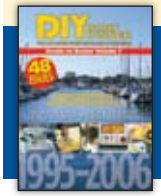
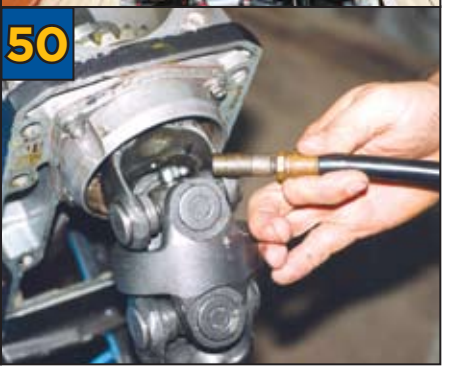
DIY BOAT OWNER
#1 2007
THE MARINE MAINTENANCE MAGAZINE

COLUMNS

DEPARTMENTS



DIY ON CD-ROM PAGE 2



ELECTRONICS SPECIAL

Whether you are fitting out a new boat or upgrading your old one, choosing the electronics package can be simultaneously enjoyable and daunting. DIY plots a step-by-step course to help you arrive at a "best-value" solution.

HOME NEXT

Technical CD-ROM Library for Boat Owners

MRT Series

CDs contain articles from past issues of DIY Boat Owner Magazine

$19.95 EACH

Building With Starboard

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

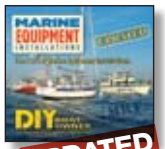
The complete guide to painting and refinishing hulls, topsides and decks with marine coatings.

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.

1995 – 2007 52 Issues of DIY:

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

$99.95

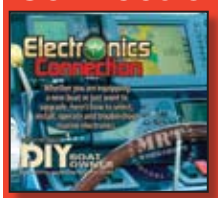
MRT BOX SET

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

$119.95
(Specify power or sail)

Making the Electronics Connection

NEW



Provides the information you need to consider when purchasing, installing, operating, and troubleshooting marine electronics for most any layout or equipment and budget in a step-by-step approach.
$19.95

Powerboat Rigging

NEW

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

DIY BOAT OWNER
THE MARINE MAINTENANCE MAGAZINE

To order call 1-888-658-BOAT or Shop Online at www.diy-boat.com

Edited by Jan Mundy

Raising the Bar

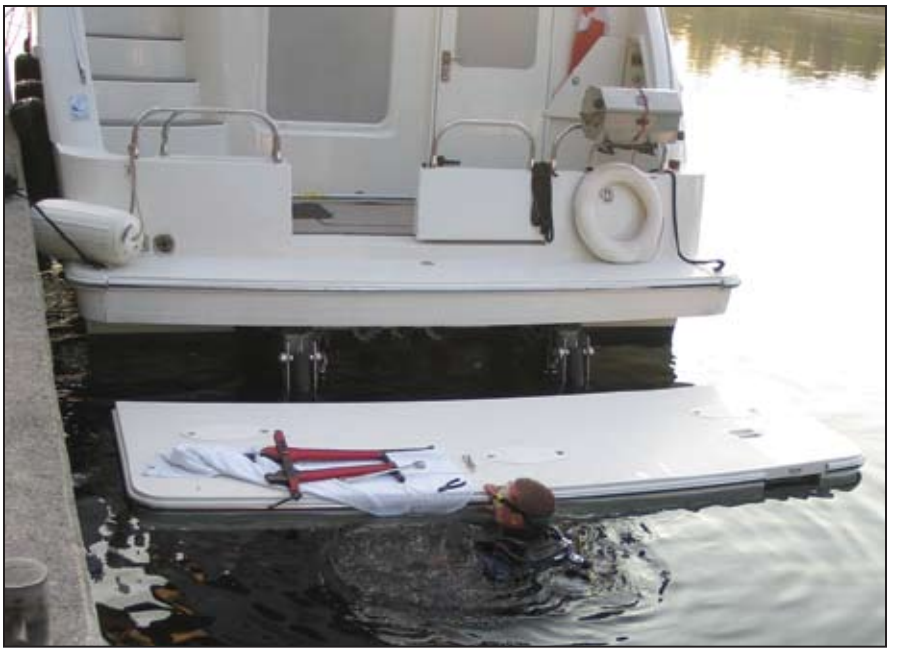
Look for the NMMA Certified logo on better-built boats.

What does a boat and a dealership that are certified with the seal of approval from the National Marine Manufacturers Association (NMMA) mean to you? Plenty, if you're looking to purchase a new boat.

All boats sold in the U.S. must meet U.S. Coast Guard minimum regulations. NMMA certified boats must also meet the more comprehensive standards set by the American Boat & Yacht Council (ABYC). These standards cover many more categories of systems and components, often not addressed by USCG regulations. NMMA certified boats undergo third-party inspection of a sample of each model built to ensure all applicable standards are met; the result is a thoroughly inspected, high-quality boat for you and your passengers.

NMMA's Marine Industry Certification Program is designed to highlight those dealerships who have made a commitment to quality products and services. The program provides dealers with a stringent set of criteria and the tools to raise service standards and provide a positive retail experience for the boating consumer.

By choosing a certified dealer and buying a certified-built boat you're assured a measure of quality that may not be attained in other, non-certified services and products.



Jan Mundy

Bad Day at the Lake

The saying, "a bad day on the water is still better than a good day at the office," holds true for most incidents except where the "bad" translates to "Break Out Another Thousand." While enroute to their homeport after taking possession of their new 43' (13m) motoryacht, the skipper cut too close to a buoy and hit an unmarked rock shoal. Hours later, a dive team from the dealership had removed the damaged bronze props. Fortunately, there was no damage to the drivetrain. Only one prop was salvageable; the other was replaced and this involved air shipping the new one from the manufacturer. A week later, the skipper hit another shoal, only this time both props were damaged beyond repair. Total the repair and installation costs plus US$2,000 per prop and a day in the office gains some appeal.

A Better Mousetrap

Your novel idea on page 8 in DIY 2006-#4 issue on how to make a proper base for installing deck hardware came to us at Gougeon Brothers like a bolt of lightning. The simple concept of using an appropriate sized and shaped plastic container to cast a proper angled base is a real breakthrough. Especially when looked at in comparison to the two-step process that we have recommended for almost 40 years. It's not only faster and more accurate but a lot less messy. I ask your permission to use this novel idea in the next edition of the "Gougeon Brothers on Boat Construction," our "Fiberglass Repair" and "Wooden Boat Restoration Repair" manuals and our upcoming "Epoxyworks" magazine, with full credit to DIY for this great idea.

Meade Gougeon, Gougeon Brothers, Bay City, Michigan

DIY replies: The KISS principle is at work again and we're pleased to share this idea with other epoxy users.

Give some amorous mice the building materials, in this case, a roll of toilet paper (left), and you have the recipe for a nesting mess onboard (right).

More Drain Ways

Further to your article on drain plug placement (page 5, DIY 2006-#3 issue), I used to plug the drain from the outside. This was done for convenience for when we pulled the boat out of the water it was easy to drain but I once had some debris wrap around the propeller and the debris pulled the plug out of the transom. Since then I have always used threaded plugs or inserted the plug from the inside. I also keep a plunger type plug next to the drain for emergencies.

Dan Wentworth, Rocky River, Ohio

Hour Meter Switch

Here's another way to set up an hour meter in connection with installation article in DIY 2006-#4 issue. It's commonly used on rental aircraft to help keep renters honest. Since the hour meter is a recording device and not a diagnostic or warning indicator, I mount it next to the engine to save panel space. Attach a wire to the alternator output terminal, add an inline fuse, connect an oil pressure switch into the oil pressure warning system and you're ready to go. The switch turns on the hour meter when the engine runs.

Keith Bartels, Atlanta, Georgia

Steve Auger replies: The method you describe of using an oil pressure switch to complete the ground circuit works fine if your engine has an oil pressure warning system. Most modern engines do but the existing warning switch won't work for the hour meter because it's an open circuit when the engine has oil pressure. The switch you describe needs a closed circuit when the engine has oil pressure. This means the addition of another switch to the engine. The process I outlined is more generic and works for all vintages of gasoline and most diesel engines.

About Engine Surveys

Is there a form or outline of what a comprehensive survey of a two-cycle diesel engine should consist of? For example, is a compression test a must? Is a boroscope examination necessary? What should the surveyor be checking and reporting on?

Doug Wade, "Reel Action," Vancouver, British Columbia

Pat Kearns' report on engine surveys on page 11 takes you into the world of looking at what you can't see. The marine surveyor of today knows a great deal about many things but specialization is becoming the norm when it comes to the marine engine and a separate and independent marine engine survey is a must before purchasing any boat with engines, from outboard

"I subscribe to DIY because...?" was the question recently asked on DIY's online poll. Of the four choices listed, 58.9% read DIY because it provides credible information they can trust; 29.9% consider DIY as their primary source of information on boat maintenance and repair; 8.4% rely on the Ask the Experts technical help service and 2.8% read DIY for other reasons. If you're not subscribing to DIY, what's your excuse? To enter DIY's current poll log onto diy-boat.com.

DIY BOAT OWNER
THE MARINE MAINTENANCE MAGAZINE

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

Publisher: Michael G. Sciulla

Executive Editor: Elaine Dickinson

Editor: Jan Mundy

Associate Publisher: Steve Kalman

Technical Editor: Patricia Kearns

Circulation: Susan Clark

Designer & Illustrator: Joe VanVeenen

Cover: Photos by Jan Mundy. Bottom inset photo by Nick Bailey.

Contributors:
David and Zora Aiken, Steve Auger, Nick Bailey, Tracy Croll, Jim Discher, Jim Grant, Harry Hungate, Roger Marshall, John Payne, Randy Renn.

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

REQUEST A MEDIA KIT
www.diy-boat.com

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

Subscription Rates:

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

Payable in U.S. Funds only

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

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

Who Brought the Cat?

DIY reader Anne-Marie Hendry emailed this to us. We're unsure of the origin and hopefully we don't offend anyone.

motors to big diesels. No one person can know everything about every kind of engine and, in today's high-tech machinery, there is often little to see on the outside of the engine. Only a brand certified engine technician can handle the computer interfaces required to assess the "medical" history and performance problems you need to know about before you buy.

Online DSC Course

Further to the article in DIY 2006-#4 issue regarding VHF radios with digital selective calling (DSC), there is now a free online marine DSC VHF radio tutorial for anyone interested in the new technology. Launched by the BoatU.S. Foundation for Boating Safety and Clean Water and funded by a grant from the U.S. Coast Guard, "Can You Hear Me?" is designed to educate boaters on the basics of these radios. The 35-minute, seven-part tutorial, found at boatus.com/mmsi, covers radio registration, emergency signaling, how to install a DSC VHF radio and connect to a GPS, an overview of the U.S. Coast Guard's Rescue 21 program and even allows viewers to try various radio buttons and sounds on their computers to simulate how a DSC VHF radio would operate. A viewer can stop the tutorial at any point and return to the same spot later on. For those familiar with some of the topics, the tutorial lets boaters skip around from chapter to chapter.

DIY Kudos

DIY gives hacks like me a shot at making boating more fun and affordable. Your articles have given me confidence to take on projects I never thought I could handle. On behalf of everyone in the "Fix One Break Two Club," thank you.
Jim Discher, "BearBoat," Long Beach, California

Under the heading of you learn something new every day, I finally got to reading DIY 2006-#4 issue with the answer to the customer's question about level deck fittings on page 8. This is the best tip I have read in any magazine all year. It was a slap myself in the head and an of-course-how-else moment. You always have the best info.
Jim Seidel, assistant marketing manager, Interlux Yacht Finishes

Varnish Wrinkles

Q: I just switched from using Z-spar Flagship Varnish to Epifanes Clear Varnish. I applied a coat and when it dried, there were a number of places where it had developed patches of small wrinkles. It was a dry day with temperatures in the mid-60s and quite windy so it dried fairly fast. What caused this and how do I fix it without having to strip everything to bare wood. Also, how do I prevent it from happening again?
John Griswold, Long Island City, New York

A: DIY contacted Epifanes (epifanes.com) on Griswold's behalf and received this response from Doug Theobalds: "Indeed, the weather conditions and/or too heavy a coat caused the wrinkling. Windy conditions can cause the film to skin over too quickly trapping solvents beneath. Breaking the surface at the wrinkled areas (possibly skinning the tops with a razor blade) and therefore exposing the wet varnish underneath will help dry those spots. Once dry, they can be spot sanded and topcoated with a fresh coat of varnish. Wrinkling sometimes occurs around fittings and in valleys where the product is more likely to pool."

Jan Mundy

Nothing turns heads than a properly applied varnish job and no other coating reveals the imperfections as well.

Sizing a Genny Track

Q: I have a Hughes 26. I want to install genoa sheet block straight tee track that is 54" (137cm) long. Where do I position the track fore and aft on the deck? How close should the track be to the cabin or toerail? What do I need as a minimum size backing plate for each thru-deck 1/4" machine screw in order not to make a mess of the cabin ceiling? Do you know where I can buy plugs to mask the holes that will be created in the ceiling of the cabin when the backing plate and nut are attached (minimum 3/4" diameter)? Any other tips or suggestions are most welcome.
Bob Griffiths, Parry Sound, Ontario

A: The position of any sail handling hardware including genoa sheet block tracks is a compromise between what the sail demands for optimum trim and what the configuration of the deck allows. First of all comes the question, "What are you trying to achieve with the new genoa track?" I presume the existing sheeting arrangement is to a snatch block on the toerail, so the most common reasons for installing an inboard track are the following: moving the sheeting angle inboard for better pointing when close hauled; allowing easier adjustment of the lead block position fore and aft for optimum trim on a particular headsail; and enabling a variety of sheet lead positions for smaller headsails or partially furled headsails. What is the after most sheet block lead position you would want to use? Once you've determined that, position the track end as far aft as possible in keeping with the trim range of your biggest headsail. With the aft end of the track positioned, the rest of the track stretching forward is available as needed for reefed lead positions, etc. If you don't know where your after most lead position is, go sailing and look for a lead position that yields an even break (i.e. simultaneous luffing) from the luff telltales. There are other more subtle aspects of sail shape involved as well so having a sailmaker or an experienced racing sailor onboard would be very helpful. The other method is to find a well equipped (and, ideally, well sailed) sistership and copy the location of its track. Athwartship placement also depends on your headsail but, generally speaking, as close to the cabin trunk as practical is best. You want that narrow sheeting angle for pointing. In most circumstances, the standard washer for the 1/4" bolt (about 5/8" in diameter) is adequate given that the load will be spread over your long track. A full length backing plate is the ideal solution but is probably overkill on a 26-footer. Any chandlery with a well-equipped fastener department will have the plugs. Genny tracks introduce a lot of "skin penetrations" (a.k.a. holes) into cored areas of a deck. These installations must be kept very carefully sealed and frequently checked with a moisture meter to avoid big problems with wet core down the road. Ideally, you should take the time and trouble to "pot" each fastener location as described on page 23 in DIY 2005-#2 issue.
— Nick Bailey

Reefer Power from DC

Q: We are currently restoring an 1981 49' (15m) Albin trawler. The AC/DC refrigerator needs replacement. What are your thoughts on using a conventional apartment size fridge with an inverter? What size inverter would you recommend for a cruising boat with the occasional night at anchor?
Jack Wohlgamuth, Hubbard, Ohio

A: After speaking with various pundits about this and of course there were some conflicting opinions about the subject, the consensus is that, with most small to medium fridges working with most inverters, you should not have a problem provided there is plenty of DC power available to the inverter. Problems crop up with full size fridges using AC electric motors that are designed to be "kick started" with a capacitor. AC powered compressor motors from around 1 hp and up (i.e., larger fridges, air-conditioning units) need a blast of high voltage DC current (300-plus volts in some cases) stored in a big capacitor to overcome the high inductive loads at start up. Apparently, the AC power supplied by some inverters does not recharge the capacitor properly so the fridge compressor motor will not start. Instead, it stalls and blows the breaker. Smaller fridges (those without capacitor-assisted motors) seem to work just fine. I recommend you use a fridge/inverter combination

CONTENTS | PREVIOUS | NEXT

that you have already seen working on another boat or stick to a proven AC/DC marine fridge. Most small to medium size AC fridges, provided they will run at all, operate off a 2,000 watt unit. The Xantrex (formerly Heart) Freedom 20 is a popular unit.

— Nick Bailey

Jan Mundy

Check for sealant beneath rubrails and toerails and recaulk as needed. Do not overtighten or you'll squeeze out the caulking.

How to Rebed a Toerail

Q: I'm looking for materials and techniques to rebed a toerail on a 40' (12m) sailboat. What caulking do you recommend? Should I dip the screw in the caulking? How do I handle any chips or cracks found under the rail?

Bruce E Johnson, Valley Cottage, New York

A: Check for sufficient caulking on the deck-hull joint hidden under the toerail and its fasteners on every new or old boat. To do this, work in 3' to 4' (91cm to 121cm) sections, remove the screws within one section and hold the rail away from the boat with wedges. Do not remove the entire rail. With the wedges prying the section away from the boat, you've got a clear picture of the construction. To recaulk this area, carefully remove any excess caulking with a putty knife or sharp utility knife (you might be surprised how little caulking was originally used) and wipe each screw hole with solvent (acetone or lacquer thinner). Lay a heavy bead of 3M 4000UV adhesive sealant around the screw hole perimeter on the hull. You want the "seal" between the rail and the hull. No need to place compound on the screw as the waterproofing is at the screw head. Just glob sealant around the perimeter of the hole, nice and thick. If the deck joint wraps over the hull, I also recommend sealing the edge where the two meet with a bead of caulking. The idea here is to caulk any opening. Caulk any loose fiberglass or cracks hidden under the toerail as well. Insert the screw and tighten until excess sealant squeezes out from under the rail. Do not overtighten. You want a 1/16" (1.5mm) bond line. Use BoatLife Safe Release or Debond 2000 to remove any uncured sealant that finds its way onto the hull or deck. Complete the section, remove screws from the next 3' (91cm) section and repeat.

— Jan Mundy

The Gut Speaks Volumes

Q: We are in negotiations for a catamaran with Volvo saildrives. The starboard saildrive oil sample came back with a high saltwater content. The iron, copper and aluminum numbers are double the port side results but are still within limits. The dealer is saying it's not a problem but my gut says different. Can you enlighten me about water damage in saildrives?
George Marasco, Green Cove Springs, Florida

A: Any saltwater in a saildrive is trouble and is likely entering via a weak or failed lower seal set. Volvo Penta saildrive units are robust products given to wonderful service if protected from stray current damage and saltwater. It's curious that you have found copper as a wear metal. Aluminum should not be a wear metal in any case, as there are no stationary aluminum wear parts. The oil slinger that, depending on model, does rotate on a shaft but is not supposed to "wear," may be wearing against wear debris in the drive lower leg indicating a serious wear condition. The mention that there was "twice as much as the other drive" tells us that maintenance on the units has not been the best as no water ingestion should be tolerated. After pressure and vacuum tests, have the drives serviced or at least the gear set, output shaft and bearings removed for inspection. This is performed out of the water. This inspection is fairly quick with the correct tools as long as the components are not chemically welded together. The fact that the units might be seized is something you should consider. There are no water pumps or shifting parts in the lower units and no intense measurements are needed to reassemble the units if everything is as it should be. Lower unit seals and O-rings would be replaced as part of an inspection. Very close inspection of the output shaft-to-shaft seal contact surface as well as shaft straightness must be made. Any bearing staining requires bearing replacement and total drive inspection. Simply put: salt is bad and, along with wear indicators, very bad, so get the systems inspected by a Volvo Penta dealer who has the proper tools for saildrive service. Listen to your gut feelings, they have been with you quite a while.
— Randy Renn joins DIY with this issue as our diesel expert.

Repairing Composite Rudders

Q: I've hauled my 1959 40' (12m) Pilot House Ketch, a wood boat covered in fiberglass. The fiberglass on both sides of the rudder has come off. What would cause this and how should I repair it?
Dennis Gaffney, Alexandria, Virginia

A: Fiberglass over wood is always a bit iffy. On a glass skinned rudder (regardless of what core material is

CONTENTS | PREVIOUS | NEXT

used), all it takes is a small crack along the leading edge or microscopic pathways that open up at the rudderstock entry to allow water to migrate between the fiberglass skin and the rudder form or core. This eventually separates the outer skin from the rudder form. Wood is a tough and resilient material but it does absorb water and will flex a bit under load. A glass outer skin has problems trying to stay bonded to a wet wood rudder. Your first difficulty is getting the wood core structure of the rudder dry enough to get glass and resin to stick to it again. Use epoxy, which has the best adhesive qualities and strength, as the laminating resin. I recommend wrapping a minimum of three or four alternating layers of 1.5oz glass, chopped mat and 12oz woven cloth all around the rudder with the seams in different locations for each layer. Start with a resin rich mat as the first layer of laminate. Avoid any seams near the leading edge to preclude a crack from developing later. Deburr and trim the layup with a grinder and then sand and level the glass using a 1,500 rpm polisher fitted with an 8" (20cm) foam pad and 80-grit disc. Next, fill and fair with epoxy putty and sand with a long board to get the shape. Straight, accurate steering requires a symmetrical rudder so you might want to use templates as a fairing guide but a simple flat shape will suffice on most full keeled cruising boats.
— Nick Bailey

Biocide Remedy

Q: My boat has a 10-gallon diesel tank. In a typical year I use about 3 gallons. I try to keep the tank quite full to reduce condensation and just prior to pulling the boat for winter, I add the prescribed amount of Valvtech BioGuard Fuel Microbiocide. I have done this for three years, thus a goodly portion of the fuel in the tank is old. Is this the best action to take or should I drain the tank and add new fuel? I've been reading the various issues with the low sulfur diesel. Is there reason for concern?
F. P. Walcott, Lake Bluff, Illinois

A: DIY emailed Stanley Fiegenbaum of Beta Marine (betamarinenc.com) and received this response: "Lets deal with the easier part of the question first and that is the low sulfur diesel. Basically, every small diesel engine that is available in the U.S. should be able to accept low sulfur diesel without any detrimental effects. Remember, these engines are also sold in the rest of the world where low-sulfur diesel is the norm. The problems arise with some very old engines (e.g., the 4.107 Perkins) and these may need an injection pump rebuild with new seals. As far as your fuel usage is concerned, I would be concerned with diesel fuel that is more than three years old. It may pay you to pump the tank clean and start fresh for this season. Diesel fuel degrades over a period of years and the cost of fuel replacement for such a small tank is certainly much

less than any potential repair caused by old fuel. Oil company experts state that we should not use the same biocide in the fuel for more than two years. For the third year, use a different formulation and then switch back after two years on a new product. The reason for this is that the little critters that grow in the fuel also develop an immunity to the biocide in much the same way as we can gain a resistance to certain antibiotics. Your keeping the tank full is best practice to keep condensation out of your fuel and prevent water accumulating in the primary fuel filter/water separator."

Changeable Readouts

Q: I just had my boat rebuilt and now, with all power off (no current), the tachometer reads 1,000 rpm and the oil gauge reads above zero. When I turn on the ignition switch, both gauges fall to zero. Start the engine and the tach correctly reads the engine rpm; the oil gauge registers pressure.
Ian Waymark, Gabriola, British Columbia

A: This is not an uncommon situation, especially if your original gauges were just replaced, and it has had no effect on the engine performance or gauge readout. The status of your gauges when the key is off can often be other than a zero reading and the instruments still read correctly when the key is turned to the "run" position. This is usually caused by a very minor resistance on the ground wire that runs from the battery through the engine and instrument harness up to the helm. It can also be caused by a minor voltage leak of one of your instruments. Run your boat without worrying about the instruments, as they will work fine in the "key on" position.
— Steve Auger

Pumping Waste

Q: We have just taken on a project boat, a 1975 Bayliner 3350. The head is an abominable big DC electric thing with an integral holding tank. It's not hooked up or secured to the boat so I would like to tear it out and get a basic marine toilet. In installing a separate holding tank, is there a practical limit to the length of the discharge hose from a manual toilet to the tank? There is a water tank closer to the head but unless I relocate the water tank, which I would prefer not to do, so that I can install the holding tank near the toilet, the holding tank would be approximately 10' (3m) away from the toilet.
John Holman, Locust Hill, Ontario

A: You'll absolutely have no problem pumping to a holding tank anywhere in the boat with a typical manual toilet. These toilets are equipped with a positive displacement piston pump that works, in principle, not unlike a good old bicycle pump. The pressure applied by these pumps is only limited by how hard you can push on the handle and, of course, the breaking strength of the pump itself, which is stronger than you think. I'll never forget one incident, where the guests on board, for some unknown reason, were willing to stand on the pump handle to force it down, inflating a rectangular polyethylene holding tank into a nearly circular balloon simply because the vent was clogged. It sure scared the tech sent onboard to check out the complaint.
— Nick Bailey

The case of the inflated waste tank.

