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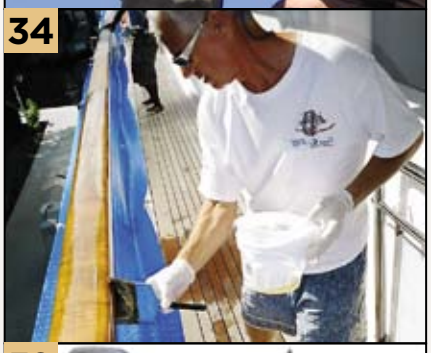

Currents

Edited by Jan Mundy

Alternate Anchor Light

Great idea to make your own LED anchor light as detailed in "Be Seen at Night," DIY Projects, 2005-#3 issue, but rating it a 9? How about a 13 for the electrically challenged? Does anybody make an off-the-shelf unit? I like the idea but electrical work and me don't get along.
Lee Kirwan, Eden, Maryland

DIY replies: *Davis offers the Mega-Light, a self-contained two LED light with Fresnel lens that uses .11 amps of power and has a photocell that automatically switches the light on at dusk and off at dawn. It's available at most marine chandleries or log on to www.davisnet.com.*

Mark your Calendar

June 17th and 18th, 2006, is the next Summer Sailstice, the sixth annual celebration of this international sailing holiday. Join thousands of sailors worldwide in a global celebration on the solstice weekend and the longest sailing days of the year. Sailors can sign up, find an event, create an event and find a boat to sail on or sailing crews at www.summersailstice.com. The 2006 sign-up begins in January and with it you'll be eligible to win prizes from the world's top sailing brands, including DIY. It's free, it's fun and it's anywhere you sail!

NMEA 2000 Info

Most electronics manufacturers are developing NMEA 2000 compliant products. If you're looking to upgrade your existing electronics and instruments, you'll find a current list of certified companies on the National Marine Electronics Association website at *http://www.nmea.org/about/news.cgi?article_id=177.*

Sunk on Land

Never leave the drain plug in the transom of a powerboat that is stored on a trailer as the boat will fill up with rainwater. (On the other hand, some of our readers in hurricane country know that an open, outboard powered boat filled with water and left on the trailer might just stay put during the storm. Before filling the "tub," remove batteries and other vulnerable electrical gear. When the storm passes, remove the plug, drain the water, reinsert the plug, reinstall batteries and go boating.) Before installing the Volvo trim tabs (see page 50 in this issue) on DIY's project boat, I first checked the moisture content of the transom to be sure it was sound. The meter pegged, which raised the alarm. Pulling the bilge drain plug solved the mystery. The bilge was full of water up to the cockpit floor.

Unhappy Prop Owner

We read with interest your article on "Sailing Without Brakes" in DIY 2005-#3 issue. When we bought our Corbin 39 in 1998, we decided to install a Martec three-blade, feathering prop and, after some headaches, it was installed (we dealt direct with the factory in California since there were no dealers nearby). We provided detailed engineering drawings of our shaft as requested, however they sent the wrong prop, which had a hub for a North American size installation; mine was a metric shaft with a different taper. To solve the

What Were They Thinking?

Not all innovative ideas on new boats make sense. Here's a look at some of the 2006 design gaffes.

Place a picnic table on this "crab deck" and you've got a party happening but the added overall length just increased your docking fees by another 5' (127cm) or so.

Why must manufacturers continue to produce beautifully varnished slippery-when-wet companionway stairs that are set up for a feet-first dive into the cabin?

Excellent idea to make use of the companionway steps for storage but you need very long arms to reach the bottom switches.

Beautifully finished hardwood floor for a house but an accident in waiting when (not if) it gets wet in this US$900,000 trawler's salon combo helm station.

Technical CD-ROM Library for Boat Owners

MRT Series

CDs contain articles from past issues of DIY Boat Owner Magazine

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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

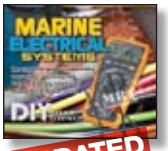
Plumbing 101

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.

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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

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problem, we then shipped the new prop and our old fixed three-blade one to Martec so the company could match the taper. The prop worked beautifully. On a trip down the Intracoastal Waterway to Florida, the revised propeller worked well until one day, two months later, when trying to leave an anchorage, we found ourselves without thrust. We discovered the prop was gone. Three days of diving was to no avail. Fortunately, we still had our fixed prop as a spare. We contacted the factory but were told that, since it had never happened before, the prop must have been installed incorrectly, albeit we'd followed the detailed instructions to the letter. The problem with the Martec prop at the time (we understand it has since been re-engineered) was in the way the prop fastened to the shaft. The prop consisted of three parts: the hub, the blade housing and the zinc cone. The hub fastened to the shaft with a single nut with the housing then bolted to it with four bolts. Because these two were closely mated, there was very little room for the nut inside and the end of the shaft was flush with the nut once tightened, allowing no room for a cotter pin to ensure the nut stayed on. Martec engineers solved this problem by changing to a locking nut but instead of having a 360° insert, as with most locknuts, it had two fiber cylinders in the nut at 180°. These two inserts were supposed to prevent the nut from backing off. What we didn't know was that, if you put the nut on more than once (e.g., for service) these inserts wear out. That's apparently what happened to our prop; the nut backed off and the prop fell off. We had many discussions with Martec but it insisted this never happened to its props. In the end, it cost us $3,000.

Bert de Vry, Ottawa, Ontario

No Diesel Fuel Swap

We're all looking for the silver bullet cure for high fuel costs. Diesel fueled engines and heating systems on boats can consume hundreds if not thousands of gallons of fuel every year. In many areas diesel fuel for "vehicle" use is heavily taxed but home heating oil is not so it's substantially cheaper. So the question is: Can you burn home heating oil without damaging marine engines? DIY asked two diesel experts and, naturally, received two different opinions. Bob Smith of American Diesel says: "By all means use the No. 2 heating oil but add some Marvel Mystery Oil for added lubricity. There is a problem with fuel quality, as some bulk heating fuel suppliers deliver nasty, dirty fuel, so obtain fuel from a top quality supplier." Daniel Mattos, a marine engine surveyor and diesel engine specialist, doesn't recommend the practice. "Heating oil standards are very loose as to quality and composition as some suppliers may even use a percentage of blended waste engine oil," suggests Daniel. "Before a boat owner uses home heating fuel in a marine engine he must invest in oil sampling and lubricity testing and be assured by the supplier that the fuel formulation and quality remain constant."

Unless your boat has two fuel tanks and one tank is dedicated to home heating oil use only, it appears that using such fuel is a risky proposition. Testing costs, possible engine fuel system component and engine damage do not offset potential fuel cost savings.

Circuit Differences

In the DIY project titled, "Be Seen at Night", in DIY 2005-#3 issue, the author writes in the circuit theory on page 52 that a series resistor is not required. I disagree. With solid-state junctions the forward voltage drop across the junction (Vf) is relatively constant with a low dynamic resis-

CORRECTION

We didn't mean to confuse our readers but in the article titled, "In the Zone," in DIY 2005-#3 issue, the author mentions an 8" (20cm) octahedral polar diagram as illustrated in Figure 2, which shows the polar plot for an 18" (45cm) octahedral reflector. The diagram is correct, the article should have read an 18" reflector rather than 8".

DIY boat owner the MARINE MAINTENANCE MAGAZINE

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Back to Boating's Roots

If you have ever dreamed of owning an antique wooden runabout or are looking for a boat-building project, take a look at the kit boats from James-Craft.

James-Craft 14' (4.2m) Zephyr.

From 1950 to '58, Chris-Craft of Algonac, Michigan, offered 13 models of do-it-yourself kit boats. Boat builder/repairer captain, Jim Shotwell, was keen on reintroducing the kits to get youth interested in antique boats and he spent the past two years researching and developing the old kit boats with the Antique and Classic Boat Society International (ACBSI), the curator of the Chris-Craft archives at the Mariners Museum in Newport, Rhode Island, the founder of the Chris-Craft Boat Club and others. He purchased the rights and produces and sells these boats under the James-Craft (a play on Chris-Craft) name (Tel: 800/554-2628; Web: www.jamescraftboats.com).

Seven original kits are offered: an 8' pram, three 12' (3.6m) and three 14' (4.2m) runabouts. Kits range in price from US$725 to US$2,450 and include MAS epoxy resin and hardener, fiberglass tape and cloth, assembled frames, transom and stem plus other wood and plywood components all precut to shape, all silicone bronze fasteners and hardware, screwdriver, instructions and decals. Each kit is easily assembled by a parent and child team with no boat building experience. Because they are exact replicas of the Chris-Craft kit boats of the 1950s, the ACBSI allows finished kit boats to enter reproduction competitions. Besides the kits, James-Craft offers the larger runabout in various stages of completion from US$7,550 to a completed boat with vintage outboard and trailer for US$13,950. Study packages cost $25, which is refunded with purchase of a kit.

James-Craft kit boat ready to ship.

Recently, James-Craft donated five kits to the ACBSI to be distributed to youth development programs. To quote Jim: "We deliver affordable fun from the 1950s." If you didn't get your boat kit in the '50s, it's not too late.

tance, therefore as the voltage rises above Vf the current rises almost uncontrolled. The zener will be ineffective as shown, actually it and R3 are not required. What's needed is a current limiting resistor, preferably in series with each leg of LEDs. Dick Smith Electronics website (www.dse.com.au) doesn't have a data sheet for the LED indicated but a similar LED had a maximum forward voltage drop of 3.4 volts. Three LEDs in series plus the .7 volts for the NE555 gives a total drop of about 10.9 volts. Using 13-volt supply as a safe number and the forward current of 20 milliamps, Ohms Law gives you a little over 100 ohms. The energy loss across this resistor is minimal.

Geoff Brown, Hamilton, Ontario

CURRENTS

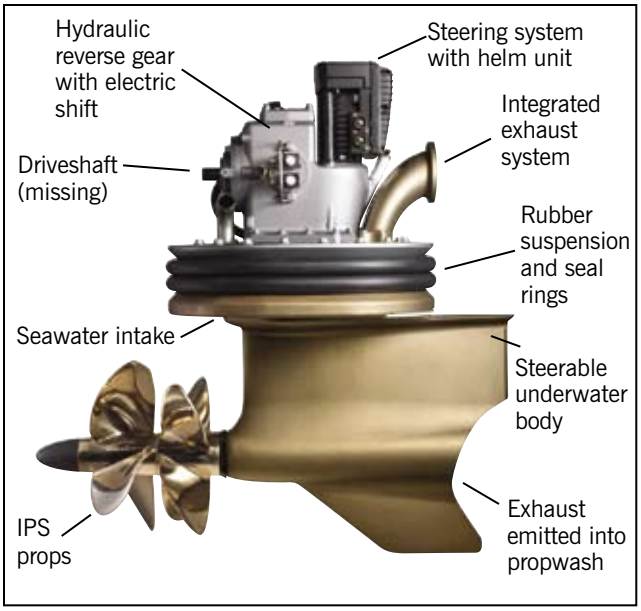
Have you ever wondered...?

It's amazing that two-stroke carbureted engines like lawn mowers, weed trimmers, cultivators, snow blowers, older outboard engines, etc., cold start every time after a few pulls (or cranks) but your $10,000, state-of-the-art EFI outboard engine takes forever to start. This is because these low-tech engines don't need to meet EPA emission standards, yet. To obtain a good cold start, such engines are massively over-fueled. New EFI outboards have to meet EPA emission standards, which dramatically reduce the allowable amount of unburned fuel emitted by the engine during a cold start using the cold start system, thus the hard start. An old tech solution for a new tech outboard problem is to pump the throttle handle, bypassing the cold start system and injecting raw fuel directly into the engine. Be aware that doing this can dump unburned fuel overboard creating pollution and the risk of a fine by law enforcement officers.

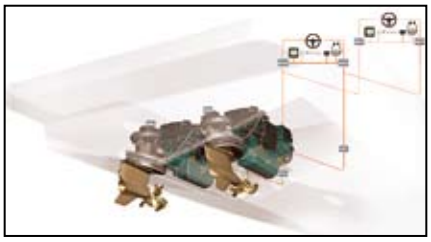
Fuel slick on water from unburned fuel dumped overboard from a carbureted V-6 outboard.

Harry Hungate replies: *Both schematics as shown are totally correct and exactly as I submitted them to DIY. I stand by the design, and it does indeed work, but that is not to say that others cannot improve on it. The zener diode and resistor R3 do protect the LEDs from over voltage (which leads to over current and failure). I tested this circuit and it works just as I intended. The circuit works as I have shown and there is testimony of other cruisers to affirm that. If LEDs with Vf of other than 4 volts DC are used, then the circuit and/or number of LEDs will have to be changed to compensate.*

A New Generation Propulsion System



The Volvo IPS (inboard performance system) drive probably represents the biggest single innovation in drive systems since the invention of the sterndrive. It's a complete helm-to-propeller propulsion package: engine, transmission, two steerable drive units, two counter-rotating propellers, gear box, integrated exhaust and seawater system, electronic steer-by-wire steering. There are no thru-hulls, mufflers, rudders, cutlass bearings or struts. Propellers face forward, similar to a prop on an airplane, and pull rather than push a boat forward to get a boat on plane exceptionally fast. Drive units are bolted to a thickly gasketed flat plate so all engine thrust is absorbed by the drive units and the hull. Fly-by-wire steering delivers fingertip control, like driving a car, that sends an electronic signal to the drives that are connected electronically and, in sync, immediately turn in the desired direction. This is a proportional steering system based on rpm so the drives turn more at slow speed but not as fast or as far at cruising speed.



With the IPS, Volvo has combined the efficiencies of a sterndrive in a V-6 inboard engine in a complete package from one manufacturer.

Published stats are impressive: up to 20% higher top speed, 15% faster acceleration, 30% better fuel economy, 50% lower sound noise, nearly instantaneous handling response at all speeds and in all directions, no thru-hulls, no exhaust smell or smoke, no shaft alignments or cable adjustments, no cavitation or prop slip, no noisy struts or rudders.

The obvious concern is the large unprotected drive units that protrude from the hull. What happens in a grounding situation? Apparently, if the boat hits something hard enough the units are designed to sheer off. There's no damage to the hull or drive train as with a traditional inboard or sterndrive installation.

(top) Volvo IPS is only available in a twin package; (bottom) Bolts spaced every 2" (5cm) hold the drive unit and are built to shear off in the event of grounding.

Boat show boats with twin Volvo IPS drives include the Beneteau Flyer 12 and Tiara 4000 Sovran. The sales guys who delivered the Flyer 12 with twin IPS 400 engines to the U.S. Powerboat Show had this to say: "With fingertip steering control, we didn't need the bow thruster to get into the show docks, the boat spins on its own axis." "It's so quiet you can stand on the aft deck with the cabin door open and have a conversation with the driver, all at full speed."

Cost for the Volvo IPS is comparable to a traditional inboard and the

savings is in the installation time, which is about half of the usual labor with no extras for added drive train components. Designed to only work as a twin-engine installation, the IPS is not a viable option for engine repowering as hulls must be custom built to accommodate the drive unit.

What about the learning curve to steer the IPS? I posed this question to Bill Pike, senior editor of *Power and Motoryacht* magazine who tested the IPS. His answer? "Because of the longitudinal centre of gravity in relation to the propeller, docking is a challenge. Before you get to the dock you need to decide whether you'll drive it like a sterndrive or drive it like an inboard."

WANTED

DIY reader Mike Matich is seeking an electronic logbook that works on a Sony Clie palm and that allows printing of pages for storage in a binder. He is aware of paper versions and Captn's Log software but is looking for other suggestions. Contact Mike at mmatich@shaw.ca.

L. Birke has a 12-year-old, 28' (8.5m) Bayliner with a large open cockpit and is looking to purchase a premade fiberglass cockpit module that includes a combined sink/fridge console. The boat's original fiberglass seat with an integral sink and cooler behind the seat was damaged beyond repair in a hurricane last season. If you know of any manufacturers (he's already checked with Bayliner without success), his email is the_nuts@netzero.net.

DIY READERS WIN BIG

The three winners of DIY's Product Information Card Giveaway from DIY 2005-#2 issue who received a Pela 2000 Oil Change Vacuum Pump, are: Sherwood Bugg, Jacksonville, Florida; Doug Lawrence, London, Ontario; and David Meyers, Kaysville, Utah.

When you need information from marine manufacturers, log onto DIY ONLINE at www.diyboat.com and click on "Information on Marine Products." This automatically enters you into this issue's draw of six 3M Marine Mildew Stain Remover.

Sacha

Wat'er Good Read

By Tracy Croll

The Hal Roth Seafaring Trilogy by Hal Roth

830 pages, Hardcover
(McGraw-Hill US$27.95, CDN$37.95)

Hal and Margaret Roth were early pioneers of shorthanded offshore cruising and their out-of-print books accounting their adventures onboard "Whisper" are now packaged into this trilogy. *Two on a Big Ocean* recounts their circumnavigation of the Pacific Ocean in the mid-60s as the first sailors to do so in a small sailboat. Departing from San Francisco, they follow the trade winds to the islands of the South Pacific, then point north to Japan and then east to the Aleutians, the Pacific Northwest and home. A few years later, these intrepid travelers answered the call of Cape Horn and, leaving from the West Coast, they circumnavigated South America, an epic trip as told in *Two Against Cape Horn*. In more than just cruising guides, Hal interweaves the history, customs and traditions of the myriad ports "Whisper" visits. In *The Longest Race*, Hal delivers a play-by-play sporting account of the first solo, non-stop race around the world in 1968. Complete with plenty of maps and captivating black and white photos, *Seafaring Trilogy* examines a different time in history. This is a compelling read that will be addictive for boaters and non-boaters alike.

