, a common failure cause.

Solid-state level switch devices such as ultrasonic, conductive probes and capacitive types are relatively rare in sump control systems. Air operated switches that are used on bilge water systems are an alternative to traditional float switches.

Building a Custom Sump

If you are installing an off the shelf shower sump unit, the main thing to consider is ensuring that the power supply wiring to the pump is properly rated for the pump unit. The inlet and outlet hose connections are standard and it is important to ensure that bends in the hose are free from kinks or sharp bends that might cause blockages.

In some boats, you may wish to install a sump custom made to fit either the shower pan or a remote location. This is relatively easy project that requires some basic carpentry and fiberglass skills.

Initially, make a mock up of the space using cardboard and masking tape. Make sure that you drain everything to one corner and allow enough room to install a drain point to go to your sump pump. If you intend using a submersible pump, make sure the sump is deep enough to fit a pump.

You can make a wooden plug for a fiberglass sump or you can clad a wood one with fiberglass. Once you get your mock-up right, make a copy using marine ply. Use 1/2" or 3/4" (12mm or 19mm) plywood and glue, or glue and screw the joints. If you are making a shower base sump unit, the top of the tray (pan) box should have at least a 1" (25mm) wood cleat around the top edges to support a person's body weight on the grating fitted on the top.

The next task is to fiberglass coat the sump interior and exterior. Chopped strand and polyester resin make a good waterproof coating. Reinforce the corners using some lightweight cloth tape. Finally, finish it off with gelcoat to give a smooth and professional surface coating. [Ed: Alternatively, build the sump of 3/4" (19mm) marine-grade plywood with all sides, including edges, saturated with five coats of epoxy resin. Add a white pigment to the final coat or finish with a polyurethane paint.]

The sump drain method I have used in the past is a simple plastic thru-hull. If you don't have sufficient space in the bottom of the sump, install it in one corner sidewall. It's necessary to grind

Example of ready-made sump for shower applications. Shower water level activates the automatic float switch that starts the pump, which runs until water recedes and the switch deactivates the pump. A removable strainer allows for easy cleaning and a check valve on the outlet prevents back flow.

away one edge of the fitting flange to ensure you get the drain as low as possible. It's also a good idea to have an overflow point in an upper corner of the sump sidewall and take the drain hose to the bilge.

Install your sump now. Depending on the location, you may need to make suitable bracket supports or glass it into the selected location. Have a custom teak grate made or make your own using either teak planks or oak, both look good and allow easy access. [Ed: StarBoard fabricates as easily as wood and makes an attractive grate with the added benefit of no maintenance.] Attach your drain hose and take a relaxing shower.

Upgrading a Sump

To renovate or upgrade an existing sump arrangement, the following suggestions will be helpful. The drain line from shower tray to the sump should be large enough to allow easy passage of hair and

soap. Typically a 1" (25mm) hose works well. All hose used in this type of system should be the smooth interior wall type to minimize the kind of clogging that occurs when drained particles (hair plus) get trapped in the ridges of corrugated type hose. The overboard discharge line should be routed to avoid kinks and sharp bends. This is a good time to install a water saving shower head as part of the system upgrades. [Ed: The author's water saver shower project appears in DIY 2002-#3 issue.]

Pump Installation

Selecting the pump is the next important step. The least expensive option is the centrifugal pump; however, the diaphragm pump is a good alternative for all the reasons previously discussed. Opting for the pump with an integrated float system is tempting and, while this is a neat option, they are relatively difficult to clean when they clog. When installing a submersible pump, it's often common practice to fasten down the strainer base and clip the pump into it at the base of the sump. On my own boat, I installed a removable plate that fitted the rectangular sump base. On this, I fastened the strainer along with the float switch. This arrangement allows the entire assembly to be lifted out for regular maintenance. As the float switch was a persistent problem, the removable assembly was practical for freeing up and cleaning the switch. Another common problem was keeping the wiring and terminations to the pump and float switch away from water. These can be fastened to the pump discharge cable to keep the arrangement dry and tidy. Always allow a small loop in the cable at the float switch so that it doesn't prevent the float from moving freely. Centrifugal pumps are not self priming and having the base slope to one end and self-draining to the pump allows the maximum amount of water to be pumped out. All these installations require regular cleaning and it's good practice to remove accumulated hair from the pump intake strainer and run hot water into the sump periodically to dissolve soap. Also, disinfect regularly as the standing water in the sump and the residual scum can get smelly. Some of the elaborate mesh systems placed round the pump and float to catch hair and prevent clogging appear to be quite successful.