•BOOK REVIEW•

Restore your Wooden Boat edited by Stan Grayson

128 pages, Paperback
Devereux US $17.95

This is a how-to by those who've done it book and is consequently full of fantastic guidance from participants whose contributions come from both extensive woodworking experience and from restorations of wooden heirlooms, which were often carried out on limited budgets. This book covers the restoration of a small cruising sailboat, cabin cruiser, daysailer, inboard, semi-dory rowboat, outboard and sloop. Each contributor crafts a narrative of their restoration that details cost, tools, materials, setbacks and successes. While most restorations took longer than planned, all were hugely rewarding experiences, the chronicles of which will appeal to classic and vintage boat enthusiasts, do-it-yourselfers and woodworkers. The one disappointing element to the book is that black and white photographs are used instead of showcasing these beautiful restorations in their full glory in color. Nevertheless, this is a valuable resource for those planning a restoration and an appealing book for someone, like me, who needs a final push to begin a project to admire.
— Tracy Croll

Certified Fit

Should you get a marine engine survey before purchasing any boat with engines? Emphatically, yes and here's why.

By Pat Kearns

A typical call to my office goes like this. "I bought a boat on Saturday and need a marine survey and I want to know how much it will cost." All to the good so far. I pursue the answers to a few questions about the subject of the caller's longing. What type of survey does he need? What kind and age of boat is it? What engines does it have and how many hours? This fellow is in a hurry and wants to take his brother-in-law fishing next weekend on his new boat. There is a banker and an insurance company in the mix and a broker who is applying the usual sales pressure to get the deal done quickly.

"Have you decided who will do the engine survey?," I asked? That stops him cold as he just wants to get this survey stuff over with but there are survey logistics to put in place, including when and where the boat will be hauled out and, not the least of which, is the engine survey. "What's that? Don't you survey the engines?" Now, I have to shift into gear to explain the need for an independent evaluation of the condition of the engines, including the generator. Come along with me to see why this is such an important step in the survey process.

When we buy a used car, we are preconditioned to inquire about its maintenance records and we usually request permission to take the vehicle to our trusted mechanic for an objective look. A test drive on the highway is another exercise that we demand before opening our wallets and closing the deal. There may even be a dealership that has records of every service or repair activity ever performed on this alluring creampuff. Neither buyer nor seller seems uncomfortable about such inquiries or requisites in relation to the used car. We're not talking perfection here, just meeting certain expectations, many of which are easily defined in the car reselling market.

To the contrary, in the case of a boat sale transaction, some buyers seem to shut down the triggers that control a similar rational approach to qualifying the condition of a boat before buying it.

In our story here, the prospective purchaser expected to have the boat surveyed but the suggestion of a separate and independent engine inspection is a surprise to him. He tells me that the broker started the engines for him and "they started right up, sound fine, look good and ran great." He tells me, further, that they were just serviced or have been "overhauled" or were "rebuilt."

Since, marine propulsion engines and auxiliary generating machinery represent a large percentage (as much as 50%) of the total investment in a boat, I recommend an independent engine survey for all such machinery. Such an inspection is usually performed concurrent with a boat survey and each professional protocol generally complements the other. A qualified marine engine surveyor is able to focus solely on the machinery, its operating and performance characteristics, its compliance with manufacturer's engineering specifications and tolerances. The surveyor can identify maintenance needs and make repair recommendations before major engine failures occur.

Certain types and makes of boats and engines experience recurring problems. A competent engine surveyor is familiar with most models and can advise you on the long-term suitability of your intended purchase and its equipment, particularly in relation to how and where you will be using it. No longer is a "sea trial" a quick run at wide-open throttle. Nor are the hum and roar, backdown test and an ear for vibration adequate to assess engine condition. The engine surveyor's tool bag is equipped with digital gadgets for just about every test, including computer interfaces for specific engine models, especially for large diesel engines. These guys are specialists in much the same way as doctors, lawyers and accountants have specialties in practice.

Pat Kearns

It's as bad as it looks but getting the look wasn't easy without an articulating mirror and some unnatural positions on the part of the surveyor.

The "aerosol overhaul" of white paint didn't stand up to the corrosion activity beneath.

Remember that all surveyors should be limiting their examination methods to those that are non-invasive and non-destructive and they cannot evaluate what they cannot see or test. An inspection also includes engine accessories, transmission, exhaust system, fuel system, engine mounts and bearers, and engine and transmission fluid laboratory analysis. Fuel sampling is sometimes included in the laboratory testing if its quality is suspect. Marine engine surveys

consist of several test procedures and evaluation methods, including but not limited to the following.

- Cold engine check. Too often the owner or broker will warm up the engines. First, the boat surveyor's job is harder and more hazardous in a hot engine space and, second, the engine surveyor must wait out (as the meter ticks) a total cool down before starting the inspection.
- Use mechanical and electronic gauges and probes, some of which are specific to certain engine models.
- Compression test gasoline engines. With a diesel engine, this test is considered invasive, as it requires opening the fuel system exposing sensitive injection components to damage in the process.
- Monitor the engine exhaust during the cold start.
- Perform a sea trial and monitor the engines at specific rpm relating to the engine manufacturer's performance specifications.
- Take oil samples (for spectroanalysis) from all engines and transmissions after the sea trial. Samples are taken when a hot engine produces the most accurate test results. Even fluid sampling on old engines, where there is no previous record of such sampling for comparison, can be useful in detecting potential for catastrophic failures.
- Consult with the client about the survey findings and recommendations.
- Issue a detailed written report following the inspection with findings, recommendations and test results.

All the testing notwithstanding, ask the seller/owner/broker for warranty, repair and maintenance records on your dreamboat's engines. If a rebuild or overhaul is advertised, make sure you have access to the records that back up the claims. Too often, the reality fails to support the extent of the work done or the overhaul was not done proactively but was, rather, a reaction to a serious engine failure. Make sure you know what was done and the why and when of it and do this before you hire any surveyor. You don't want to find out, on your account, that the engine conditions were misrepresented.

An engine survey is not a guarantee that the engines are perfect. That's not the intention of any survey process. The purpose is to provide you with information so that you can make an informed decision. We buy used cars knowing that there are unknowns about their past life on the road. We should accept that marine engines in preowned boats need maintenance, upgrades and, eventually, repair. The key to happiness is having knowledge of what you are buying, the good and the bad. A marine engine survey is "stitch in time …" to save you from unpleasant and expensive surprises.

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

Download a sample form developed by a certified engine surveyor by clicking here.

On-Target Shower: If your boat is without a built-in shower but has a suitable compartment, mount a common compression sprayer (available at garden centers) on a bulkhead. Add water to a marked fill line on the container, pressurize by pumping the handle and then squeeze the lever at the nozzle, adjusting the spray for a soaking stream or fine mist.
Hal Roth, "Whisper," Oxford, Maryland

Fresh as a Rose: Solar powered ventilators are the best way to rid cabins of stale air, odors and to keep them mildew-free. A 4" (10cm) vent delivers about 18 cubic feet of fresh air per minute, without draining the unit's batteries, every day the sun shines. Better yet, the battery powered ventilators, when fully charged, will usually run for a couple of days without the sun recharging them.

Dave Gerr, director of Westlawn Institute of Marine Technology (westlawn.edu).

Clamp Guard: To protect your skin from cuts or hoses from chafe and damage from contact with the sharp end of a hose clamp band, install a Clamp-Aid. Made of flexible plastic, heat resistant up to 266F (130C), it fits most bands. Just cut with scissors for short bands or stretch to fit larger ones.

Long-Lasting Brightwork: For a durable, varnish-like finish that lasts 18 months in California, apply one coat of Armada to bare teak, followed by three coats of Cetol Gloss, with a light sanding between coats.
Tim Cronin, Auburn, California

Sacha

No Spill Filter Change: To change horizontally mounted oil or fuel filters, loosen the filter a few turns by hand, being careful not to loosen it so much that it leaks. Take a zip lock bag, big enough so it loosely slips over the filter, fold over the zipper opening then slide the bag over the filter. Rotate the filter off by hand and zip the bag shut for disposal.
DeLos and Marcia Spencer, "DeeMarDs," Grand Rivers, Kentucky

Liberate Loctite: I had to disassemble my boat's Harken furling system to replace a damaged section and, rather than using a torch to release the set screws secured with red Loctite, an approach that might cause irreparable damage to the aluminum extrusion, I used boiling water to provide sufficient heat to release the Loctite.
Mike Young, "Cameo," Nobel, Ontario

Rest in Peace: If, after a refit of your boat's plumbing system, you have a spare seacock, the simplest and best thing to do is leave a perfectly good fitting in place. For added security remove the handle to lock it in the "off" position. If this valve is in a seawater system, make sure to also seal the fitting with a threaded cap. Unnoticed corrosion could destroy the fitting and lead to flooding the boat.

Antenna in One: If your boat has a masthead VHF antenna, consider installing an AM/FM/VHF band splitter, such as Shakespeare Model 4357, available at most marine suppliers. With this device, you can connect an AM/FM/CD system with a masthead antenna for great reception.
Ken Pole, "Santiva," Ottawa, Canada

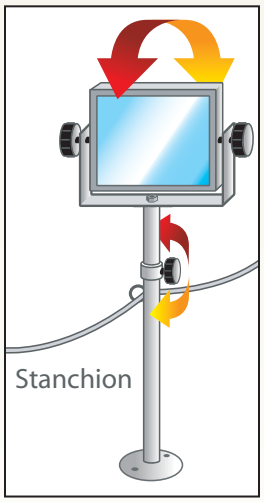
TECH TIPS WANTED

Do you have a boat-tested tip or technique? Send us a photo (if available) and a description, your name, boat name and homeport and mail to:

DIY TECH TIPS
In the US: P.O. Box 1072, Niagara Falls, NY 14304
In Canada: P.O. Box 118, Lindsay, ON K9V 4R8
Or fax us at 705/359-2097, or E-mail to: tech@diy-boat.com.

If we publish your tip, we'll send you an ABSORBER PVA CLOTH

Over the Transom: Affix a rear-view mirror on a swivel mount to the windshield frame or on the dash on powerboats and to the bimini frame or a stanchion on sailboats so when navigating busy waterways, the driver can view the boats approaching from the stern. The helmsman's eyes can now concentrate on the traffic ahead and he can react sooner to passing boat wakes.



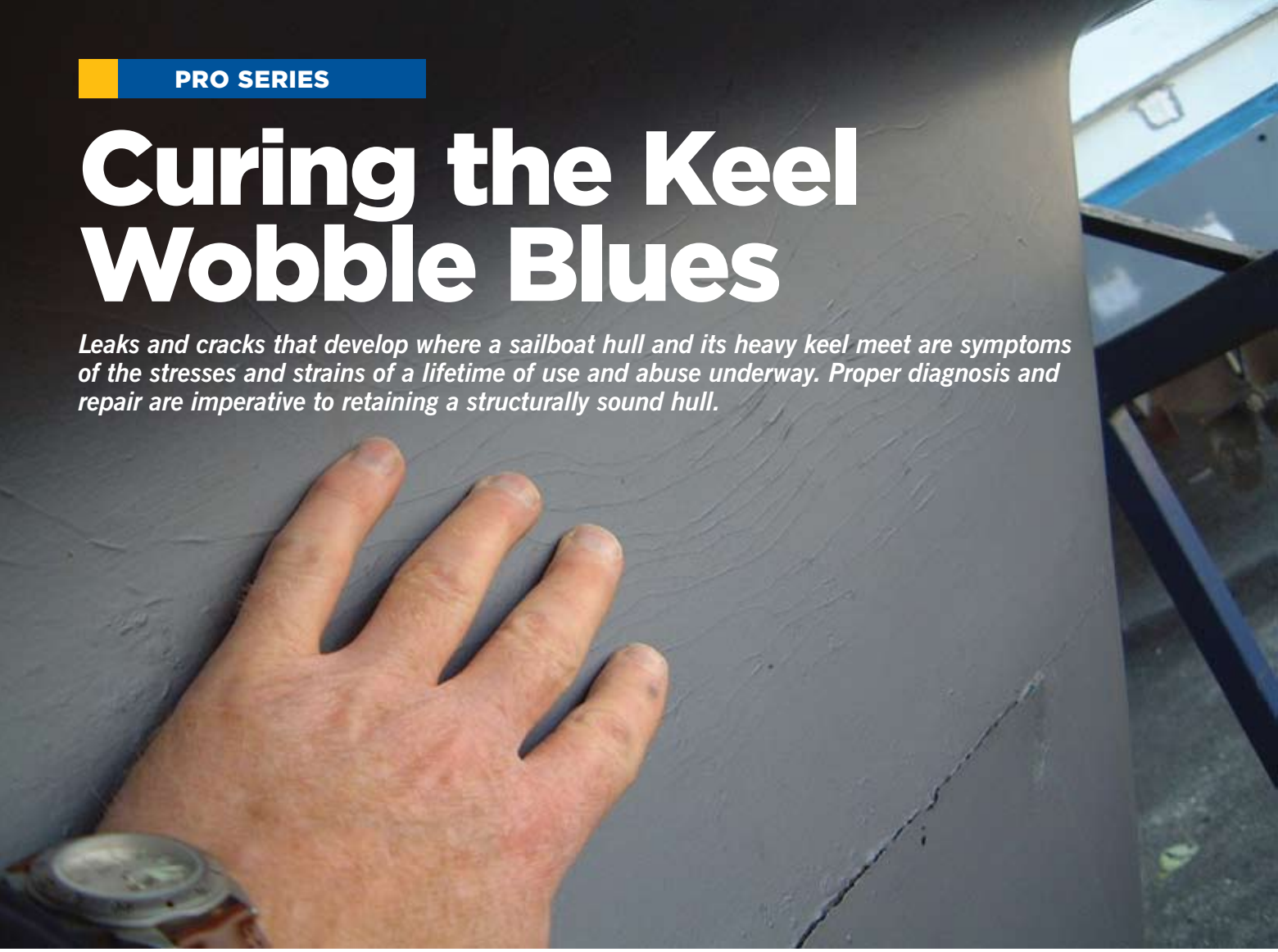
Sacha

Shower Heater: Solar shower bags are a practical source of hot water and to boost their utility after heating the bag during the day, stow it in a soft cooler bag so you have warm water at night as well.

PRO SERIES

Curing the Keel Wobble Blues

Leaks and cracks that develop where a sailboat hull and its heavy keel meet are symptoms of the stresses and strains of a lifetime of use and abuse underway. Proper diagnosis and repair are imperative to retaining a structurally sound hull.



Story and photos by Nick Bailey

Horizontal stress cracks along a keel stub or hull near the keel can indicate excessive flex.

Every sailboat needs to be able to sail upwind. This is related to the corollary of Murphy's Law that dictates the destination requires a long beat to weather. You could take the easy out and furl the sails and fire up the motor but the boat's designer and builder went to a lot of trouble to ensure the boat can sail there even if you are not too keen on the idea.

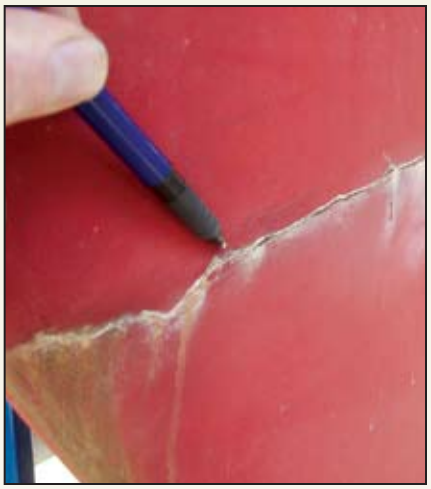
Although it's standard practice today, attaching an external fin keel or molding heavy ballast into a fiberglass hull and keeping it fixed there for the duration still presents an engineering challenge. Loose keel bolts are the most common problem and are usually easy to rectify but there are other serious structural problems that can cause keel wobble. There are also those traumatic events, such as a hard grounding or stranding that can separate a keel from its roots in the hull [Ed: For details on repairing loose keel bolts and the proper torque specs when tightening refer to DIY 2004-#3 issue.].

Our boats are maturing and not always gracefully. Engineering that worked well when the boat was new is being challenged by the aches and pains of aging. Logging the miles over the years can cause the hull and its internal support structure to lose the required characteristics of stiffness and strength for the keel to do its job when sailing upwind. Soon a downward spiral begins. Over time, even normally expected flexing can weaken the structure, resulting in more flex and so on until something fails. Luckily, there are plenty of warning signs: leaks, stress cracks and the squeaks and groans when the boat heels. Ignore them at your peril.

Diagnosing External Fin Keel Wobble

Inspecting for this kind of damage requires that the boat be hauled out of the water. With the boat still in the lift slings, the hull is blocked with stands (no keel blocks) to resist moving when pressure is applied to the keel laterally. Visually check for movement by firmly pushing or even kicking the bottom of the keel sideways. If the keel moves at all, try to get it swinging like a pendulum and watch for significant flex in the hull near the keel. If flex is obvious, this is the time to look for structural problems.

Make sure the hull bottom has been thoroughly cleaned of all marine growth and closely examine the outside of the hull for telltale stress cracks surrounding the keel root. Check inside for separated tabbing or cracks in the structural grid or floor beams. Any suspect areas should



(top) The popped secondary bond at the bottom of a main bulkhead is not a good sign. (bottom) Note the crack in this keel sump near the forward keel bolt.

This sort of keel-hull joint crack looks bad but may indicate only that the keel bolts need tightened.

be tapped with a hammer ("percussion sounding" in surveyor-speak) to reveal the sickly, soft thud of delamination. If damage is suspected, this is a good time to engage your favorite marine surveyor for a professional opinion and you should contact your insurance company if the boat has been aground. Your insurance company will want to have the situation assessed before any claim for reimbursement of costs related to repairing grounding damage.

Not all keel wobble is cause for alarm. If the keel moves and the hull does not and, if the crack at the keel-hull joint (as shown in the photo above) can be seen to open and close a little, tightening loose keel bolts to the specified torque using a torque wrench could be a relatively simple fix.

Some boat hulls are naturally more flexible than others and allow for some keel wag even when everything is in good shape. How much keel movement is cause for concern? In most boats, more than 1" (25mm) of movement at the keel tip is worth further investigation to determine if there actually is anything amiss.

Example Repair

Although the details of every repair are different, in the case of an external ballast fin, curing the keel wobble blues involves rebuilding and reinforcing the hull structures tasked with supporting the keel. The following repair was carried out on a lightly built fiberglass T-Bird (a 26'/7.9m racing sloop). The boat was about 20 years old and still quite competitive (a testament to the skipper's ability) but had suffered hard groundings in the past followed by dubious repairs. It now had incurable leaks near the keel bolts as well as other vague symptoms such as odd lurches and a generally "squirmy" feel. A previous attempt to stiffen the bottom by bonding Lyasil (a heavy unidirectional bundle of glass fibers) to the inner skin had failed with a bang on the first breezy day. It was now time for some vital repairs.

Assessment

We already knew this keel was wobbly. The extent of the damage and the method for the repair were the real questions. Percussion soundings provided the answer to the first question. Our suspicions of severe delamination were confirmed when the hammer reverberated with dull thuds instead of resonating the bright sounding, sharp raps over much of the bottom near the keel flange. This boat did not have any athwartship floor timbers or structural grid reinforcing the bottom at the keel bolts and relied solely on the hull bottom laminate to carry the keel loads out to the nearest stringers located under the bunk face about 18" (45cm) outboard on both sides. The dangerous loss of stiffness in the central hull section required the repair strategy address two problems: first, restore the damaged laminate and second, find a way to redistribute the keel loads and enhance the stiffness of the hull.

Since we needed to access both the inside and outside of the hull at the keel flange, the keel had to come off. This involved loosening the bolts and jacking up the hull. After some persuasion with wedges, the 3M 5200 adhesive sealant released from the hull, allowing the keel to separate. The hull was then raised enough to allow repairs inside the keel flange recess, while the flat-bottomed keel was securely chained in place, upright on the trailer.

External Prep

A 36-grit mini-grinder removed the patches left from the old grounding repair to reveal cracks deep into the hull laminate at all four corners of the flange. It would be straightforward to improve on this Band-Aid-over-broken-bone previous repair by applying much larger (and deeper) repair patches at the

The easiest way to handle a T-Bird keel is leave it upright on the trailer, securely restrained.

Cracks from old grounding incidents, never properly repaired, weakened this hull.

Not a pretty sight, keel bolt locations were delaminated and stained from water leaking through the laminate. Note the white resin-starved appearance of delaminated glass.

corner cracks and a single overall layer of new glass covering the keel flange recess. To prep for the exterior glasswork, the cracked corners were beveled out to a radius of about 3" (76mm) and the entire keel recess was ground back just enough to remove the gelcoat. These external patches were not the main event; the major repair work would take place on the inside.

Internal Prep

Based on the hammer survey, it was obvious that restoring the hull strength would require a lot of new glass. This is much easier to do on the inside (as opposed to working overhead, against gravity) and also has the advantage of preserving the nicely faired racing bottom. As it turned out, the most severe delamination involved the innermost glass layers anyway.

Gaining access to the inner hull surface called for removal of the teak and holly plywood cabin sole and disconnecting the glass sub-floor 2" (50mm) inboard of the bunk face perimeter using a diamond cutting wheel on a high speed pneumatic die grinder. The 2" (50mm) flange remaining allowed the floor to be neatly glassed back into place later.

The inside surface of the hull below the cabin sole was now fully exposed and it was not a pretty sight. The Lyasil stringers mentioned above had not just popped loose but had also torn away pieces of the hull laminate. The bond failure was not at the Lyasil itself but had occurred between layers of the hull laminate underneath. Much of the inner skin showed the characteristic "dry" opaque white color of fractured delaminated glass instead of the translucent blue-green of laminate in solid condition. Although initially wounded by grounding impacts, the relentless flexing imposed by a 1,650-lb (748.4kg) keel had done in this single skin hull laminate. Some of the inner layers were debonded badly enough to be easily peeled back with hand tools.

After shrouding the interior with protective plastic, a determined professional wielding a big grinder fitted with an aggressive disc (probably 24 grit) reduced the remaining damaged glass to dust. If not for modern protective clothing (Tyvek hazmat suit, respirator, hood and face shield, vinyl gloves) he would still be itching a year later. The original laminate schedule in this area had been approaching 1/2" (12mm) thick between the bunk faces but now only the intact bottom layers were left in place to act as a molding surface for the replacement laminates.

Renewing Interior Laminates

After vacuuming the bulk of the debris, the freshly ground surfaces were wiped down with acetone dampened rags to remove any residual dust. New glass (five layers of 1810 Stitchmat in the worst damaged areas, plus two layers overall for the entire area under the cabin sole) was sized, cut, dry fitted and laid out neatly nearby in order.

The hull layer attached to the Lyasil web is delaminated badly enough to be peeled back with hand tools.

The prepped hull surface was wetted out with unwaxed polyester resin using a large brush and roller. Using unwaxed resin allows any secondary glasswork to bond without prep sanding. Working quickly, the first prefitted glass layer was placed, wetted out in situ and then carefully worked in with a bubble busting roller to remove trapped air. A new batch of resin was mixed for each new layer and the lay-up continued in sequence until completed. Seven layers are about the maximum you can do at once without too much exothermic heat building up during the cure phase of the resin. [Ed: For resin specifics, refer to DIY 2006-#3 issue.) Removing

CONTENTS PREVIOUS NEXT

Fresh new laminate of 1810 Stitchmat. Note the color difference from the delaminated stuff, visible in the "before" photos.

New floor beams with glass kits awaiting installation.

The new floor beams glassed in place.

excess resin from the last layer with a squeegee ensured a strong laminate with a high fiber to resin ratio.

Installing New Beams

The traditional way to stiffen the flat center section of a hull and redistribute the keel loads outboard to the first longitudinal stringer is to install structural floor beams athwartships, adjacent to the keel bolts. These were solid wood and not just tabbed but fully laminated in place with heavy glass secondary bonds (three layers of 1810).

The wood pieces were initially bonded in place with chopped fiber and resin (shop term: "chops"). Next a fillet with a radius of about 1" was also applied around the perimeter with chops. This avoided any sharp 90° corners that make it difficult for the glass secondary bond to conform to its form. The secondary bonds were then applied using the same general layup technique as outlined above.

New external glass in place and the keel fitted; filling and fairing is pending.

Drilling the keel bolts. Note the glow from the guide light outside the hull.

The completed job, painted with air-dry gelcoat and with the sub-floor glassed back in place.