How to Restore your Wooden Runabout Volume 1/How to Restore your Wooden Runabout: Volume 2 by Don Danenberg

240 pages/192 pages, Paperback
(Motorbooks, US$29.95, CDN$47.95/ US$29.95, CDN$39.95)

Danenberg's books are wonderful sources of information for the amateur restorer as well as a reference guide for professionals. He takes the amateur (through text and color photographs) from defining classifications for gasoline-powered boats and surveying/labeling traditional construction, to restoration methods from preparation and disassembly to steam bending wood, to bottom, topside and deck planking and on to varnishing. While Volume 1 focuses on the woodwork, Volume 2 covers finishing, hardware, plumbing and upholstery with plenty more in between. Learn by following his examples; these manuals can enable you to employ the craftsmanship to return your wooden runabout to its original or better construction.

Heart of Glass – Fiberglass Boats and the Men Who Made Them by Daniel Spurr

380 pages, Paperback
(McGraw-Hill, US$16.95 US, CDN$24.95)

One critic has called this book "a true masterpiece, a wonderful and exciting journey through the world of fiberglass from World War II to the present." This book documents a history of the materials and tools used to build these innovative boats as well as the people who brought fiberglass boats to life. Featuring black and white photographs, autobiographical accounts and company profiles, this history of fiberglass boats is an unprecedented publication telling a rich and colorful story of making affordable, faster, better boats of all shapes and sizes.

The Weekend Navigator by Bob Sweet

250 pages, Paperback
(McGraw-Hill, US$22.95, CDN$32.95)

GPS has made navigation easy and within hours you can learn enough to get out on the water but it's important that you also learn the techniques from a generation past to cover you in those inevitable times when electronics break down. This book can be considered both a quick start guide to navigation and a reference guide. While the early chapters quickly get you up to speed the later chapters provide guided steps to learn advanced techniques, using both GPS and traditional methods. Clearly presented through text and accompanying color maps, photographs and diagrams, the book also includes a MapTech Training CD so you can easily practice your new skills. Sweet, who holds a senior navigator rating with the Unites States Power Squadrons, has tailored the information specifically for boaters and boating uses. While the claim of the book to "learn to navigate in a weekend" might be a little over-optimistic, this still remains a valuable resource to ensure that, no matter how far you drift from home, you can always return.

Stapleton's Powerboat Bible by Sid Stapleton

440 pages, Paperback
(McGraw-Hill US$18.95, CDN$26.95)

This is a comprehensive guide to choosing and using a cruising powerboat whether you are a first-time buyer or an experienced yachtsperson. It aims to take the confusion out of the

bewildering sea of choices you are faced with when deciding on a boat that fits your lifestyle and usage, as well as covering the hundreds of accessories available to you when it comes to outfitting your comfortable home on the water. *Stapleton's Powerboat Bible* represents an accumulated wisdom that can only be discovered over a lifetime on the water. From helping you figure out whether you are being offered a fair deal on your purchase, to radio and GPS, to planning a cruise, weather and medical emergencies, this should be a handy reference book and will prepare you for the challenges and excitement of the cruising life.

Marine Amateur Radio by United States Power Squadrons

120 pages, Spiral bound paperback
(McGraw-Hill US$12.95US, CDN$16.95)

Marine Amateur Radio is the complete Power Squadrons guide to the use of ham radio for two-way and network communications among boats and between boats and shore stations. It has everything a boater needs to use ham radio aboard including: how to get a technician class or general class operator's license; how to select and install a transmitter and antenna; understanding maritime mobile nets; understanding and choosing ham frequency bands according to time of day, range, etc; how to learn Morse code for the general class license; and how to send and receive e-mail. The practical spiral bind is easy to use and the built-in flap on the cover makes for a handy bookmark. This is an accessible book that brings all the many bits and pieces of the topic together as a single resource for the recreational boater who wants to become a ham operator or an operator who wants to become a recreational boater.

Choosing a Cruising Sailboat by Roger Marshall

210 pages, Hardcover
(McGraw-Hill US$24.95, CDN$35.95)

Written by a naval architect and DIY contributor, this book takes the reader through five different sailboats to ensure you choose the one that features all the elements to accommodate comfort and seaworthiness that fit your cruising needs. The book begins by suggesting types of boats based on your current knowledge and experience and then, in clear language and 200 illustrations, leads you to a solid understanding of what your sailboat will and won't do and why. This book aims to ensure you're familiar with your boat from the masthead to the keel, including how much maintenance will be needed. Included is a 12-page comparison table of 130 production sailboats, packed with information for convenient and revealing comparisons. A must-read book for ensuring that you make the right choice for your sailing lifestyle.

Stitch-and-Glue Boatbuilding by Chris Kulczycki

240 pages, Paperback
(McGraw-Hill US$22.95, CDN$30.95)

While the esthetics of this book would benefit from color photographs instead of the black-and-white therein, that does not detract from the excellent information and step-by-step processes for creating a beautiful and seaworthy small boat with your own hands. It lays out the basic building techniques from cutting plywood panels to stitching and gluing to fiberglassing. As well as providing building plans, it also shows how to select tools and materials and how to paint, finish and outfit your boat. You certainly don't need to be an expert woodworker as you can learn most of the skills in a few hours. This definitive how-to manual is excellent reading for planning the perfect project whether it be a kayak, skiff, daysailor or rowboat.

Boatowner's Mechanical and Electrical Manual by Nigel Calder

800 pages, Hardcover
(McGraw-Hill US$49.95, CDN$66.95)

This updated edition of Calder's popular treatise on boat systems and maintenance contains 35% more pages than the previous version. Similar in structure to the previous editions, there is considerably more detail, along with new sections on air-conditioning, bow thrusters, lighting and watermakers and references to ABYC and ISO boatbuilding standards. Detailed illustrations and black and white photos found in this book have created a renowned maintenance "bible" for boat owners and industry professionals.

Fast Powerboat Seamanship by Dag Pike

250 pages, Hardback
(McGraw-Hill US$29.95, CDN$43.95)

Fast Powerboat Seamanship really stresses the fact that, while fast powerboating is fun, to operate this type of boat you need specialized knowledge and skill. Through 11 chapters the author tells you how to handle your fast boat for maximum performance, pleasure and safety while avoiding that increasingly narrow line between success and failure, the latter of which can really spoil your day. As well as explaining design, hull performance, engines, propulsion and controls, it examines the sea itself and how it moves and how you can develop the skills to adapt to different sea and weather conditions using the controls and a range of driving techniques. Complete with tips, anecdotes and illustrations, the wisdom in this book will make you a better, safer driver.

Seaworthy Essential Lessons from BoatU.S.'s 20-year Case File of Things Gone Wrong by Robert A. Adriance

270 pages, Hardcover
(McGraw-Hill US$24.95, CDN$33.95)

There's nothing like learning from somebody else's mistakes. Literally hundreds of often vital pieces of information have been organized and placed between the covers of this book, ranging from statistical data to chronicles of the hundreds of things that happen to boaters who are unlucky, thoughtless, foolish and downright stupid. Having figuratively experienced the real life disasters of other mariners, you'll be forewarned and forearmed to make sure you don't end up a sorry tale in a sequel. Accompanied with lots of black and white photographs, this is a book that is full of good advice that should be taken to heart but, as the foreword says, "don't be ashamed to find yourself enjoying it" as it also appeals to our voyeuristic appetites for the sensational and will have us simultaneously chuckling, cringing and horrified.

Talkback Q&A

Helpline info@diy-boat.com

Straight Oil Facts

Q: Can you please tell me why Mercruiser recommends only using straight weight oils and not using multi-viscosity oils?
Rod Christie, "Blue Fox,"
Port Dover, Ontario

A: Multi-grade automotive oils are not recommended for marine engines for three reasons: they are designed for low engine speed operation and tend to foam at prolonged high engine speeds; designed operation range goes from -40F (-40C) to approximately 100F (37C) and since marine engines don't operate in such cold temperatures they use thicker viscosity oil; finally, most automotive multi-grade oils have a shear point that is too low for the high load application of a marine engine. Shear point is the oil's ability to remain in place to lubricate critical engine components. An oil with a low shear point, for example, will be pushed out of the 0.003" space between the engine's connecting rod bearings and crankshaft. A marine-grade oil remains in place protecting and lubricating those components. In 15 years at Mercury Marine I have never seen a lubrication failure caused by using quality marine oil. I have, however, seen valve lifter and valve train failures from using automotive oil in a marine engine.
— *Steve Auger*

Gas Tank Mounting

Q: I have replaced my dual fuel (gas) tanks of approximately 95 gallons (359L) each. Measurements are 48"L by 31"H by 15"W. I also replaced the filler, new grounds, filler gaskets with staple ground, new filler chain and connected grounds on tanks to main ground on boat. Also, I replaced fuel level senders with Livorsi units because the tanks are greater than 24" (61cm) deep. I also added new Racor LG100 overflow prevention devices. So, this time, I'm trying to do it right. Supporting the tanks is the boat frame covered with fiberglass on each side of the boat. The tanks do not contact the sides, tops or ends. The only contact is the bottom. There is about 1" space from the back near the side of the boat but there is a slant to contend with. The old tanks were removed because of deterioration on the bottom. They originally had carpet on the bottom of the tanks and a galvanized metal strap to secure the tank. I removed the old hardware and carpet and cleaned up the mess and am now starting all over. What is the best method to secure the tanks at the base or bottom where they sit on fiberglass? Do I need carpet again? Will metal straps hold? If so, what type of straps and how many?
Richard Schultz, Stockton, California

A: Metal or wire straps work the best. One method is to attach heavy-duty stainless-steel pad eyes, bedding with 3M 5200 or thickened epoxy resin, to the frames on both sides of the tank. Make up four wire

Fuel tank hold-down made of stainless-steel wire with adjustable turnbuckles and anti-chafe material at bearing points.

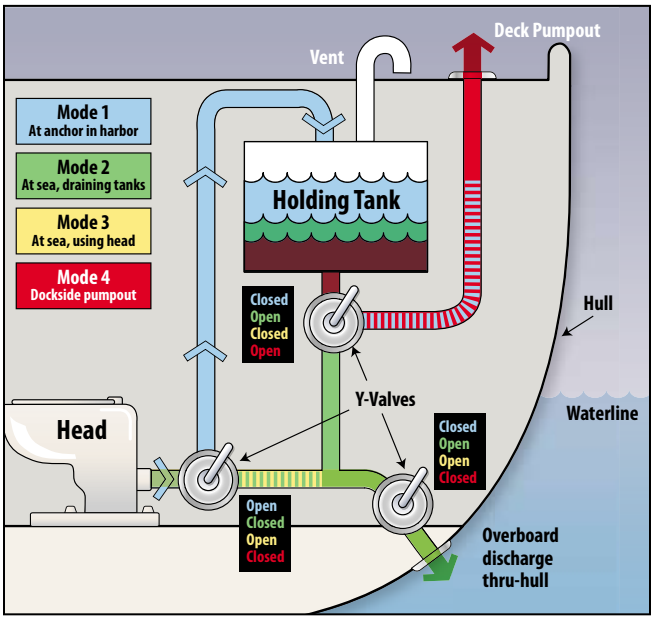
strops, two per tank, of 3/16" (4mm) stainless-steel wire attached to a turnbuckle (the kind used for lifelines or sailboat rigging) on one end and a loop secured with a Nicropress or swage on the other end. Attach the looped end via shackle to one pad eye. At the corners of the tank, so the wire doesn't chafe the metal, fold a square of 3/16" (4mm) anti-chafe material over the corner and under the wire. Attach the turnbuckle to the one pad eye and tighten the turnbuckle until you have the exact tension. Don't lay carpet under the tank as it absorbs water and advances corrosion. ABYC H-24 (Gasoline Fuel Systems) doesn't specifically prescribe any installation methods, it's specific about what not to do. ABYC H-24.10.6 reads as follows: "All non-integral tank supports, chocks, or hangers shall be separated from metallic tank surfaces by a non-metallic, non-moisture absorbent and non-abrasive material suitable for the purpose (e.g., neoprene, Teflon, and high density plastics) permanently bonded to the tank surface with impermeable, non-hydroscopic adhesive. Polyurethane adhesive/sealant, such as 3M 5200, or equivalent will accomplish this. 24.10.7 says: "Metallic fuel tanks installed above flat surfaces shall be separated from the surfaces by at least 1/4 inch (6.35 mm) air space when filled with fuel, and the flat mounting surface shall be self-draining." The key to doing it right here is to use materials that are not moisture absorbent or abrasive on, around, under or between anything that will touch a metal tank's surfaces.
— *Jan Mundy*

Expelling Sewage By Gravity

Q: I was onboard a Jeaneau recently and was informed that the boat had a gravity holding tank system (no need for a macerator). The owner was very happy with this simple system, as there was little to go wrong. I am

looking at retrofitting a holding tank and similar system onboard my 32' (9.7m) sailboat. I have a locker in my head compartment in which I could fit a small tank. I think that I can achieve the appropriate heights to have the tank empty via gravity and also to pump up to the tank via the head outlet. Essentially, the system I'm proposing uses the tank for either a straight through discharge via an open thru-hull and when I need to contain the sewage in the holding tank I just close the thru-hull. The tank could then be either pumped out later via a deck outlet or by opening the valve and discharging via the thru-hull when in open water or a discharge zone. I plan to fit a hand pump between the discharge of the tank and the present thru-hull rather than rely on gravity alone.
Barry Hodgkin, North Sanich, British Columbia

A: Holding tanks that empty by simply opening a valve and allowing them to drain out to the sea are popular on European boats but rarely seen in North America where our regulations generally don't allow discharge of sewage inside the 3-mile limit and not at all in inland waters. I was impressed by the simplicity of the gravity drain system while cruising in the Grenadines on a friend's Halberg Rassy. Turning a diverter valve (Y-valve) on the head discharge line would switch it from either straight overboard or up to the holding tank. A small stainless-steel tank (about 7.9gal/30L) was at eye level tucked up under the deck behind a cupboard door. On the bottom of the tank an outlet hose and ball type shutoff valve was within easy reach. The tank also had the usual deck pump out fitting for occasional dockside use but, instead of having a separate pumpout fitting connected to the tank, the pumpout line was simply teed off the holding tank drain prior to the overboard drain valve. Of course, the tank also had a conventional vent. When at anchor in a crowded bay, it was customary to divert all sewage to the tank. (Hopefully, everyone else in the anchorage was doing the same.) After leaving the anchorage for open water, the drain valve and seacock could be opened and the



Joe VanVeenen

Gravity drain plumbing schematics and valve positions in various modes.

Talkback Q&A

Helpline info@diy-boat.com

tank quickly drained overboard (where legal). Underway in the open sea, the head discharge diverter valve was then switched back to straight overboard discharge and the holding tank not used until the next anchorage. Your design sounds simple enough and should work. My only concern of your gravity drained holding tank is a build-up of unmacerated solids that may eventually clog the outlet unless you install an oversized drain hose (1-1/2"/38mm ID) and outlet. The Halberg Rassy toilet was equipped with a noisy but effective electric macerator using a 1" (25mm) ID discharge hose and drain. With the addition of a manual pump, the design of your system is getting close to the well-proven "Florida" system. In fact, with a manual pump teed into the pumpout line you could go with a larger tank mounted anywhere in the boat. Of course, the primary advantage of the gravity drain concept is zero effort. No laborious pumping required. Any good quality manual diaphragm bilge pump also handles sewage. The Henderson pump that comes with the Lavac head, various Whale Gusher models or the Jabsco 45820-0000 all have high tolerance to waste solids to get the job done.
— Nick Bailey

Direct Drain

Q: Any reason I can't adapt a Whale Gulper electric pump to my manual toilet? I plan on building my own fiberglass holding tank with only one electric pump from the toilet and a straight, free-flow outlet to dump at open sea without a pump.
Steve Camp, "Argo," Greece

A: According to the techies at Whale, there is no reason why you cannot use the Gulper Toilet pump (BP2552B) and adapt it to a current manual toilet. Whale doesn't know of any customers that have done this as, typically, it drains from the holding tank rather than your setup, which is draining direct from the toilet.
— Jan Mundy

Throttle Check-up

Q: I have a 1999 Bayliner 2452 CD with a Mercruiser Alpha 5.0L engine, and the Quicksilver Commander 3000 classic throttle control is sticking. Can it be lubed or do I need to replace the cable?
William Snyder, Petaluma, California

A: Remove the cables from the engine and see if there is less effort required to throttle and shift. If it feels the same as when connected you may need new remote control cables. Remove the cables from the control box and if shifting is still stiff you'll need to replace the remote control. The commander 3000 has been redesigned and now called the 4000 series, a much more robust system. If the remote control requires replacement I would advise moving up to the 4000 series.
— Steve Auger

Diesel Fuel Storage

Q: What do you recommend for over wintering diesel fuel for my Mercruiser 1.7DL diesel and Alpha drive.
Adolfo J de Bold, "Miss Cecilia," Manotick, Ontario

A: According to DIY's diesel specialist, Bob Smith, the only product recommended to add to diesel fuel that is stored for extended periods is a fungicide (i.e. Biobor) and Marvel Mystery Oil. No fuel stabilizer is needed.