If you choose a self-priming diaphragm pump, you'll be able to install the pump and associated wiring away from the water. Normally, the pump suction line is routed to one corner and a strainer head inserted. The sump should slope to drain the water to one corner and, if space permits, the suction line can be routed from below one corner to pump the sump dry. The float switch in this arrangement mounts close to the suction; however, float switches always cut out the pump before water is completely drained, sometimes leaving 1" (25mm) of water.

Control Systems

Using a bilge pump arrangement with a hands-free switch works well and, in the case of a diaphragm pump, results in complete draining of the sump with virtually no water remaining, which keeps it cleaner and reduces maintenance. There are some good waterproof switches and switch control panels available and also touch pad membrane units, both of which I have used successfully on projects.

If you are installing a sump pump switch control panel, usually located in the head and shower compartment, keep it well away from the shower spray or provide some other device to protect the switch. It's important to make sure the panel has an indicating light to show when the pump is running or you risk running the pump dry and damaging it. You can usually hear a diaphragm pump operating but a centrifugal pump is quiet and, if left on, can easily run down the batteries. As any extended wiring run can introduce voltage drops into the circuit that can reduce pump efficiency, always increase the wire size to compensate for a 10% voltage drop (per ABYC). The use of a relay in the circuit can reduce this but it makes the circuit unnecessarily complicated. Pumps and switches require the appropriate fusing or circuit breakers. If you cannot install electrical connections well above the expected bilge water levels, then waterproof them with heat-shrink and adhesive-lined terminals were needed.

There are a variety of ways to improve such a simple system and improve reliability. Keep it simple and it will give trouble-free performance.

About the author: John Payne, DIY's electrical consultant, lives in Mons, Belgium, on a 65.6' (20m) canal boat built in U.K. in 1896. He is author of "The Marine Electrical and Electronics Bible" and "Motorboat Electrical and Electronics Manual," (Sheridan House).

•BOOK REVIEW•

Your First Sailboat by Daniel Spurr

270 pages, Paperback (McGraw-Hill, US$14.95/CDN$21.95)

Had I had this accessible reference book when I began to learn to sail, I would probably have been more successful, had fewer bruises and avoided a number of humiliating capsizes. Giving detailed instruction for the real beginner on how to sail a sailboat, Spurr also answers the questions you probably wouldn't even have thought of yourself so that you can buy and maintain your first boat without mishap. In a very clear, fun and down-to-earth approach, you will learn how to raise the sails, how to tack and jibe, how to stop and basically, how to use the wind to take you where you need to go and how to get there when the wind just isn't there. Learn all the knots you'll ever need, learn all the do-nots and the what-not-to-buy or "nautical tire kicking" when considering your first sailboat purchase. This is a fun and extremely helpful resource for the first-time sailor and it takes you a long way along the road to success. Having read this book, my appetite has again been whetted to don my lifejacket, raise the halyard, trim the sails and take advantage of a broad reach. — *Tracy Croll*

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PROJECTS

BUILD A COCKPIT TABLE

Indicates the degree of difficulty with 10 being the hardest and 1 being the easiest.

6

Step-by-step instructions to build a wheel pedestal-mounted teak cockpit table.

By Graham Collins

Finished cockpit table gets a 20lb (9kg) stress test. The table is supported by the compass mounting plate and mounts to the wheel guard with rail clamps. When not in use, the sides fold, allowing unimpeded movement throughout the cockpit.