Exterior fairing done and repair epoxy primed.

Tightening the keel bolts using the 40-years experience torque gauge. Don't do this on your boat — always use a torque wrench.

Exterior Hull Repairs

Because the inner portion of the cracked laminate at the corners of the keel recess had already been replaced during the general interior hull rebuild, the external repairs required only relatively shallow patches. These were applied using straight 1.5oz mat using a relatively "hot" resin to catalyst mix to provide the fast cure required for overhead work.

Next, the entire area including the keel recess received a layer of 1.5oz mat. This resin-rich skinning layer was then leveled with a medium speed (1,500 rpm) sander/polisher fitted with a foam pad and an 8" (20cm) 80-grit disc. A fill with vinylester putty followed and block sanding with 80 grit brought the outside patch to paint-ready status for finishing with an epoxy barrier coat primer.

Reassembly

Shining a light through the translucent hull showed exactly where the old keel bolt holes were located (now buried deep in the new laminate). It was a simple matter of using these as a template to drill the new holes for the 1/2" (12mm) keel bolts.

Since the keel is not expected to require removal anytime soon, 3M 5200 sealant was again used to caulk the keel bolts when the boat was lowered back onto the keel. The keel bolts were then tightened, while proper alignment positioning was verified with the aid of a laser level, tape measure and the human eye.

Once the keel was secure, the new glasswork inside was painted with an air-dry gelcoat. Next, the glass sub-floor was dry fitted and the new structural floor timbers were shimmed (with chopped glass and colloidal silica) and then trimmed to provide a solid floor support. Gelcoat around the perimeter of the cutout was ground back to expose raw glass about 2" (50mm) on either side of the cut allowing room for a 4" (101mm) glass tape joint to restore the one-piece floor.

The sub-floor went back down and was bonded in place on the floor timbers with more thickened chops and glass tape (1.5oz mat) applied over the seam, ground smooth and finished with brushed gelcoat. The 1" (25mm) thick teak and holly sole was originally installed to help the boat meet minimum class weight but given the 7 gallons (26.5L) of resin and 125 square feet (11.6 sq. m.) of 1810 Stitchmat put into this repair, it was declared surplus.

Cost

This repair was estimated and billed at 80 man-hours but took a bit longer. The bill for materials approached $1,000. Nonetheless, the owner considered his money well spent. He sailed his rejuvenated boat to victory in the season's Fleet 10 Championship.

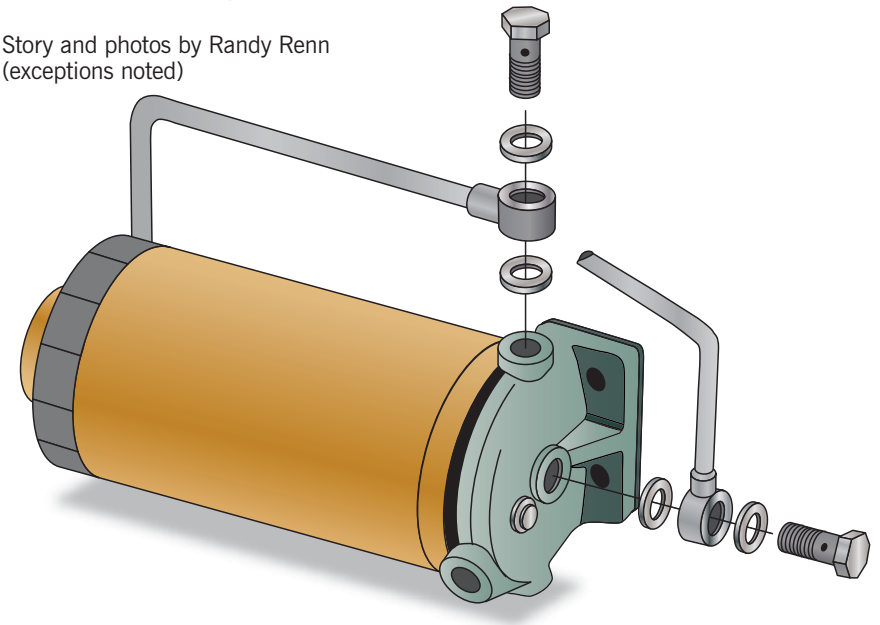
About the author: Despite 30 years in the boat repair business, Nick Bailey still can't resist the temptation to help his sailing competition go faster.

CONTENTS | PREVIOUS | NEXT

The Three Rascals

There is little so annoyingly silent as a diesel engine that sputters into repose without instructions from the helm. Surprisingly, just three small fittings cause most common failures.

Story and photos by Randy Renn (exceptions noted)



Typical fuel filter arrangement with hollow bolts, washers and banjo fittings.

Worn bushing on a fuel injection pump where a clevis or pin post throttle fitting might go.

Banjo fitting and hollow bolt that's sealed with metal O-rings (a.k.a. "crush" washers).

Ball joint type fitting found at throttle cable ends.

Spend time on the docks in any marina and you're sure to hear echoes of the sea stories from boaters whose boat engines have fouled a day on the water: "Another #X!Z* tank of bad fuel and it's the third time this season;" "My engine is really hard to start these days; it slows down, speeds up and then quits." There is the ever familiar; "I have to keep adjusting the rpm so the engine runs steady. My buddy says I should install throttle clamps." It's unlikely that you have overheard, "I shut the engine down after making a perfect landing in the slip. Do I love that engine? Old reliable." Nope. The good stuff just isn't as interesting. Engine failure happens between the stone jetties in August just before dark with a thunderstorm brewing. Murphy's Law in practice.

Words like these should stimulate our posture to query the Holy Trinity of fuel systems: supply, storage and delivery. One can be fairly certain that, if a diesel engine did not seize into a solidified mass of metal or did not overheat or loose an obvious gasket, the most likely suspect for the problem resides in a fuel or fuel delivery control issue caused by the three rascals, all cousins in the fuel scheme and, each in its way, leads to performance concerns in an insidious manner.

Rascal #1

The first question that relates to the possibility of "bad" fuel concerns the fuel fill deck fitting cap. When the friendly fuel dock attendant asked if he could change your fuel fill O-ring during fill up did you agree? When did you last change the fuel fill inlet cap O-ring? The cap O-ring is an easy item to overlook but a bad one (or none at all) can ruin a day on the water and cause other problems that attack your wallet and lose precious boating time. Every fill cap has one and they don't live forever. The rubber ring can crack, harden and/or lose itself at the bottom of the fuel tank. Rainwater, snow/ice melt, sea spray and washdown water that submerges the fuel fill fitting can violate this critical seal, making its way, via the fuel tank fill line, into the fuel tank, eventually fouling filters, system corrosion and injector/injection pump damage as well as engine harm, all conditions often thought to

CONTENTS | PREVIOUS | NEXT

Corroded and bent metal crush washers shown on the left; new ones on the right.

Banjo bolt fitting on a fuel line.

Clevis type fitting for throttle cable end.

result from condensation forming in the tank. Boats with cockpit fills and fuel fills placed in side decks or washboard corners where water rests are in particular jeopardy.

Replacement O-rings, available at most marine outfitters are easily installed and almost all are for 1-1/2" (38mm) fuel gas or diesel fills. Other than cleaning and smoothing the mating surfaces, installation requires no special designators or preparation instructions. Replace the fitting if the fuel fill neck or cap is corroded or damaged. Lifting chrome, damaged plastic fills and cross-threaded caps are conditions that preclude a good seal. While you're at it, O-ring change time is an opportunity to check static ground for the fuel-fill fitting. [Ed: ABYC H-33, Diesel Fuel Systems, requires grounding of both diesel and gasoline fuel systems with metal or metallic plated/coated parts, albeit the risk related to static spark is minimal for diesel.] Now's also the time to have a look up into the exterior fuel tank vent fitting(s) to make sure they're free of dirt, salt, wax and corrosion buildups, and insect nests that can block effective tank venting.

Rascal #2

Like a middle child, the second rascal is largely silent and unnoticed. If one little part can claim the "Sneaky Pete" award this is it: the banjo bolt washer. Never heard of it? Banjo or hollow bolt washers are usually found at fuel and delivery pump inlets and fuel injection system fuel return lines. Sometimes, a washer is also located under fuel filter

bleed screws and filter element clamping fasteners.

These washers are generally quite soft and the bolts, being hollow, shouldn't be over tightened. Unfortunately the very characteristic that makes the seal work (being soft) is reason enough for failure. Washer compression is what makes sealing with a banjo bolt effective yet washers are so soft as to easily deform under excessive pressure.

Washer failure from over tightening, external corrosion, dissimilar metal attack or physical damage causes several conditions that may not seem obvious. Poor sealing is one such condition. When the failed washer is on the positive side of the fuel system, which is from the fuel delivery or lift pump towards the engine and from the fuel return line fittings towards the fuel tank, you'll have fuel leaks.

In the real world there is no weeping or seeping where fuel is concerned. If fuel is seen, felt or smelled, then there is a leak. The oil rags we see under fuel pumps or at filters on returns are solid indications of washer failure. The condition may be a bothersome leak or may manifest itself as rpm loss, the need for frequent system bleeding or hard starting (particularly the first of the day). Engine shutdown is rare with a positive side leak.

The opposite is true of a failure on the negative pressure side. The negative side of the fuel system runs from the fuel tank to the engine fuel lift pump (first pump) and possibly also from the fuel filter on the engine to the engine fuel delivery/injection pump. With this type of washer failure, we find the engine likely starts and then shuts down requiring bleeding but with no signs of external leaking. The engine may run, repeatedly increasing and then lowering rpm, run smoothly and then, some distance later, shut down. Frequently, you'll have engine stumbling. In this case, a tiny air leak, truly microscopic, allows air into the fuel system.

TIP

Engine mythology

Running the engine on low fuel tank levels does not result in pulling water and contaminates from the bottom of the tank. Water and contaminates are always at the bottom of the tank, albeit those elements can be further agitated when subjected to the sloshing of a low fuel level. The fuel tank pickup never gets any lower into the fuel mass than its installed position. *— RR*

Just because the washer surface looks smooth does not mean air won't migrate across its short surface. Almost by nature, as boaters, we like things tight but these washers deform further as they give way to tightening. When the washer bottoms out, the hollow bolt stretches and then fails and breaks leaving the broken portion in a filter or injector body. This is never good.

So what is the solution? If you have any fuel leaks at these fittings or an engine that is stumbling or "grabbing air" and requires frequent bleeding, it's time to change the banjo bolt washers. Mating surfaces of the bolts and banjo fitting must be clean and smooth. Replace any fittings losing plating or with pitted mating surfaces. Washers cannot tolerate any contamination like paint chips, rust, etc.

Washers come in a variety of sizes and materials. Purchase replacements from an engine dealer only. These are usually available in kit form. Never try to match washers with "similar" ones and never, ever, use a washer of a different material as a substitute for the correct part.

Consult your engine manual for the proper tightening specifications. You'll need a torque wrench to do the job. Never use sealant or Teflon tape within the fuel system. A washer change is a good time to consider fuel system upgrades and a total filter change. You'll want to inspect fuel lines at the same time. Remember to have extra washers and bolts at hand. These items are not magnetic as they are copper, aluminum or fiber so, when one dives for the bilge, it's gone. This anticipated scenario holds true for banjo bolts as well. They may be magnetic but they just never come home. Washers can be easily bent or dented. We stow ours in a CD jacket in a paper CD cover (same goes for seawater pump gaskets).

Rascal #3

Our last offender is a fitting I see worn on a large percentage of engine inspections. Indeed, the condition is so common as to be nearly normal in older engines of all stripes. The item is the throttle pivot at the fuel delivery pump. The throttle cable connection, whether the cable is from a hand driven system or linear drive actuator, terminates in a pin post, sometimes ball joint or a clevis pin connection. (Direct nano-actuators with computer drive systems do not have such external connections.)

Diesel engines are speed regulated by a governor that attempts to keep engine rpm steady by changing fuel quantity, thus increasing or decreasing without changing the throttle position. Let's say, for example, the throttle position is set at 1,800 rpm in calm water. The engine makes XX hp of a potential XX.5 available at that rpm. The boat encounters a wave, is slowed, and the engine governor attempts to increase fuel to maintain 1,800 rpm, to which the engine responds. The wave passes and the engine decreases fuel quantity to maintain the 1,800 rpm. This is one of the reasons for diesel engine economy. This coming and going of governor activity is partially dependent on having a steady point of resistance. Unless the governor has a very steady frame of reference, it reacts constantly in an effort to maintain the rpm it perceives is asked for by the throttle. The steady state of running is disturbed and wear factors go up exponentially.

What the operator feels as simply inconvenient is really evidence of a greater event. What is happening rather rapidly may not be perceived by the human ear and truly is not corrected simply by installing a throttle cable clamp, a common boatyard fix. A cable clamp (a fitting that puts pressure on the throttle cable jacket and squeezes the inner core) may temporarily appear to take some wear out of the cable and make the throttle feel tighter but it does not correct the whole problem. A worn throttle pivot should be replaced before other measures are considered.

First, check the fitting at the engine. This is a simple matter of moving the pump arm, without the engine running, and observing what movement there is between the pin, cable fitting and pump arm. The pin/pivot relationship should be snug but not tight. Rust or dark dust around the fitting is a dead giveaway of excessive wear. A slight movement in any direction indicates wear. Take apart the fitting noting position of pin, washers and fasteners. The injection pump arm is not removed, as we are only concerned at this point about items that do not require a diesel technician.

Novices should never remove any component that is part of the injection pump and never touch anything on the pump that is locked by locknuts or wired in position. With the pin in hand, look for grooves and hollowed parts. Any wiggle in a ball and socket type indicates wear and should automatically trigger the need for replacement. A worn clevis or pin type fitting likely means a trip to the local marine supplier. The clevis type comes with a new pin. Pin type pivots are made of aluminum or plastic and are quite easy to screw off and on. Take care to keep the idle position of the throttle cable the same and not loaded by cable tension when at idle. If, however, the injection pump arm is worn or hollowed, it then requires a bushing installed by a technician.

If clearance allows, you might change the connection to a pin type. In all but very rare installations, the cable to the pump arm is a Morse 33 type. Whatever the effort, never use a standard threaded bolt as pivot or pin.

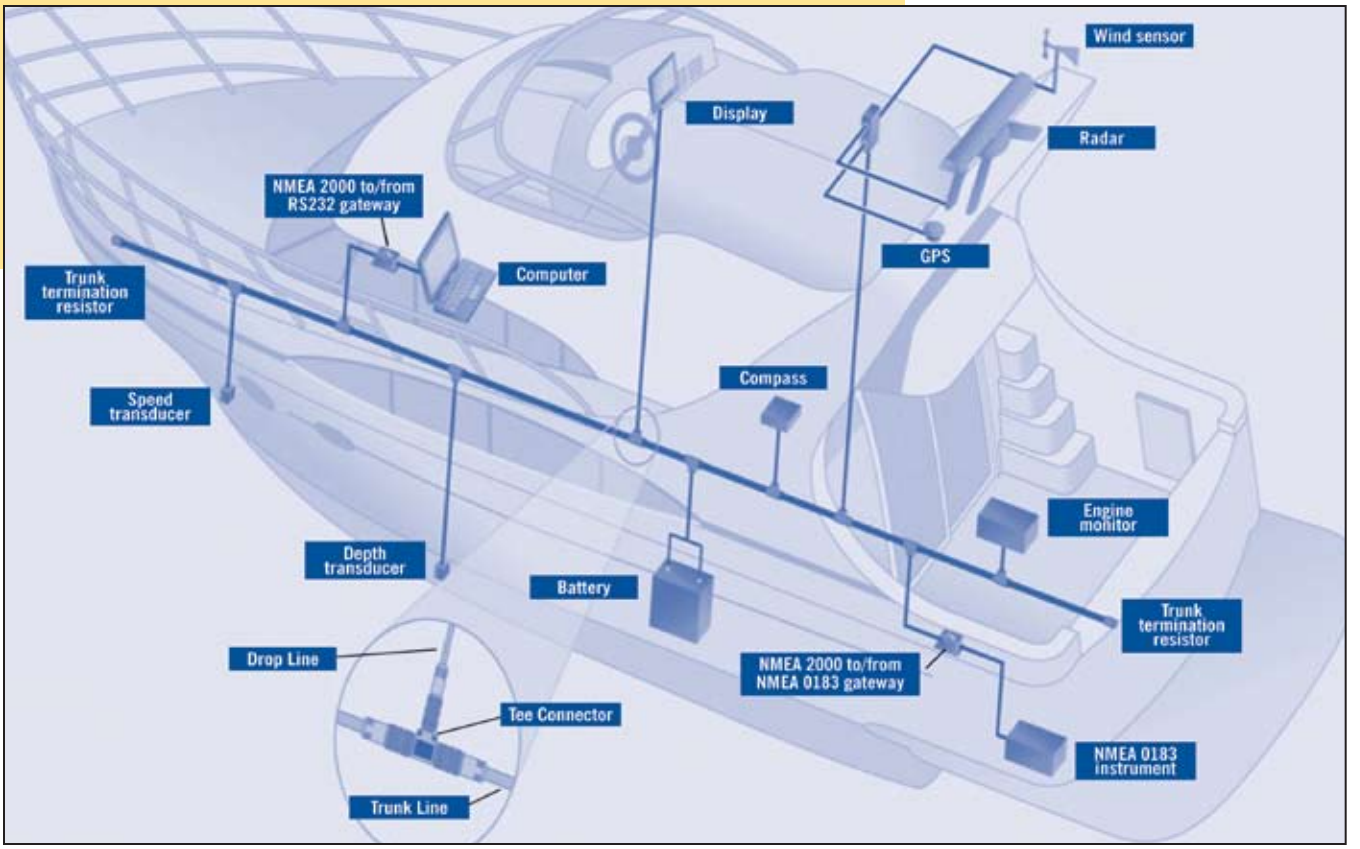
Our goal here is to stabilize the injection pump and a worn fitting at the engine end very likely means a worn fitting at the throttle control end at the helm. The cable itself may require replacement but attend the worn fittings in any case. Here, the cable ends are locked by jam nut or cotter pin and the cable bracket fixtures are seized with wire or other type of tie. Always support cable runs on the boat structure where possible. Test all systems before leaving the dock. There should be no binding or resistance in the throttle movement.

Costs of the items mentioned are minimal: fuel O-rings run US$2.15 each, banjo bolt washers, US$1.25 to US$1.75 each and throttle pivots and parts, approximately US$17 per end. It's another case of economical maintenance with a very high satisfaction level and benefit ratios.

About the author: James R. (Randy) Renn is USCG a licensed operator, avid sailor, sport fisherman and is a SAMS-AMS (fully accredited by the Society of Accredited Marine Surveyors) with 40 years experience in the fields of survey and investigation, training in boat and engine maintenance and repair, and machinery installation. He is one of a few marine surveyors to also be accredited as an engine surveyor. Randy operates Marine Forensic Technicians in Stevensville, Maryland.

Integrated Networks: Bridging the Gap

Plug and play networks integrate a broad range of electronic equipment for sharing information throughout the boat. As networks are increasingly installed on boats, knowledge of the networks in common use today will help you make informed buying decisions.



NMEA

Sample NMEA 2000 simplified network.

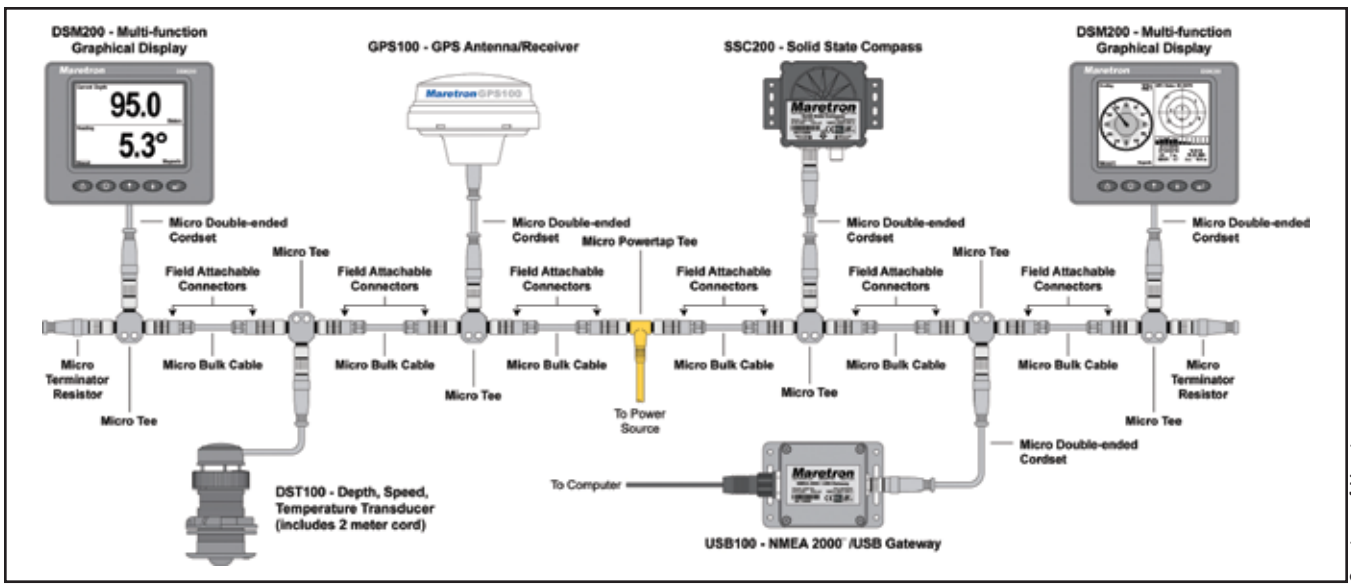
By John Payne

Intel and Microsoft originally developed the concept of plug and play (PnP) with the Windows 95 operating system initially enabling early PnP, which is specifically designed to automatically facilitate hardware detection and configuration of any connected peripherals or devices in a network environment.

Times have changed since early skeptics referred to PnP as "plug and pray." Plug and play technology automatically configures devices connected to your computer or processor-based marine equipment so that both hardware and software work together without any major user intervention or additional complicated setup requirements. As the name suggests, you can plug in and immediately use or play with any of your newly connected devices. These days, most marine instrument systems and peripherals can be plugged directly into the network and used immediately. When instruments and processor equipment is initially powered up, the boot and power up process routine recognizes any new equipment.

The most important attribute of PnP is that marine electronic hardware must be capable of having the various new devices added to the system without any physical or electrical damage to the network and other connected equipment or creating software glitches. There are some electrical interfaces that cannot withstand being plugged or unplugged without sustaining permanent electrical damage to various system components. This is one of the challenges that marine equipment manufacturers had to overcome. Plugging a new peripheral into a live system is known as "hot swapping." Not everyone likes to take this leap of faith and it's always good practice to power down first, plug in to connect and then power up again and play.

To understand the development of plug and play marine instrument systems is also to understand the evolution of modern electronic technology and it's impact on boat instrument systems. Instrument life started on boats with discrete, stand-alone instruments, such as the venerable old speed/log, depth sounder and wind



Courtesy of Maretron

Typical equipment sending data through a NMEA 2000 network includes, for example, the status from a GPS, depthsounder, engine, battery, compass, wind instrument and autopilot.

instruments. Next, the microprocessor came on scene and the trend to integration of instruments began. Some data transfer started with manufacturer standards, such as Autohelm Seatalk and, with this, was a part plug and play and part wiring solution to connecting instrument heads to transducers and sensors.

About NMEA 0183 and Interfacing

The National Marine Electronics Association (NMEA) devised the first general digital standard in 1980 with NMEA 0180. This was developed primarily for position fixing systems to allow autopilot communication and to transfer cross-track error. NMEA 0182 and NMEA 0183 followed. In many cases, this involved communication or interfacing with devices outside the basic instrumentation network and the most common scenario was the exchange of data with the GPS or autopilots. This interfacing standard was specifically developed to facilitate the transfer of an array of information between position fixing systems, radar, compass, plotters and autopilots, as well as any other systems that were either sending or requiring data.

NMEA 0183 is generally considered a single talker, multiple listener architecture, consisting of standard message sentences that transfer the data. These messages were then divided into input and transmit sentences, where many data sentences were simply transmitted as inputs to the various processors. Other data and information was also transmitted to the various devices for display only. One of the issues then was that a lot of relatively small diameter wiring had to be connected and this was physically very small and also created many reliability problems.

Ensuring quality connections at the various devices was a major problem and poor quality terminations caused many data transfer failures. A second problem was ensuring that wires were correctly connected, such as the right input and output terminals being used, as the various designations were not standardized as to which was to receive and which was for transmit? Then came the issue of proper grounding. This was based on reference grounds for data transfer and also for the proper termination of cable screens. Another big issue was interference and noise corrupting data and this was usually caused by poor wiring installations and practices.