Smoking Black

Q: One of my boat's 220 hp Perkins engines emits noticeable black smoke but doesn't burn any oil. This engine was rebuilt 500 hours ago.
Larry Kilbride, Seattle, Washington

A: Helping you find the cause for black smoke on just a few facts is a tough job but I will offer a few suggestions. Since the engine is one of a pair and was recently rebuilt does point to a couple of possibilities. If the engine has smoked ever since the rebuild, it's possible that the injection pump timing was set incorrectly or that the injectors were serviced to the wrong specifica-

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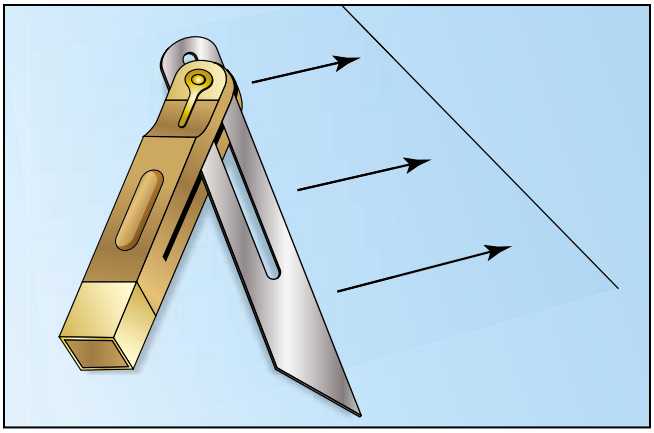
tion. Normally, both the injectors and injection pump are rebuilt during an engine rebuild. Describing the smoke as shade of blue and worse, when first starting the engine, suggests that the rings have not yet seated. Sometimes, running a rebuilt engine at full power rather than babying it causes the rings not to seal. Another possibility is that the follow up service work of torquing the head and adjusting the valves has not yet been done. For that matter, tight valves cause engines to make black smoke. That smoke is showing you the product of incomplete combustion. Low compression, poor fuel delivery, timing of delivery and a demand for more power than possible (overload) are all possible causes. Knowing the maximum rpm at wide open throttle for both engines is a good test of power output.
— Bob Smith

Installing Rod Holders

Q: We plan on installing flush mount angled rod holders on the gunwale of our Bayliner 242. I presume that I use a hole saw to drill a hole approximately the size of the traced bottom of the holder, then treat hole edges with epoxy, apply some 3M 5200 around the flange of the holder, etc. I'm wondering mainly about drilling the hole, as we are nervous about drilling into our new boat and would like to get it right the first time. Because the rod holders are angled, do I need to drill at an angle, or do I just drill straight down and then adjust the hole with a grinder or jigsaw? The material we are drilling through is probably a thin layer of fiberglass without any core.
Dana DeHart, "Acute Angler," Ballentine, South Carolina

A: Your procedure is correct but use 3M 4200, just in case you need to remove the holder in the future. Ideally, you should drill through the deck at an angle. Drilling vertically means you'll have to enlarge the hole with a file or grinder and it could be as much as 1/2" (12mm) thick, especially if the deck is cored. To drill at an angle, first take a bevel measurement of the angle using the rod holder and then hold the bevel up against the drill and cut your hole. You could also transfer the bevel to a thin piece of plywood or even cardboard, cut out the shape and hold it against



Joe VanVeenen

Use a bevel gauge to duplicate the angle of the rod holders when drilling through the deck.

the drill. This reduces the amount of reshaping of the hole. You might need to predrill a small pilot hole to prevent bit chatter. You won't need to coat the hole with epoxy resin unless it's plywood cored (Balsa and foam cores require potting the core to prevent water migrating into the core.) Use plenty of sealant and don't torque down the fasteners too much or you'll squeeze out too much sealant. Best to have a 1/32" (2mm) or so bond line.
— Jan Mundy

Cold Starting Engine

Q: I purchased a 2003 Yamaha F-60, four-stroke outboard new in 2003. While the engine runs perfectly once started, it is very hard cold starting in cool weather. The dealer I bought the motor from gave me a number of different starting procedures, none of which seem to work well. A local dealer told me that some Yamaha's are just hard starting and it would be a waste of my money to have a mechanic look at it. The procedure that seems to work best is to turn the key to on (not start), advance the throttle lever five or six times and turn to start. If this procedure is followed three to five times the engine starts and once idling, runs perfectly. I like the engine in all other respects but find this problem a nuisance, especially when the launch ramp area is busy. My engine manual does not address cold starting procedures. My two previous four-stroke engines (Honda) started immediately.
Al Hunter, "Thumper," Wiarton, Ontario

A: After checking with two different Yamaha outboard dealers I'm afraid that the hard starting issue you are experiencing is common to Yamaha four-stroke carbureted outboards. Both dealers advised to pump the throttle three to five times prior to attempting to start the engine when cold. The engine is equipped with a cold start enrichment system that should provide extra fuel during cold start up but it appears that this system is not up to the task. Each time you pump the throttle handle the accelerator pumps are dumping the required raw fuel into the intake. The only fix offered was to move up to an EFI model. Not all news is good news.
— Steve Auger

Lead Boosts Older Engines

Q: The former owner of my 1974 Grew 245 with a 188 hp Ford V-8 recommended that a lead substitute be added to the fuel on a regular basis to maintain valve seats. Can you recommend a product for this purpose and where I might purchase it?
Cam Burns, "Benchmark," Kingston, Ontario

A: Inboard and sterndrive four-cycle engines produced before 1986 were designed to be run on leaded marine fuel. In the new millennium, the fuel supplied to run your boat is unleaded automotive fuel that is up to 10% alcohol and full of additives to meet EPA standards (emissions). This modern fuel can cause valve train problems, including sticking valves and valve seat recession that dramatically reduces the engine performance on engines built prior to 1986. Using lead substitute (also known as valve lubricant) on older engines helps these components live longer. Most modern 4.3L and 3.0L inboard and sterndrive engines also benefit from adding lead substitute as they do not have hardened exhaust valve seat inserts equipped on 5.0L and larger engines. Look for Formula Lead Substitute at automotive suppliers. A 15 oz. (450ml) bottle treats up to 198 gallons (750L) of fuel.
— Steve Auger

Painting Aluminum

Q: I'm looking for a brushable vinyl paint to apply to the aluminum end caps of my 1977 Ericson 35II.
Dudley Hattaway, "Hideaway," Pt. Richmond, California

A: According to Jim Seidel of Interlux Paints, painting aluminum is all about preparation. Aluminum oxidizes nearly instantly and aluminum oxide is very hard (that's why it's used as sandpaper abrasive). The system that Interlux recommends is to first degrease using Special Thinner 216, and then sand with medium grit emery cloth. Immediately after sanding, remove the sanding residue and apply one coat of Viny-Lux Primewash 353/354 that has been thinned 25% with Viny-Lux thinner 355. Viny-Lux Primewash is an etching primer that uses an acid, some vinyl resin and zinc chromate to etch the metal and provide some anti-corrosion protection. Overcoat Viny-Lux Primewash within 24 hours with either a primer or finish

coat. Though Interlux no longer makes a vinyl paint, many of these have changed over to water-based formulae that can be applied over the Viny-Lux Primewash.

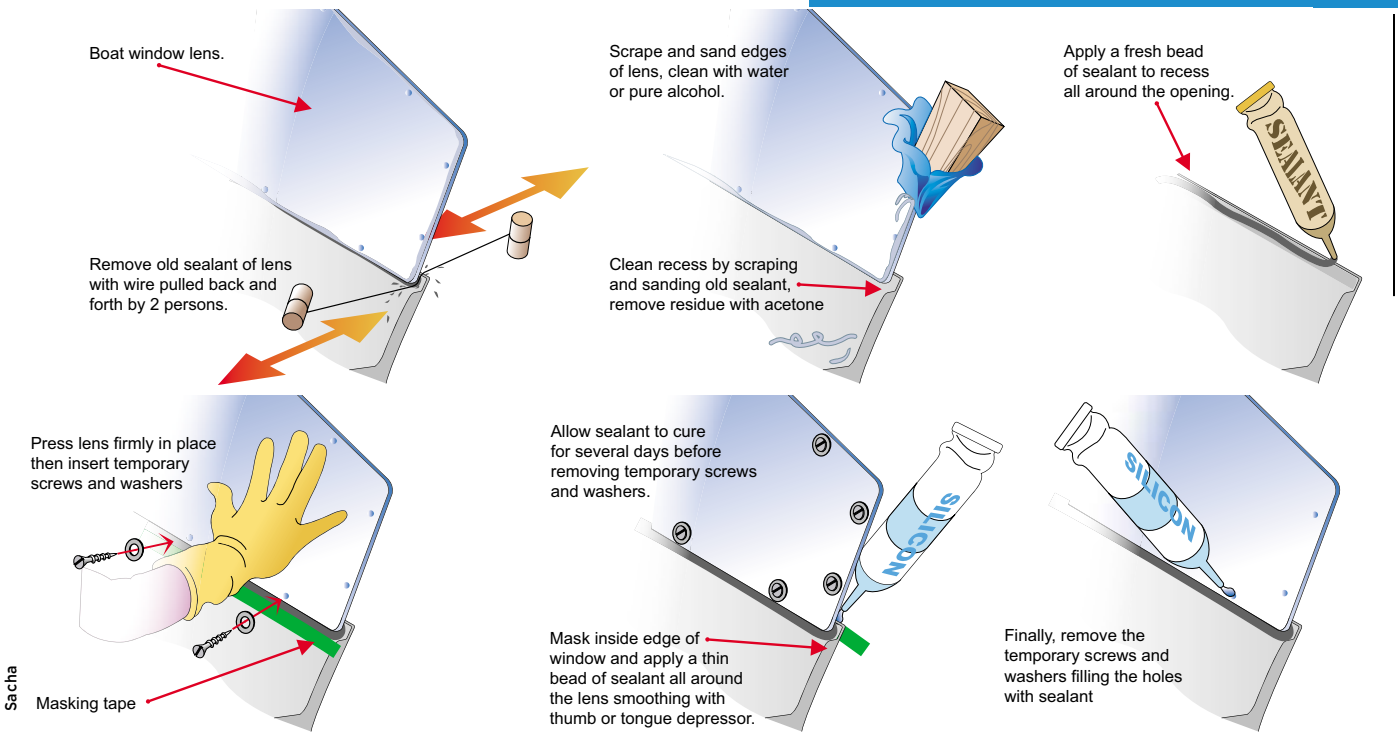
Recaulking Cabin Windows

Q: I'm hoping you can assist me with resetting one of the cabin windows on our 2003 Hunter 326 sailboat. The aft edge of the window has come loose from its adhesive bed and caused a leak into the salon. I've sealed it temporarily with some silicone caulk but want to pull the window and reseat it properly. The window is secured with a black adhesive that seems very similar to auto windshield adhesive. I don't see any screws, so it looks like the adhesive is the only means of attachment. There are holes in the Plexiglas window but they are filled with the adhesive, which is flush with the outer surface.

Loose and leaking is the long forward side window on a two-year-old Hunter.

Mike Damon, Newtonn, Connecticut

A: According to Ted Graham, the service manager at Angus Yachts, a busy Hunter dealership in Toronto, Ontario, the cabin windows in your Hunter are held in place and sealed with nothing more than Dow Corning #759, a high-performance glazing silicone. The holes that are now filled with sealant are left over from the temporary retaining screws used to clamp the window in place while the original sealant cured. Once curing has taken place, the glazing silicone is strong enough to hold the window without assistance from mechanical fasteners. The holes are touched-up later by filling them with silicone. You are correct in assuming that the window should be removed and remounted to properly reseal it. To cut the remaining sealant get a piece of strong wire about 3' or 4' (91cm or 122cm) long — a low E guitar string or piano wire works — and push one end through the perimeter sealant bead and into the cabin. Now, with one end of the wire inside and one outside, a team of two people can saw the wire back and forth to cut the sealant. Wrap and tie each end of the wire to a short length of sawed-off broom handle for a better grip. Once the window is out, cut, scrape and sand off all the old silicone from the window edge and the recess in the cabin trunk. Clean up the recess with acetone and the wedge of the acrylic window lens with a clean rag dampened with water or pure alcohol. Apply masking tape (e.g., 3M 233+ or Safe Release) around the edge of the window and the recess to simplify cleanup and to create a crisp sealant edge. Apply a continuous bead of sealant on the inner part of the recess where the lens contacts the cabin and carefully fit the window in place. Keep applying firm clamping pressure by hand and install new clamping screws with large washers into the existing holes (these fasteners were carefully selected ahead of time of course) The clamping screws are tightened gently a little at a time while alternating in a diagonal pattern back and forth (like tightening a wheel nut or an engine cylinder head). Do not over tighten since it's all too



Sacha

easy to crack acrylic. Once the window is securely fastened, fill the remainder of the gap around the perimeter of the window with sealant and smooth it out with a tongue depressor (or a thumb inside a rubber glove). Leave everything as undisturbed as possible, keep the boat in the shade, don't jump around on deck, etc. Once the sealant has dried on the surface, remove the masking tape but do not remove the clamping screws for several days. A week is safe at most temperatures. When the screws are removed, fill in leftover holes with sealant. — *Nick Bailey*

Neat Boating Stuff

Compiled by DIY's technical team.

The new bulkhead mounted wastewater tank from Vetus (tel: 410/712-0740, web: www.vetus.com) is a new product that complies with requirements for boat waste holding systems. Pre-installed connections that connect to an existing toilet pump make these tanks easy to install. Tanks are easily emptied via a gravity discharge without any pump. Tank mounts on an above-waterline bulkhead and comes in 16- or 22-gallon (60.5L or 83L) models with or without a level indicator. Tanks are made of thick-walled, black roto-molded plastic and are virtually odorless. ***Prices are US$318.50 and US$334.50 respectively.***

Space savers are Vetus bulkhead-mounted wastewater tanks.

Port Blind Kit (tel: 215/956-0957, web: www.portblindkit.com) is a unique and inexpensive way to solve your light and privacy concerns onboard and is simple to install. The kit includes durable non-woven polyester material in a variety of colors and patterns and with either vertical or horizontal pleats. The easily installed blind fits into portlight via an adhesive frame. The window opens and closes without moving the blind aside. Blinds open by either sliding across (vertical pleats) or pulling up by attached cords (horizontal pleats). The standard Port-Blind Kit fits most rectangular shaped portlights, even those with a raised-edge rim, with a lens up to 20" by 12" (50cm by 30cm), and retails for US$25 (vertical pleat version). Kits for hatches and larger, slanted or curved ports and windows are also available.

Do-it-yourself portlight and hatch blinds.

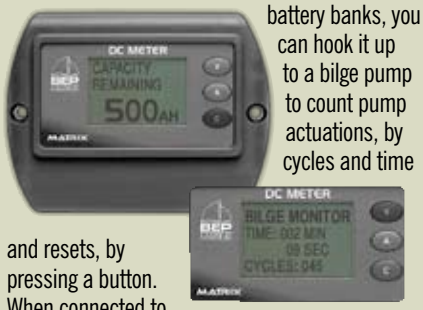
If you've ever lost a cowl overboard to a loose line gone wild, yanking it from the vent, then **Dorade Guards from Mariners Hardware (tel: 877/765-0880, web: www.marinershardware.com)** are for you. These cleverly designed guards are available to fit most boats and are designed for do-it-yourself installation. The "legs" fit into a 90° socket for flat decks or a unique ball socket that rotates to accommodate deck cambers up to an extreme 45°, thus reducing the need for a custom wedge. Because the guards are made of 1" (25mm) tubular 304 stainless steel with a 0.065 wall thickness they won't buckle under a clumsy foot and the "legs" are extra long so, once fitted over the vent and dorade box, they can be cut to the desired height with a cut-off grinder or rod hack-saw blade. Guards range in price from US$199 to US$257 plus US$20 for either the standard, ball or weldable socket, including a pre-drilled backing plate.

Dorade Guards keep vents onboard.

Ryobi Technologies produces affordable, portable, cordless and benchtop power tools for do-it-yourselfers. The One+ System works on the concept of a single rechargeable 18-volt battery connecting individually to 10 tools and accessories. The Ryobi Starter Kit Combo comes with drill-driver, circular saw, flashlight with a swivel head, two batteries and one-hour diagnostic charger in a heavy-duty hard plastic carrying case for just US$119. The powerful drill is well balanced and features two speeds, reverse, a bit storage area, a small tray to hold small fasteners, etc., and two levels to align drill bits during both horizontal and vertical drilling. The full-featured 5-1/2" (14cm) circular saw has a bevel adjustment setting up to 45° and a maximum cutting depth of 1-9/16" (4cm). You'll enjoy it's compact size and light weight and like the drill, it has a comfortable grip that doesn't transfer any vibration into the hand. Surprisingly, it's not a power hog; you can make many cuts before discharging the battery. Three additional combo kits and individual power tools are available at home improvement stores.

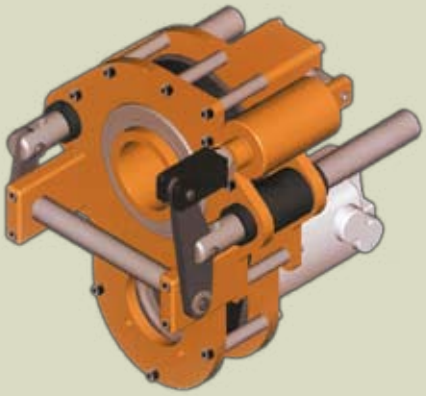
The Ryobi One+ System Starter Kit — one power source, many possibilities.