After a day sailing, we often have snacks and beverages on board at the mooring before heading home. This has meant either sitting below or sitting in the cockpit with plates balanced precariously. A pedestal-mounted table is the obvious solution. My DIY barometer for this project criteria was that the table had to be removable for storage in the aft locker, be built with readily available materials (no serious metalworking) and that it didn't require any disassembly of the pedestal, as the electronics wiring runs through it.

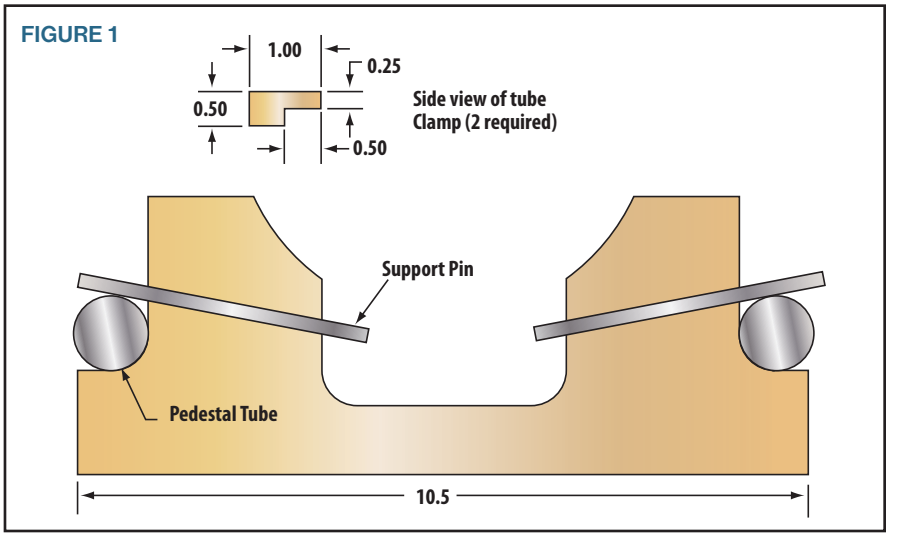
The design that emerged can be easily attached by sliding the table on top of the compass mounting plate, sliding out two support pins that retain the aft side of the pedestal guard tubes and clipping a support rod into two rail fittings that are clamped onto the pedestal guard tubes. The rail fittings are the only permanently mounted pieces, the remainder of the table can be folded up and fits easily into a locker. The table has two fold-down leaves that give a width of 21" (533mm) or it can be used folded with a width of 10-1/2" (266mm). The only unique tool required is an extra long 3/16" (3mm) drill bit, available at most hardware stores.

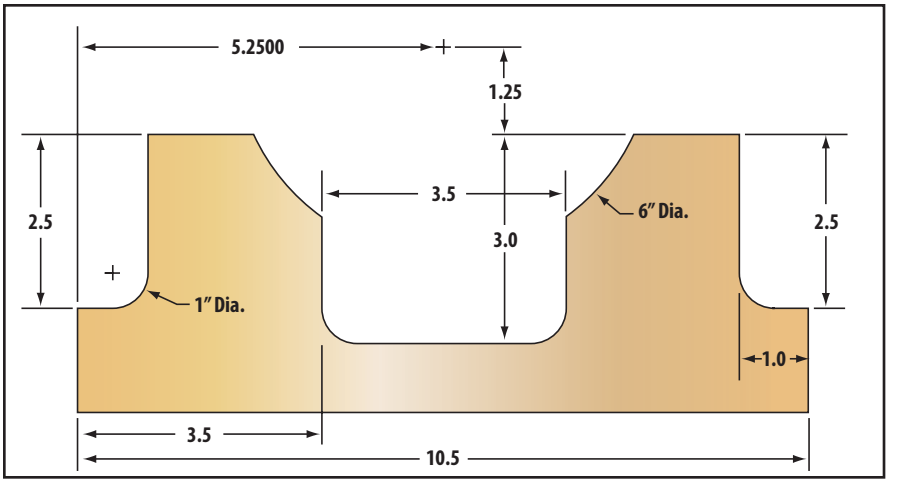
Table Details

The goal was to make a table approximately 26" (660mm) long by 21" (533mm) wide. If you want a longer or shorter table, scale accordingly. As the table is not exposed to bad weather, almost any material will do. Try to select wood with the grain perpendicular to the surface to minimize warp. I selected teak, a piece of 3/4" by 5-3/4" by 10' (19mm by 146mm). This was cut into two pieces 28" (711mm) long for the main table, two pieces 24" (609mm) long for the fold-up "wings" (sides) and I ripped both on a table saw to 5-1/4" (133) wide.