The final problem was the proper configuration of the software in each device so that all connected equipment read the data or transmitted the data. This also often required the selection of the correct input and output ports. There were many factors that required consideration by the equipment manufacturers. This included the type of physical equipment involved, waterproofing, voltages, impedances and the current values and signal timing. All of these factors impact the plug and play concept with respect to the physical design of plugs, sockets and cables.

What about NMEA 2000?

Plug and play has taken on a new dimension with the launch of the NMEA 2000 interface standard that was developed in conjunction with International Electrotechnical Commission (IEC). This is essentially a low cost, bi-directional serial data protocol that allows for multiple talkers and listeners to share the same network data and has 20 times the bandwidth of the previous standard. This allows the GPS, radar, chart displays, sounders, autopilots, engine monitoring and entertainment systems to exchange digital information over a single channel.

The NMEA 2000 standard is actually based on the Controller Area Network (CAN) protocol that was originally developed for the automotive industry. Along with this network development and the dramatic increase in computing power within systems came the requirement for plug and play instrument and marine electronics systems to improve both the installation performance and the reliability.

Manufacturer Specific Communications Protocols

There has long been a trend for the development and implementation of manufacturer in-house communications protocols, and in tandem also a plug and play design philosophy. The principal reason is that very fast broadband data transfer is required to enable the use of video and graphics images such as that from radar, chart plotter and fishfinder screens onto multifunction displays. With split screen capabilities, that is a lot of data to transfer.

The Controller Area Network (CAN) is a very fast serial bus that was specifically designed to be an efficient and reliable link, connecting sensors and actuators. The CAN system uses a twisted pair cable for communications at speeds up to 1M bits per second and can cope with up to 40 devices being connected. The system does require an interface for NMEA communications.

Raymarine SeaTalk and High Speed Bus (HSB and HSB2) protocols have existed for many years and are used for total systems compatibility between all Raymarine instruments and equipment only. ArcNet is used as the backbone for the Pathfinder HSB network. The system allows addition of any equipment, from radar, chart plotters, GPS, logs, sounders, to fishfinders and compatible engines and more. The newer SeaTalk 2 protocol is also based on the CANBus format.

Furuno NavNet uses an Ethernet 10BaseT (twisted pair) system, which is relatively common in many shore-based data systems. Only usable with Furuno electronics, the system has a star topology with each connected device having a separate set of wires that radiate out from the hub. When a fault occurs, it's then confined to that one device or cable. Ethernets have high data rates and the network cables must meet the UTP (unshielded twisted pair) standard to ensure data integrity. This means that instrument cables must be routed well away from fluorescent lights and other equipment to avoid interference and data corruption.

Simrad also uses an in-house developed proprietary protocol that is known as SimNet. This allows high-speed data transfer between all connected devices and is also NMEA 2000 compatible. Like all plug and play networks, it has a small and single cable that simply plugs into the device or display.

Brunswick's SmartCraft system is also based on the CAN data bus technology. The system is somewhat different, innovative and more sophisticated than other systems, and this is in keeping with the functional requirements. The CAN technology is implemented across three separate and independent pairs of data communication lines. These are nominated as CAN X, CAN P and CAN V and each of the CAN lines is specifically dedicated to a set of boat functions. The CAN X data bus processes safety critical data and information, including to and from the boat's electronic throttle and shift control, which obviously requires a high level of access and data security. The CAN P is nominated as the propulsion data bus. This handles the engine data and also diagnostic information. The CAN V is nominated as the boat data bus and this supports all the remaining systems, which include generators, data bus switching and other sensors. As part of the redundancy and reliability of this architecture, the system supports cross communication between the three buses while still maintaining data security for the safety-critical systems. The system also runs a bus management software called CAN Kingdom that further increases reliability. Integration is simplest when using electronics from Northstar or Navman or other Brunswick companies.

Lowrance also has its own high performance network called LowranceNET. Based on the NMEA 2000 standard, it also allows multi-station sensing and display of all boat and engine systems. This system is expandable and it uses intelligent sensors known as Electronic Probes (EP). These electronic probes have integrated microprocessors and system redundancy is maintained, as one sensor does not fail the whole system. The sensors transmit data in the NMEA 2000 format and this is used on multi function displays and other equipment.

Garmin's network is a proprietary Ethernet-based network that connects only Garmin devices such as its chartplotters, GPS, radar and satellite radio. Some of these devices have NMEA 0183 ports to export data to other networks.

What are 2000?

Devices sold as NMEA 2000 compliant must be certified by the NMEA. Go to nmea.org/pub/2000/index.html for a current list of certified equipment.

PnP Basics

The basis of having plug and play instrument systems is that precision manufactured waterproof connectors with quality pins and sockets terminate the single network data cables. This ensures low loss and high reliability electrical connections. This, coupled with the system automatic configuration of such networks, allows quick startup and play.

There was a time when you were hostage to a particular manufacturer but this is no longer the case. The new generation of plug and play networking allows connection of devices from different manufacturers. You can connect a Raymarine device to a Simrad device and also to a NMEA 2000 network, even to a computer.

Plug and play marine networks save time and installation costs and allow the novice to get systems up and running fast. The primary caveat to success is that a new user must read and follow the manufacturer installation manual instructions. In addition, follow basic wiring and setup rules for installation of the network cable so that it is protected from mechanical damage and routed away from possible interference noise sources. For reliability, also be careful (and gentle) when inserting the plugs and ensure that they are locked in to ensure good connections.

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

Buying Right
Navigating the Electronics Maze

Whether you are fitting out a new boat or upgrading your old one, choosing the electronics package can be simultaneously enjoyable and daunting. This DIYer shares his lessons learned from a nav-com refit and plots a step-by-step course to arrive at a "best value" solution.

Pat Kearns

By Jim Discher

Personalization is a concept that is taking modern marketing and product development by storm. Download only the music you want to listen to on your iPod. Accessorize your vehicle with the equipment that makes it distinctly yours. Make a personal statement every time your cell phone rings when you select a ring tone of your choice off the web. Create an Internet home page that serves up only the information that is important to you.

As we move into the future, the big winners will design products that give their customers the flexibility to customize them to their individual needs. To some extent, this concept has taken root in marine electronics. Consider the number of ways you can personalize your nav-com systems today. Onboard satellite antennas deliver literally hundreds of digital quality TV and radio programs. Manufacturers like Garmin and Raymarine offer real time weather feeds direct to your boat. Custom build your multi-function display screen with only the information you want to see. Electronic devices to enhance our safety and lifestyle on the water are abundant.

While we take them for granted, today's nav-com electronics almost defy logic. They are smaller, thinner, faster, brighter, smarter, better, easier to use and a fraction of what they cost just a decade ago. Refitting your boat with the latest electronics has never been more affordable. Continuous improvement in modern technology gives us the benefit of a constant stream of exciting new navigation and communication options. However, sorting through the blinding array of options can be confusing, even intimidating.

Herein follows what I learned through the buying and installation of my own nav-com refit last summer. This information offers you a pragmatic yet thoughtful approach to help you reason your way through the multitude of options and arrive at what I call a "best value" nav-com solution for you and your floating passion.

First and foremost, be an informed shopper. Before you start spending or even shopping, take time to learn the basics of how each component works and how they work together. Understanding the fundamental principles behind how GPS, radar, VHF and sounders gather and send data gives you a solid foundation for evaluating the best system for you. A simple Google search leads you to a number of great websites that arm you with this information. (The "West Advisor" at westmarine.com provides a good overview of how these components work.) Assuming you understand the basics, let's jump in with the critical three: budget, space and type of boating you do.





Jan Mundy

A clear sight line from the helm seat is critical when mounting electronics.

Step 1: Budget

Budget has to come first. Options range from hundreds to tens of thousands of dollars. Taking time to make a realistic financial assessment up front goes a long way in helping you narrow your options. Having some vision at this point insures you end up with a complete solution with components that integrate nicely and you'll have money left over for the installation.

Itemizing all the supplies and tools needed to complete the job and then adding 20% to 30% for the unforeseen helps you come up with a realistic budget.

While you have your checkbook out, think about purchasing extended warranty coverage (see "Service Contracts: Buyer Beware" on page 31) for your new system. Consider the advantages of this enhanced protection against the cost of repairs due to the tortures these components are subjected to: sunlight, heat, water and even worse for some, saltwater, and whatever pounding the seas decide to serve up on any given day. Don't forget that this can also be dropped, spilled on and my old favorite, installed wrong.

Step 2: Space Confines

Unless you're outfitting a megayacht, you'll have space limitations and this gives you another criterion to whittle down your list. I have broken the topic of space into three categories.

The helm. Safe and convenient access to all nav-com equipment at the helm is top priority. Experienced boaters know running in unfavorable seas brings out all the weaknesses of your planning. Consider how viewing angles change when your boat is underway, how direct sunlight might wash out displays and how running after sundown might create night blindness. Data needs to be visually accessible and within easy reach, without overly distracting you from navigating. You'll also need to account for possible interference from your magnetic compass and any antenna obstruction.

To accomplish this you'll need a game plan. Sketch a system wiring diagram, including cable routes and component locations. I made cardboard templates for each of my components prior to installation. (The size of the Raymarine C80 display is almost exactly that of a standard letter size pad of paper.) Using these templates, I was able to uncover sightline, footprint and accessibility issues before committing to drilling those dreaded holes.

Topside considerations. Whether it's a mounting on a mast, radar arch or hardtop, you'll need to give each component the required amount of space. VHF antenna reception is limited to line of sight. The formula for

Grouping antennas can create interference with certain electronics.

When routing the cabling be sure to leave extra length to allow for easy turnaround or removal of the display.

John Discher

As a rule, it's not recommended to cut cables but coil them instead in neat bundles in a concealed area (inside the radar arch in this photo).

calculating the antenna range in miles is: square root of height above water (in feet) times 1.42 miles. Simply put, the higher your antenna, the better the range. GPS antennas need an unobstructed view of the sky to pick up satellite signals. Radar scanners do their best work when they have an unobstructed 360° view and have a running attitude that is parallel to the surface of the water when underway. If you have a planning hull, have a friend take a picture of your boat running up on plane to get an idea of how the attitude changes. The change in attitude of my boat on plane from its static resting attitude afloat is pretty drastic.

Cable and wiring: Map out the paths of your wiring and cable runs. A little planning on sequencing your pulls can save a load of work. Carefully, use existing cables to pull through the new ones if possible. I like to lubricate the new cables with SailKote Dry Lubricant. It's a versatile, dry film lubricant that won't attract dirt and helps you slide through those tight spots and turns.


Jan Mundy


John Discher

Borrow this product from the sailor's tool kit and make it part of yours.

I ran all cables separately to minimize any radio frequency leakage or interference, especially between the GPS and VHF radio. I don't know if it made a difference but I have zero interference from one system to the other. Keep in mind that cables and wires take space as well. For a 30' (9.1m) run between the radar antenna and the display I had 50' (15m) of cable. As a result I had 20' (6m)

Jan Mundy

Displays function as single stand-alone or multi-function combination units.

John Discher

Electronics stowed below in the cabin or concealed behind a locking panel offers protection from the elements and discourages thieves.

of cable left over that had to be coiled neatly and stowed somewhere.

Step 3: Type of Boating

How and where you do your boating has everything to do with your best value solution. As a starting point, take inventory of your requirements, relative to the type of boating you do, and then find products that fit those needs. Are you a lake boater? Are you a coastal cruiser doing day trips and weekends? Are you a long-range cruiser, heading for open water, 200 miles or more offshore? Will you need to remove display or head units before storing the boat? Do you trailer your boat? Is there secure dockage or storage? Do you leave your boat in the water year-round? Answering these questions further boils down your options. It may also help prevent you from being dazzled by features and gadgets that have no practical use for your style of boating. (Remember all those buttons on your home stereo system that you've never used because you can't remember what they do or how to use them!)

Ideally, you'll find a system that only has the features that you need. By not under or over buying, you maximize value because you utilize a higher percentage (ideally 100%) of the system's capabilities. The result is a solution that represents the most efficient use of your dollars and a best value solution for you.

Lessons Learned

The primary function of a nav-com system is to provide you with data. Think about all the information you have to pay attention to while underway: weather, sea conditions, flotsam and jetsam, navigation information, engine sounds, gauge and instrument readouts, watching out for other boats and the whereabouts of passengers onboard. To maximize the data you have at a glance, buy the biggest screen you can afford and have the space to accommodate it. In fact, if budget and space are ample, I recommend installing two separate displays and networking them. This set up maximizes the data available to you at all times and minimizes the need to toggle between screens, which in my experience can be dangerously distracting.

Another down side to having only one multifunction screen is if it goes down you loose everything. Consider

View Discher's electronics buyer's evaluation worksheet by clicking here.

budgeting for a handheld GPS and VHF as back up. At a minimum, always have updated paper charts and a magnetic or hand bearing compass onboard.

As for the radar antenna, don't buy the 24 mile or 48 mile based on distance. Buy it based on clarity. Moving from a 2kW to a 4kW antenna yields sharper images in a more eminent navigational zone of 0 to 3 miles. The Raymarine C80 gives the ability to overlay or superimpose radar on top of the GPS. It's pretty cool, saves a screen split and gives room to display other information on a multifunction screen.

Radar antennas that spin are for show, if you have the dough. While researching nav-com at last year's San Diego Boat Show, I had an interesting conversation with the West Coast rep from a very prominent radar systems manufacturer. He told me that, even though open array antennas look cool and feed the ego, they don't deliver better performance for comparable kWs in the domed version. Essentially, he said spinners aren't worth the extra expense.

A gripe on documentation: from my personal experience, the installation and owner's manuals from ICOM and Raymarine are not very well written. They are vague and leave out logical bits of information. For instance, manuals detail all features and settings but don't provide the benefits of one setting over another. As a result, all this has to be discovered by trial and error. This can be a dangerous distraction while underway. I would encourage these manufacturers to check out the documentation that KVH provides with their TracVision products. It's top of the class in my opinion.

When it came to mounting the C80 display, I gave the Navpod Grand Prix PowerPod serious consideration. It provides protection from the elements, security and a tidy look but just doesn't swivel enough to provide the variety of viewing angles I need. Installing black box components like a fluxgate compass or fuse blocks in places that are easily accessible for resolving future problems or for upgrades is just being smart. Take pride in a clean, quality install. I like to install tie-downs every 24" (61cm); 18" (46cm) on all cable and wire runs. Leaving things dangling and subject to the tortures we put our boats through is just asking for trouble. Do the due diligence to understand the manufacturer's recommended installation and get help if you can't quite master it.

About the author: Since discovering boating just five years ago, Jim Discher has nearly completed his second boat refit on "BearBoat," a 1989 Trojan 12 Meter Express Cruiser. His article on the selection and installation of a satellite TV system appears in DIY 2006-#3 issue.

Service Contracts: Buyer Beware

Service contracts, often referred to as extended warranties, are marketed on the promise of help to the consumer once the manufacturer's warranties expire. Whether they fulfill that promise is another story.

Extended service contracts are not warranties, but repair insurance policies administered by third-party independent companies. They do not create any legal obligation for manufacturers to assist with repairs or make good on defects; though in many instances, a reputable boat dealer and/or manufacturer is your first contact who then facilitates processing of your claim. For some high-ticket items, service contracts offer the boater an assurance policy against equipment failure.

Before signing up, take time to see exactly what is offered and especially look at the exclusions. Ask to read the actual agreement, not just the promotional material. Consider these points.

- Is it too expensive? Contracts should not cost more than 10% to 15% of the value of what they cover.
- Does the coverage period overlap with the manufacturer's warranty period? It shouldn't. Look for service contracts that commence only after the manufacturer's warranty expires.
- Does the contract void itself when the pay-out for claims exceeds the value of the product covered? You could be left with no coverage.
- If you sign up for a service contract, call the company within a couple weeks to make sure they received your premium and that the contract is in effect. One-fourth of complaints about marine contracts involve the dealer's failure to submit the application and premium.
- Follow the service contract's requirements for maintenance and repairs. Some require specific shops perform all maintenance. Make sure all repairs are authorized, otherwise your claim could be denied.

— *Caroline Ajootian, director of the BoatU.S. Consumer Protection Bureau*

Installing Electronics
Tips, Tricks and How-to

Story and photos by Harry Hungate
(exceptions noted)

With inputs for GPS sensor, radar, digital depthsounder, autopilot and other instruments, Raymarine C-series multifunction displays offer complete navigation and control functions on one screen.

"Cormorant," a Corbin 39 cutter, has been home, at home and away from home when we cruise, since 1997 and we recently upgraded our onboard electronics. Our choice of electronics was influenced by our successful experience with the equipment we already had onboard as well as the good service provided by the local dealer. We began our cruising life with Autohelm, Raytheon and Raymarine products and happily chose to stay with them. This article, while specific to the Raymarine product line, contains sufficient general information to be of use with other manufacturers' equipment.

We have had CRT and monochrome LCD radar displays but, after one look at the new color displays, the choice was easy. It's almost impossible to purchase a radar-only display, as the displays available today are chartplotters with options. Sensors added to the basic display offer radar, GPS, real-time weather and depth sounder/fishfinder features. Memory cards provide detailed nautical charts.

On "Cormorant," the radar display is mounted atop the circuit breaker console in the pilothouse, where it can be seen from the cockpit and nav station. Since both of us are on the far side of 50, it didn't take much time to decide on the largest of the displays. This is the first point worth remembering: your eyes aren't going to improve with age, so buy large now!

The C-series C120 display fit nicely in the space available and power consumption was only 2 watts more than the next smallest display. The bad news was that our "old" two-year-old radar scanner was not compatible with the new displays. The options were a new 24-mile or 48-mile radar scanner. We selected the latter unit because it had mini-automatic radar plotting aid (MARPA) that gives the heading and speed of other boats to help assess the danger of collision, a very useful feature in the crowded seaways that we encounter along the east coast of Australia. Assured that the new scanner cable was the same diameter as the old one, we purchased the C120 display and the 48-mile scanner.

As our old Micrologic GPS was nearing the end of its useful life, we replaced it with a Raymarine Ray 120 GPS receiver. It has the latest satellite, wide area differential correction features (WAAS and the European counterpart, EGNOS). This unit is a receiver only and has no display but connects to the C120 radar display via Raymarine's SeaTalk network. (Raymarine's latest offering is the Raystar 125, which is NMEA 1083 and NMEA 2000 compliant.)

Although our old autopilot worked perfectly, we were advised that, since MARPA requires frequent speed and heading data updates, our current equipment wasn't up to the task and we should update to the latest model. Also, the fluxgate compass would need replacing. We kept the old autopilot display, course computer and fluxgate compass as spares and sold the monochrome LCD radar display and scanner to another cruiser.

Our new electronics' package can interface with other devices via the SeaTalk network or NMEA ports or with a SeaTalk to RS-232 adapter. Computers, radios with digital select calling (DSC) or speed, depth and wind instruments can exchange data with the network.

The latest Raymarine E-series displays also have the option of adding a Sirius SR100 satellite receiver to provide real-time weather displays. Older E-series displays require updated firmware (software embedded in the hardware) for this feature. The weather displays resemble a combined GRIB and Weather Channel picture and are currently limited to North America, Mexico and Caribbean.

CONTENTS | PREVIOUS | NEXT

UPS for Electronics

While sailing in fog, eyes intently fixed on the radar screen, you decide to start the engine (or a windlass or thruster) and the radar goes blank abruptly. To protect electronic equipment from recycling or shutting down due to DC system voltage drops when starting the engine, install a Newmar StartGuard (newmarpower.com). This US$199 device contains a sealed rechargeable battery that is switched on line to electronics when the starter switch or solenoid is engaged. Once the engine starts, StartGuard automatically goes off-line and the alternator recharges the internal battery. There are input terminals for two electronic devices with a limit of 20 amps each, so you'll need to find another solution for the autopilot.
— *Jan Mundy*

Power Requirements

Give careful thought to the power requirements of each device on the SeaTalk network. The SeaTalk cable has three conductors within a foil shield. The red conductor is positive and the yellow conductor is the communications' line. The bare wire is ground and is common to both the red and yellow conductors. Due to inter-unit isolation requirements, the current-carrying capacity of the SeaTalk circuit is limited to just 150 milliamps. It's extremely important that the maximum allowable load is not exceeded.

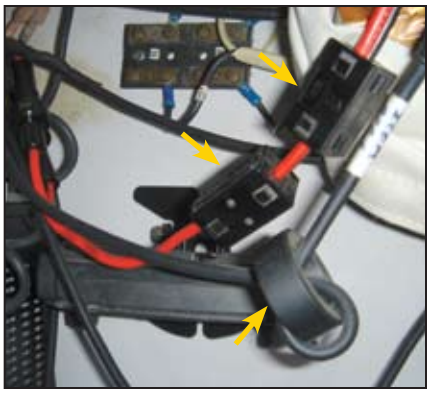
SeaTalk allows multiple power connections. Each device on the network can have its own power connection with fuse or circuit breaker. As a minimum, you'll want the autopilot, chartplotter/radar and GPS receiver on separate circuit breakers. This allows you to minimize power consumption by turning off the autopilot while at anchor, leaving on only the chartplotter and GPS with the anchor alarm enabled. When interconnecting two separately powered devices, simply cut the red wire in the SeaTalk cable to eliminate any power cross-feeding problems.

Installation manuals state that voltage fluctuations can cause the electronics to reset. What this really means is that if your electronics are powered from the same battery that starts your engine or powers the anchor windlass or bow (or stern) thruster, the voltage dips and transients from the starter and windlass motors causes your electronics to lose calibration and user settings. We experienced problems with our wind instrument losing direction calibration and the radar resetting to default values. The problems were due to the anchor windlass and the electronics drawing power from the same battery bank. The National Marine Electronics Association (NMEA) recommends providing a dedicated battery for electronic equipment. Few boatbuilders provide this and battery upgrades are expensive. On our boat, the best solution was to power the electronics directly from a house bank battery that's isolated from the bank with a normally closed relay. When the windlass circuit breaker is off, the relay is closed and the battery charges and discharges as normal. Energizing the windlass circuit breaker opens the relay. [Ed: For details on installing a relay that isolates onboard electronics refer to page 59 in this issue.]

Interference Solution

Interference with other electronic devices is an important issue. Installation manuals advise mounting devices several feet from a single sideband radio (SSB) and to avoid routing cables next to antenna coaxial cables, etc. Follow these guidelines as closely as possible.

Most cables require ferrites, either molded onto the cable or clipped on. These devices serve as electronic tourniquets to prevent radio frequency energy from traveling along the cables and causing interference in electronic devices. Ferrites should be installed on both ends of each cable. Toroidal ferrites are very effective when the conductor is looped through several times (as shown in the photo above). A wire-tie around a clip-on ferrite maximizes its effectiveness by eliminating any air gap between mating surfaces. Also, wire ties wrapped around the conductor on either end of the ferrite hold the ferrite in place on the cable as near the connector as possible. Obtain additional ferrites from your electronics' dealer, as the material from which they are made is specific to the frequencies of the energy to be blocked. Usually types 31, 41, 43, 75 and J ferrite material are best for onboard use.



Doughnut-shaped and clip-on type ferrites prevent radio frequency interference. If possible, make a cable loop or two through the ferrite.

Installation Basics

Once your purchases are onboard, inventory everything and allow yourself sufficient time to read and absorb the installation manuals, taking notes as you go. Time spent here pays handsome dividends during the actual installation process.

Assemble your tools. You'll need screwdrivers, wire cutting pliers, electrical tape, self-amalgamating tape, tube of silicone grease, tube of corrosion inhibiting jointing compound, wire lubricant, heat-shrink insulation, heat gun, assortment of crimp-on wire terminals (the heat-sealed type), crimping tool, wire stripper and paper towels. You'll also need a cordless drill and drill bits if you are doing an initial installation.

Mount the chartplotter/radar display where it's protected from spray yet read-

able from the helm and nav station. Various swing-out mounts are available for maximum viewing flexibility.

Route the power and signal cables as far as possible from AC power cables and radio coaxial cables and never, under any circumstances, allow them to lie parallel to these sources of interference.

Installing the cable between the display and the radar scanner is best begun from the display end due to the size of the display connector. Interconnecting cables are mostly plug and play. [Ed: For details on plug and play network operation, refer to page 23.] SeaTalk is especially easy to work with, as the cables are cut and spliced as required. Purchasing bulk cable simplifies the fabrication of custom lengths but requires heat-sealed crimp connectors on every join. (Not all cables can be cut so consult a pro before doing this.) Use high quality terminals and terminal strips and coat everything with an electrical sealant such as CRC SoftSeal or equivalent. When bending cable, don't exceed the manufacturer's recommendations for angle of bend tolerated. As a rule of thumb, a radius bend should be no smaller than four times the diameter of the cable. For a 1/4" (6mm) cable, the minimum radius bend is 1" (25mm).