BEP Marine's (tel: 770/486-6770, web: www.bepmarine.com) Matrix DC Meter watches up to three battery banks and it monitors more than just batteries. With two battery banks, you can hook it up to a bilge pump to count pump actuations, by cycles and time and resets, by pressing a button. When connected to one battery bank, the house bank, for example, this device monitors battery voltage as well as amp functions: amp hours, charging and discharging amps, amp-hour capacity remaining by percentage or you can monitor three bilge pumps and no batteries. DOT matrix display (same as cell phones) gives a clearer readout with more information than a conventional LCD display.



DC Meter monitors more than just batteries.

It's a great "fuel" gauge for system monitoring and troubleshooting.



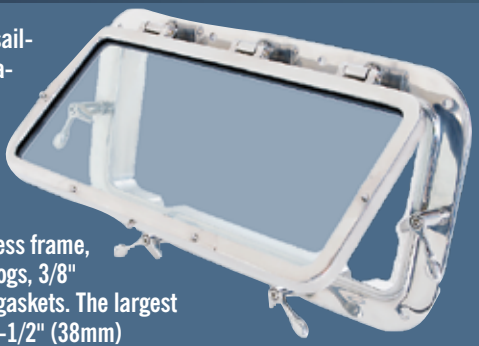
Submitted for IBEX Innovation Awards 2005, this is a "get-home" rig that works. **BEI's Bayview Auxiliary Tug** (US$8,500 without bracket mount) **or BAT (web: bayviewedisonindustries.com, tel: 888/466-4164)** for short is powered by a boat's generator or propulsion engine, mounts directly to the transmission case and can support the propeller shaft in radial as well as thrust dynamics. Should the main engine or its transmission fail, just engage the 35-hp BAT with a lever or an optional push button at the helm station to control speed and direction. Another option allows controlling speed using the main engine throttles.

Cuddy cruisers can now enjoy cool comfort away from dockside power. **Dometic's (tel: 954/973-2477, web: www.marineair.com) Cuddy Cool air-conditioner** (US$1,799) is a compact, lightweight, self-contained 3,500 BTU system designed for boats without an onboard genset. Powered by a boat's 12-volt power supply, either a 120-volt inverter or deep-cycle batteries, the system draws about 30 amps DC under normal conditions. Supplied with an AC compressor, blower and DC pump, it's designed to cool small outboard or sterndrive-powered cruisers. Measuring just 8" deep by 9-1/4" high by 15" long (20cm by 23cm by 38cm) and weighing 29 lb (13kg), it fits easily beneath a vee berth or storage area below deck.

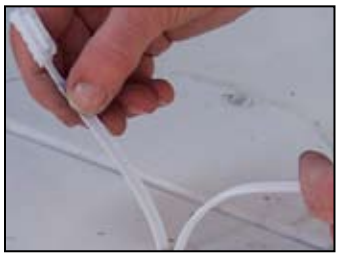
3M Marine's Marine Mildew Stain Remover (tel: 877/366-2746, www.3M.com/marine) is a must-have for every boat owner. It's a fast acting chlorine bleach-based, spray-and-wipe formula that works in conjunction with the 3M Marine Mildew Block. To use, spray the mildew stain, allowing the remover to penetrate the affected area and then wipe clean. Follow this with 3M Marine Mildew Block for long lasting protection. It works on vinyl seat backs and cushions, deck furniture, showers and ceramic walls and other surfaces, although users should first do a spot test. Both the Stain Remover and the Mildew Block are available in 16.9 fl oz (500ml) bottles at marine retailers. *[Ed: Request product information at www.diy-boat.com and enter to win a bottle of Mildew Block. Refer to the insert on page 41 for details.]*

Spend less time cleaning and more time boating with 3M mildew removal/prevention products.

For owners of Hunter, Cheoy Lee or Gulfstar sailboats, new large size opening portlights, measuring 8" by 18" (20cm by 46cm) and 7" by 26" (18cm by 66cm), are now available from **New Found Metals (tel: 888/437-5512, web: www. newfoundmetals.com).** Like all portlights in the company's line up, they feature a 316 high-polish stainless frame, built-in drains, fully adjustable hinges and dogs, 3/8" (10mm) tempered glass and EPDM long-life gaskets. The largest portlight is available in either the standard 1-1/2" (38mm) spigot length (US$525.95) or extended 2" (50mm) spigot length (US$545.95).



Replace old fixed windows with new, larger, opening portlights.



How do you mount pedestal seat bases, davits, ladders on swim platforms, cockpit tables, stanchions and pulpits, flag holders and other gear when you don't have access to attach a nut on a thru-bolt? **Weaver Industries (tel: 800/367-4062, web: www.weaverindustries.com)** has solved this problem with the patented Toggler. A similar concept to drywall anchor bolts, these bolt anchors fit a 1/4"-20 screw bolt. Just drill a 1/2" (12mm) hole, slide the stainless-steel channel through the hole, hold the plastic straps, ratchet downward on the plastic cap (this takes a lot of force as cap slides on the ribbed plastic straps) until flush with the deck or platform. Snap off straps level with the cap and then insert a bolt and tighten. DIY's editor used these incredibly strong Togglers to mount pedestal seat bases on DIY's project boat (refer to DIY 2004-#2 for details). These work on 3/8" (10mm) to 5/8" (15mm) thick surfaces and need a 1-7/8" (47mm) minimum clearance behind to accept the Toggler.

Surface-mounting hardware is easy with Togglers.

New generation reefer.

The newest model in **Sea Frost's (603-868-5720, www.seafrost.com)** line of 12 and 24-volt DC marine refrigeration and freezer systems offers 33% more compressor capacity than its popular BD. The BDxp offers the option of air or water cooling, custom-sized cold plates and tube lengths and, when coupled to two stainless-steel direct evaporator plates, it creates a perfect deep freeze in any well-insulated icebox with up to 8 cubic feet (.74 cubic meters) of volume.

Tech TIPS

Edited by Jan Mundy

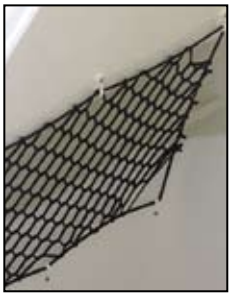
Two Holes in One: When you need to enlarge a hole for a thru-hull,

take a holesaw drill with a deep mandrel and slide a holesaw of the new hole diameter onto the mandrel then insert a holesaw that matches the diameter of the existing hole and tighten the assembly. As the smaller holesaw fits the previous drilled hole it acts as a guide when drilling the new hole.
Will Heyer, Annapolis, Maryland

Who's in Charge: In case you need to know, as commander of a boat at sea, you have absolute command of that boat and the legal powers to use force to suppress piracy and mutiny, if necessary.

Bilge Treatment: Algae, fungi or even moss-like growths thrive in the habitat of a boat's bilge. To eradicate these nasty beasties, treat the bilge with a zinc compound in addition to benzyl ammonium chloride to create a broad spectrum killer of bilge growths Follow with a detergent-type bilge cleaner to get rid of the dead organic debris. As a long-term solution to prevent reoccurrence, regularly apply a biological product to the bilge, such as Capt. Phab One Shot Treatment.

Hanging Storage: Nylon nets, available from automotive suppliers,



can be strung up with shock cord to make it easy to handily stow needed but often-elusive gear.

Best Furling Line: If you have a line drive furling system and the furling line often jams on the drum, replace with polyester yacht braid that has had the core removed so it lays flat like webbing.
Nick Bailey, Toronto, Ontario

Single Point Drain: Since most outboard engine cooling water is self-draining, the best position for long-term storage of these engines is in the "down" (running) position with the drive vertical.

Clean and Fast: A clean propeller is more efficient as the flow of water over the prop is smooth and unimpeded. If engine rpm drops suddenly, the culprit could be a foul prop.

Pet Peeves: One of this editor's beefs is the slippery finish on the companionway steps on many boats.

Though you can apply some non-skid paint or stick on non-skid adhesive strips, one of the surest remedies is to glue down a synthetic anti-slip material, such as Treadmaster or Vetus Non-Slip Deck Covering.

Sleep Comfort: Turn your hard and uncomfortable foam berth

cushions into a feather bed with the purchase of a feather or synthetic mattress topper.

Cheap Pilot Lights: If you need to replace a burned out instrument panel indicator light, Radio Shack sells 12-volt LED red or green lights that draw 15 milliamps and fit into a 9/32" (7mm) hole for about $4 (part number is 276-270). Crimp an extra 12" (30cm) of wire on each lead, then heat-shrink the joint. Cut to length when installing.
Doug Booth, Kingston, Ontario

Reserve Lighting: A solar garden light makes a good spare anchor light. Simply fasten the fixture to the rigging with a wire tie or you can use it as a spare cabin night light after its day in the sun.
Robert Thomas, "My Fair Lady," Port Dover, Ontario

Handy Knife: Things can go awry on a sailboat, especially when the wind gusts and having a knife safety stowed by the companionway makes it easy for the

crew to take action when needed instead of waiting for the skipper who is fiddling with his belt-carried knife as he tries to hold a course.

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
P.O. Box 22473
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Reader tips are not tested by DIY, but we won't publish anything we feel might harm you or your boat.

Three Ways NOT to Save Money In Your Boat's Engine Room

Every marina has at least one "expert" who claims the reason manufacturers put the word "marine" in front of a product is so they can charge twice as much. While this may be true for deck chairs and pillows, there can be significant differences between the parts used in an automobile and the *almost*-identical marine parts used on a boat.

Unlike automobiles, which have engines that are open to the road below, boats have enclosed bilges that will trap spilled gasoline. Even a half-cup of gasoline can blow up a boat if a spark is provided. A recent study by BoatU.S. Marine Insurance found that 8% of boat fires were started by leaking fuel. Most skippers are aware that engine parts like starters and alternators on a boat must be ignition protected, (required by the U.S. Coast Guard), which means they won't spark. This protection may cost a little more but is absolutely essential in a closed compartment.

The same is true of marine-grade engine hoses. The Coast Guard-approved J 1527 hose is less permeable to odors than comparable automobile hoses and the Type-A will withstand a 2-1/2-minute burn test.

While less well known, the list below includes three other marine parts that should never be compromised:

1. Removing the Anti-Siphon Device

When a new fuel tank was installed in the 26-foot boat shown above, somebody didn't bother to re-install an anti-siphon device in the fuel line between the top of the gasoline tank and the carburetor. Automobiles don't have anti-siphon devices but they're required by the Coast Guard on a boat whenever the gasoline tank is installed higher than the carburetor.

In this case, the mechanic probably didn't think it was very important because anti-siphon devices don't make a boat go any faster and, besides, if they aren't the correct size, they cause stalling problems.

Sometime later, the carburetor's float bowl valve jammed slightly. Since the fuel tank was above the carburetor, gasoline leaked freely onto the top of the engine. Something ignited the fumes and —

If your mechanic tells you anti-siphon devices are a nuisance, show him this picture. The boat was destroyed because gasoline leaked down onto the engine and started a fire.

ker-BOOM! — the boat was destroyed. Luckily, everyone escaped without serious injury.

Stalled engines are annoying, to be sure, but a gasoline engine that lacks anti-siphon protection is dangerous. Since the anti-siphon device prevents gasoline from spilling into the bilge, skippers who remove it are unwittingly increasing the chances of a severe fire or explosion. The removal of the anti-siphon device is also a violation of federal regulations.

Steven Walesh, the president of a company that manufacturers anti-siphon devices, said that fuel flow problems are typically caused by devices that are not calibrated to a specific installation. The result is over-protection, which causes the fuel system to have more resistance built into it than the engine can handle. Finding an anti-siphon device with the correct calibration for your engine's fuel system requires a mechanic with some savvy or, lacking that, the problem should be referred back to the boat manufacturer via the boat dealer. Other solutions include the installation of a larger diameter fuel hose and a larger diameter anti-siphon device, a mechanical shut off, or an electric stop valve.

2. Installing Truck Fuel Filters

A small engine room fire can also escalate quickly if the wrong fuel filter was installed. Racor, a company that makes quality marine diesel fuel filters, also makes truck filters, which are like the marine filters in every way, save one. The marine filters are built of fire-resistant materials, which have passed an Underwriter Laboratories (UL) 2-1/2-minute burn test. That means the marine filter gives you at least 2-1/2 invaluable minutes to put out a fire before the filter melts and starts spewing fuel onto the flames. With a truck filter, a small engine fire can get ugly much sooner. For the record, West Marine and BoatU.S. only sell Racor's marine fuel filters.

3. Adding Inexpensive Soundproofing Insulation

The final example of what can happen when you improvise in an engine room has to do with engine insulation. BoatU.S. member Cliff Steele was boating on Lake Michigan recently when clouds of black smoke began billowing out of a hatch of a friend's boat, a beautifully restored 1957 Chris Craft ("the queen of the marina").

Steele says he spent three or four terrifying minutes helping his friend extinguish the fire, which was caused by a short at the generator. The wires themselves had barely burned but the heat scorched the thick foam soundproofing insulation, which caused the aforementioned clouds of noxious smoke.

With the exception of maybe a few raving gearheads, nobody likes a lot of engine noise on a boat. But soundproofing ability isn't the only thing to consider when you're adding or replacing insulation around your engine. Engines are hot and can throw off flammable vapors that are absorbed by porous foam.

According to the National Fire Protection Association 302 standard for recreational boats, material used for sound insulation should be fire retarding and designed and installed so that it won't absorb hydrocarbon vapors. If there's one thing worse than foam that burns readily, it's foam that burns readily and is soaked with explosive vapors.

— By Bob Adriance

Based on the BoatU.S. Marine Insurance damage-avoidance publication, Seaworthy, *is now a book published by International Marine/McGraw Hill. Called the "ultimate guide to preventing, responding to, and surviving accidents," it's available at Amazon.com and in most bookstores.*

PRO SERIES

Rebuild Versus **Replacement**

Regardless of TLC carried out over the years on the engine, sooner or later there comes a time when "the old lump" is so worn, corroded and unreliable that it requires a complete rebuild or replacement.

A modern small diesel

By Nick Bailey

"It's a great old boat in good condition, a classic in fact. Too bad the engine is such an old clunker." I hear this all the time from boat owners, prospective buyers, brokers and surveyors. This rarely comes as a surprise when so many of the boats we know and love are still being propelled by their original machinery, engines long out of what was state-of-the-art decades ago.

"The Old Lump."

Deciding whether to remove and rebuild the old auxiliary or replace with a shiny new one can be a tough call. It's basically a cost versus value question and a professional yard looks carefully at the boat to determine what costs are involved with either option.

A rebuild is always less expensive but a new engine, with all new accessories (transmission, alternator, water pump, etc.) will be inherently more reliable than a rebuilt one. A new engine, particularly if changing from gas to diesel, increases the boat's value, bringing improved safety and fuel efficiency while "new" extends the operational life expectancy . The accepted rule of thumb for determining the economic sense of a rebuild comes down to this principle: The cost of a rebuild of 40% to 50% of the cost of the new engine is not worth doing.

A well-executed repower always adds value to the boat but it's unrealistic to expect the higher resale to offset the entire cost. This is especially true if you are repowering a small sailboat originally equipped with a gas inboard under 15 hp. Cheap gas inboard auxiliaries were popular with boat builders during the '70s but not with the service staff coping with them years later. Even the smallest of today's diesel engines are technologically far superior in every way to those old budget gas auxiliaries. They are also far more expensive and the cost of repowering a small sailboat can often equal or exceed the market value of the boat. The only less expensive gas engine repower option for smaller boats today is bolting an outboard on the transom. Regardless of the boat size, the daunting economics of a repower job mean that it should only be undertaken if you plan to keep the boat, not sell it.

Repower Options

Among the major players in the North American small diesel auxiliary market are Beta Marine, Universal, Vetus, Volvo, Westerbeke and Yanmar. Other engines you'll see include, to a lesser extent, Nannidiesel, Perkins, Bukh and Lombardini.

Diesel auxiliaries range from just under 10 hp with a price tag around US$5,000 to upwards of 100 hp, at which point they start to qualify as main engines for powerboats. Various transmission options are available with different output angles and reduction ratios typically ranging from 1.5 to 3:1, along with V-drives. If a more radical repower approach is called for Volvo and Yanmar (as well as some of the lesser known European makes) also offer saildrives. Manufacturer package price the options and accessories, including the transmission and connecting components, shaft coupler, flex mounts, exhaust mixing elbow and engine instrument panel.

Prices are competitive among the makes and all engines are high quality, long lasting pieces of marinized

DIY MECHANIC

Doing service procedures yourself can save money and time and discover problems before they result in major engine damage or failures. Articles written by marine mechanics and previously published in DIY Boat Owner Magazine will guide you in servicing your engine to a step-by-step approach with clearly detailed photos and illustrations.

machinery. It's important to choose an engine for which there is good service support and parts availability in your area. Many service yards are authorized dealers for more than one manufacturer and should be able to give you a detailed quote showing different engine options. There is a fair amount of preliminary measurement work and research just to get to the quote stage, keeping in mind the installed cost of a new diesel can be two to three times the cost of the engine package itself and it becomes a can of worms when tanks, engine bearers, fuel and exhaust systems have to be addressed to match a new engine. A fairly simple repower may take less than 40 man hours but it's not unusual to see labor costs running over 100 hours if the new engine is a different configuration than the old as is often the case with gas-to-diesel conversions (see below).