Two halves are glued together on a flat surface using thickened epoxy resin.

FIGURE 1





End view of table provides cutout measurements of compass housing and wheel guard.

(left) Dry fit the hinges then (right) using a template cut the hinge recesses.

Join the 28" (711mm) pieces edge to edge. If you are using teak, I would recommend epoxy glue due to the natural oils in the teak. I reinforced the joint using biscuits (but this may be overkill). The end that mates to the pedestal tubes is a bit of a complex shape. Either mark the end per **Figure 1** or trace the cut out pattern on one end of the glued-up piece. Cut out the end and, if so desired, round off the opposite corners of the table round (so you don't knock a kneecap loose on them). For the wings to match, round off three of the corners to the same radius on each piece. From a piece of scrap, cut two cleats (as shown in the bottom photo on page 68) and then pre-drill the cleats for the screws. Make sure the pieces line up properly when folded by butting all three pieces up against something flat and then mark for the hinge locations. I made a router template for the hinge mortise, used the template to route out the mortises and then used a rotozip to cut out the deeper section for the hinge knuckle. With the hinges fitted, install fiddles on the sides opposite the hinges of the table wings, if desired. This will give a bit more stability to plates if used with the wings folded in.

Hinge details: (top) cut the deeper section for the hinge knuckle, then (bottom) check the fit.

Making the Pins

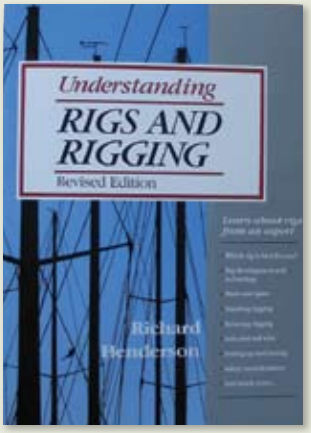
Cut the two holding pins, 4" (101mm)

Bracket hardware consists of: (top to bottom) holding pins of 3/16" (3mm) rod; support rod bent to shape and assembled with bent flat bar clamps; purchased rail clamps.

long, from the 3/16" (3mm) rod. Drill a 3/32" (2mm) hole through one end of each rod close to the end. To get the drill bit started, file a section flat so the bit doesn't wander. Check to make sure the split rings fit the hole.

From scraps of flat bar make two rod clamps to fasten the support rod to the underside of the table. Cut two pieces of bar, about 4" (101mm) long, and bend them in half over a

•BOOK REVIEW•



Understanding Rigs and Rigging (Revised)

by Richard Henderson
250 pages, Paperback
(McGraw-Hill US$24.95/ CDN$39.95)

Learn about rigs from an expert. Richard "Jud" Henderson is a lifelong sailor and in this, his 20th book about sailing, seamanship and yachts, he gives advice both to the novice boat buyer and seasoned sailor (who may be swayed by the hype of newer, high-tech, "bendy," rigs that can be a bit temperamental in their tuning needs) in selecting rig, sail plan and rigging systems best suited to need. One aim of the book is to point out potential weaknesses in rigging and related gear. Though this book lacks in detailed illustrations, it's an exhaustive discussion on everything above the deck on a sailboat including its history and variety of different configurations. You will find out how best to utilize your rig for your sailing interests. — *Tracy Croll*

(top) Use extra long bit to drill for holding pins. (bottom) Holding pin positioned in table.

piece of rod to make the clamps. Use a vise to get a good, tight fit around the rod. Drill two holes in each rod clamp for the screws that hold it to the table underside.