Use a cable lubricant when pulling wires or cables through a conduit. It's quite possible to destroy an expensive cable by pulling too hard on it. Use a corrosion inhibitor, such as Tef-Gel or Duralac, on the threads of all bolts, especially when installing stainless-steel fasteners into aluminum.

If your scanner is mounted on the mast, you must make provision for pulling the mast without withdrawing the cable. This requires either an extension cable or a waterproof junction box at the base of the mast. Cut and splice as needed but be sure to follow the manufacturer's instructions.

Mounting the radar scanner on the mast is best done on a windless day. Trial fit the scanner on the mount before hoisting it up the mast. The scanner is fitted with a small rubber drain tube. Make absolutely sure that this is installed properly and add it to your checklist when going up the mast to inspect the rig before an offshore passage. Insects have been known to plug up the drain tube, allowing moisture to accumulate and ruin the electronics.

Chartplotter/radar display is easily viewed from the cockpit and nav station when mounted in the author's pilothouse.

Aside from a new mounting plate, the new scanner was a simple bolt-on installation. Be sure cables are long enough to provide strain relief and a "service loop" so you can turn the equipment to examine the backside.

Sheryl Shard

Paul and Sheryl Shard, international sailors, authors and producers of the TV series "Distant Shores," prefer their chartplotter/radar mounted in the cockpit. "It adds a lot to our sense of security when alone on watch in the dark and it keeps us awake too, since it's like a video game to play with while on watch."

All of the new radar products can be owner installed, as there are no calibration or alignment requirements requiring a licensed electronics' technician.

Installation of the autopilot display, course computer and fluxgate compass were straightforward exchanges as they were the same physical size as the old units.

Mount the autopilot course computer and fluxgate compass in an accessible area, down low, near the center of the boat, except on a metal hull, where it's mounted away from the hull, as in up the mast. Install ferrites on the power cable to the course computer. One ferrite should surround both power conductors and loop the conductors through the ferrites as many times as you can. Dress and secure the power and signal cables neatly. Finish the job by clearly marking and labeling all cables.

Mount the autopilot display head where it's accessible from the helm. Hand-held remote controls are available, either wireless or with a cable. Power to the display head is provided over the SeaTalk cable. Install ferrites according to the installation instructions.

Loop power supply and negative cables through ferrites and secure with wire ties.

Autopilot display is mounted with a clear view from the helm.

GPS receiver threaded onto an antenna mount on a stern platform.

Flush mount the GPS receiver or thread it onto a standard 1", 14 threads per inch, antenna mount. Always mount a GPS receiver where it has an unobstructed view of the horizon, as far away from transmitting antennas as possible and out of the radar beam. Choose a lower location rather than a higher one to minimize course over ground (COG) and speed over ground (SOG) errors caused by the boat rolling and pitching.

Install the rudder position transducer exactly according to the installation instructions. Be sure to route the cable where it's clear of steering gear. A ferrite or two on the cable is a good idea, especially if your autopilot makes an unexpected turn whenever you transmit on your VHF or SSB radio.

There is really no maintenance to be done on the new systems aside from making sure that the radar scanner drain is clear, the cables are securely connected and are chafe protected and keeping the displays clean. Loose terminations and poor splices cause most operating problems.

Checks and Tests

When all of the devices are installed and wired up, have a friend review the installation before turning on the power. Most Raymarine dealers (good to have as friends) will provide this service for you.

Rudder position transducer mounted with ferrite on the cable.

Author's wife inserts chart card into slot on chartplotter. Electronic charts provide more information than paper charts and are read by most chartplotters.

After initial power-up, the setup and calibration procedures are lengthy but this exercise will force you to become acquainted with the many features of the equipment. Make careful notes in the installation and commissioning manuals as it's impossible to remember all settings.

Before leaving the dock, confirm that the autopilot and rudder reference transducer indeed turn to port and starboard instead of the opposite. More than one helmsman has had a hair-raising experience because of this simple error. Transmit on your radios at high power while watching the autopilot, GPS and chartplotter for interference. Take corrective action before releasing the docklines. A loose or faulty ground wire may be the cause of the problem.

Fine Tuning

Chartplotter features are truly awesome and the firmware is user upgradeable with new versions downloadable from raymarine.com at no charge. Electronic chart cards are now available for almost every area in the world. The information available on these charts increases yearly, with port services, satellite pictures and sea floor details now available. Transferring data from your personal computer to the chartplotter requires a compact flash card reader and a formatted compact flash card.

Always remember that reality is much preferred over an electronic display. If where you are headed doesn't match what you're viewing with the display, slow down, stop or turn around until you know why. In the far reaches of the South Pacific, we have found the electronic charts (which are simply copies of the traditional paper charts) can be as much as 2 miles in error in longitude.

One feature that we value greatly is the course track recorded by the chartplotter. The ability to reverse the course track and follow it back to open water can make a night departure less risky when the weather turns your snug anchorage into a lee shore.

About the author: Harry Hungate and his wife, Jane Lothrop, are current cruising around Australia aboard "Cormorant," a Corbin 39.

ADDITIONAL READING (DIY ARCHIVES)

All About VHF Antennas	2001-#4
Autopilots for Sailboats	2004-#4
Communications at Sea	2004-#3
Compass Selection, Adjustment, Servicing	2001-#2
GPS: Connecting to a Computer	2004-#2
Radar Navigation	2003-#4

EQUIPMENT LIST

Below is a list of the Raymarine equipment, unless specified otherwise, and prices in U.S. dollars as of November 2006. Installation hours vary widely, depending on your choice of equipment, your boat's configuration and skill level.

Equipment

Chartplotter C120	$2,450
Navionics Gold chart card for New Zealand ($99 for most areas of the U.S.)	$269
Chartplotter E120	$3,900
Autopilot ST-6002	$570
Autopilot course computer S3G	$2,400
Rudder reference transducer	$345
Fluxgate compass	$180
Autopilot linear drive Type 2	$1,650
SeaTalk three-way junction box	$21
GPS receiver Raystar 125	$300
Radar scanner 4kW 48 mile with 50' (15m) scanner cable	$1,800
Radar scanner extension cable 16.5' (5m)	$180
Sirius WX SR-100 satellite weather receiver with antenna (requires Sirius subscription service: www.sirius.com/wi/i/marineweather/marine_faq.html)	$900
Power cables, terminals, circuit breakers, fuses	$250
Total	**$15,215**

Installation (in hours)

Chartplotter	1
Autopilot	1
Course computer	2
Rudder reference transducer	2
Fluxgate compass	1
Autopilot linear drive	2
GPS receiver Raystar 125	4
Radar scanner	20
Total	**33**

Get Your Ducks in a Row Before Buying or Selling a Boat

Once you've decided you're ready for a new boat, you don't want anything to slow down the process. So before the wheeling and dealing begins, make sure to have all your loose ends tied up neatly.

BoatU.S. Members have access to a number of valuable online services such as FREE estimates of the fair market value of your boat as well as FREE insurance quotes and affordable financing.

We will also handle the cumbersome details of your transaction such as escrow, settlement and documentation services at BoatUS.com. These services are available only to BoatU.S. Members and are well worth checking out!

Visit the Boat Buyer Services page at BoatUS.com *Today!*

It's a one-stop source of information that can help the process of buying or selling a boat go as smoothly and quickly as possible.

BOAT BUYER SERVICES

***at* BoatUS.com**

Silence is Golden

The right products properly installed minimizes engine roar and enables you to savor the pleasures of quieter times on the water.

By Jan Mundy

With the advancement in soundproofing materials made in the past 10 years there's no reason for a boat to be as loud as a machine shop that mandates hearing protection for workers. Surprisingly, few production builders address this issue adequately, with sound insulating material installation usually limited to the engine space hatch covers or the underside of the engine space overhead.

I was reminded of how archaic builders are last fall when I went for a test ride on a 28' (8.5m) trawler with its engine mounted in a raised motor box. It was impossible to converse without shouting. The engine noise was deafening.

While sound intensity can be measured, the reaction to loud noise is largely a subjective response. I was the only one of three onboard this boat who was propelled into a flee response within minutes of my exposure to this din. For some people, intense noise radiating from an engine is more than irritating, leading to physiological and psychological harm. It wouldn't surprise me if unbearable noise is on the list of reasons boats are not used or are ultimately sold. After all, would you tolerate sitting in a "boom" car for 10 hours? Not likely. For as little at .5% of the boat's value, you can effectively suppress objectionable noise from an engine. To understand the noise produced by marine engines, you must first consider the basic concepts of sound decibel and exposure limits.

How Loud is too Loud?

The loudness or intensity level of sound, measured in decibels (dB), and the length of exposure to the sound determines your risk of hearing loss. According to the National Institute for Occupational Safety and Health (1998), the maximum toleration exposure time at 85 dB is 8 hours. At 110 dB, exposure time tolerance drops drastically to 1 minute and 29 seconds. As a rule, the higher the dB, the more hazardous the effects on hearing and emotions.

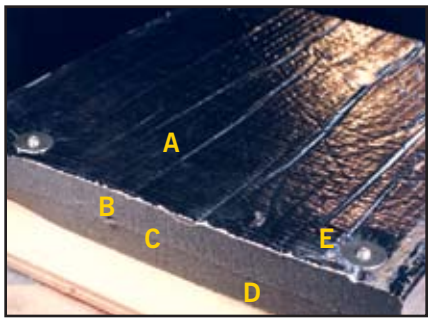
Consider these decibel levels of common noise sources. Normal conversation is in the 60 dB range, shouting raises it to 110. Rain falls at 50 dB, thunder roars at 120. Most household appliances, a ringing telephone and lawn mowers are mainly in the 50 to 95 dB range. An ambulance siren rings in at 120 dB as does a car horn, chain saw, rock concert and jet plane on the tarmac.

Now consider your boat's engine room. A typical engine at wide-open throttle tops out at 110 dB. Enclosing the engine in a plywood box drops decibels to 95. Treating that box with properly applied soundproofing material can lower decibels another 10 to 15 dB. While this may not seem like a huge improvement, consider that each 10 dB decrease equates to a 10 times decrease in sound intensity.

Noise is further classified into two types: air transmitted sound and structure borne sound. On a boat, the primary sources of airborne noise are your boat's engine, transmission, propeller and exhaust. As noise relates to revolutions, revving up the engine produces higher noise levels. Structure borne noise is sound transmitted through the stringers, engine mounts, propeller shaft and other components, imparted to the hull and deck and then radiated as airborne noise. It's important that you understand the difference as the remedy varies with each noise

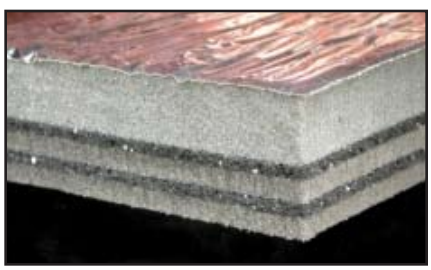
Jan Mundy

When considering a sound insulation refit, it's important to treat the entire compartment. This engine box needs a gasket around the hatch perimeter to prevent noise leakage.



Jan Mundy

Multi layer composite soundproofing materials consist of: a protective facing (A); an absorption layer (B) that absorbs reverberating sound in the engine room by filtering sound waves; a barrier mass (C); a decoupler layer (D) that acts as a second wall along with the enclosure bulkhead to reflect sound back into the absorption layer; and metal or plastic pin fasteners (E) placed 15" (38cm) apart to secure the insulation to overhead surfaces.

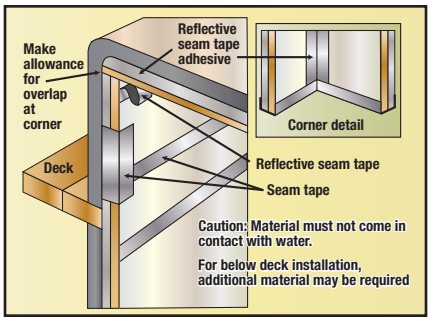


Courtesy Glacier Bay

Barrier Ultra-dB from Glacier Bay uses two decoupler layers made of rubber particles glued together loosely so they vibrate and tuned to attenuate sound within the frequency range found in a typical engine room installation.

CONTENTS | PREVIOUS | NEXT

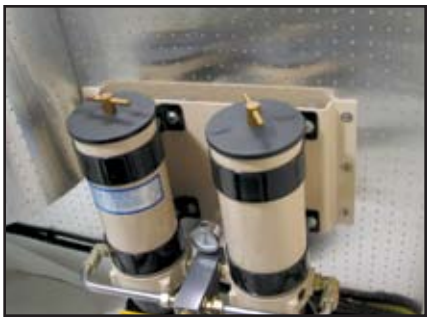
Courtesy of Soundown /Joe VanVeenan



Sample installation.

Jan Mundy

Soundown's custom-made quilted fiberglass curtain mounted with Velcro or hooks forms a flexible bulkhead to contain sound from radiating around and escaping aft of the engine or into quarter berths.



Perforated aluminum facing protects the insulation, provides a durable, easy-clean finish and allows the mounting of component parts.

type. Regardless, the object here is to achieve the lowest noise level possible. Effective control utilizes an assortment of barriers and absorption materials that block sound from escaping through the walls and, at the same time, absorb sound within the same space, and by the use of dampening products to isolate vibration.

There are many products to choose from ranging from brush-on compounds to self-adhesive composite foams to suspended panels to carpet pads available from 3M Marine, Glacier Bay, Silent Running, Soundown, Vetus and other manufacturers. Some products provide both insulation from vibration and noise absorption; other materials only provide noise absorption, while others dampen vibration. Material qualities and installation methods determine a product's effectiveness in reducing noise.

Options Matter

Presuming that the engine is correctly mounted so it doesn't generate excessive vibration (e.g., flexible engine mounts, proper shaft alignment, etc.), the next step is to choose the right product for the job. Like so much boat stuff, this is a case where you get what you pay for and cheap will not reward your efforts.

Effective sound insulation con-

Courtesy of Silent Running

Silent Running's brushable coating dampens structure borne noise and is ideal in compartments with limited access or applied to bow thruster tunnels, underneath water pressure pumps or sanitation vacuum pumps.

sists of multiple layers of foam or fiberglass, sandwiched between a sound barrier slab of a lead or non-lead mass and finished with a thin film that reflects heat, enhances sound absorption and protects the foam from dirt, fuel and oil. Available in several thicknesses and weights, these sound-deadening composite materials both insulate against vibration and absorb noise.

Newer composite products replace the traditional heavy lead barrier panels with lighter PVC or vinyl sheeting or rubber particles that deliver the same noise blocking characteristics but at about half the weight.

Exterior (decoupler) and interior (absorber) foams (also fiberglass) that envelop the barrier are, in order of preference, polyether, polyurethane, polyimide and polyester. Quality polyether foam has a life of 15-plus years when properly installed. Cheaper foams are susceptible to drying out and crumbling from exposures to high humidity and heat/cool cycles. As a rule, the thickness of the two foam layers plays a big part in noise control. A 2" (50mm) composite foam, in general, provides better low frequency performance, while the attenuation of high frequency is comparable among quality composite products.

Single-layer insulation made of foam, fiberglass and other materials is an inexpensive way to reduce sound absorption, at about half the cost of a composite material. Used in applications that do not require a barrier, such as a refrigerator compressor, air conditioner mounted under a bunk or a noisy pump, this material provides noise absorption but does not eliminate vibration, making it unsuitable for engine room applications.

All of these insulation products are covered with a protective facing. These are available in various colors of Mylar, urethane and vinyl as well as perforated aluminum sheet.

Installation tips

Noise is like light and it passes through the smallest opening. With a well-insulated engine box, any leakage can account for a 50% increase in unwanted noise. Be sure to overlap butt joints and seal all gaps or voids around hatches or where wires and hoses pass through bulkheads or ventilation ducts with crush-resistant gaskets or line with an absorption material. Seal loose-fitted edges with a Mylar or aluminum tape, which also protects exposed foam edges from vapors, fumes and moisture. The goal is to achieve a tight acoustic seal while also providing for adequate engine ventilation, necessary for both combustion and cooling. [For complete installation details refer to DIY 1996-#4 issue, available on DIY's 1995-2006 Hands-On Boater CD-ROM.]

Composite and single-layer products attach to a substrate with a self-adhesive peel-and-stick backing for easy installation or require a brushable or spray adhesive for gluing to the engine enclosure.

Vibration Controls

Damping materials control structure borne vibration in much the same way as the absorption component in airborne sound. Applied directly to surfaces bordering the engine (gen-set, etc.) or above propellers or suspended from the overhead they add mass to a material to change the resonance characteristics so that it doesn't vibrate and, as a result, reduces noise.

Brushable sound dampening "paints" are ideal in areas where hatch and bulkhead clearances do not allow the use of thick composites. These coatings can be applied to fiberglass, metal and plastic and the inside of the hull where the shaft and propeller are located. Some compounds are formulated for a thick application, as much as 2.5 times the hull thickness; others require a thinner coating for a sound reduction of 5 dB to 10 dB.

Don't expect to completely eliminate all noise. A totally quiet package involves controlling vibration from shafts and struts, rumbling propeller and exhaust noise at the transom, whining blowers and ventilators and other machinery. Expect to pay about US$20 per square foot to effectively insulate a 30' (9.1m) powerboat with a composite soundproofing material, slightly less for a sailboat of the same length. Costs rise if you factor in flexible engine mounts and shaft couplings, carpet underlay in accommodation spaces, dampening tiles, drop curtains or exhaust silencers.

Before committing to a large purchase, consult with a marine noise control specialist for advice on the best materials and installation methods for your application. A well-engineered package will make life on the water a lot more peaceful.

About the author: Jan Mundy is editor of DIY.

Sail Checks

A sailmaker helps you get your sail inventory ready for launch with this step-by-step checklist.

Story and photos by Jan Mundy

Spring is fast approaching and, while you eagerly anticipate the launch of your boat, reserve a few hours to give your sails their annual checkover. Actually, this process is better done in the fall when sail lofts aren't busy building new sails and you can take advantage of attractive rates and storage fees. Regardless of the season, regularly examining your sails for wear could save costly repairs later when worn or frayed areas finally rupture beyond repair.

Pick a large room with a clean floor (consider using a school basketball indoor court, a church all-purpose room, yacht club or marina meeting room for this purpose), spread out each sail then follow the steps below and on the following pages.

Inspection begins at the head, follows down the leech to the clew, along the foot to the tack and up the luff, returning to the head. Check stitching, batten pockets, hanks, grommets, rings, slides and slugs, headboards and clews, leech lines and foot lines, telltales, webbing, handsewing, luff tapes, UV covers, seams and tabling. Mark all areas that need attention with a sail repair tape. When you do take your sails in for repair, this exercise saves your sailmaker time and you money.

Repair costs vary with the loft normally charging you a set fee for the sail inspection and an hourly rate for repairs. The sailmaker also checks the "hand" or feel of the cloth to determine the sail's condition. Older sails sometimes don't warrant repairing but leave that decision to your sailmaker. Just don't wait too much longer if your sails need repairs or you'll pay a premium, especially for a quick turnaround.

Mainsail

Headboards rarely break. Sometimes, the holes elongate without a liner and eventually pull through, requiring a new headboard. Better sails have stainless-steel rings pressed into the headboard holes to eliminate wear. The headboard slide is under tremendous downward loading. Metal slides are best as plastic ones often break.

Check the leech stitching all the way down to the clew. Examine the leech cord where it terminates and at each reef point and pull it to see that it holds in the plastic cleats.

Look for broken stitching around the batten pockets, especially at the ends. Check the elastic and Velcro closures. Check for chafing where the mainsail comes in contact with the shrouds and spreaders. Often there is a patch at this chafe point. If wear is apparent, it's a good idea to have the sailmaker sew on a patch.

The clew slug takes all the leech load from the mainsheet and often needs restitching or new webbing. Note the torn footrope caused by the misaligned slug. Slugs should be a pencil width higher than the rope. This makes it more difficult to feed into the boom, often requiring pleating the rope to feed it in but the slug then takes all the load and the rope doesn't tear.

Make sure all slides or slugs are securely fastened. Inspect the webbing, if sewn on. If shackled on, which is obviously a lot faster labor wise, they tend to twist and catch in the mast track if a loose fit. Hand sewn slides present a nice snug fit. Plastic slides often break so carry spares in your repair kit. Inspect the tack corner. The bottom luff slide is under a heavy load, especially when reefing. Cranking the outhaul before tensioning the halyard when putting in or shaking out a reef pulls on the slide and tears the sail.

On full batten mainsails, check the batten pockets at the luff (right). These endure a lot of wear and hinging, especially on the lower battens. This grommet (left) has pulled through from hinging. Check the luff tape stitching up to the headboard. Remove shoes or wear soft-soled slippers and walk over the sail, checking stitching at seams and reef diamonds (middle).

Genoas and Jibs

Starting at the head, examine the pressed ring, which often becomes overstressed from flogging and fatigues the cloth. Flex the ring and, if it feels stiff, it's okay.

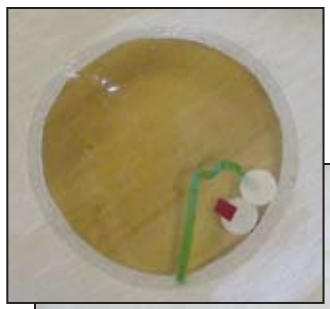
The spreaders are potential chafe points. It may be necessary to install spreader patches, if not already equipped. Check for broken stitching and wear along the entire leech length. If it's a roller furling headsail, check the stitching on the UV leech cover.

Check the plastic leech and foot cords for damage and wear. Check that the Velcro closure is secure and tug the line to make sure it's still working.

Examine pressed rings in the clew and tack. These are susceptible to hinging when overstressed, especially on laminated sails and/or furled sails. Check the stitching along the foot. Often the stitching is broken where the sail rubs against the bow pulpit and along the foot of the sail where the shrouds rub when the sail is sheeted in hard. Consider a tack patch to protect these areas.

Check the luff boltrope for chafe. Your sailmaker will assess the rope tension by stretching the sail between pulleys using a tension gauge. If a jib has batten pockets, check that the battens have not broken. Thoroughly inspect snap hooks (hanks), carefully pulling each one to make sure the pistons are working freely. If sewn on, inspect the whipping. If the hanks are pressed on, make sure they haven't twisted and are securely attached.

Roller furling jibs often tear along the luff tape slot in the metal extrusion, particularly at the head. This one is sure to catch in the feeder. If the sail's maker didn't allow for tack setback (same as for a mainsail slug), as much as 3" (76mm) back from the headstay, then the luff tape, where it enters the feeder, takes all the load and tears. Check for frayed ends and burn with a hot knife to seal. Check the UV cover stitched on the luff and foot, if equipped.



Check the telltale plastic windows. Take shoes off and walk across the entire sail, looking for broken stitching.

CONTENTS PREVIOUS NEXT

Downwind Sails

Surprisingly, the spinnaker is the most difficult of sails to inspect. Light and finicky, it takes two people to hold this sail overhead, while visually searching each panel for pinholes and small rips that let in the light. Tip: Holes in spinnakers are best spotted when sailing with the sail hoisted in bright daylight that allows the light to shine through tears in the cloth.

Special thanks to Greg Bratkiw, president of Quantum Canada (800/505-5359; quantumsails.com), the manufacturer and service facility for Quantum sails in upstate New York and central eastern Canada, for assistance with this article.

Spinnakers have a tendency to snag on lifelines and deck fittings or to be damaged by crew handling. Look for pulled stitches and tears along the edges and for frayed edges that could easily catch on a cotter pin or other hardware. Take a hot knife and burn off these threads.

Carefully examine the taped edges. Check the leech cord.

Check all corner rings for looseness and broken stitching. Most spinnakers have external rings that are secured with webbing and are not susceptible to hinging.

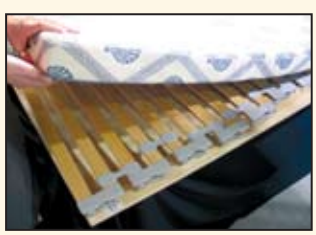
Performance Thrust

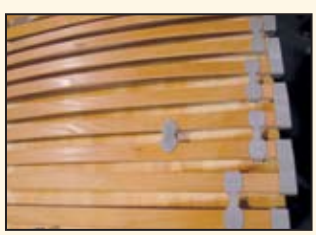
Bow thrusters are considered essential equipment on many power and sail cruisers as a means to control the unintended movements of a boat's bow, caused by wind or current, that otherwise might lead to uncontrollable consequences. Though thrusters are operated in intervals of mere seconds, their propellers are prone to cavitation, resulting in a noisy prop wash. Vetus (vetus.com), in collaboration with the Maritime Institute Netherlands, a hydrodynamic laboratory, developed a uniquely shaped, six-blade propeller that produces little or no cavitation and reduces noise by half. Available on all 2007 thruster models, this new prop improves thrust force by 9%, supplies equal thrust to port and starboard and reduces power consumption by up to 10%.