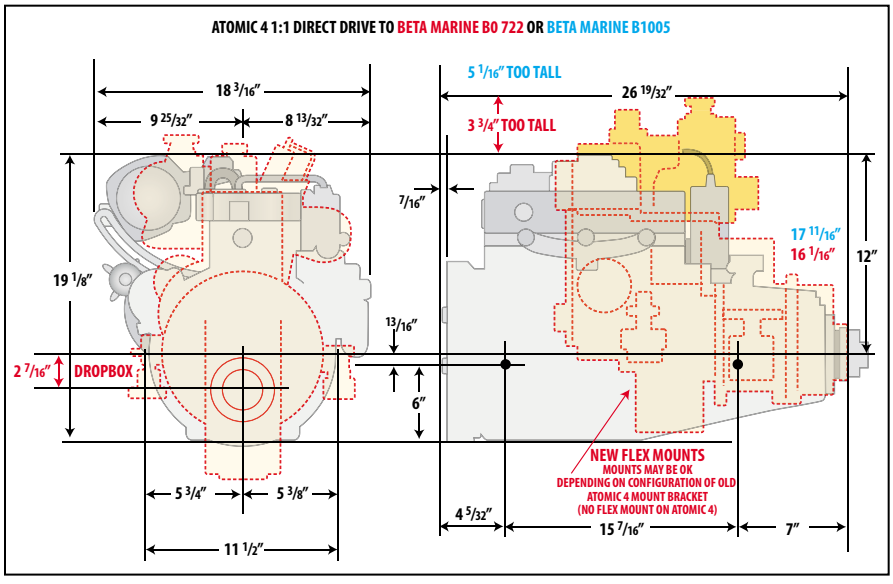
Product Influences

The yard's repower recommendation should take into account the following factors: horsepower, physical layout and compatibility.

How much horsepower is enough? Generally speaking 10 hp per 5,000 lb (2,268kg) of displacement is considered adequate for most sailboats. Except for a Macgregor with a 50-hp outboard, sailboats are displacement craft. Extra power does not make a displacement boat move significantly faster than the speed of its own wake, a limit determined by waterline length and referred to as hull speed. Extra power helps maintain hull speed against adverse headwinds and sea conditions so, a boat intended for passage making needs more reserve power than a day cruiser. It's useful to know the rated horsepower and rpm of the old engine to make a comparison but, because of its better torque characteristics, a diesel outperforms a gas engine of the same nominal power rating.

The boat's existing physical layout is also part of the prescription for the replacement engine. The service points, such as the oil fill, dipstick and filter, seawater pump, fuel system bleed points, etc., on the new engine must be located to provide convenient access for servicing.

Compatibility is the most important engine selection factor affecting the complexity and the cost of an installation. The goal is to find an engine that has the footprint and dimensions that suit your existing engine compartment, bearers and running gear. Most yards start by comparing the critical dimensions of the new engine candidate with the old unit. This can be done quickly by tracing the relative positions of the motor mounts to the output flange and the outer extremities of one motor onto a scaled drawing of the other. The next step is to chose an engine and transmission option. This may require some changes to the



Joe VanVeenen

Overlaid drawings at the same scale help to determine if the new engine fits in the same location as the old.

• TIP •

Quick Fit Homemade Jig

Jig made of flat bar, 1" by 1/8" (25mm by 3mm), clamped to a pipe with one end threaded to the transmission coupling can make quick work of an engine installation. Two pieces of flat bar are cut to length and spaced to equal the footprint of the engine mounts. Position of the aft crossbar matches the actual distance between the engine coupling and the aft engine-mounting hole. To use, mate the jig coupling to the corresponding prop shaft coupling, align and support the jig. Its position determines the height of the engine mounts off the floor and their athwartship position. Subtracting 25mm (1") from the height measurement gives enough play to allow a final alignment of the couplings using U-shaped shims available from auto parts stores.

— DIY reader Julian Hood, who in the process of restoring an O-Day 27, needed to fit new engine beds

existing running gear.

Gas-to-Diesel Issues

Some gas-to-diesel repower jobs are definitely simpler than others. To keep costs down, the ideal repower should be as simple as possible but will not likely be the true "drop-in" that the engine manufacturer's salesperson describes as a the perfect replacement for your old Atomic 4 with its direct drive (1:1) gear ratio. With many gas-to-diesel repowers, the limited propeller tip clearance, particularly if the old prop is a small 11" or 12" (28cm to 30cm) in diameter, makes it difficult to find the perfect engine/transmission configuration to work with the old running gear. [Ed: For more details on how the choice of transmission affects the entire engine installation, see DIY 2005-#2 "A Calculated Approach to Gear Ratios."] When the old prop size is too small major adjustments are sometimes required to gain the necessary clearance at the hull. Changes to the engine bearers and the running gear are required, relocating the shaft log at a new angle and installing a shaft of a different length and diameter. The modifications will require a new stuffing box, stern bearing and/or strut assembly. A full-keel boat may only require some surgery to enlarge the prop aperture or cramming a very special four-blade prop of a diameter that fits the aperture and still retains required blade tip clearance.

Problem: Not much room for a larger prop here. One Solution: Switch to a four-blade feathering prop to maximize the blade area that can fit in a restricted aperture.

In addition to these potential running gear complications, it is usually also necessary to upgrade the existing exhaust, water and fuel plumbing to meet the current ABYC standards. Unlike gas engines, the diesel upgrade will require fuel tank modifications to provide for a return line that carries the unburned fuel from the engine back to the tank.

Out with Old

After finalizing the replacement engine selection, the old engine is prepped for removal. This involves disconnecting the electrical connections, all the plumbing, shaft coupler, control cables and finally the engine mounts. Both positive and negative cables of the DC electrical supply are disconnected at the battery first. Only then is it safe to disconnect gasoline fuel lines. The fuel supply petcock is shut-off, the line disconnected and safely drained and plugged if necessary. If the boat is still in the water, close the cooling water intake seacock, remove the hose and cap the fitting. Plug and secure the exhaust hose well above the exhaust discharge port to prevent the possibility of siphoning. Don't use rags or other soft material to plug the hose (or the exhaust outlet) as this can slip back into the hose and cause trouble later. [Ed: A surveyor we know has handled several claims for boat sinkings that were caused by hoses "temporarily secured" during an engine repair or refit.] Uncoupling the shaft can be a problem on saltwater boats as fasteners on the shaft coupler are often so badly seized they must be ground or cut off.

It's difficult to remove this corroded coupler without cutting something.

It's easiest to remove the old plumbing after the old engine is out.

In most sailboats, the engine is located under the cockpit but there are a fair number that have them located in the main cabin under the dinette table or galley counter. The usual exit route is via the companionway although some boats are fortunate to have removable panels in the cockpit sole or even a large cabin hatch over the engine. The horizontal distance that the engine must travel to reach the chain hoist is always a challenge. There may be some small engines that one can manhandle off the bearers and carry to the hoist; an Atomic 4 that weighs over 300 lb (136kg) is not one of them. Removing the old engine without doing any damage to the rest of the boat requires that you protect the cabin sole by covering it with plywood and the joinery adjacent to the exit path should be armored with heavy cardboard or Masonite. In most cases, the engine is then jacked up onto wood blocking that serves as a skid pad and dragged into position using a come-along. It's often necessary to dismantle any cabinetry over top of the engine to provide easier access for the hoist. Alternatively, the chain-hoist is brought to the engine by hanging the hoist from the end of

The removable cockpit sole on this Contessa 26 allows easy access for repowering.

a forklift and maneuvering the fork through the companionway and into the cabin. Once the hoist is directly over the engine, it's simply a matter of hooking up the engine-lifting eye (or bolt on a chain bridle) and guiding it up and out.

Engine Compartment Prep

With the old engine out of the way, strip the compartment of old plumbing and antique equipment and then degrease, clean and repaint in preparation for installing the now obligatory drip pan. Now is the time to service or replace all that "stuff" that is hard to reach with the engine in place. This could include a new or modified fuel tank, properly sized waterlift muffler and exhaust thru-hull, new seacocks, new intake strainer, new fuel/water separating primary fuel filter and upgrading the engine compartment insulation. This is also the time to carry out any major "gross trim" work on the engine bearers that preliminary measurements indicate are necessary along with the first stage of any changes to the prop shaft angle and running gear. This sets the stage for dry fitting the engine and doing the "fine trim" work to precisely locate the new engine.

Engine compartment (left) before; (right) after.

Dry Fitting

It's now time for the painstaking procedure that tests the fit of the new engine. Detailed measurements are taken for the creation of the necessary shims, additional mounting brackets or any additional tweaking of the engine bearers required to achieve good alignment with the prop shaft. Any changes planned to the prop shaft angle should be considered now as the dry fit allows fixing the new shaft angle so the new shaft log and strut can be aligned and installed. Even if the existing prop shaft location and angle is good, it's routine to install a new shaft of a different length. The minimum labor required is to remove the shaft to "fit and face" a new coupler matched to the output flange of the new transmission.

Atomic 4 Engine Service

The lads from Atomic 4 Engine Service, Vancouver, British Columbia, demonstrate good form with the chain hoist as they guide a Vetus diesel engine to and through the companionway.

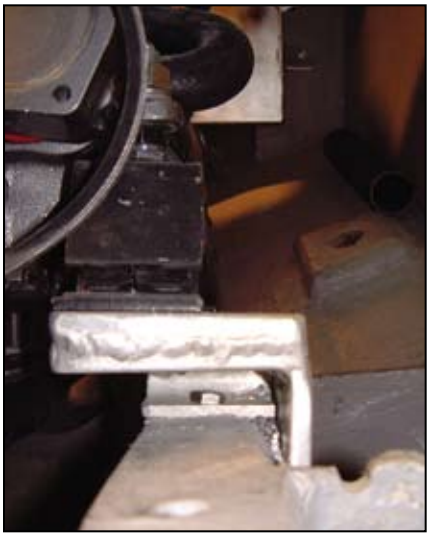
Sometimes it's difficult to hang the new engine in place for dimension checks and dry fitting. In this case, a lightweight

The engine is lowered into place for dry fitting. Any required compensating shims and adapter brackets are fabricated and fitted.

jig is made of wood or aluminum with all the exact same mounting locations and transmission coupler position as the new motor. Instead of the motor itself, this jig is lined up with the shaft coupler and used to determine the fit but eventually the motor must go in for final fitting. During the dry fit procedure, it's also important to ensure the motor mounts are in the center of their adjustment range. When you're ready for the final alignment, you'll be able to correct small errors occurring during the dry fit. To avoid alignment errors from sag at the coupler end of the prop shaft, it's normal to support the inboard end of the prop shaft just enough to relieve it of its own weight.

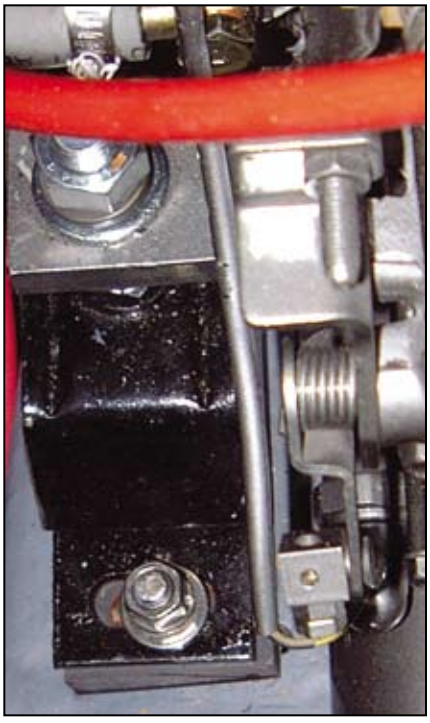
In With the New

Based on measurements taken during the dry-fit, any required compensating brackets or metal shims are fabricated, drilled, and lag (or thru) bolted onto the bearers and the engine is placed in its final position for fastening the mounts to shims and/or bearers. The engine flex mounts are now securely fastened to the bearers using lock washers or Nylok nuts to prevent the vibration from jiggling the fasteners loose. The engine is now aligned to the usual 0.004 inch or less variance at the mating face of the transmission and shaft couplers. If the boat is onshore or the rig is out, alignment must be adjusted again when the boat is launched and the mast is stepped and tuned.



Brackets, shims and motor mounts are bolted or lagged to the engine bearers.

Custom engine bracket fits over engine bearer.

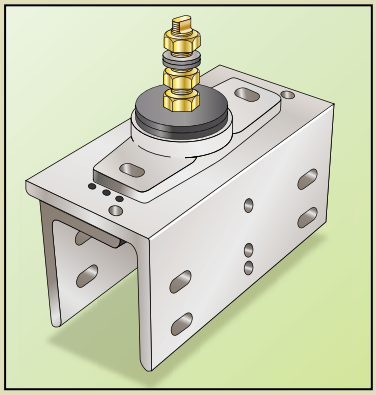


Lock washers are required on all mount bolts. Note also UHMW polyethylene shim under the black flex mount.

Next, connect the new wire reinforced water intake hose and exhaust hoses (SAE J2006 spec for exhaust hose as per ABYC), siphon break (if the engine is below the waterline), fuel supply and return hoses (USCG Type A). Use double hose clamps where the nipple length allows it. Connect the (usually new) DC wiring to the starter and from the alternator. At this time, replace the shift and throttle cables, especially if the old gas engine required a massive Morse/Teleflex 64 series shift cable. Modern transmissions are easy to shift and only require the smaller

• TIP •

Time Saver



Joe VanVeenen

IMG 8-Way Anchor Adjustable Engine Mounts (Tel: 888/586-4455, Web: www.imperialquality.com) let you precisely and securely mount an engine without the aggravation of modifying the engine stringers or bearers to fit engine mounts with absolute accuracy. Mount assemblies consist of an inboard or outboard mounted, L-shaped angle bracket, with or without slotted holes, bolt plate and backup plate plus optional gussets added to the bracket ends for extra support, spacers and crossover tubes to eliminate cutting stringers. Made of 1/4" (12mm) thick 6061 aluminum with a black or clear anodized finish or powder coating in seven colors, IMG offers several sizes of adjustable engine bearers. Prices vary depending on size; the popular three-piece 4" by 6" by 9.5" (10cm by 15cm by 24cm) bracket costs US$72.48.
— *Jan Mundy*

diameter 33 series. Some transmissions run equally well in either direction so it's important (in the interests of reducing dockside accidents) to be sure the shift lever is set up to actuate in the same direction as before. Mount the new instrument panel with its supplied electrical harness and engine stop cable.

Final alignment should achieve a clearance variance of no more than 0.004" between any two parts of the transmission and shaft coupler faces.

Finally, add oil and coolant to the dry engine and transmission, prime the fuel system and bleed of air and ready the engine for first start up. At this point, do-it-yourselfers should step aside and the start up should done by an authorized technician if that is required to honor the warranty. In any

Commissioning a used Yanmar 2GM for installation.

case, it's a good idea to decompress the engine (check your service manual for information; on some engines, it's simply a matter of raising the compression lever) and crank it long enough to ensure oil pressure is up and then crank the engine over with compression. Once the engine fires, verify water flow at the exhaust thru-hull and check all hose connections for leaks. Check the engine itself for oil, fuel, and coolant leaks and, if needed, top up the closed-coolant system with a 50/50 antifreeze-water mix and bleed of any trapped air.

Sea Trial

Once the engine installation has passed the start-up checks, it's time for a sea trial, including a brief full throttle test in flat water to verify the boat is correctly propped. During the full throttle test, the engine should achieve at least its rated rpm for continuous duty service, usually about 200 rpm below maximum. Check your owner's manual for this stat. If the horsepower selected is correct, the boat should hit hull speed and leave a respectable quarter wave astern. An engine that doesn't do that, at the rated rpm, is probably swinging an overly large prop. This causes the engine to labor and is, in effect, artificially governing the engine to a lower horsepower. Meanwhile, the full throttle setting at too low an rpm causes the engine to be over-fueled. This can lead to overheating and excessive black soot in the exhaust. On the other hand, if the engine revs easily to the governed maximum and the boat has not achieved hull speed, the prop is likely too small. If the prop is already at the maximum size that can be fitted and the engine has the lowest reduction ratio available, this test result is big trouble. There is no easy solution. This usually only happens after a customer chooses to ignore the advice of the yard, insists on a less than optimum engine package and for one reason or another (usually budget) declines to carry out the modifications required to fit the bigger prop required. So if the yard warns you of possible issues and then asks you to sign a warranty waiver about the potential performance of your chosen package, it's time to listen up. I have a sign over my desk that quotes the famous oil well fire fighter Red Adair: "The only thing more expensive than hiring a professional is hiring an amateur."

Beta Marine diesel replacement for the Atomic 4.

About the author: Nick Bailey is DIY Magazine's repair specialist and has spent 26 years in the boat repair business. He is the service manager at Bristol Marine in Mississauga, Ontario.

Additional Reading

Step-by-step Rebuilding the Atomic 4 DIY 1997-#4
Repower or Trade DIY 1999-#4

DIESEL

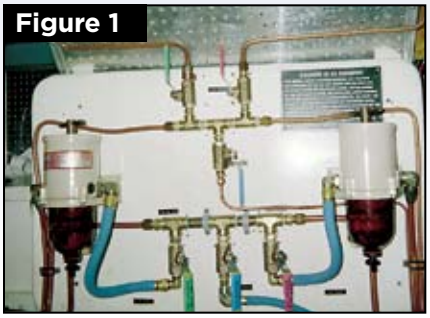
Fuel System Modifications

This captain discovers that not all is as it should be when he inspects a new yacht's fuel delivery system. Designing a "raw fuel/clean fuel" system adds selective isolation, cross-connect capability, a "get home on the jerry can" option and filter service indicators.