Slide the clamps onto the middle of the remaining section of rod. Mark 1/2" (12mm) from each end of the rod, and mark 4-1/2" (114mm) to each side of the middle of the rod. Bend at 90° at each mark to make the support rod. Using four 3/4" (19mm) pan head screws, fasten the support rod to the under side of the table, approximately 10" (254mm) from the pedestal end and centered equally from the sides. Check that the free ends of the support rod slide freely into the clamp-on rail fittings. If they are tight, drill out the hole in these fittings to match.

Bottom view with bracket and pins installed.

Cockpit meals are no longer buffet style with this easy-to-make table that the author built in 8 hours.

On Board Assembly

To fit the main table section to the boat, place the main table section against the pedestal guard tubes, with the top resting on the top of the compass mounting plate. Have an assistant hold the table level and loosely attach a clamp-on rail fitting to each pedestal guard tube. Fit the support rod ends into the clamp-on fittings and tighten the fittings in place. Next, using four 1" (25mm) flat head screws, fasten the cleats to the bottom of the table surface, located to press against the bottom of the compass mounting plate so the end of the table doesn't flip up.

Finally, with the assistant holding the table tightly in place, drill holes for the holding rods. The extra-long drill bit is required for this operation. Holding the drill against the pedestal guard tube, sight along the drill bit to make sure that it's level and that the exit point will be approximately where desired. Carefully drill the holes — you only get one chance at this!

Back in the workshop, remove the support rods and clamps. Apply glue and reinstall the cleats on the bottom. Sand the table and apply a finish of your preference. I used a spar varnish as it gives a good, hard surface and really shows off the teak. Install the hinges and reinstall the support rod and clamps. Slide the holding pins in from the outside edge (they should be too long to fit in the other way), placing the hole end toward the center of the table and put a split ring on each.

Back on the boat it should all fit together. Just clip the support rods into the rail fittings, slide the table up against the pedestal, and slide the holding pins out until at least 1/4" (6mm) protrudes past the center of each pedestal guard tube. Crack open a beverage and lay out some snacks and enjoy!

Graham Collins, wife Jill and toddler Sam sail the waters around Halifax, Nova Scotia, on their Aloha 27, "Tardis."

DIY Bill

All items to build the table are available at home improvement centers. Look for hinges, split rings and rail clamps at marine stores. Prices shown are in U.S. funds with the Canadian equivalent shown in brackets using a 1.12 exchange rate.

Teak, 1" by 6" by 10" (25mm by 152mm by 254mm)	$129.46	($145)
2, 1" (25mm) clamp-on rail fittings	$28.50	($32)
3' (914mm) of 3/16" (3mm) stainless-steel rod	$4.46	($5)
3' (914mm) of 4" (101mm) stainless-steel flat bar	$11.60	($13)
Stainless-steel screws	$8.00	($9)
2 stainless-steel split rings	$.89	($1)
6 (3 pair) stainless-steel hinges	$40.00	($45)
Total	**$222.91**	**($250)**

Labor	
Make pedestal mock-up and table end mockup	1.5 hour
Take pictures, etc.	1 hour.
Cut teak to length, assemble and glue pieces	1 hour
Fabricate holding pins and support bracket	.5 hour
Fit table on boat	1 hour
Sand, varnish, final assembly	3 hours

CONTENTS/ PREVIOUS/ NEXT/

8

Rebuild your Alternator

Since alternators are very similar in design, if you learn to repair one, you can repair them all. Follow these three steps to maintain, troubleshoot and repair your alternator.

Story and photos by Harry Hungate

It's a rare boat that doesn't have at least one 12-volt alternator. All are very reliable and very similar in design, which simplifies maintenance, troubleshooting and repair. Before doing any service work, whether you are an experienced mechanic or just learning, it's vitally important to always label or tag each wire, nut and bolt as you remove them to avoid a frustrating error at reassembly time. Masking tape and a felt tip marker are very useful and practical. A digital camera is also a useful tool, but don't rely on it exclusively. Take a picture and you will quickly see what I mean.