Trailer Security

Theft of boats on trailers is on the rise and the recovery rate is negligible. The newest entry into trailer anti-theft protection is Steal Shield (stealshield.net), a patented heavy duty, powder-coated steel hitch lock (CDN$80) designed by a retired policeman. Measuring 5" wide by 9" long (127mm by 228mm), it slips onto most lever lock couplers on Class I, II and III trailer tongues up to 2-5/16" (8mm) in the 2,000lb to 5,000lb range (907kg to 2,268kg). A flat metal locking bar slides through slots in the sleeve that places the locking bar behind the hitch lever and is secured by a lock and pin mechanism. Any attempt to remove the Steal Shield by force results in damage to the hitch rendering the hitch assembly inoperable. Besides deterring trailer theft, this device also provides protection for the coupler from other physical damage. We saw this at a boat show in January and liked it so much we bought two.

Cushion Saver





Jan Mundy

Cushions and mattresses laid over berths and locker and flats are ideal breeding bases for mildew. Neptune flexible slat systems are manufactured in the Netherlands and distributed in North America by Payne's Marine Group (paynesmarine.com). These slats raise cushions 1.6" (40mm) to allow airflow under cushions, thus thwarting mildew growth, as well as providing a contoured, flexible platform to enhance cushion comfort. Kits are comprised of 30 varnished beach wood bent slats, in 39" (99cm) and 55" (139cm) widths, both 80" (203cm) in length, starting at CDN$150. To assemble, simply cut the slats to the desired width, install the molded plastic end caps and attach the connecting clips. Plastic caps prevent the slats from sliding and these easily roll up or unclip to access hatches. A pair of adjustable brackets (CDN$70) raise the slats to convert to a headrest is optional (shown in the left photo).

Power Watch

Monitoring the amount of electricity flowing through a circuit is easy with the Kill A Watt manufactured by P3 International. Plug this inexpensive (about US$40) volt-amp-watt-Hz-hour meter into an AC receptacle, insert the plug from the device that you want to monitor and then read the display. See how many watts (or amps) your computer, TV or other device is drawing at any given moment or how many kWh you've used since you turned it on. Monitor the quality of the shore power supply by displaying volts and line frequency (Hz). This meter also detects voltage drops and brownout conditions before they damage delicate equipment.

Cetol Goes Natural

If you like using Cetol as a wood coating, you might fancy the new Sikkens Cetol Marine Natural Teak (yachtpaint.com). Unlike Cetol Marine and Cetol Marine Light that can turn wood an orangey color, this new satin translucent finish is a rich golden color that preserves wood's natural tone and grain and doesn't darken over time with successive applications. Natural Teak can be used on bare interior or exterior wood. It's formulated for the same ease of application and maintenance of the original Cetol wood finishes but with Sikkens Next Wave Technology. Specialty resins and enhanced UV absorbers, which work similar to sunscreen, provide greater protection, durability and longevity.

Detailing 101

Swobbit

Simple techniques that clean and protect gelcoat surfaces with less time and effort will give you more time for boating.

Clean-up Kit

- 2 large buckets
- Sponge or wash mitt
- Hose with plastic nozzle
- 1 soft brush, 1 medium stiff brush
- Applicator pads
- Micro fiber cloths
- Electric buffer (my preference but optional)
- Absorber
- Squeegee
- Cheap bristle paint brushes or foam rollers to apply stain remover
- Boat soap, rubbing compound and glaze (if needed), wax or polish, sealer, spray wax
- Safety equipment: gloves, goggles, protection clothing

By Jan Mundy

Boats are subjected to harsh conditions that, over time, dull fiberglass, dim the shine of metals and fade paint. Winter storage is particularly unkind to boats sitting sadly neglected for several months. Boats in southern climates endure tropical exposures that age their appearance faster so, either north or south springtime clean up demands some powerful cleaning aids. Factor the multitude of products on store shelves and as many theories on their application and you have the makings of a job gone awry. As with any task, choosing the right tools and materials can save you time and money.

Before heading to the boatyard, collect your tools (refer to the clean-up kit on this page). Once there, follow these steps to quickly and easily clean and protect your boat all season long.

Rinse First

Cleaning rule number one: Thoroughly rinse the boat with plenty of water to remove any loose grime and grit that may be clinging to the surface. Begin rinsing at the highest point on the flying bridge or cabin top and work down, moving from the bow to the stern so the water drains out naturally.

Add some boat soap to your bucket and using a sponge, wash mitt or brush wash surfaces, working again from the top down. Rinse the sponge or cleaning mitt in the bucket often. Don't let any soap dry on the surface. Keep a hose nearby to rinse frequently with plenty of water. For the final rinse, remove the nozzle from the hose and allow the water to sheet off the surface. Less water hastens the drying time.

Hand apply polish with an applicator pad or micro fiber towel in a small, circular motion.

Swobbit

Use the right brush for the application: (left) Extra soft blue brush for windows; (middle) soft yellow brush for all-purpose cleaning; (right) medium stiff brush for cleaning non-skid and teak decks.

Cleaning is simple. If, when using a wash mitt or brush you're sweating and applying a lot of elbow grease, you're working too hard. Harsh scrubbing forces contaminants into the surface, which can scratch the finish. Let the cleaning products do the work for you.

Soap Sense

Cleaning rule number two: Always use a boat soap. Leave the Cascade, Fantastic, Palmolive, Simple Green et al at home. Household products may work great but they can damage gelcoat if allowed to dry on the surface. Most of these products are highly alkaline with a pH of around 12 to 14 (**Figure 1**). They can completely strip wax layers and even etch the gelcoat (known as alkaline streaking), if allowed to dry. Neither acidic nor alkaline, most soaps formulated for marine use have a neutral pH of 7 and are safe to use on gelcoat surfaces.

Soaps come in liquid and granular form and some liquids are concentrated. Concentrates are nice because you use as much as you need to get the job done. The first spring cleaning demands full strength soap; for routine cleaning dilute the soap. Some soaps remove wax so take care to select the right one if you want to remove wax. If it's not stated on the label don't assume it's safe; house-

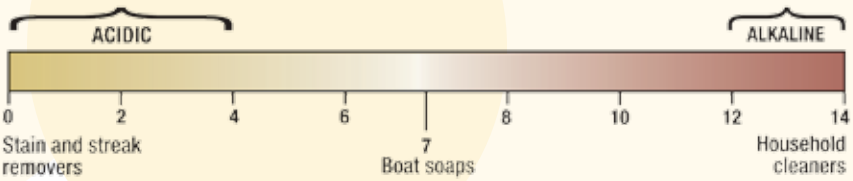


Figure 1

Swobbit

Swab the decks to remove dew and rainwater, which cleans and dries in one easy step.

hold soaps definitely remove wax.

As for cleaning power, boat soaps work equally well. A high-sudsy soap doesn't clean better and, with suds, less is best. We associate suds with cleaning power but covering the surfaces to be cleaned with suds obscures the dirt that needs your attention.

One-step wash and wax products apply an additional barrier that, depending on the amount of rainfall and sunlight your boat withstands, gives up to two weeks of protection. These waxed soaps make surfaces easier to clean and slightly enhance surface gloss. For the final rinse, remove the nozzle and turn the hose pressure down to about 50% so water gently wets the surface. Spraying surfaces with a blast of water won't remove the wax affect but you're adding more water to the surface than necessary and this extends the drying time.

To remove wax you'll need a heavy duty acidic cleaner. Use full strength or dilute following the manufacturer's instructions. Some products will damage painted surfaces so, again, check the label and look for "paint safe." Always follow with a thorough scrubbing with soap and water and rinse well to remove all residue, which contaminates surfaces and leaves a hazy finish after waxing. If the gelcoat is in good condition, follow with a wax or polish or apply a rubbing compound on faded surfaces. [Step-by-step instructions on refinishing dull and faded gelcoat and the proper application of rubbing compounds, glazes and waxes appears in DIY 2002-#1 issue.]

More than Bristles

Cleaning rule number three: Invest in quality brushes and you'll need more than one. Brushes are useful to clean those hard to reach areas and to apply more cleaning power on deck non-skid. We've owned a variety of inexpensive brushes sold for home and auto use and none cut the mustard. Wood brushes rot where the handle shaft screws into the brush and, with wear, the bristles flatten and fall out, leaving a blue trail on the deck and exposing the screw that secures the handle. Better brushes are made of plastic or poly with a molded-in handle. Premium brushes have a rubber bumper around the edge that protect surfaces in contact with the brush head.

Brushes are rated by firmness and for most cleaning jobs you'll need two: a soft brush for cleaning gelcoat and painted topsides and a stiff brush for cleaning non-skid decks, teak, canvas and cushions and scrubbing waterline stains. Flying bridge cruisers with a large enclosure will want a third, very soft brush to gently clean windows. This super-soft brush is gentle on graphics, too. A brush that curls and pushes out or flattens usually means you've been scrubbing too hard.

Spot-free Finishes

Cleaning rule number four: Always dry surfaces. Professional boat detailers always dry a boat yet most boaters opt for air-drying. Drying does a couple of things. The freshwater used for rinsing contains a concoction of chlorine, lime and maybe iron from well water. These sediments create a residue on surfaces that is only removed by wiping down.

A secondary benefit is that drying gets you up close with your boat so you can check for damage or defects and inspect fittings. After rinsing, wipe down all surfaces using a PVA cloth (Absorber) or use a squeegee for a spot and streak-free finish. Surfaces will look cleaner and glossier if dried. [Submit a tip to DIY and if published, you'll receive an Absorber free. See page 13 for details.]

Why Wax?

Cleaning rule number five: Protect smooth gelcoat surfaces (everything but non-skid) with an application of wax or polish. The porous, colored resin finish on your boat is only 20 mils thick, that's about 5 sheets of office copy paper. UV rays, salt, atmospheric pollution, acid rain, insect fluids and bird droppings wage a never-ending war on your boat's finish. Waxing puts a protective layer between the gelcoat and the environment. It also makes your new or old boat look better. In choosing a protective product, here are some points to consider.

Synthetic polishes and waxes have been available for many years now and offer ease of application and maximum durability. Paste waxes put a slightly heavier film thickness on the surface than polishes but they take more energy to apply and remove. Also, because they go on thicker, they deliver slightly longer protection. Liquid polishes apply and come off with much less effort. Paste products are traditionally applied and removed by machine, liquid by machine or hand.

Swobbit Quik Dry Water Blade dries gelcoat and painted surfaces, windows and enclosures and leaves a spot-and streak-free finish.

When manually working with either of these products, use an application pad, preferably a micro fiber one. You'll find less expensive micro fiber rags and towels sold at Costco, Sams and Target stores.

I've always been a big fan of paste waxes applied with a buffer. Last season, for the first time, I applied a polish using the same technique I would to buff

Step-by-step instructions on refinishing faded gelcoat and the proper application of rubbing compounds, glazes and waxes can be found in th 2002 #1 issue.

Cleaning Dos

- Cover your boat for long-term storage, preferably with shrinkwrap, which offers better protection, lessens chafe and keeps the boat appreciably cleaner.
- Before using any product, read the application and first aid instructions on the back label and then follow them.
- When washing a boat in a slip or a mooring, use a biodegradable, environmentally friendly soap.
- Start rinsing and cleaning at the highest point and work your way down.
- When cleaning a very dirty boat, have a second large bucket filled with clean water to rinse the brush or wash mitt often to remove dirt and grime.
- Minimize soapsuds so you can see what you're cleaning.
- For the final rinse, remove the hose nozzle and reduce the water pressure so water sheets rather than beads on the surface.
- Dry surfaces after washing, rain or heavy dew.
- Vigorously shake product bottles for a few seconds prior to opening.
- Apply rubbing compounds in a back-and-forth motion. Apply polish (or wax) in a circular motion.
- Apply polish to everything onboard, including painted (except Awlgrip) and varnished finishes, metals and plastics, for a glossy, easy-to-clean protective layer.

a wax but my large, swooping circles left dull and shiny patches. Proper application of liquids takes a golf ball size amount squirted on the applicator pad and working just within arms length, wipe in a small circular motion. As soon as resistance is felt on the pad, add more liquid. Use lots of polish. Wait a few minutes for it to haze and then remove it with a clean and dry micro fiber cloth, turning it frequently to expose a clean surface. Move along the surface, working in small areas, applying and removing.

Seal It!

Cleaning rule number six: Regardless of the wax or polish used, follow with Interlux Teflon Wax Sealer. Just as a glaze (3M Marine Finesse-it II) is the essential second step when compounding, a sealer follows waxing. The extra effort is worth the results. When applied over wax, this product completely fills the gelcoat pores and within 24 hours dries to a mirror smooth and hard, non-stick finish that repels dirty water, salt spray, dirt, oil, UV rays, engine exhaust, rust and waterline stains. Apply a second coat and you'll triple the life of your wax. On new boats, apply sealer directly onto the surface without wax for season-long protection. A very thin liquid, Teflon Sealer goes on using the same technique as a polish.

Sustain Finishes

Cleaning rule number seven: It's not necessary to clean with soap every

Cleaning Don'ts

- Use alkaline cleaning products that can damage surfaces and the marine environment.
- Use a metal hose nozzle as it will chip or crack the gelcoat when (not if) dropped.
- Dry wipe bird droppings with a towel or you'll scratch the surface area with the excreted seeds and nuts that birds eat.
- Use a towel or rag as contaminants might scratch the surface. Use micro fiber towels, which gently lift and remove dirt and grime without smearing or streaking. When dirty, toss them into a washing machine and machine dry.
- Use a fabric softener, dryer softener sheets or a detergent with fabric softener when washing any rag.
- Scrub hard or you'll scratch surfaces. Let the cleaning products do all the work.
- Use any products that contain silicone oil.
- Let any soap dry on surfaces. Keep a rinse hose handy.
- Apply rubbing compounds, polishes or waxes on hot surfaces and never apply in sunlight.
- Apply polish on a wet surface as water droplets can cause streaking or make the polish difficult to remove.
- Apply a polish or wax to non-skid surfaces. Woody Wax, when applied according to label directions, offers good non-slip protection to non-skid surfaces.
- On painted boats, use products that are not approved for use on painted surfaces.

time you wash your boat. Before and after every outing just rinse the boat with freshwater to remove surface dirt and towel (or squeegee) dry. The natural abrasiveness of soap, regardless of the "safe" product claims, does break down wax. Under normal circumstances a wax lasts 2 to 4 months. Scrub it with soap every week and its life is much shorter. When you do need to use soap, use a diluted solution.

On mornings with heavy dew, dry surfaces using an Absorber or mop and you're good to go. On clean, dry surfaces, liberally apply a spray-on wax. This restores the gloss and renews the UV inhibitors so the sun doesn't begin to break down the protective layer of polish. Salt is hard on metals and will, over time, oxidize aluminum and rust stainless steel. Routinely rinse off salt from railings, anchor chain, the windlass and other metal hardware.

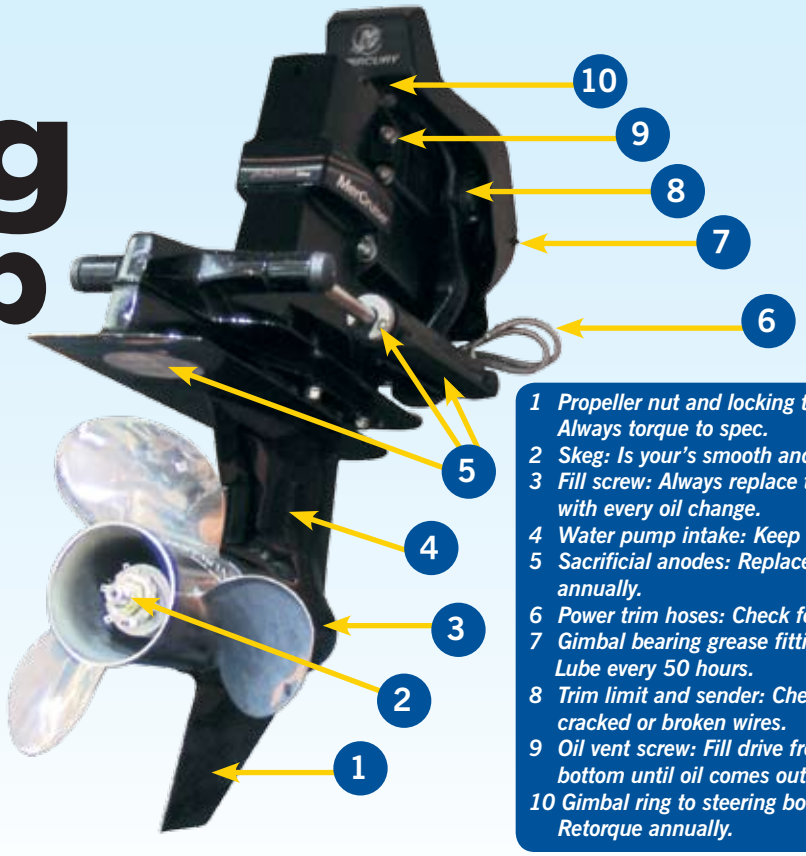
Proper cleaning helps to protect your boat from elements that spoil its appearance and otherwise might damage finishes and fittings. With the right techniques this is achievable so you spend more time on the water and less time cleaning.

About the author: Jan Mundy is editor of DIY.

Spring Tune up

Follow these maintenance steps to prepare your sterndrive and transom assembly for another boating season.

By Steve Auger



1 Propeller nut and locking tab: Always torque to spec.
2 Skeg: Is your's smooth and straight?
3 Fill screw: Always replace the gasket with every oil change.
4 Water pump intake: Keep it clean!
5 Sacrificial anodes: Replace annually.
6 Power trim hoses: Check for leaks.
7 Gimbal bearing grease fittings: Lube every 50 hours.
8 Trim limit and sender: Check for cracked or broken wires.
9 Oil vent screw: Fill drive from bottom until oil comes out here.
10 Gimbal ring to steering bolts: Retorque annually.

Before launch "make ready" involves key maintenance tasks to ensure that your sterndrive unit and transom assembly are up to uneventfully propelling your boat. Have your marine mechanic attend to processes that are beyond your skill level, especially if your engine and drive components are under warranty. Other tasks are well-suited to a DIYer equipped with a service manual, a foot-pound torque wrench and the usual hand tools. It's up to you to decide which jobs you have the skills to complete.

The sterndrive and transom assembly control the steering, hydraulic power trim and the horsepower transfer of the engine to the propeller. In order to ensure the safe operation of these systems and to safely repair them, you will need a service manual. I do not recommend performing any repairs on the sterndrive system without the appropriate safety equipment and service manual. If an OEM service manual is not available, there are generic manuals from Clymer and Seloc available from chandleries and bookstores.

Step 1: Check Over

- Complete a visual inspection of the drive and transom assembly looking for corrosion, oil leaks, damaged power trim lines, skeg and propeller damage.
- Check the condition of the sacrificial anodes, broken continuity straps (bonding conductors) and connections that interrupt the effectiveness of the corrosion protection system.
- Replace any damaged or deteriorated power trim lines. Always replace power trim lines with the drive in the full down position, preferably with a safety stand placed under the skeg for safety. If trim lines are leaking oil, it's likely that the system has water in the power trim oil. Verify that the oil is clear and if not, bleed the system as per your service manual. Note: each sterndrive manufacturer outlines repair procedures for the hydraulic power trim system with safety being the number one factor. Due to the high pressures involved in the power trim system operation, it's strongly advised to have a marine mechanic bleed the power trim system.

Steve Auger

Check connections and ground straps on your corrosion protection system.

Step 2: Prop and Skeg Service

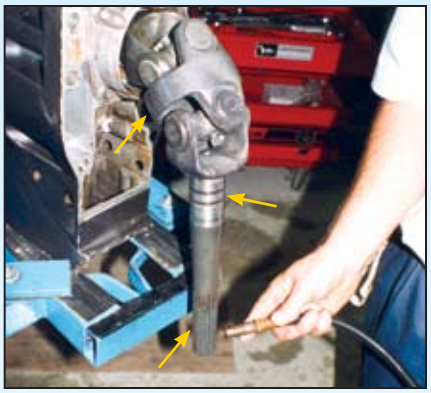
- Remove the propeller and inspect the prop blades for any damage including nicks, bent blades and cracks.
- Inspect the hub for any signs that it may be spinning inside the prop and for dry or cracked rubber.
- Inspect any thrust washers for cracks or galling.
- Replace or repair any propellers that are not in excellent condition. A damaged propeller severely compromises fuel economy and overall boat performance. If the propeller blades have major impact damage, have the propeller shaft checked for straightness using a dial indicator gauge. Most sterndrive prop shafts can tolerate up to 0.007" of deflection before they require replacement.
- Ensure that the prop retaining nut and thrust washers are in good condition. On models with castle nuts and cotter pins, only replace the cotter pin. On models with nylock nuts, replace the prop nut every other year. Before installing your good propeller, inspect the propeller shaft for damage to the splines, threads and thrust bearing contact areas.


Steve Auger

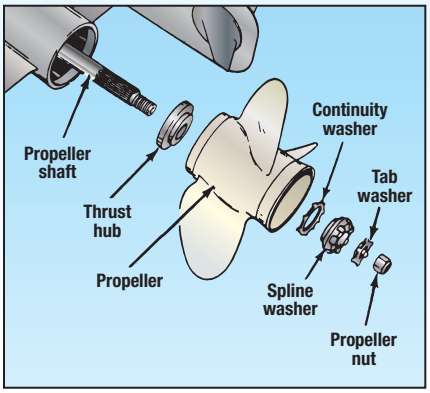
This drive unit did not get new anodes on a regular basis.


Steve Auger

This damaged prop is sure to hurt fuel economy.


Jan Mundy

Lubricate joints and coupler splines as outlined in your service manual.



Seloc Publications

Apply a liberal coat of a waterproof grease to the propeller shaft.

- On models built after 1996, there may be a sacrificial anode attached to the thrust bearing carrier that may need replacement. As a general rule, replace all anodes annually (more often if they are wasting) to ensure effective corrosion protection of your very expensive sterndrive assembly.
- Inspect the prop shaft for fishing line entanglement and or other debris. If there is a large accumulation of fishing line, it may have damaged the prop shaft oil seals and it's advisable to have the drive unit pressure tested for leaks.
- Once the propeller shaft, prop and fasteners have been qualified, lubricate the propeller shaft with waterproof grease, install the propeller and fasteners in the correct order and torque the prop nut to the specification listed in your service manual. Install a new cotter pin on models so equipped (e.g., OMC Stringer drives).
- If the skeg has only minor nicks and scratches and is still its original length, file the leading edge and repaint the area with touch up paint available at most dealerships. If the damage to your skeg is more severe, you may want to enlist the services of a dealer or propeller repair shop. If the damage is limited to the leading edge of the skeg and only a small (say 1-1/2"/38mm) amount off the bottom, a propeller repair shop may be able to repair the skeg without removing the sterndrive from the boat. Major skeg and propeller damage requires the services of an authorized dealer to verify that no internal damage has taken place. It's less expensive to have the drive inspected for possible damage than to pay for a major repair or rebuild later in the season due to a missed bent propshaft or chipped gear set.

Step 3: Coupler, Output Shaft and Joints

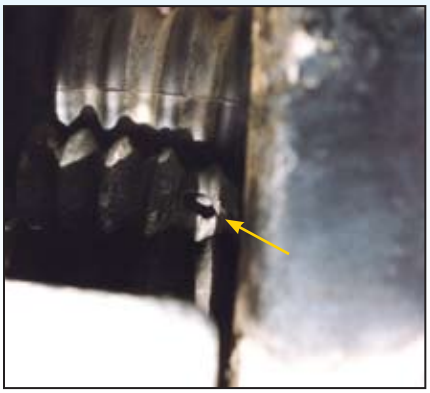
- Older OMC sterndrives use a ball gear drive system that has oil cavities for the output shaft and power tilt system. These should be drained and refilled when winterizing the boat. Verify that the oil cavities are full of the correct lubricant.
- Replace ball gears if they are 50% consumed. This is a job for your marine mechanic. An engine that requires new ball gears every couple of seasons is indicating that the drive is not fully tilted down before operation. Inspect the power tilt system to verify that it is working correctly.
- Mercury, Volvo and OMC Cobra drives use a universal joint and an engine coupler system with a steady (gimbal) bearing between the sterndrive and engine coupler. Early versions of these sterndrives require the removal of the sterndrive assembly from the transom assembly to lubricate the engine coupler splines and the universal joints. This is usually a dealer procedure but can be performed by an advanced DIYer with a sterndrive engine alignment tool.
- Correct engine alignment is crucial to engine coupler, gimbal bearing and universal joint life. Verify the engine alignment, check for any oil leaks in the bellows and lubricate all these components on an annual basis for a long service life. Models usually have grease fittings to lubricate the upper and lower steering pins. If you elect to perform this particular task, be sure to use a new sterndrive-to-transom-assembly installation kit that includes the required gaskets and O-rings. Use a torque wrench to torque the drive installation fasteners to the specification in your service manual.
- Inspect the water hoses, shift bellows, universal bellows and exhaust bellows for any cuts, cracks or UV damage.