Story and photos by Alan Donn

In the summer of 2004, I took a job as paid captain on the 40' trawler yacht "Lady Ileene," owned by a couple in New London, Connecticut. The boat was new, having crossed the Pacific Ocean and transited the Panama Canal as freighter cargo to its port of entry at Fort Lauderdale, from there to be delivered north on its own bottom. Propulsion is by two Cummins 5.9L supercharged diesel engines and AC electric power is provided by an 8kW Westerbeke generator. These three engines were fueled from two 200-gallon (757L) tanks installed outboard in the nicely arranged engine space via individual Racor 500 filters. All in all, not a bad setup as shown in **Figure 1**.

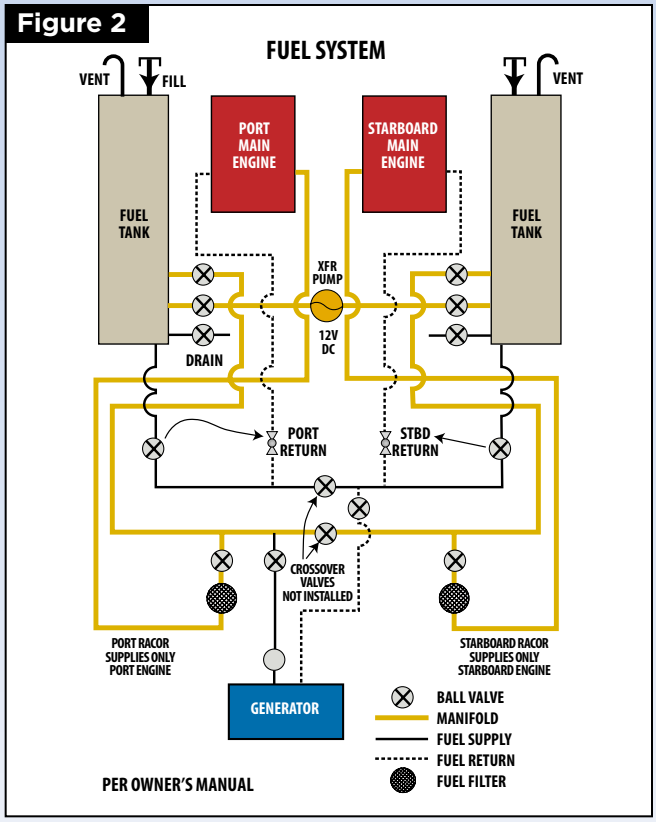
Figure 1



Details to note from the builder-supplied fuel system include: copper tubing with good mechanical support and union type fittings; quick-acting ball valves; USCG approved Type A fuel system hose and good mechanical support for components and piping. The third Racor for the gen-set is out of view to the lower right.

At first glance, this is a perfectly adequate and up-to-date system but, as in most things, the devil is in the details. In keeping with habits ingrained by 20 years of service in Admiral Rickover's nuclear submarine navy, I did a thorough, bilge crawling system trace and was not happy with what I was finding. I also checked the fuel system schematic (**Figure 2**) provided by the boat builder to be sure that what I was seeing was in keeping with the designer/builder's intent. If you roll your eyes in dismay at this schematic, your instincts are good. Aside from being wrong (the cross-connect valves shown on the schematic were not installed), it's also abysmal as an aid to understanding the system. It's laid out for the convenience of the draftsman, not for the efficient display of information to the viewer. My years in the engineering departments of submarines taught me that the basic truth that all systems, mechanical and electrical, can be sorted out into basic series-parallel relationships and sketched out so that their functional behavior becomes crystal clear, even to a relative novice.

Figure 2



Joe VanVeenen

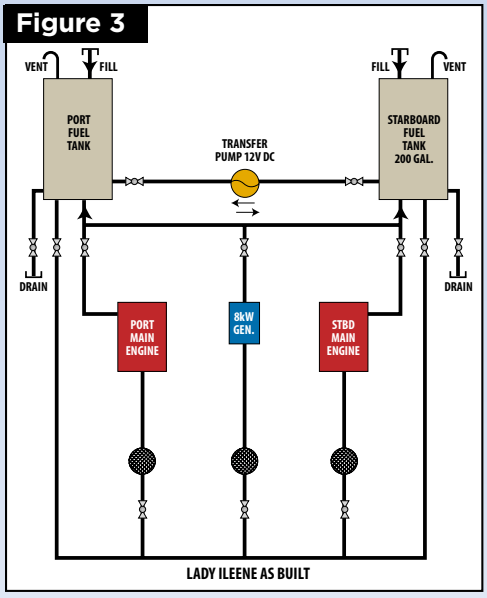
Owner's manual shows schematic of the fuel system.

Achilles' Heel

Applying this principle to "Lady Ileene's" as-built fuel system, some system weaknesses become immediately apparent (**Figure 3**). The basic system layout has each filter/engine combination as a separate unit with no selective isolation or cross-connect capability. If a filter needs underway servicing, its respective engine needs to be shut down, not a desirable characteristic for a seagoing vessel. Fuel can be drawn from one tank at a time to any engine combination but, if a slug of water or sediment from that tank comes through, it takes down all three engines, which must then be shut down until the Racors are serviced and the alternate fuel tank is put on service. There is no way to introduce an emergency fuel supply to the system, a "get home on the jerry can" option. There are no vacuum pressure gauges in the system to indicate the need for filter service. Visual inspection of the filter bowls provides some indication but, if fine sediment is present, your first indication of the need for filter element replacement could be the engine stopping. Another issue with the as-built configuration is the absence of metal flame shields on the Racor filter bowls.

It's really hard to convince an owner who has just spent a lot of money on a new boat that the fuel system is inadequate for a 1,500-mile (2,414km) trip back to winter storage in Florida and that it will cost about US$1,000 to rework it for improved serviceability. The proposed new

Figure 3



Joe VanVeenen

Simplified schematic of existing fuel system. Servicing the system becomes complicated without the ability to isolate or cross-connect the filters.

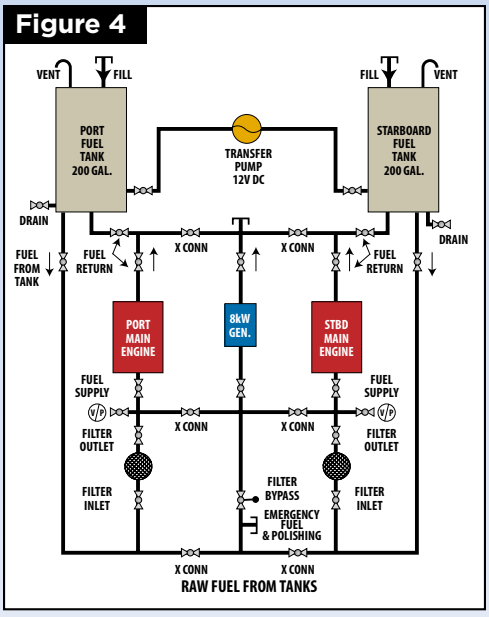
fuel system appears in **Figure 4**. From a "filter/engine" layout we have gone to a "raw fuel/clean fuel" layout. This eliminates the need for one Racor filter unit. For super reliability a third, smaller, Racor 110 or 120 could have been included just for the gen-set but the Racor 500s, at 60 gallons (50L) per hour, are only working at a fraction of their rated flow. Other features of the system ensure enough redundancy so that the gen-set has a reliable fuel supply. Either fuel tank can still supply raw fuel. The system can be split so that the starboard tank supplies the starboard engine and the port tank supplies the port engine with the gen-set either isolated or taking fuel from either side. One Racor 500 unit can supply clean fuel to all three engines with the standby second unit ready. If gross fuel contamination occurs in one tank, raw fuel suction can be quickly shifted to the clean tank and the clean Racor unit without a loss of propulsion. Good management of your tank fueling procedures should protect you from contaminating both tanks from one bad fuel source. Emergency raw fuel can be introduced at the tee connection between the filters and either fed through the Racors or directly to the engines, bypassing the filters. Each engine can be completely isolated from the system. This is not a new capability over the as-built system but the Racors now stand functionally apart from the engines. Compound pressure vacuum gauges (2-1/2"/6cm liquid damped) provide indication of filter element condition. They will normally indicate a slight vacuum. When the vacuum at the filter outlets starts to increase, change the elements.

Those familiar with Racor products will recognize that this could all have been accomplished with one duplex Racor unit but the two simplex units in parallel permitted some other features to be piped into the system and provide physical separation as protection against damage from gear adrift in rough weather.

Setting up

Implementation was surprisingly easy. The entire system was assembled in the shop and taken to the boat for final connection to the tank and engine connections. All components in the new system fit in the same footprint on the mount-

Figure 4



Joe VanVeenen

Proposed new raw fuel/clean fuel system adds redundancy and back up systems and improves reliability not offered on the builder supplied system.

ing board provided by the boat builder. (Ed: It's imperative that all fittings in a diesel fuel system meet ABYC H-33 Standards. The standard states, "Metallic fuel lines shall be aluminum or copper alloy pipe of no less than schedule 40 or copper alloy tubing with a nominal wall thickness of at least .032 inches (.81mm). Further, that standard requires that flexible fuel lines (hose) "shall be USCG Type A complying with the requirements of SAE J1527, Marine Fuel Hoses." ASTM and UL listed fittings apply to industrial plumbing and pipe but not marine fuel systems. Finally, ABYC H-33 requires that, "The system and all components shall be capable of operation within an ambient temperature range from -20°F (-29°C) to 176°F (80°C) without failure or leakage…Components of the system and the fuel distribution system shall be designed and sized to provide the required fuel flow to the engine at the maximum power setting of the engine…All individual components of the fuel system, as installed in the boat, shall be capable of withstanding a 2-1/2 minute exposure to free burning fuel (N-Heptane) or No. 2 diesel fuel without leakage, when tested in accordance with Title 33 CFR, Section 183.590, Fire Test."]

The compound 2-1/2" (6cm) pressure vacuum gauges are available through Racor (part number RK19476) or from industrial suppliers such as Grainger or McMaster-Carr. Be sure to get the liquid damped option. Dry gauges have a short life due to the continuous pressure pulsations in the system caused by the engine fuel injection pumps. The Racor gadget that combines the compound gauge into the cover's tee handle isn't recommended because it can't be isolated in the event of a physical wipe out.

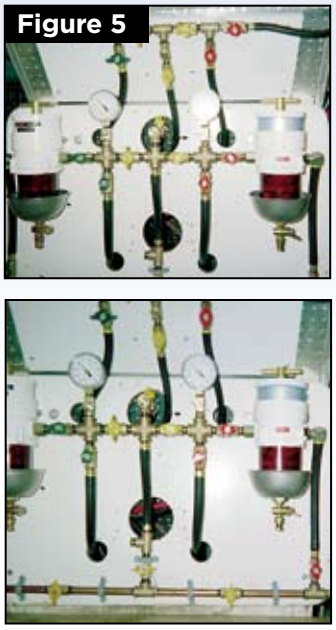
Also notice the valves at the bottom of the filter bowls in **Figure 5**. This is an extra cost option (Racor part number RK19492). The standard bowl drain is 1/4" (6mm) pipe plugs. I recommend the drain valve option for convenience of servicing. In case you're tempted to go cheap and provide your own drain valve, remember to provide a pipe plug downstream of the valve as shown. This protects against accidental opening of the drain valve.

Field Testing

Sharp-eyed observers of the photos in **Figure 5** may notice that I installed the emergency and fuel-polishing tee on the wrong side of the filter bypass valve. Emergency fuel will always bypass the filters. After a few weeks of "What's wrong with this picture?" I corrected the installed system to be as shown on the proposed schematic (**Figure 4**). Future installation of a fuel polishing capability may use either the installed transfer pump or a dedicated pump. Underway, fuel polishing would be a bit difficult to implement without some unwanted system complexity or more tank penetrations but, in port, fuel polishing would be quite easy.

The system has been operating for more than a year with good results. My normal system lineup is to have one filter supply all three engines from one fuel tank with the second tank and filter unit isolated and in standby mode. Remember that these Racors are operating at a fraction of their rated flow rate of 60 gph (227 Lph) so any measures that can boost the flow rate through the unit aids the centrifugal filtration (turbo) action. The boat tends to develop a list as fuel is consumed from one side, so after a few hours, I dive the engine room and shift suction to the opposite fuel tank. The redundancy and backup inherent in the system enabled us to make a quick recovery from an inadvertent introduction of potable water into fuel tank that would have had us adrift without power with the old system.

Figure 5



Amended fuel system incorporates ball valves, liquid-damped Racor pressure vacuum gauges and valves at the bottom of filter bowls for ease of servicing.

A final word on systems. Know your boat's systems. Don't be intimidated by those spaghetti bowl schematics. Sit down and sketch things out in simple series parallel relationships. Then go find things on the boat. Last, but most important, play the "what if" game and prepare yourself mentally for some of those unpleasant surprises that are a routine part of life on the water. They may have serious potential for consequences but, if you have thought them through beforehand, they won't be surprises.

About the author: Alan Donn operates Yacht Management Services, a powerboat and sailboat delivery and yacht management firm based in Groton, Connecticut. He served 20 years in the U.S. Navy submarine service and holds a master 1,600-ton, oceans license, is an IMO/USCG certified maritime instructor and an electronic navigation systems consulting engineer for the USGC R&D center. He owns a 1987 Island Packet 38.

ELECTRICAL

Power Generation

Upgrading an alternator or regulator isn't simply an off-the-shelf purchase. You need to consider all components of the boat's charging system.

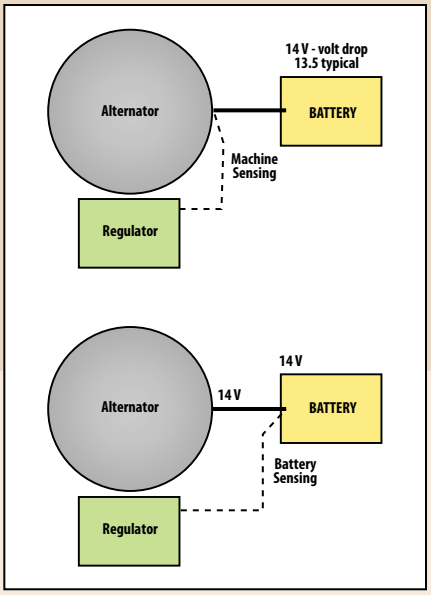
By John Payne

An alternator is the electrical powerhouse for most boats. There is a wide range of alternators available, from air cooled to water cooled, and all are derived from various vehicle applications. In most cases, you get what comes with the boat's marine engine with its purpose of simply topping up the start battery. On many boats, the alternator is then required to change function to that of charging large capacity and deeply discharged battery banks. Vehicle alternators are designed around the basic criteria that includes the maximum current required not just to charge but to also supply electrical power to the vehicle systems and the rotational speed range, that is the operating speed of the engine, including the low idle speeds of many engines including slow traffic conditions. Of course, this varies considerably to the service we want to subject the alternator to on our boat; namely, charging large capacity deeply discharged battery banks in short time periods with relatively low engine speeds, where the engine changes from a propulsion source to just a power generation source.

Alternator 101

The alternator consists of a fixed three-phase winding called the stator, and stator windings are formed onto a laminated core. The rotor is the rotating part of the alternator and the rotor shaft typically comprises 12 magnet poles, along with the excitation winding that terminates at each of the two slip rings. There is also a cooling fan at either one or both ends of the shaft and the bearings that support and enable the rotor to turn. As the rotor turns, the magnetic flux flows through the pole body and across the air gap to the stator winding and back across the air gap and opposite pole to complete the magnetic circuit. During this rotation, this field of force cuts through the three stator phase windings and every 360° rotation induces six sinusoidal waves within each phase. An excitation current is used to generate a magnetic field within the rotor so that required alternator voltage can be induced into the stator windings. The excitation current flows through the exciter diodes, then through the brushes to the slip rings and to the excitation winding. The brushes are normally made of copper graphite and are spring-loaded to maintain correct slip-ring contact pressure. This goes to the field terminal of the voltage regulator and then to negative terminal of the voltage regulator. The circuit is completed as it goes back to the stator winding through the power diodes where it's then rectified to produce a DC output for battery charging though the full wave bridge rectifier. There are variations in alternators and they tend to follow automotive developments with a trend towards higher outputs for smaller package sizes and lower weights. There have been significant diode rectifier improvements that also improve the cooling and therefore efficiency and power outputs. Improved heat transfer from the stators also improves efficiency so that many modern vehicle alternators are far superior to standardized units often coupled to marine engines and worth consideration when planning to upgrade. Marine alternators are ruggedized units that are over engineered, corrosion resistant and ignition protected.

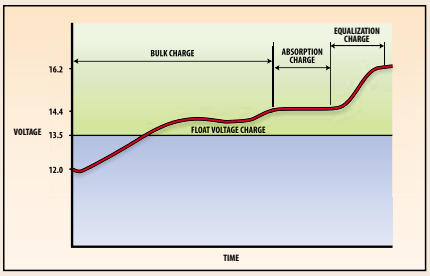
One must also consider the engine speed because, if you are trying to charge at low or idle speeds, the factor of pulley ratios is important. The alternator will only start to produce electrical power at a specific cut-in speed and this is the ideal maximum alternator output at the lowest possible engine speed. The alternator has three speed levels that need to be considered as there is a direct relationship between the alternator output current, efficiency, torque, horsepower (kW) and the alternator speed. Makers produce graphs and the ideal speed can be selected from these characteristics, so get hold of those for your alternator. The alternator speed ratings are called the cut-in dpeed when a voltage is generated; the full output operating speed when full rated output is available and the maximum output speed for the alternator, after which destruction will occur. The trade-off is that if the pulley size is too small the alternator may over-speed and if too large the proper cut-in speeds may be wrong.