Step 1. A few simple routine maintenance actions further increase the reliability of your alternator and very possibly prevent a very costly catastrophic failure. Thankfully, there is little to do on a routine basis, except to check for loose wires and obvious signs of overheating. It's a good idea to loosen the drive belt and rotate the alternator drive sheave by hand, listening and feeling for dry or noisy bearings. This can be done at oil change time. Be sure to retension the drive belt properly. You should just be able to turn the alternator by pulling on the cooling fan. An over-tensioned belt causes premature failure of both your alternator bearings and your water pump. Inspect the drive belt and replace it if it's frayed or glazed. A good quality toothed belt, as shown in the photo above, will give you the best service. If your alternator has two drive belts, be sure to replace them only with matched pairs. Clean the exterior of the case and use cotton swabs to clean the cooling air slots in the back end plate. Heat is the alternator's worst enemy and anything you can do to insure a good airflow and good heat transfer greatly prolongs the alternator's life.

Pictured is a marinized version of the very popular Delco alternator, marketed by Kenyon and many others, and rated at 120 amps. Replacement parts are readily available at any auto parts store.

Step 2. If your alternator has no output and shows signs of overheating or smells burned, your best bet is to seek profes-

sional help. However, don't be misled by a light coating of black soot around the cooling fan, as this is only harmless carbon dust from the brushes. If your alternator is noisy and/or the drive belt seems to be wearing out quickly, worn bearings are the most likely culprit. Slack the drive belt and rotate the alternator shaft with your fingers. Bad bearings are noisy and feel rough. Dry bearings present no resistance to turning and are not far from failure. Good bearings are quiet, smooth and present a slight drag. Sight along the drive belt to ensure that the alternator, water pump sheave and crankshaft sheave are properly aligned. Inspect the sheaves visually and by feel for wear.

Reduced or no output can indicate failed diodes, bad stator windings or a faulty regulator. Begin by turning the engine start switch to the "run" position (starter not engaged). The engine oil pressure light and alternator alarm light should be "on." Hold a steel wrench or screwdriver to the drive end of the alternator shaft. A strong magnetic field should be felt. If there is no magnetic field, check for voltage on the "field" terminal on the back of the alternator. A "P" type alternator has a positive voltage on the field terminal and an "N" type has a negative voltage on the field terminal. No voltage can mean a broken wire or faulty regulator. Remove the wire from the field terminal and connect full battery voltage directly to the field terminal. (Put a 10-amp fuse in the circuit for your protection!) Check again for a magnetic field, in which case the regulator is probably bad. No field means a bad rotor, stator, and/or bad brushes.

Step 3. Begin by insuring that the battery switch is in the "off" position. Label the positive and negative cables and terminals. Your alternator probably has an external regulator, so locate and label the "field" wire and terminal. Another wire that may be present will be the tachometer sensor wire. Label it also. Remove the wires and tape all exposed wire terminals to prevent short circuits.

Slack the drive belt, remove the mounting bolts, and remove the alternator to a suitable well-ventilated work

Use an Allen key to remove fan and sheave.

surface. Clean the exterior using a spray cleaner, such as CRC XD4 cleaner and degreaser or equivalent trichloroethylene-based degreaser. Insert a suitably sized Allen wrench (hex key) into the hole in the end of the shaft to prevent the shaft from rotating. A few sharp raps on a box end wrench loosens the nut and allows you to remove the drive sheave and cooling fan. If there is no hole for an Allen wrench, then hold the shaft by inserting a large screwdriver into the cooling fan. Carefully note the positions of any washers, spacers and keys. Mark the two end plates and center section with a felt tip marker or center punch. Remove the three or four bolts holding the alternator together. Gently tap on the shaft while spreading the end plates apart with a wide straight blade screwdriver. The end plates are cast aluminum and won't take a lot of stress, so don't hammer on them. Remove the drive end plate and pull out the rotor from the back end plate. The stator windings (the center section) are connected to the diode assembly and back end plate. Remove the three nuts holding the stator windings and lift the stator clear of the back end plate. The diode assembly can be removed at this time. Again, carefully label the wires, washers, insulators, etc. for proper reassembly later.