Harry Swieca

Usually the tool of choice for engine alignment is a long metal shaft with several steps cut into the shaft.

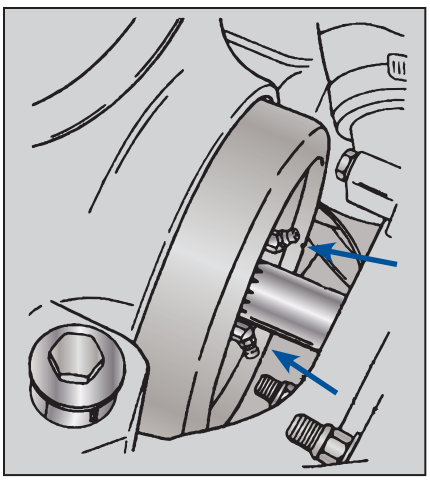
Harry Swieca

To check for play in the steering, have a helper hold the wheel tight while you grasp the drive at the anti-ventilation plate and attempt to move it sideways.



Jan Mundy

Note hole in shift boot (exhaust bellows is below). An inevitable and certain cause for a boat sinking.



Mercury Marine

Engine coupler spline grease fittings on late model Bravo One and Two drives.

These pleated, flexible rubber membranes that run between the inboard engine and outdrive have a limited lifespan. Bellows and hoses require replacement every 5 years as preventative maintenance.

- Modern sterndrives produced after 1996 may have grease fittings on the engine coupler and also incorporate the use of non-greaseable universal joints that only require inspection every 300 hours or so. This minimizes the need to annually remove the drive unless you put more than 300 hours on your engine each season. The gimbal bearing on these sterndrive units likes lubricant every 50 hours. Be sure to get the correct lubricant for each application as specified in the lubrication section of your service manual. These models may or may not have grease fittings for the steering system.

Step 4: Steering Systems

- Obviously repair and service of the steering system is for trained professionals; however, lubrication and inspection of these components is important relative to the safety of the boat's occupants. If you have inspected your steering system and still are not sure if you have a steering problem, quell your doubt by having the system inspected and serviced by a professional.
- Though each sterndrive model has its own proprietary steering system, all of these systems should not allow the drive unit to move when the steering is in a static state. This means that, when the steering wheel is held in a locked position, the drive should not move left and right when moved by hand at the anti-ventilation plate just above the propeller. Some service manuals provide a tolerance for this left to right movement to indicate when steering components require replacement. Some models, such as the Mercury Alpha and Bravo drives, have through bolts in the gimbal ring that require loosening and retorquing to specification each season. This routine improves the life of your steering system components.
- Both manual and power steering systems usually require lubrication and tend to become stiff or hard to turn if the steering cable has not been lubricated at regular intervals. When lubricating mechanical steering cables always have the cable fully retracted before greasing the cable to avoid hydraulically locking the cable. If the steering system is stiff after lubrication, you may need to replace the cable. Most helms on sterndrive-powered boats do not have grease fittings but there are exceptions and you should inspect yours to see if it's so equipped. Do not over lubricate these mechanical cables. A couple shots of grease are all that's required. Contact a dealer for an estimate if you require major steering system repairs or need to replace any worn or broken components.
- Power steering control valves produced before 1994 may require lubrication as well so consult your service manual to see if the engine is so equipped.
- Check the level and condition of the power steering fluid in the reservoir. The fluid should be a translucent red color. The fluid level in the reservoir should be between the low and full mark on the dipstick. If the fluid is cloudy, there is a water leak. If the fluid is burnt to a brown color, the power steering fluid cooler needs repair or replacement.

ADDITIONAL READING (DIY ARCHIVES)

A Simple Approach to Lube Diagnostics..... 2005-#3 Common
Winterizing Mistakes ....2003-#3 Corrosion Protection ..... 2005-#1
Decommissioning your Sterndrive..... 2004-#2
Sterndrive Alignment..... 2002-#2
Sterndrive Lay-up & Start-up..... 1999-#3

CONTENTS | PREVIOUS | NEXT

Steve Auger

Maintain the power steering fluid level at the correct levels on the dipstick.

Typical power steering belt system.

Jan Mundy

A simple retrofit is a gear lube monitor that monitors gear oil levels and condition.

- Inspect the power steering pump drive belt for the correct tension and to ensure it's not worn out or cracked.
- Inspect the connecting hardware where the steering cable attaches to the tiller arm of the sterndrive. All components should be tight and allow no movement up or down.
- Check that the mechanical steering cable does not have any wires or cable ties strapped to it for the last 6' (1.8m) of cable prior to the power steering control valve. This prevents the power steering control valve from working correctly and may cause shudder in the steering wheel.

Step 5: Interior Drive Components

- Modern sterndrive packages come equipped with a gear lubricant reservoir mounted inside the engine compartment that allows the operator to monitor the level and condition

(Continues on page 55)

Quick Lube

Follow these step-by-step procedures for doing a sterndrive oil change.

Jan Mundy

Pump the oil from the fill screw up into the gearcase until it comes out the vent screw. Note the oil collection container and gear lube pump that attaches to a standard oil bottle.

Tools and Materials

- Large slot screwdriver
- Vise-Grip pliers
- Oil drain bucket
- Sterndrive oil
- Sterndrive oil pump
- New fill and vent screw gaskets

Modern sterndrives from Mercury, OMC and Volvo require regular oil changes at least once a year or every 100 hours, whichever comes first. If your drive system has a gear lube monitor you can easily inspect the level and condition of the drive oil. For engines not equipped with a gear lube monitor then a drive oil change is the only way to verify the oil condition and level.

Outlined here are the basics of the process for sterndrives produced after 1990. As always refer to your service manual for the detailed steps, especially for older or low production engines, such as BMW, Mercury 60, 80 and 90 drives, OMC 400 and 800 series Stringer drives and Yamaha that have unique engineering.

Steve Auger

(left) Drain/fill screw at the base of the lower unit housing. (right) Vent screw located on the upper gear housing.

Emptying the Gearcase

Modern drives have a drain/fill screw in the gearcase and a vent screw in the upper half of the drive unit. With the drive in the down position, place the drain bucket under the drain screw and remove the screw (some Mercury Bravo models require removing the propeller to access the drain screw). These screws are in quite tight so the bigger the slot screwdriver the better. I use a screwdriver that allows the use of an open end wrench on the shaft to apply the required torque. You could also clamp a Vise-Grip on the shaft of the screwdriver to increase the torque.

Inspect the drain screw slot. If it's worn or damaged replace the drain screw. Inspect the magnet portion of the drain screw, if equipped. A coating of fine metal is normal; a ball of metal shavings means a trip to your dealer for a drive inspection to find the metal source.

Remove the vent screw from the upper portion of the sterndrive unit. Remove the cap from the gear lube monitor, if equipped, and allow all the oil to drain from the sterndrive unit and gear lube monitor into the oil drain bucket. This draining process can take some time, depending on the temperature of the oil. If possible, allow a couple of hours to ensure all oil drains out of the system. Remove the old drain and vent screw gaskets and replace with new gaskets.

Refilling

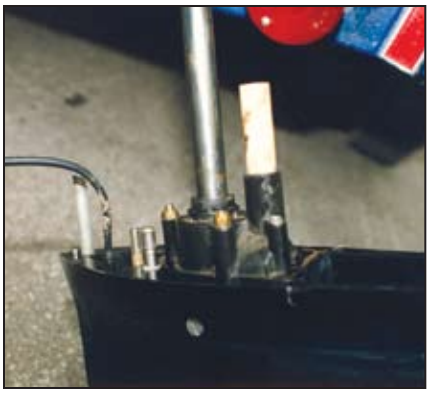
To fill the drive with new oil purchase a gear lube pump (US$8). This attaches directly to a quart (946ml) lube bottle and comes with a threaded metal adapter that screws into the fill plug location.

To use, screw the pump fitting in the fill drain. Pump the correct oil from the bottle until oil flows out the vent screw at the top of the drive unit. Install the vent screw complete with a new gasket and tighten securely. Remove the pump fitting from the fill screw area and install the cleaned fill screw/magnet assembly complete with new gasket and tighten securely.

If equipped, fill the gear lube monitor to the full level. Remove the vent screw from the drive unit to purge any air in the gear lube monitor hose. This process takes 15 minutes or so. Next, reinstall the vent screw and tighten securely. Refill the gear lube monitor to the full mark and reinstall the gear lube monitor cap. After your first trip check the gear lube level. You may need to add oil as air is purged from the system.

Be sure to dispose of the old oil at an oil recycling center. It's wise to keep drive oil onboard in order to top up the gear lube monitor (if so equipped) in case of a sterndrive oil leak.

— *SA*



Jan Mundy

(left) Water pump housing. (right) Damaged water pump body shows signs of scoring caused by overheating.

(Continued from page 53)

of the sterndrive oil from inside the boat. These reservoirs contain a float switch connected to a warning horn that activates if the reservoir runs dry, dramatically reducing the possibility of a major sterndrive unit failure. (Ed: Older models of sterndrives can have these reservoirs retrofitted as a kit, as detailed in DIY 2005-#3 issue). These gear lube monitors, when equipped with an audio alarm horn, are good insurance against a major drive failure.

- Insure the lubricant used for the sterndrive oil is high quality and is the correct type and viscosity for your application. (See "Quick Lube" on facing page for the correct procedures.) Different models from different manufacturers use different oils. However, the primary job of the oil is to cool the gears and bearing efficiently ensuring the longest possible life of the gears and bearings. Don't go cheap on oil!
- Some sterndrives have a seawater pump mounted inside the drive unit. Service these water pumps on an annual basis but, unless you are an experienced DIYer that is prepared to take on this job that, if bungled, can cook your engine, have the service performed by your dealer, either during winterizing or recommissioning.

If each one of these systems is qualified as being in good working order, your boating season will be one step closer to being trouble free.

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

The finished outboard cover.

Cover Up

Simple covers offer protection for hatches, outboard engines or windlasses.

Story and photos by Jim Grant

There are some sewing projects that are just so easy that I hesitate to offer instructions. Small covers are among them. The one cover I sorely needed was for an outboard motor of mine so here are the steps to make it. The same techniques outlined here are perfectly appropriate for hatch covers or windlass covers or almost any other small, regularly, shaped object cover.

Patterns for objects like a hatch with square corners are easy. Unfortunately, outboards and windlasses have no such corners, though they can be considered regularly shaped. This problem is easily overcome. Place a rectangle of cardboard on top of the object. Use double sided tape or duct tape to hold it in place. Then drape fabric over the flat, cardboard surface to make patterning quite accurate. Of course, the final fit without the cardboard in place will not be perfect but a glove tight fit is not appropriate in any case, as you want air circulation under the cover to eliminate moisture build-up and the resulting condensation.

SurLast draped (wrong side out) over the cardboard pattern.

Form Fitting

Start with a rectangle of fabric wide enough and long enough to drape over the object and down all sides with at least 2" (50mm) extra overlap on all sides. Drape the cloth so that the "right" side (if there is one) is underneath.

This cover is made using SurLast (60" wide, US$13.95 per yard), a 100% solution-dyed polyester from the same company that makes Sunbrella. It's nearly as durable as Sunbrella in resistance to UV and is far more resistant to abrasion damage. It's also about 25% lighter than Sunbrella so it's an obvious choice for any cover. One side of SurLast has a urethane coating that should be considered the under (wrong) side.

A couple of strips of double-sided tape on the cardboard surface (or the hatch top) keep the fabric from sliding. When properly positioned, mark the four corners as they drape over the cardboard (or the corners of the hatch as appropriate). If the cover is shallow, say 4" to 6" (101mm to 152mm) deep, gather the excess fabric at each corner into "darts" and temporarily staple in place with a regular office stapler. With deeper covers (the one for this outboard is 10" (254mm) deep), these darts are difficult to form with accuracy so remove the fabric and spread it flat on a table where it can be marked accurately. Indeed, the accuracy that results with the following marking method is a good idea even with very shallow covers.

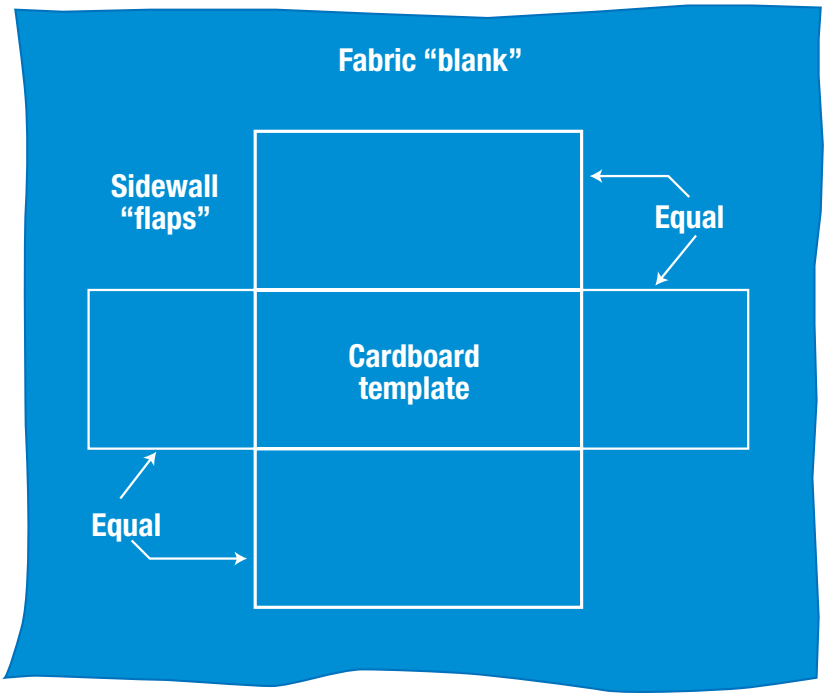
Lay the fabric outer (right) side down. The four marks made over the cardboard corners should be visible. My corners form a rectangle measuring 17" by 7" (431mm by 177mm). Mark the rectangle on the cloth using a square to ensure right angles and straight lines. Continue the lines out beyond the rectangle the depth of the cover plus 2" (50mm). Connect the ends of the lines on the flaps of fabric at the ends and sides. The finished pattern should look like **Figure 1**.

Hold the fabric with the under side (the one with all the marks) against a window so the marks can be seen and transferred to the right side. Just put dots at the corners and line ends. Draw lines on the right side joining these dots using a straight edge so the pattern is visible on both sides of the fabric.

Corner Shaping

With the right side up, place double-sided basting tape on the outside edge of one of the marked flaps. Peel the paper backing away from the tape and

CONTENTS | PREVIOUS | NEXT



Jim Grant/Joe VanVeenen

Figure 1: *The outboard motor cover pattern.*

Slit the angle between flap panels.

bring the outside edge of the neighboring flap over on top of the tape smoothing it in place so the lines of the two flap edges are on top of one another. It's helpful to cut down the center of the angle between the taped lines to a point about 2" (50mm) or so from the apex. You'll find it much easier to manage the positioning of the fabric.

Sew on the corner lines with long straight stitches. Be sure to back tack your stitches (reverse four or five stitches) at the corner end to prevent raveling (the other end of the stitch line is over sewn when hemming). Trim away the excess cloth in the darts, leaving a seam allowance of 1/2" (12mm). A nicely finished look and increased durability results if a binding is placed over this seam allowance and sewn in place. Do this at all four corner seams.

(top) Fold the seam lines over on top of one another. (bottom) Now, sew on top of the matched seam lines just inside the double-sided tape.

Now, turn the cover right side out and test fit.

Assuming all fits properly, take the cover off and adjust the lines on the outer edges of the flaps. The seaming process is seldom perfectly accurate so some adjustment might be required to the lines designating the bottom of the 2" (50mm) hem allowance. Once these adjustments are made, cut away excess material at the bottom of the cover.

Use a binder attachment to cover the raw edges of the seam allowance to prevent unraveling.

Cut the binding away to reduce the bulge in the hem along the bottom of the cover.

Edging

Turn the cover inside out and fold up 1/4" (6mm) of fabric. Trim away most of the seam allowance and binding at each corner to make a flat fold. Use double-sided tape to secure that fold, if necessary. A light scoring along the fold line makes your work easier and more accurate. We use a dull awl along a straight edge to make the score line. The same technique can be used for the second fold, 1-3/4" above the first. Use double-sided tape to baste the hem in place.

Secure the double folded hem with a single row of straight stitches. Leave a 1" or 2" (25mm or 50mm) section open then insert a length of bungee (shock) cord all the way around inside the hem. Secure the two ends of the

Hand sew the shock cord ends together, penetrating the cords three or four times and wrapping them with 10 or so turns.

(left) Binding a small opening is easier if the presser foot and binder are placed inside the hole in the fabric. (right) Completed bound opening ready for the outboard handle.

shock cord so that it makes a loop small enough to lock the cover in place firmly. Do this by hand sewing the cord ends firmly together or locking them together with hog rings (part #100952 from Sailrite) or short lengths of wire (tape over any sharp edges). Close the opening in the hem, turn the cover right side out and use it well.

Made to Order

Custom touches can be easily fitted. My outboard has a steering handle that would normally prevent pulling the cover all the way over the top of the engine. I cut a hole in the cover for the handle and bound the raw edge with a prefabricated 1" (25mm) wide acrylic binding tape (US$.35 per foot from Sailrite). Now, the handle is easily run through the hole in the cover as it's pulled down over the engine. Not only does it fit better but also the likelihood that it ever comes off in high winds is greatly reduced.

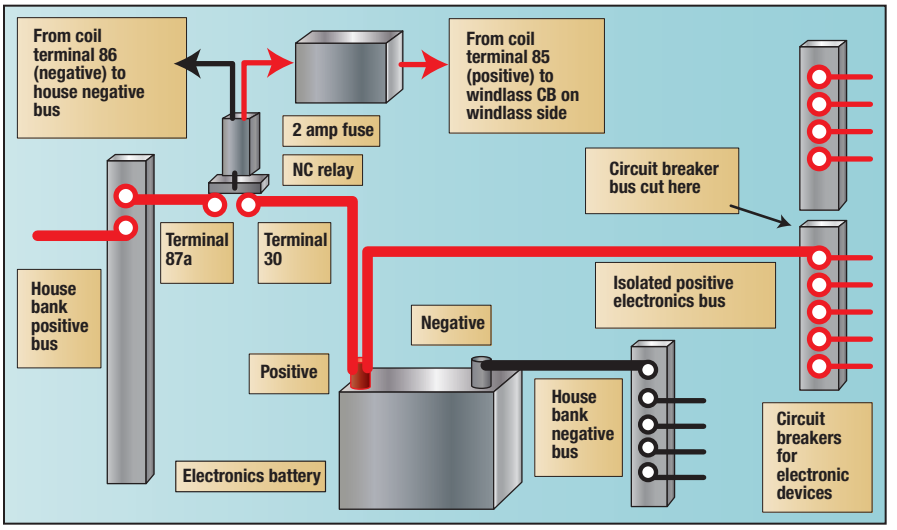
About the author: Jim Grant is the founder of Sailrite (sailrite.com), a supplier of specialty marine fabrics, component hardware and tools, sewing kits and sewing machines for boaters to build or repair canvas and sails.

7

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

Isolating Electronics

Electronic devices that lose calibration or reset to default values for no apparent reason can benefit from the installation of a simple isolator relay to resolve the problem.



Harry Hungate/Joe VanVeenan

Figure 1 *Wiring Schematic*

The article titled, "Installing Electronics: Tips, Tricks and How-to," on page 32 in this issue mentions a possible need to isolate onboard electronics from voltage spikes and drops. Today's electronic devices are designed to operate on widely varying voltages and can withstand without damage excursions beyond their design limits. However, voltage spikes and drops created by switching on high current loads, such as engine starting, thruster and windlass motors, can cause electronic devices to lose calibration or reset to default values. This is annoying at best and, at worst, may lead to possible navigation errors.

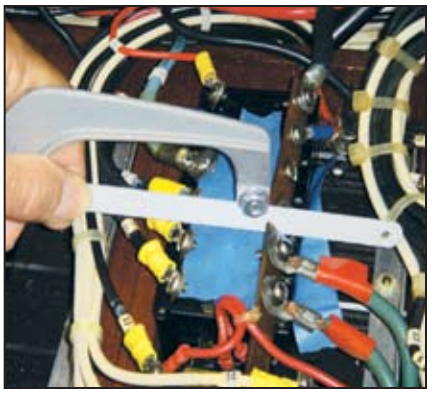
Since most boats have a dedicated engine start battery, it's unusual that the starter motor would affect electronics. The culprit is more likely to be the anchor windlass (or thruster), as it's often powered from the house battery bank. Electronic devices (GPS, radar, autopilot, wind instruments, depth and speed, etc.) are then subjected to whatever voltage transients are created by this motor's heavy current draw.

We had a problem with our wind indicator losing calibration and the dealer could find no fault with it. After we installed a new radar, it appeared to randomly reset to default values. Fortunately for us, the Raymarine dealer in New Zealand recognized the cause of our problem and recommended that we either power our anchor windlass from the engine start battery or try the isolated electronics' battery solution. We opted for the isolated battery.

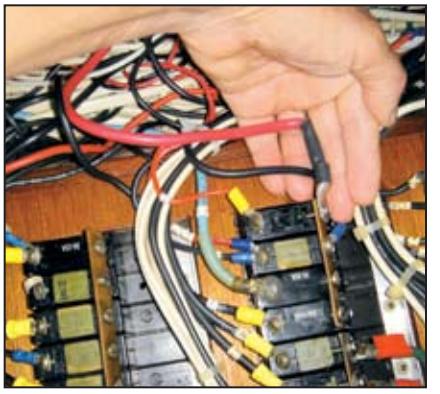
While using the windlass, all of these electronic devices are powered directly from one battery in the house bank. Installing a normally closed relay isolates this battery from the rest of the house bank (and voltage transients). This relay is energized (opened) by activating the windlass circuit breaker. In normal operation (with the windlass circuit breaker off) the electronics' battery connects to the house battery bank and thus charges and discharges normally along with the other batteries in the house bank. For the relatively short period of time that the anchor windlass circuit breaker is energized, the drain on the isolated electronics' battery does not significantly discharge the battery.

Installation Steps

The circuit breakers serving the electronics on our boat shared the same vertical stack on the circuit breaker panel with other devices. The electronics' circuit breakers had to be isolated from the rest of the circuit breakers in that vertical stack.



Cutting the circuit breaker bus bar. Strips of tape, adhesive side up, capture metal filings.



Dedicated power cable connects the now isolated electronics' circuit breaker bus to the positive terminal on the electronics' battery.

Isolating relay and clearly marked 2-amp inline fuse. Note use of heat-shrink tubing for corrosion protection.

This is fairly easy to do by simply cutting the copper bus bar in the stack of circuit breakers. First, turn off the power. Using a hacksaw, cut the bus bar, catching the metal chips with a few strips of masking tape. Next, install a new positive power cable. If your boat has a dedicated circuit breaker panel for the electronics, then obviously you can omit these two steps. The new positive cable connects the now isolated electronics circuit breaker bus to the positive terminal on the electronics battery. Note that the existing negative cable on the battery that connects to the house negative bus remains unchanged.

Install a 40-amp, normally closed, relay in the existing positive cable between the house battery bank positive bus and the dedicated electronics battery. The relay coil connects to the windlass circuit breaker so that, when the windlass circuit breaker is closed, the relay is energized and opens the circuit between the electronics battery and the house positive bus. A 2-amp inline fuse protects the relay coil. Label the fuse so that you'll always know what circuit it serves. Refer to **Figure 1** to gain an understanding of the changes. The relay is Jameco (jameco.com) part number 171432. It has normally open (NO) and normally closed (NC) contacts, so be sure to identify the correct terminals: terminal 85 is coil positive; terminal 86 is coil negative; terminal 30 is relay common and terminal 87a is normally closed. Terminal 87 is normally open and it's not used in this application. The 40-amp relay is the heaviest that I could find.