(top) A machine sensed voltage regulator maintains alternator output voltage to a nominal set value but is unable to compensate for charging circuit voltage drops. (bottom) Regulator with battery sensing capability senses voltage at the battery terminals and adjusts the alternator output voltage to the nominal voltage.

Making DC from AC

The rectifier part of any alternator comprises a bridge or network of six diodes and these are interconnected between the positive and negative plates. Two power diodes are connected in each phase, which means that one diode is connected to the positive side and one to the negative side. These diode plates also serve as heat sinks to help dissipate the heat generated from the power conversion process within the diode. The positive sinusoidal half waves pass through the positive side diodes and the negative

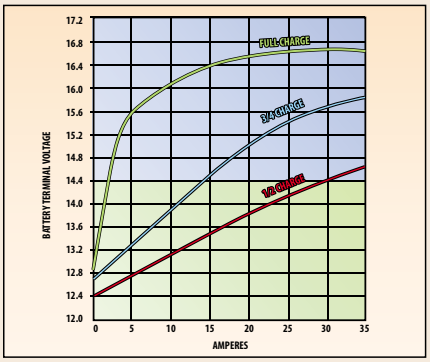


There are four recognized stages of a charging cycle and understanding these stages is crucial to understanding charging problems.

half waves pass through the negative diodes. This rectifies the three generated AC phase voltages into the DC output for charging. Two diodes are used on each winding to provide full wave rectification. The rectifier diodes also prevent the battery discharging through the three phase winding as the diodes are polarized in the reverse direction.

Role of Exciter Diodes

The exciter or pre-excitation diodes are a network of three low power diodes that rectify each AC phase and then give a single DC output for the warning light function. The exciter diodes are necessary as the residual magnetism of the stator

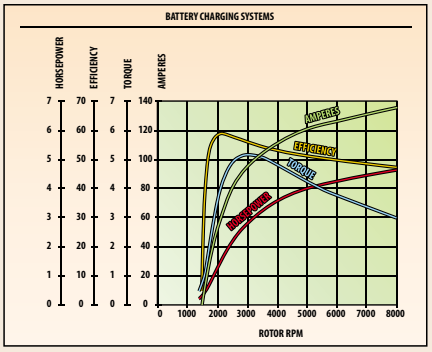


When battery voltage rises to 50% charge, the regulator starts limiting the voltage level. As battery voltage level rises, the charge current levels off and this is called the regulation zone.

core is generally too low when engine is operating at relatively low revolutions during starting and idle to initiate the self-excitation that is required to build up the magnetic field. This condition only occurs when the alternator voltage exceeds the voltage drop across the two diodes. Current then flows through the alternator warning light, through the excitation winding then back through the voltage regulator to ground. This current then pre-excites the alternator. The warning lamp also functions as a resistor and provides pre-excitation current, which generates a field in the rotor. The power rating of the lamp is quite important and 2 to 5 watts is typical. As many have discovered, the alternator will often not operate when the lamp fails and this is due to the dissipation of the residual voltage or magnetism. When the lamps are undersized you will see that characteristic need to "rev" the engine to get the alternator to "kick" in.

About Voltage Regulators

The voltage regulator is essential to the safe and efficient charging process of any battery and also to prevent the alternator voltage from going above a nominal set value that is typically 14 volts. Higher voltages could damage the battery, the alternator and other boat electrical and electronic equipment. The voltage regulator used to be a large and separate electromagnetic contact type device. Modern electronics design has seen the development of regulators that are solid state with no moving parts, very reliable and temperature tolerant with high control accuracy. Earlier solid-state regulators had discrete components and they are now what are called monolithic with everything in all one microchip or hybrid regulators that incorporate both integrated circuits and transistors. The regulators are usually integrated with the brush gear or mounted internally adjacent to it. Voltage regulator sensing is normally connected to the main output circuit. The voltage regulator is a closed-loop controller that varies the field voltage when the voltage drops below the set value or exceeds the upper set point value. The majority of alternators are configured as machine sensed. This means that the regulator senses the output terminal voltage and then controls and maintains the alternator output voltage to the nominal set value. The machine sensed voltage regulator does not compensate for charging circuit voltage drops. Voltage drops include under-rated terminals, cables and the negative path back through the engine block. Many regulators now have battery-sensing capability that will sense the voltage at the battery terminals and adjust the alternator output voltage to the nominal voltage. The battery sensed



This graph shows the relationship between output current, efficiency, torque and horsepower against rotor revolutions. Optimum speed can be selected from these characteristics.

regulator compensates for voltage drops across diodes and charge circuit cables. As a note, regulators and field windings have two possible field polarities and this has nothing to do with the positive output of the alternator. The positive polarity regulator controls a positive excitation voltage. Inside the alternator, one end of the field is connected to the negative polarity. The negative polarity regulator controls a negative excitation voltage. Inside the alternator, one end of the field is connected to the positive polarity. You have to make sure you get the right regulator.

Increasing Charging Performance

The simplest way to improve charging performance is ensuring that all cables and terminations are rated for the maximum current, so that voltage drop is reduced or minimized. Additionally, you can reduce losses by installing a negative cable the same size as the positive from the alternator case or negative back to the battery. Also ensuring good ventilation helps to reduce overheating when using a special regulator so reducing losses. You can opt for installing a much higher output alternator; however, if the output is within the 70- to 90-amp output range, the best solution is often to use of one of the many regulators designed to maximise the output and optimise charging. Larger output alternators often require multiple drive belts and pulleys and this costs more in engineering and economic terms. [Ed: Information on the use and installation of high-output alternators appears in DIY 1998-#2 issue or on DIY's MRT "AC Electrical Systems" CD-ROM.]

Smart Regulators

The traditional voltage regulator is designed to recharge a partially discharged battery in a relatively short period and also to supply the onboard electrical power in the vehicle. To achieve the efficiencies we require on a boat, we have to look at improving the power availability of the alternator. The best way to do this is by using one the many "fast charge" voltage regulators on the market. These often "intelligent" regulators tend to be multi stage, step charge or programmed cycle devices that have either automatic or user settable charge settings. Alternators and regulators are inextricably linked to the battery sizes along with battery types, and matching of charging characteristics is important. The use of any fast charge regulator must consider the whole system and not simply be used in isolation as a cure for charging problems. Most multi-step regulators have similar operating principles. The first charging step is the bulk charge phase and this is where voltage rises steadily up to approximately 14.2 to 14.4 volts and maximum current output occurs up until approximately 80% charge level. Many fast charge regulators allow this to be set to suit the battery type and are different for AGM, gel or flooded cell lead-acid batteries. The second charging step is the absorption or acceptance phase and this is where the charging voltage is maintained at a constant level and the charge current slowly reduces. The third and final step is the float charge phase where voltage reduces to approximately 13.8 volts and maintains a float charge to the battery and this stage suits most boats where there are long motoring periods. Some cycle regulators repeat this so that the battery is brought up to full charge and follows the optimum charge curve to a battery, which can only accept charge current at a finite rate. Of the Balmar regulator range, one has a microprocessor-controlled regulator and also has several user selectable multi-voltage variable-charge time programs that suit six battery types. The basic principle is the use of an automatic absorption time program. Some regulators also incorporate battery temperature compensation sensors and alternator temperature sensors for improved accuracy. Some of these units have an equalization function that is a user adjustable feature. The function enables the application of an equalization current until battery voltage reaches 16.2 volts. Other regulators generally follow similar principles that are variations on step charging techniques.

The smart fast charge voltage regulator is only effective in upgrading the charging performance of an alternator when all parts of the charging system are considered. If the battery bank is too large for the alternator capacity, the smart regulator may simply stress and overheat the alternator, causing early failure. The charging source must be capable of meeting the expected maximum charge current demands. The factor of speed range also needs to be considered and getting the right pulley ratio is an important issue. In many cases, under rated cables and terminations also become a problem as the circuits are designed on some systems to carry less than the rated maximum output of the alternator.

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

Different Strokes

The brightwork pros all agree that preparation and the right products are the essentials of a successful, enduring and beautiful varnish job. These tricks of the trade will give you the professional edge.

By Jan Mundy

As an owner of a wooden boat, I've had my share of varnishing mishaps. Every spring would find me in the boat yard scraping, sanding and varnishing. Somehow, I never had enough time to apply the build up of coats needed to protect the varnish from the sun's rays but I always had to make time to scrape away the peeling, cracking varnish of last year's effort. Three or more coats of spar varnish were then delicately applied with an expensive China bristle brush but, by mid-summer, the sun would have its way and the next spring would find me scraping again. My obsession for the well-varnished look drove me in my search for the Holy Grail of a quick-and-easy finish to protect brightwork, a quest compromised by my letting go of my goal of the "royal" finish that some can achieve with a magic formula that perennially eluded me.

Ask four boat detailers what varnish they use and how they apply it and you'll get four different answers. Knowing a little about varnish chemistry might help select one that's right for your project.

What's Varnish?

Varnishes are generally a concoction of oil, solvents and thinners, resins, dryers and additives. By varying these ingredients and/or their proportions in the mix and adding ultraviolet (UV) inhibitors to protect the wood from the harmful effects of the sun and other proprietary ingredients, each varnish achieves its own unique "personality." Most are brushable, some are only sprayable, some give a high gloss and others a matte finish. They can vary in depth of color. Which varnish "personality" is best for you?

Chemically combining a resin with oil produces a liquid varnish that cures to a solid film after application. High-quality marine varnishes use Chinese tung oil derived from trees. Lesser quality varnishes use linseed, soybean or other oil. Oil improves penetration into the wood and provides resistance to cracking and crazing. The ratio of oil to resin determines the flexibility of the coating, drying times and application method. Varnishes containing 45% to 60% oil form the basis of all marine varieties.

Hard resins used in varnishes are generally derived from tree stumps or are processed from crude oil. Phenolic resins, derived from crude oil, are used primarily in varnishes requiring a faster dry and harder finish for maximum water resistance. Of the oil-modified polyurethane resins, there are two groups: aliphatic modified polyurethane resins and aromatic polyurethane resins. Both offer excellent abrasion and chemical resistance. The aromatics are more popular but the aliphatics provide better color, gloss and clarity. Poly-Flow 4000 is an aliphatic resin, which is unique to Interlux Goldspar 95 varnish.

Solvents increase the leveling characteristics of a varnish. By maintaining a wet edge, the varnish is applied without any trace of brush marks from overlapping new areas.

Driers accelerate the dry times and the hardness of the coating. The blend of driers can impact the clarity, color, the actual rate of dryness and the stability of the product.

Additives are the newest components added to varnish. An anti-skinning agent allows the varnish to maintain a wet surface upon exposure to oxygen. Since varnishes have high resin content, they tend to develop a surface skin once opened. Flattening agents, used for interior var-

To remove oil from teak prior to varnishing, clean with a one-part teak cleaner and lightly agitate the surface with a soft bristle brush.

nishes, achieve a rubbed effect look.

An ultraviolet stabilizer is the single component that most directly impacts long-term performance. UV light is energy that is either absorbed by the coating or dissipated. Without the use of adequate stabilizers, the varnish (or any coating for that matter) absorbs the UV energy. This leads to a dramatic loss of gloss, film cracking and yellowing. Oxygen reacting with the coating now oxidizes the surface, causing the varnish to fade and become cloudy. Most external-use marine varnishes contain a UV absorber that diffuses and disperses UV to prevent coating damage. Some varnishes also contain a surface stabilizer to repair UV damage and anti-oxidants to combat surface oxidation. Yellow is sometimes added to a varnish as a UV inhibitor and gives the finish an amber tone.

Climactic and environmental conditions all affect the longevity of a varnish, assuming the varnish was properly applied. As a varnish oxidizes, it becomes more brittle and prone to cracking and crazing. Varnish that is continually immersed in water tends to blister and delaminate. Salt crystals, acid rain and other contaminants magnify sunlight's intensity and cut through the coating. Spilt fuels, alcoholic beverages and even sunscreens can damage a varnished finish.

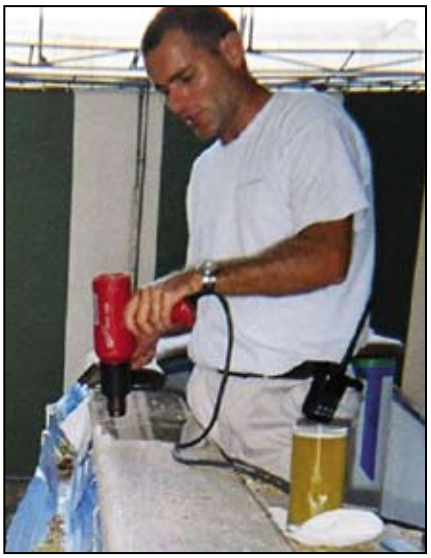
What's to Choose

Varnish application and the final finish vary depending on the product's chemical composition. Walk into any well-stocked marine store and you'll find an array of products. What do you choose? Phenolic or alkyd resins combined with tung oil produce a varnish with good water resistance, adequate hardness, exceptional flexibility and good grease and UV resistance. It's called spar varnish. Awlspar, Epifanes Clear Varnish, Interlux Original and Schooner, Petit Bak-V-Spar, Captain's and Flagship, Sikkens Rubbol, System Three Spar Urethane and West Marine Admiral's are examples of spar varnishes. All are one-part coatings, known for their ease of application and some are compatible with epoxy resin.

Hard and durable, polyurethane varnishes exhibit the finest abrasion, chemical and water resistance but are the least flexible. A tiny crack or nick can allow water to creep under the film, raising the grain and peeling the coating. Their hard finish can be buffed or polished (see "Maintenance Tricks" on page 63) to produce the finest smoothness and gloss. Varnish purists might consider their high-gloss, almost "plastic" wood look, a detriment. One-part polyurethanes (e.g., Detco Crystal, Interlux Goldspar 95, Sikkens PU Clearcoat) require less care and are more easily applied than the two-part coatings (e.g., Interlux Perfection, Epifanes Polyurethane Clear Gloss). Interlux Perfection combines both UV absorbers and anti-oxidants to deliver UV protection up to four times longer than traditional varnishes. Awl-Brite Plus is a three part acrylic urethane for professional application only. As expected, urethanes are the most expensive of the varnishes, as much as three times more than a spar varnish.

Fast dry finishes contain a modifying resin to produce a varnish with remarkably fast drying times. Toluene or naphtha, listed on the label, identify a coating as a fast-drying finish. Fast dry times mean less dust and fewer bugs to get stuck in the finish as it cures. Bristol Finish is a two-part acrylic urethane coating with a one to 24 hour recoating time without sanding between coats. In one day, you can potentially apply eight coats or more. A fast build up is especially practical for early spring and late fall varnishing or anytime there is a diminished weather window.

Some specialty varnishes are applied without the hassle of sanding between coats. Epifanes Wood Finish Gloss is a blend of phenolic-modified resin and tung oil that builds up coats quickly without sanding if recoated within 72 hours. Five coats of Wood Finish are equivalent to seven coats of varnish. Epifanes Rapidclear, a one-part modified alkyd and urethane resin finish, goes on very thin so it doesn't fill the grain like a varnish but requires only five coats over bare wood. It's not necessary to sand provided moisture or dust isn't trapped between coats.



Hold the heat gun at an angle and scrape off the loose varnish. Keep moving the gun so it doesn't scorch the gelcoat or wood.

Most of these products are compatible with oil-based penetrating wood stains, many can be applied over epoxy-resin-coated wood and, with the proper preparation, most bond well to teak. Generally,

Some of the tools in the author's varnishing kit are bronze and synthetic wool pads, brushes and brush spinner, dust mask and respirator, power sanders, sanding blocks of various shapes and sizes, Scotch-Brite pads scrapers, wet/dry sandpaper and tack cloths.

Removing old varnish with a 2" (5cm) blade scraper is tedious work.

traditional spar varnishes take longer to dry than the urethanes and require a build up of eight or more coats. Two-part polyurethane varnishes are dry to the touch in one hour or so, giving bugs and dust little time to adhere. They are recoatable in three or four hours and, as they only require five or fewer coats for the same level of protection, the varnishing is completed in a weekend. Rarely is there a compatibility problem between one-part varnishes. Problems occur when overcoating a two-part finish because it acts like paint remover; exceptions include one-part Bristol Finish and Detco Crystal. As with all coatings, read the application instructions carefully and apply to a test area before starting a big project.

Alternative synthetic varnish look alikes (e.g., Cetol, Amazon Teak Lustre) are more popular each year. They are an easy-to-apply option, especially over oily woods like teak, with good durability and a passing-grade finish. Cetol is an alkyd resin formulation containing synthetic transparent iron oxide pigments that protect the wood against UV absorption. It's these pigments that turn wood a "golden" hue. Cetol is very easy to maintain. When the coating begins to loose gloss, simply scuff it up with a Scotch-Brite pad, rinse with a vinegar/water solution and apply a few fresh coats. Amazon's Teak Lustre is a one-part, water-based acrylic coating that can be applied over many teak oils. It's a quick drying finish, ready in 45 minutes or less for sanding between coats, which allows for the recommended three coats to be applied in an afternoon. (For comparison purposes, even though I'm not discussing interior varnishes, the popular anti-slip cabin sole finish, Ultimate Sole, is a blend of mineral spirits and aromatic and aliphatic resins.)

Ask a dozen boat owners how they maintain their boat's brightwork and you'll get an equal number of opinions. To help separate the facts from fiction, I consulted a few professionals who earn a living varnishing. One detail pros do agree on is that proper preparation can make the difference between a mediocre and a quality varnish work.