The two slip rings on the rotor should be smooth and clean. Use 1,200-grit wet or dry paper to brighten them up a bit. A light touch is required here, just hold the paper against the slip rings and slowly turn the rotor. Clean the slip rings with degreaser. Measure the resistance across the two slip rings as shown in the photo above right. An open or a short

Measuring resistance of rotor with a digital multimeter.

circuit indicates a bad rotor. A good rotor should measure around 2.5 to 5 ohms. Replace a bad rotor as it cannot be repaired.

Degrease the diode assembly. There are three positive diodes and three negative diodes arranged in pairs. It's necessary to lift the copper tabs clear of the terminal and adjacent diode. Check the diodes with your digital meter's diode test feature. Measure from the positive terminal to the tab of each diode and note the readings. Reverse the test leads and compare the readings. One reading should indicate an open circuit and the other reading should read very low, 0.45 or so. If both readings are high or low, the diode is bad and needs replacing. Repeat the same test on the negative set of diodes, reading from the negative half of the heat sink to the copper tab on each diode. If one or more diodes are faulty, replace the whole assembly and reinstall it. (Note that a digital multimeter ohm function cannot be used to test diodes. Only an analog meter can perform this test.)

Degrease and inspect the brushes and replace them if they are worn in excess of 50% of their original length. "And," you ask, "how can I tell how long they were originally?" Simple. Take the brush-

Brush restrainer inserted in back plate.

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es with you to the auto parts store when you purchase new bearings. Folks at the store will surely show you new brushes, hoping that you will purchase them. Now, carefully reinstall the brushes. On close examination of the back end plate, you will notice a small hole in the brush holder. Fully retract each brush into its holder and insert a paper clip, toothpick, etc. into the small hole (from the outside) to hold the brushes fully retracted so that it's possible to reinsert the rotor without damaging the brushes.

Degrease and inspect the stator windings for failed insulation and/or broken wires. Repair as necessary. Measure the resistance between each of the three stator terminals. An open circuit means a bad winding. A good winding should measure a very low resistance of around 0.5 ohms.

If your alternator has over 2,000 hours on it, chances are that the bearings are getting a bit dry. If the bearings are the least bit noisy, by all means change both of them. If you are suitably equipped, press out the drive and back end bearings, degrease the end plates and press in new bearings. It helps to heat the end plates with boiling water. Otherwise, take the end plates to a repair shop and have them install the bearings for you.

Reassemble the alternator, paying particular attention to the stator wires and brushes and carefully tighten the bolts. Remove the "brush restrainer" and rotate the shaft to insure freedom of movement.

A brief note on reassembly: carefully clean the threads on all fasteners with degreaser and apply a drop or two of blue Loctite or equivalent thread locker to keep them from vibrating loose.

Reinstall the alternator and perform the magnetic field check as in Step 2 above. Retension the drive belt after 5 hours of operation.

Here are two suggestions to improve the reliability of your alternator. First, install a separate ground wire from the alternator case to your battery negative bus. Use the same size wire as the positive wire (4 AWG minimum). This minimizes current flow through the bearings. Secondly, construct a cooling shroud of fiberglass cloth and resin to fit over the back plate of your alternator. A small, brushless 12-volt fan connected to the shroud via clothes drier duct tape provides cool air from outside the engine compartment. Wire the fan to the alternator output terminal using a suitably rated in-line fuse.

Shroud made of fiberglass cloth and resin and duct tape helps to cool the alternator.

Your alternator should now provide another 2,000 hours or more of reliable service with little attention other than periodic external cleaning.

Harry Hungate and his wife, Jane Lothrop, have lived aboard their Corbin 39 cutter "Cormorant" since 1997 and have cruised over 24,000 miles. Harry acquired his skills as a diesel generator mechanic in the Louisiana Air National Guard and U.S. Air Force Reserve. They currently reside in New Zealand.