It's very conservatively rated as the electronics load on our boat is never above 15 amps and the electronics battery charging current rarely exceeds 15 amps. The relay is inexpensive and it's a good idea to order an extra relay to hold as a spare. Use high grade, tinned marine cable of 6 AWG minimum for the current carrying cables and 14 AWG for the two wires to the relay coil terminals. The relay has flat spade connectors on all terminals. Crimp marine grade female spade terminals to the relay ends of the cables and wires and crimp ring terminals to the other ends. Protect the relay terminals with heat-shrink tubing. Heat-shrink tubing over the ring terminals and cable ends prevents corrosion from gaining a foothold on your new wiring.

These relatively simple modifications cured the problems with the wind instrument and radar. The new circuitry requires no changes in operating procedure and no periodic maintenance.

— A frequent contributor to DIY, Harry Hungate and his wife Jane Lothrop, are currently cruising Australia aboard their Corbin 39 cutter, "Cormorant."

Propane Tank Storage

7

Simple DIY installation mounts propane tanks out of harm's way.

Propane tanks positioned on deck behind the wheelhouse provide convenient access and eliminate the associated risks of propane leaks from the tank or its fittings into the bilge. A regulator with pressure gauge mounts on the bulkhead above the starboard tank.

Propane (liquefied pertroleum gas or LPG) is a common choice for fueling the galley stove, whether the boat is used for weekend cruising or full-time living aboard. Cooking with gas is familiar and reliable and propane provides clean, controllable heat. Once the system is in place, it's feasible to add a cabin heater or barbecue grill. Still, for some nervous boat owners, propane remains an ongoing source of worry, partly because of the precautions required for safe use, more so because of the dramatic photographs of the accidents such precautions are meant to prevent.

In actual fact, though, propane use has led to fewer catastrophic galley fires than alcohol fueled appliances and priming an alcohol stove burner can be intimidating. In part, it's likely that propane "paranoia" among boaters and boat builders has triggered rigid compliance with the stringent standards for the installation of propane systems and appliances and that has led to pro-

Tank platform, strapping and protective handhold.

pane's relative safety record in marine applications. [Ed: For the right way to DIY a LPG system on a boat, consult "A Boater's Guide to Propane" in DIY 2000-#4 issue.]

Propane is heavier than air. If a leak develops inside the boat, the propane vapors would settle and remain trapped in the bilge, creating an explosive atmosphere just waiting for ignition by a stray spark. Tank storage could thus create a potential problem. Though it's possible to store propane tanks in a seat locker or a deck box, they can also stay out in the open on deck or cabin top, lessening any chance of a propane leak from the tank or its connections from making its way to the bilge and also ensuring convenient access for disconnecting, reconnecting and inspecting the tank and fittings.

After considering various storage locations, we mounted the tanks on top of the aft cabin, one on each side, just behind the wheelhouse of our center-cockpit sailboat. A similar arrangement will work on other boat types as well.

Platform Construction

Boat surfaces are not level and in order to direct water runoff, decks slant outboard, cabin tops are arched (cambered) and so on. Unless you are using a LPG tank that is specially designed for horizontal installation, the tank must be installed vertically and you must compensate to achieve a level mounting surface.

Cut a platform for each tank from 1" (25mm) thick teak or a synthetic material like StarBoard but make a cardboard pattern first. Start with a rectangle about 2" (50mm) inches wider and 3" (76mm) longer than the diameter of the tank base. Fit one of the short ends flush against the bulkhead; the other end is rounded to follow a half-circle that is 2" larger than the diameter of the tank base.

Install the platform securely against the back of the wheelhouse. First, attach a length of angle aluminum to the bulkhead. Screw the back of this L-shaped bracket to the bulkhead a short distance above the cabin top, making certain that the bottom of the "L" is on a level horizontal plane. The wooden platform rests in this bracket and the tank stands atop the platform without tilting.

For additional support, shape a couple of short wood blocks as legs to fit under the platform. Also, with the platform thus raised, no water collects underneath it. Screw the wooden legs to the platform and screw the platform to the cabin top.

Tank Hardware

Place the tank in position. To prevent the tank base from sliding, attach three small wood blocks to the top of the platform, one at each side of the tank and one at the back. These wood pieces should be about 1/4" (6mm) thick and curved on one edge so the round tank base fits snugly against them.

To hold the tank in place, use stainless steel or aluminum strapping (or a stainless-steel ring buoy holder) bolted to the back of the wheelhouse. To ensure that the tank stands vertically, it may be necessary to add a spacer (another small wood block) between the tank and the bulkhead.

To guard against crewmembers accidentally grabbing the tank (or worse, a hose), add a grabrail or handhold. Bend stainless-steel tubing into an inverted L-shape that fits above and behind each tank on the outboard side. The tubing functions as the handhold but it could also hold tie-downs to further secure the tanks in heavy weather.

The top of the tubing attaches to the bulkhead via a welded-on plate while the bottom fits into a standard stanchion base, shimmed with an angled or arched wood block so the tubing stands vertically. Instead of using stainless tubing, boat owners with the tools and the ambition might prefer to laminate wood pieces with the proper curve.

On our boat, the "in-use" tank is on the starboard side. To complete the installation, a regulator with pressure gauge mounts on the bulkhead above the tank. A narrow wooden covering box protects the valve and hose. The stove flame is extinguished because the gas supply has been cut off at the tank; no gas can remain in the line that leads from tank to stove.

Each time a newly filled tank is reconnected to the system, the connection is checked with the traditional soapy water solution. [Ed: Instead, it's highly recommended to use a leak detector solution specially sold for this purpose to prevent corrosion of brass propane fittings.] The pressure gauge required in the system also serves as the leak detection device. Acrylic fabric covers provide UV protection for the tanks.

— David and Zora Aiken have been meandering by boat for more than 20 years and are authors of numerous books on boating, camping and travel. They live aboard "Atelier," a 35' (10.6m) 1963 Chris-Craft center-cockpit ketch currently berthed in Kilmarnock, Virginia.

Trailer Tongue Repair

Steps to fix a structural hole in a tilting trailer.

6

My brother's mid-70s tilting trailer developed a large rust hole at the latching point of the tilt tube. After agreeing to repair the damage, I checked with a local steel supplier to see if it had a steel tube that would work. This job required a tube 3" by 3/16" and 10'3" (76mm x 4mm x 3.1m) long, a coupling and various bolts, nuts and washers.

The photos on this next page explain this cheap and easy repair process. Total cost was US$120; total time was 4.25 hours.

The rust hole is large enough that it might snap the tube. The arm sticking out is the pivot release lock for this tilting trailer. In the six years my brother has owned the boat and trailer, he has never used this feature.

Close up of the rusted area with the tube tilted. The welded bolt on the back is the latch point. Before lowering the tube, remove the grounding wire at the front and pull the wire harness through.

Matching square tube purchased from a metal supermarket (US$96) and cut to length. The tube is coated with rust inhibiting silver paint to match the trailer.

No longer a tilting trailer, the new tube is through bolted to the old frame. Because I had to drill up through three steel plates, a jack held the drill. To drill, I laid on the Styrofoam insulation, rested my leg on the jack handle to keep a steady pressure and sprayed lube on the steel for easy drilling. The wood on top is to stop me from drilling into the boat, while drilling through the last layer of steel. Supporting the entire trailer on blocks gave me room to work underneath.

Rear mounting point of the new tube visible from underneath. I used the old mounting point but purchased a new nut, bolt and washers. The purple is course thread Loctite. The bolt end was later cut off using a cut off wheel on a 5" (127mm) die grinder.

New trailer ball coupling (US$14) replaces the original, which was worn out and welded into place, and is clamped in place prior to drilling. Wires are pulled through the tube prior to coupling installation.

Old chains were reused. When installing the grounding wire make sure you sand the area to get a good ground.

Old keel guide wheel reinstalled.

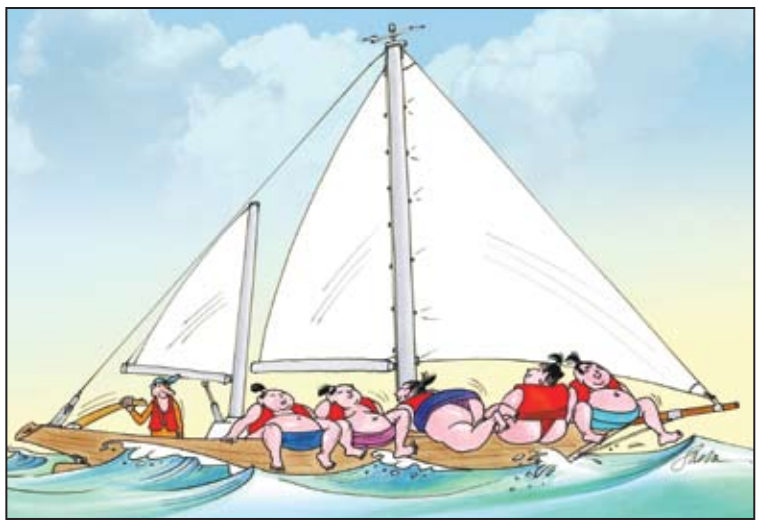
— A skilled DIYer and fiberglass expert by trade, Mark Yeates has rebuilt, redesigned and restored numerous boats and engines. His current boat project appeared in DIY 2002-#2 issue. A complete rebuild of his Yamaha Vmax 150 appears in an upcoming issue.

View from the Stern

How Long is Fast?

Waterline length means more than overall length when it comes to achieving speed on a displacement hull, such as a sailboat or trawler.

By Roger Marshall



According to an Englishman named Froude, who experimented with hull designs in 1896, the waterline length of a displacement hull is directly related to its speed. He towed planks of wood coated with things like paraffin wax, sandpaper and varnish through a trough of water he had built in his basement and developed a set of laws on which we base our entire theory of naval architecture today.

Today's computer programs produce amazing designs and technical data to project speed potential but Dr. Froude's theory still stands as sound and true. These laws determine, for one thing, how fast a sailboat can go. When the speed of a boat goes beyond the range of Froude's laws, for example, when it gets out of the displacement mode and on plane, an entirely different set of laws apply.

We won't get into the specifics but the short of it is that a longer waterline allows a boat to go faster and if you race, you want to sail the fastest boat you can.

What can you do, in an aftermarket way, to make your boat longer so that it will go faster? The simple answer is nothing. At least not on today's production sailboat designs. However, if you have a classic boat with long overhangs, you can sink the boat down in the water, immersing more of the ends. It has the potential, in the newly acquired waterline length, to go just a teensy bit faster.

That deeper immersion to create a longer waterline required adding weight so your next problem is deciding how to make the boat a little heavier. Here's a tip: the best movable ballast is people. Ergo, take your largest friends sailing and your boat will sail faster! That means, instead of bringing along your three best racing buddies, assemble the biggest crew of Sumo wrestlers that you can find. Theoretically, the weight of the Sumo crew sinks the boat down in the water and makes it faster. That is, of course, as long as the wind blows hard enough to move the mass. If it's light, you're out of luck.

Let's suppose you have a vertically ended racing boat with a plumb bow and a straight transom. What can you do to make it go faster? Well, these boats go fastest when they are light. That's why they are built of carbon fiber and other super-expensive, exotic materials. So, you need a racing savvy, svelte and lithesome crew. Keep in mind that the most svelte people around are professional models and such a crew would be a real winner, with the winning not limited to the racecourse.

Most sailboats don't get on plane but powerboats do so relatively easily with propulsion that enables them to operate beyond the range of Froude's laws. The rate at which they get on plane is known as a "hole shot." An article in a boating magazine boasts that the Doodah 23 has a hole shot of 4.7 seconds. This is rather like drag racing, which measures the speed of a car in a standing quarter mile.

Once a boat gets beyond the hole shot and on plane, it goes really fast. On plane, a boat is actually floating on the dynamic lift created by the force of the water against the hull. This force is governed by the planing area and the speed at which the boat is moving. The boat's waterline length no longer matters as a factor in speed, hence the crew can be anything you want it to be. In fact, most of the boat is out of the water with just the props, rudders and part of the back end of the hull submerged. At this speed, these appendages are the sole cause of all the resistance. According to the latest in towing tank information and computerized fluid dynamics (CFD), the appendages on a powerboat can account for up to 70% of the total resistance. If we could get rid of them, the boat would go a whole lot faster. CFD calculations are accurate but they require the power of a supercomputer to calculate the reactions of a boat in waves and in high-speed conditions.

Which brings us to the point of this story. Waterline length is important if you are going slowly, such as on a sailboat. It's not important when you are going at very high speeds on plane.

About the author: Roger Marshall is a boat designer and author of 12 books on sailing and yacht design.

PORT ENGINE PRIMARY RECOMMENDATIONS

1. Safety Item: Engines are not equipped with start in gear protection. Serious vessel damage or injury could occur if the vessel is accidentally started in gear. Provide start in gear protection.

2. Propeller shaft packing leaks in a steady stream and access to shaft log is very restricted. Shaft vibration was noted and shaft was difficult to turn during haulout.
   A. Clean and repack shaft log using Teflon packing.
   B. Check and adjust engine alignment as required.
   C. Sea trial vessel and verify that no shaft leaks or vibration is present.

3. Exhaust elbows have carbon build up (especially outboard). Tighten, repair or replace components as required.

4. Engine Alarm System Lower Station:
   A. Engine water temperature alarm indicator light is inoperative. Repair or replace components as required.
   B. Temperature switch on inboard exhaust elbow has been broken off and wiring has been twisted together. Remove broken fasteners and replace temperature switch. Connect wiring and test all engine alarm circuit functions.

5. Engine mechanical water temperature gauge with capillary tube has been broken off. Replace gauge assembly.

6. Seacock access is severely restricted. Service seacock and provide extension handle to assist in closing the seacock in an emergency.

7. Marine gear has oil leak at sending unit. Reseal or replace components as required.

8. Marine gear needs corrosion clean up especially around the out put flange. Clean corrosion using care not to damage output seal.

9. Air Sep elements need to be cleaned and replace missing retaining springs. When these elements are worn attempt to use original equipment elements that are properly sized for the lids.

A visual inspection of the #1 and #2 cylinders of the inboard bank revealed very good liner crosshatching evident. Ring wear indicators were visible and rings were free. Very light start up smoke was noted and the smoke cleared quickly.

No borescope or compression tests were requested or performed.

MAINTENANCE ITEMS:

A. Change engine oil and oil filters.
B. Drain and flush cooling system. Refill with Detroit Power Cool and distilled water.
C. Change marine gear oil and replace filter or clean screen.
D. Replace pencil zincs.

OPTIONAL IMPROVEMENT:

- Replace secondary canister type fuel filter with spin on unit.

STARBOARD ENGINE PRIMARY RECOMMENDATIONS

1. Safety Item: Engines are not equipped with start in gear protection. Serious vessel damage or injury could occur if the vessel is accidentally started in gear. Provide start in gear protection.

2. Propeller shaft packing leaks in a steady stream and access to shaft log is very restricted. Shaft vibration was noted and shaft was difficult to turn during haulout.
   A. Clean and repack shaft log using Teflon packing.
   B. Check and adjust engine alignment as required.
   C. Sea trial vessel and verify that no shaft leaks or vibration is present.

3. Exhaust elbows have carbon build up (especially outboard). Tighten, repair or replace components as required.

4. Inboard fiberglass muffler inlet pipe to the muffler is fractured and leaking seawater. Make necessary repairs or replace components as required.

5. Oil leaks were noted in the following areas:
   A. Outboard valve cover due to wiring being routed under the valve cover gasket.
   B. Inboard turbocharger; remove insulating blankets and tighten or reseal components as required.
   C. Governor housing oil leak. Reseal or replace.
   D. Oil leak around gear type fuel pump. Repair or replace as required.

6. Wiring harness split tubing is melted where it contacts the inboard turbocharger. Inspect wiring, replace split tubing and properly support so harness does not rest on the turbocharger.

7. Exhaust blankets for the outboard exhaust pipe and turbocharger are deteriorated. Replace exhaust blankets.

8. Salt deposits were noted at the forward end of the aft intercooler. Service, test and repair intercoolers as required.

9. Seacock access is severely restricted. Service seacock and provide extension handle to assist in closing the seacock in an emergency.

10. Marine gear case is heavily corroded. Extensive clean up and preservation will be required. Use CRC Corrosion Inhibitor or LPS III to help preserve the lower housing of the marine gear after cleaning.

11. Hydraulic pump for the NIAD stabilizer system on the Starboard engine has had the V-belt removed for a long period of time (pulley is rusty). In the event of single engine operation (loss of the Port engine) having this hydraulic pump connected would still allow your stabilizers to function.
    A. Clean corrosion on pulley.
    B. Install V-belt.
    C. Have a stabilizer qualified technician check system operation.

12. Starboard Engine Freshwater Cooling System:
    A. Drain and flush cooling system. Refill with Detroit Power-Cool coolant and distilled water.
    B. Replace defective header tank cap.
    Have a qualified mechanic inspect all engine cooling system hoses and clamps. Replace all worn components.

13. Air Sep elements need to be cleaned and replace missing retaining springs. When these elements are worn attempt to use original equipment elements that are properly sized for the lids.

14. Temperature sending unit wiring to the outboard water manifold is too short causing wiring to become disconnected. Re-route or extend wiring as required.

15. Fuel valve handles at the secondary fuel filter are loose and vibrating. One handle appears to be stripped. Tighten or replace fuel valves as required.

16. Marine gear needs corrosion clean up especially around the out put flange. Clean corrosion using care not to damage output seal.

A visual inspection of the #1 and #2 cylinders of the inboard bank revealed visible liner crosshatching. Cylinders in this engine were worn and in very good condition for an engine with 1400 hours since reported major overhaul. Ring wear indicators were visible and rings were free. Very light start up smoke was noted and smoke cleared quickly.

No borescope or compression tests were requested or performed.

MAINTENANCE ITEMS:

A. Change engine oil and oil filters.
B. Drain and flush cooling system. Refill with Detroit Power Cool and distilled water.
C. Change marine gear oil and replace filter or clean screen.
D. Replace pencil zincs.

OPTIONAL IMPROVEMENT:

- Replace secondary canister type fuel filter with spin on unit.

#1 PORT GENERATOR PRIMARY RECOMMENDATIONS

1. Exhaust elbow has rust blisters. Replace exhaust elbow.

2. Control box lid is not fastened and rattles. Install and tighten lid.

3. Oil leak noted from seawater pump mounting gasket. Replace gasket and reseal; check for leaks.

4. Overlfow tube to filler cap neck has a broken solder joint and tube is in drip pan. Repair or replace filler neck assembly.

5. Replace defective header tank cap.

6. Replace soundshield fasteners and consider making generator access more functional.

7. Replace heat exchanger pencil zinc.

No borescope or compression tests were requested or performed.

MAINTENANCE ITEMS:

A. Exhaust manifold on this unit is saltwater cooled and appears to be original. Have a qualified mechanic remove and inspect manifold. This manifold is a primary cause of engine failure due to saltwater intrusion.
B. Change oil and oil filter.
C. Clean water trap and change primary and secondary fuel filters.
D. Adjust valve lash.
E. Replace seawater pump impeller.
F. Check generator end bearing; replace if worn.
G. Replace any fuel hoses that are not U.S.C.G. approved Type A-1 or armored hoses.

#2 GENERATOR PRIMARY RECOMMENDATIONS

1. Exhaust hose is double clamped at exhaust elbow but only one clamp is securing the hose to the exhaust nipple. Reposition and install the hose far enough on the exhaust nipple so that both clamps are on the clamping surface.

2. Oil leaks were noted in the following areas:
   A. Seawater pump mounting gasket.
   B. Timing gear access plate on the timing cover.
   C. Valve cover gasket.
   Replace gaskets, run unit and check for oil leaks.

3. Injection line clamp is loose. Tighten clamp.

4. The Donaldson air filter is missing the lid. Provide new lid or replace the housing.

5. The exhaust hose from the muffler outlet to the through hull discharge is kinked. Replace exhaust hose using marine grade wire insert exhaust hose and double clamp all connections.

6. Control box lid is not fastened and rattles. Install and tighten lid.

8. Replace soundshield fasteners and consider making generator access more functional.

9. Replace heat exchanger pencil zinc.

No borescope or compression tests were requested or performed.

MAINTENANCE ITEMS:

A. Exhaust manifold on this unit is saltwater cooled and appears to be original. Have a qualified mechanic remove and inspect manifold. This manifold is a primary cause of engine failure due to saltwater intrusion.
B. Change oil and oil filter.
C. Clean water trap and change primary and secondary fuel filters.
D. Adjust valve lash.
E. Replace seawater pump impeller.
F. Check generator end bearing; replace if worn.
G. Replace any fuel hoses that are not U.S.C.G. approved Type A-1 or armored hoses.

VESSEL GENERAL

1. High bilge water levels have caused electric motors, water heater and some wiring to be submerged and corroded. Have a qualified marine electrician inspect all A.C., D.C. and bonding system wiring. Make sure that all electrical components are in serviceable, working order and that no galvanic corrosion issues exist. Test, inspect, repair or replace components as required. This repair work is especially important on 32VDC electrical systems.

2. Thruster batteries tested to be marginal and thruster battery charger may have a blown fuse or require repair.
   A. Replace thruster batteries.
   B. Test and repair or replace battery charger as required.

3. Engine Glendinning engine synchronizer is inoperative. Have a Glendinning dealer make needed inspection and repairs.

4. Emergency bilge pump requires removal, service and impeller replacement. After Repairs or replacement, install and prove operation. Pump should be exercised Every 3 months with fresh water. Replace pump discharge hose.

5. Unused copper fuel line is kinked off behind the Starboard engines marine gear. This was possibly a fuel feed or return line for the Starboard generator. Inspect both Port and Starboard fuel systems and make sure that all unused fuel system lines and hoses are properly removed or capped off.

6. The Starboard engine muffler hold-down strap fastener is pulled out of mounting base. Mounting base of muffler is deteriorated and loose. Evaluate and determine whether muffler platform can be repaired or requires replacement.

7. Only one 32-Volt battery bank has been replaced. 32-Volt electrical system batteries should have all batteries (both banks) replaced at the same time. Clean and protect all terminal connections.

8. Fuel is dark and contains sediment. Be prepared for frequent fuel filter changes. Drain Racor sediment bowls daily if required. Carry an ample supply of spare primary and secondary fuel filters. Treat fuel with Bio-Bor fuel treatment and keep fuel tanks full when possible.

9. White PVC air conditioning raw water manifold should be modified or replaced (see hull surveyor's report).

10. Port and Starboard main engine raw water strainers should be disassembled and cleaned. Assemble with new gasket.

11. Sumps below the Port and Starboard marine gears are full of debris, old hoses and rust. Clean compartment and provide white oil zorb pads.

12. 8D gel cell battery outboard of the Starboard engine needs terminal clean up and protection. After cleaning coat with Corrosion Block Inhibitor.

13. An unidentified seawater strainer forward of the Starboard engine is dirty and requires disassembly and cleaning. Disassemble and clean seawater strainer. Assemble with new gasket kit.

Routine Maintenance & Checks

DAILY CHECKS

1. Coolant level
2. Oil level
3. Transmission oil level
4. Seawater strainers
5. Visual check of propeller and rudder shaft packings for leaks
6. Check Racor sediment bowl and drain if needed

MONTHLY CHECKS

1. Check all belts for condition and tension
2. Clean seawater strainers
3. Work seacocks
4. Check all bilge pump float switches and alarm systems
5. Check air filter element

EVERY 90 DAYS

1. Check all zincs anodes
2. Coat all surfaces that may corrode with Boeshield T-9

EVERY 6 MONTHS OR 100 HOURS (whichever occurs first)

1. Change engine oil and oil filters
2. Change primary fuel filter elements and if fouled, also change secondary elements
3. Change transmission fluid

ANNUALLY

1. Change coolant
2. Change seawater impeller

EVERY 1000 HOURS OR FOLLOWING MANUFACTURER'S RECOMMENDATIONS

1. Adjust valve clearance
2. Test injectors

Discher's Best Value Evaluation Matrix							
	Manufacture						
Considerations	Raymarine	Garmin	Furuno	Lowrance			
Components Available:							
GPS							
Radar							
VHF							
Sounder							
Autopilot							
Satellite TV							
NEMA 0183							
NEMA 2000							
Factory Warranty Coverage							
Extended Warranty:							
Coverage							
Cost							
Overall Dimensions & Footprint							
Web site::							
Ease of use							
Quality of information							
Manuals available on line							
FAQ's helpful and extensive							
Bulletin board or blog available							
Technical assistance via email							
Responsiveness of Tech email							
Toll free customer service							
Toll free technical assistance							

CONTENTS