Balancing Forces

Steering a sailboat by wheel or tiller shouldn't be a fitness workout. A well-balanced boat points to windward with a light hand on the helm to keep the proper sailing angle. This quiz helps to recognize and achieve your boat's best helm condition. By Roger Marshall

They say that the primary impediment to good helmsmanship is the block of wood on the end of the tiller. A misshapen rudder (did you think I was talking about the blockhead on the other end of the tiller?) can make the boat uncontrollable under a variety of conditions or it can make the boat so controllable that it becomes deadly slow, exposing the crew to painfully long trips. Slow progress on course can also leave the boat vulnerable to bad weather if it cannot get back to port quickly enough when storm warnings are posted.

What can you do about your rudder? First you need to diagnose the problem. Is the helm heavy (you fight the tiller or the wheel) all the time or does it become heavy as the boat heels or as it accelerates? Can you relieve the helm's resistance by easing the main sheet or does letting the sails fly do little to help the situation?

Here's a pop quiz on your boat's helm condition.

1. Is the helm heavy (takes lots of effort to keep the boat on course) in light winds? As the wind increases, does the helm become even more willful?
2. Is the helm neutral in winds under 10 knots but gets heavy (requiring half a turn of the wheel or pulling tiller to windward) before you reef?
3. Is the helm neutral until the boat heels and then it gets really heavy?
4. Is the helm neutral until boat speed increases and then it gets heavy?
5. Is the helm so light that you can hold it with one finger and never need more than that?
6. Is the helm light and does the boat has a tendency to dive downwind when a puff hits?
7. Is the helm generally okay but as the wind increases it tends to wander without you moving it and you never know which way it will go?
8. Is the helm okay when the boat is moving straight but it's really hard to turn the wheel or tiller?

Now, ask yourself how much rake the rudderstock has. Is it vertical? Does it have 10° of rake? Does it have 20° of rake? Does the boat have a balanced rudder or a skeg ahead of the rudder?

Keep your answers handy. Match up the question numbers with the answers below and you'll find an interpretation of each condition and some possible remedies.

1. If the helm is heavy all the time, there's a pretty good chance that your rig is in the wrong place. With the rig in the optimal location, you should be able to sail the boat in winds up to 10 knots with one finger on the helm. If the rig is too far aft, the helm will feel heavy and it will get heavier as the wind increases and the boat sails to windward. Moving the entire mast forward (how far forward depends on boat size but sometimes just 1"/25mm will do) helps restore neutral helm in light winds with a little increase in heavy winds. If the boat dives off to leeward when a puff hits (question 6 above), the rig is too far forward and needs to be moved aft slightly. If you can't move it aft, rake the masthead aft by tightening the backstay.
2. If the helm is neutral in light winds and gets a little heavier in moderate winds, that's perfect. If a gust hits, the boat should want to head into the wind. Easing the mainsheet traveler (traveler first, then the sheet) or if there's no traveler, then easing the mainsheet should return the correct balance.

3-4. If your rudderstock is raked aft and you find that, as the boat heels or as speed increases, the helm gets heavy, that's usually a problem caused by the rake of the rudderstock. I could get into the forces involved but it would take more than this allotted space. Suffice to say that a more upright stock would probably eliminate the problem.

5. If the helm is light and it stays that way under all conditions, you are lucky. Perfect helm balance is as good as you can get as long as the boat wants to head up (to windward) in a puff.
6. See answer 1 above.
7. If the boat has a balanced rudder, the rig needs to be moved slightly aft. If the boat has a skegged rudder, you should check that a big skeg (or gap between the skeg and the rudder's leading edge) is not causing turbulent water to flow across the rudder blade. If the blade is smothered with turbulent water, you may have to turn it until it gets outside the zone of turbulence. Plastic flaps covering the gap between the rudder and skeg might mitigate the problem.
8. If it's really hard to turn the rudder at speed, quite possibly there is too much rudder blade area behind the rudderstock. Making the rudder blade a little more balanced will reduce this problem.

These are simplistic solutions to what is often a complex problem. If you have any doubt as to whether you can solve a problem on your own, ask your local boatyard manager, sailmaker or other expert to sail with you and help to diagnose the problem fully.

About the author: Roger Marshall is a boat designer and author of 12 books on sailing and yacht design. He has a boat design company in Rhode Island and is the president of Boating Writers International.