Surface Prep

If you've no clue what the existing finish is, take a rag dampened in acetone and lay it on the surface for 5 to 10 minutes. A coating that softens is a one-part product; if the coating remains intact, it's two part. Again, read the application instructions for specifics.

Provided an existing varnish is in good condition, wash the surface with a boat soap to remove any contamination. Sand with 220 to 320-grit wet or dry sandpaper and,

once dry, wipe with a rag dampened with the recommended solvent (check the label). Some detailers scuff the surface with a 3M Scotch-Brite pad (gray or red depending on the surface condition) and then varnish. Again, check the manufacturer's guidelines for procedures.

Any coating that shows signs of discoloration, lifting, cracking or peeling must be removed either completely or, if the damage is isolated, at the very least, do a spot repair. While you can use a cabinet scraper, file sharpened to a chisel edge, to painstakingly remove varnish in poor condition, you can expedite the process with chemical strippers and machine sanders. (Refer to DIY 2002-#1 issue for the test results of marine paint strippers.)

Scott Van Allen operates a varnish-maintenance business in Ft. Lauderdale, Florida, and has been varnishing megayachts for 20 years. He prefers the one and two-part urethane varnishes because of their short dry times and extreme hardness. "A traditional varnish that takes three or more hours to dry becomes a sticky landing place for dust and every passing mosquito," says Scott. When stripping 300' (91m) of cap rail, Scott and his crew use a heat gun to soften the varnish and then scrape with a 2" (5cm) blade scraper. A light coating of paint stripper follows. This is scrubbed with scrapers and bronze wool brushes (the kind used to clean barbeque grills) to extract the varnish buried deep in the wood grain. Removable pieces, a flagstaff for example, are first scuffed with 60- or 80-grit sandpaper

Brush or pat sandpaper clean using a 3M Scotch-Brite Scuff Sponge to remove sanding residue and to improve cutting action.

and then liberally coated in stripper and wrapped in cellophane or tin foil. "Apply about a 1/8" (3mm) thickness of paint stripper, cover with wrap and place the package in the shade so the solvent doesn't dry, and it bubbles and cooks the varnish," says Scott. Depending on thickness, it may take up to 5 hours to remove seven coats of varnish. "Remove the wrap and wash the part with a hose. The wood now is clean and as flawless as new without having to sand out the gouge marks from scraping,."

Once stripped, many woods need a good cleaning, especially if previously oiled. When I overlooked this important step by overcoating oiled wood with epoxy resin followed by multiple coats of polyurethane varnish, it all peeled off. I prefer to clean teak with a one-step teak cleaner and then lightly scrub the

Use a chemical, moisture and UV resistant masking tape, such as 3M 233+ or 3M Fine Line for weekend use or for longer-term jobs, use 3M Safe Release.

wood with a soft bristle brush rather than using the horribly toxic acid/alkaline cleaners. Don't scrub hard or you'll raise the grain. This might take several applications if the wood was oiled for many years.

Besides an inventory of various scrapers and a file to keep them sharp, sanding blocks of different shapes, dual action or orbital sanders and plenty of aluminum oxide sandpaper ranging in numbers from 60 to 320 grit, you'll also need bronze wool, masking tape, tack cloths to remove surface residue, various size brushes (see "Bristles Vs. Foam" on page 62), filters to strain the varnish, 3M Scotch-Brite pads and a vacuum cleaner with an upholstery attachment on the hose end.

Dry sand the wood to remove any imperfections caused by scraping. Begin with 80- or 120-grit paper, depending on the surface condition and the type of wood. Always sand with the grain and sand "by the numbers," working up to the next finer sandpaper until you reach 180 or 220 grit, though some craftsman sand further with finer grades. Smoothness of the final wood surface all pivots off your acceptance level. I rarely go above 180 grit when applying a two-part polyurethane varnish. (Unfortunately, all imperfections only become highly visible after applying the final varnish coat.) Always wear a dust mask when sanding. The best mask for the job is 3M 9211. With its double straps, neoprene upper gasket and a purge valve (like a diver's facemask), it's comfortable to wear all day.

A clean workspace helps to reduce the dust that always settles on cured varnish. Vacuum the wood and surrounding areas and remember to clean the ladder you use. Wet down the floor or ground to prep for varnishing and, just before you varnish, solvent wipe the wood and finish off the prep by wiping with a tack cloth.

Application 101

Gingerly stir, never shake, the can to reduce the amount of air introduced into the varnish. Pour a small quantity into another container and promptly reseal the can. Never varnish directly from the can. Besides adding dirt and other contaminates with every brush stroke, the solvents evaporate and the varnish thickens.

All varnish products contain a solvent; some are more toxic than others. When in doubt, wear a respirator with a charcoal filter. If applying two-part varnishes, you'll need a fresh-air supply system.

Traditional varnishes are always thinned when applied over bare wood. Depending on the system and wood type, thinning ranges from 15% to 50%. When varnishing mahogany, Doug Theobalds, a former wooden boat craftsman and president of

Railstar is a reusable catchall for run-off material to prevent polluting the waterways when varnishing with your boat afloat.

Epifanes North America, recommends thinning the first coat 50%, the second coat by 25% and the third by 15% and then applying successive coats at full strength. "Three thin coats seal the wood to give maximum penetration and good adhesion of subsequent coats," explains Doug. "This achieves an effect similar to applying an oil-based sealer that is wet-sanded into the wood, a technique favored by purists for teak and other oily woods." When varnishing bare teak, thin the first coat by 25%, progressively building to full strength. Always use thinners of the same brand as the varnish. Between each of the first three coats, dry sand smooth with 150 to 220-grit paper, depending on the roughness of the surface. Vacuum all surfaces, wet the surrounding area again to reduce dust and then wipe the wood with a tack cloth. For the next three coats (build up at least eight coats for maximum UV protection), it's not necessary to sand between coats unless it's to remove obvious defects or too much time has elapsed between applications. After the second to last coat, sand with 220 grit paper and apply the final coat. Perfectionists may wait a day or two to let the varnish cure before sanding and then wait for the ideal weather conditions before applying the final coat, as humidity and temperature both affect a varnish's cure. Some pros sand with 400-grit paper or a 3M Scotch-Brite pad between the two final coats.

Since one-part and two-part urethanes vary in the application process, follow the manufacturer's guidelines. Scott's delivery method differs radically from conventional practice. "Too many people varnish like they're painting a fingernail. When I varnish a rail, I get a mop, actually a 4" (10cm) brush, and apply it so thick the varnish drips off the rail," explains Scott. His application method led to the invention of Railstar, a reusable frame assembly consisting of self-adhesive plastic hangers and a plastic or vinyl tray to catch all runoff material: scrapings, paint stripper and varnish. The Railstar Frame System (tel: 954/465-9005, web: www.railstar.net) solves a

TIP - Cover Up

If you're really serious about your varnish regime, cover brightwork with acrylic canvas covers. By limiting UV exposure, you extend recoating times.

Professional varnisher Scott Van Allen, who makes a living refinishing brightwork on megayachts, slops on urethane varnish in "the thicker the better" Style.

potential pollution problem for owners who varnish while the boat is afloat. "Railstar allows me to put on a thick coating of varnish and any drips fall into the tray," says Scott. "This increases the product's working time as the solvents evaporate more slowly, which is especially important when applied in full sun and on windy days."

One detailer I spoke with prefers the fast dry finishes. Bristol Finish has a one to two-hour dry time between coats, depending on temperature and humidity. When tack free, the next coat is applied. Most varnishes don't set up in extremes of high or low temperatures. Apparently, Bristol Finish's working temperature range is a cold, 30F (1C), up to a hot, 120F (49C).

The Wooden Boat Shop in Cincinnati, Ohio, chemically removes all paint and varnish, sands the wood with 60 grit and then 80-grit paper, followed by 120-grit paper. Next, Interstain paste wood filler stain is mixed with Interlux Brushing 233 to a pea soup consistency and is applied liberally and then rubbed off in a circular motion using a rag dipped in stain followed by dry rags. All excess filler is wiped away and the finish is allowed to dry for at least eight hours before removing dust with a tack cloth. At this point, two coats of Interlux Clear Sealer 1026 are applied, sanding between coats. Hand sanding with 280-grit silicone carbide paper is done between every coat.

When the LeDonne family of Pittsburgh, Pennsylvania, built "YNOT," a near-replica of a 1950s Wilbur Storter runabout (written up in WoodenBoat 186), they were meticulous about finishing the brightwork. Wood is dry sanded up to 220 grit before applying three or four coats of Smith and Company Clear Penetrating Epoxy Sealer and sanded once again just before the final coat with 220 grit paper. Before the sealer dries, it's covered with three coats of Awlspar. This creates a chemical bond between the epoxy and varnish for a long-lasting finish. The first coat is dry sanded with 320-grit paper to remove any imperfections and successive coats lightly rubbed with a 3M Scotch-Brite pad to break the glaze and provide sufficient adhesion. After the last coat of varnish, depending on the temperature, it takes 72 hours and up to 10 days to fully cure before sanding with 320-grit paper. Now, apply three coats of Awl-Brite Plus, waiting about four hours before recoating. It's not necessary to sand between coats, unless the surface is gritty or the recoating time exceeds 24 hours. Lightly rub the surface with a Scotch-Brite pad if needed. Allow 12

Continued on page 62

Sewing With Sailrite

Sew a Fender Cover

In this first article of a new do-it-yourself column, Jim Grant, founder of Sailrite, gives step-by-step instructions on making fender covers that protect your boat's topsides and the fenders themselves.

Story and photos by Jim Grant

Soft and durable covers for tough vinyl fenders can protect the finish of your hull from abrasion. Covers can also increase the useful life of the fenders themselves and, if properly constructed, they can be very attractive.

Sailrite's BoatBlanket Protection Kit (US$50.40) makes excellent homemade fender covers possible. Customer reports of multiple trips through the Panama Canal attest to the outstanding durability of these soft protective covers. The heart of the kit is a solution-dyed polyester, non-woven material called BoatBlanket that is extremely tough, resistant to damage from UV exposure, immune to mildew, colorfast while remaining soft and resilient. It doesn't unravel when cut with scissors and sewn with a home machine. In addition to fender covers, you can use the kit to make other projects with included instructions for boat cover pads, piling pads, trailer bunk covers, pads for boat sling straps and strips to wrap around metal dodger frames to insulate window vinyl against scorching.

Kit contents.

Each kit contains a 72" by 72" (183cm by 183cm) piece of BoatBlanket in either beige, black, blue or grey; a 350-yard (320m) spool of white V-69 thread; and 20' (6m) of 1"- (25mm-) wide white polyester Velcro (hook side only). There's enough material in the kit to build four covers for fenders measuring up to 34" (86cm) in diameter by 36" (91cm) in barrel length or six covers for fenders up to 34" by 24" (86cm by 61cm) or 16 covers for fenders up to 16" by 18" (40cm by 45cm). Extra BoatBlanket material retails for US$19.95 per yard (.91m) in 72" (183cm) widths.

(left) Measuring the barrel length, 24" (61cm) for this fender, and (right) the barrel diameter, which is 27" (68cm).

To construct a single fender cover, follow these instructions.

Cover rectangle measures 29" by 24" (73cm by 61cm).

Step 1 Cut a rectangle of BoatBlanket the length of the fender minus the fender eye ends and the width of the fender's circumference plus 1" or 2" (2.5cm or 5cm). The extra allows for a closure overlap. Length is not critical as long as the material will wrap around the tapered end of the fender.

Attach Velcro hook to the back side of the cover.

Step 2 Position a strip of Velcro hook tape lengthwise down one side of the blanket material along its edge on the "smooth" side of the material. The woolly side of the blanket material acts as the loop fastener. Use the longest straight stitch possible to sew it in place, sewing all sides of the Velcro. Reverse over the first few and last few stitches on each pass to lock the thread in place. I always sew Velcro in place on top as shown in the photo above. The hook surface does not interfere with the sewing machine.

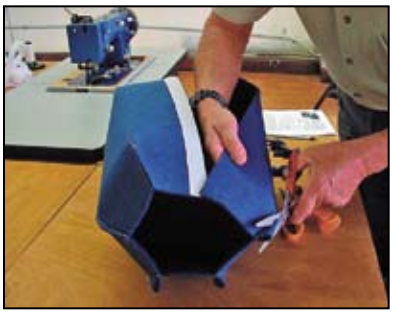
The darts marked out.

Step 3 Dart the top and the bottom edges of the rectangle with evenly spaced pleats along the top and bottom. This forms a snug fit around the contours of the fender top and bottom. Each dart shortens the edge of the cover by 2" (5cm). The edge should be shortened to 2/3 of its length. For a 29" (73cm) barrel like this one, I'll shorten it 10" (25cm) or so (the calcula-

tion can be rough). Since each dart shortens the edge by 2" (5cm), this cover needs five darts. Divide the length of the edge by the number of darts plus one (for example if there are five darts divide by 6) to determine proper spacing or 5" (12.7cm) in this case. These measurements are very rough so don't worry if your darts take out more or less than the recommended amount. I like to draw the darts on the backside of the material with a marking pen as shown in the photo below.

Sewing a dart on back side of cover.

Step 4 To form each dart, begin pinching the material on its smooth side approximately 3" (7.6cm) in from its top or bottom edge. Gradually widen the dart to 1" (2.5cm) at the edge of the material. Once again, use the longest straight stitch possible and sew each dart in place down its length, reversing stitching at the start and finish of each pass to lock the stitches in place.



Step 5 After sewing the darts, cut away the excess triangles of cloth on the inside surface of the cover.

Cut away excess fabric at the back of each dart.

Finished boat blanket.

Step 6 Your BoatBlanket fender cover is finished. Simply wrap the blanket, woolly side out, around the fender and smooth the Velcro down onto the BoatBlanket to lock it in place.

Sewing the binding on the top edge.

Step 7 To give the covers a more finished look, I like to run a 1" (25mm) binding tape round the top and bottom edges. This is just a cosmetic touch since the BoatBlanket does not readily unravel. Note the use of a swinging binder

to help accurately guide the 1" (25mm) acrylic binding in place. The work could be done without the binder but not as easily or accurately.

The finished bound edge.

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

SAILBOAT RIGGING

Shaping Underwater Speed

A symmetrical, well-shaped keel and rudder of proper size and thickness can positively impact your boat's performance.

By Roger Marshall

A boat's keel provides hydrodynamic lift that balances the aerodynamic driving forces from the sails. If you know the lift and driving forces developed by a sailboat's sails, you can precisely calculate the size of the keel that will develop enough lift to counter the sail forces. To make the keel area as small as possible, the keel must be shaped optimally and that's where the going gets tough.

If you are going to race your boat, you want a keel shape that develops the maximum amount of lift for the minimum amount of wetted surface. The best keel shape to do this job is one that is shaped like an airplane's wing, long and thin. Of course, a 25' (7.6m) long wing that measures 5" (12.7cm) fore and aft (along the chord) hanging from the hull of your 30-footer is impractical and undesirable for lots of reasons. For the racing sailor, the keel configuration may be even more important than sails and their trim.

On a cruising boat, the problem is not one of getting enough lift, but one of giving the boat enough lateral area to prevent its slewing around at anchor or when moored. A boat with a long fin keel will slew around at anchor and not give the crew much rest. If you never race your boat or don't care about performance, the sheetrock, spackle and tape approach to keel fairing works fine. If performance is a concern, fairing a keel faired to perfection is a high priority.

Racing Form

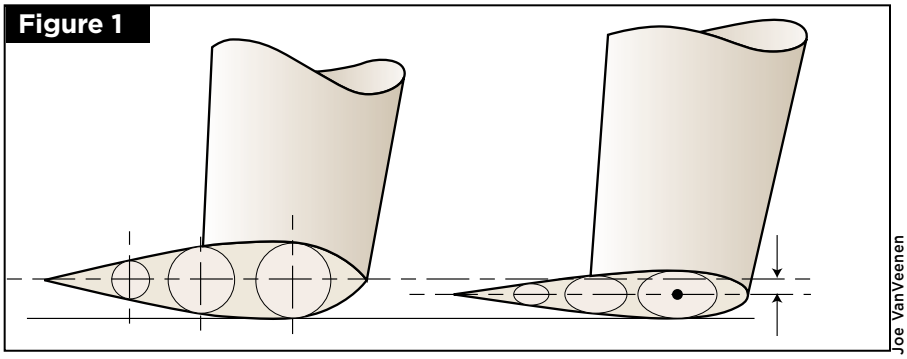
If we assume that a 30-footer (9.1m) has a draft requirement of between 4' and 6' (1.2m and 1.8m), we establish a design parameter. If the boat is a light, sporty boat that will be raced, obviously we want to reduce the keel wetted surface as much as possible and make the leading edge as long as possible. Unfortunately, a long, thin, airplane wing-like blade of this nature gives the designer no place to put the ballast unless it's inside the hull. There's another trick that can be used to solve this problem. In aerodynamics, the effectiveness of an airfoil is almost doubled by having an "end plate," i.e., a plate at the bottom of the keel to direct the water flow across the keel instead of diagonally across it. This is why designers put a bulb on the keel bottom as it serves as an end plate. The bulb also serves as a place to locate the ballast. Plus, because all the lead is so much farther away from the center of gravity, much less lead can be used to get the same stability as you would normally get from a more conventional keel. So, not only has wetted surface been reduced but also the amount of lead has been reduced and the leading edge has been made as long as possible. Another way to increase the leading edge without increasing draft is to make the bulb elliptical, as shown in **Figure 1**. The flatter bulb improves the end plate effect and gets the weight even lower.

Bulb keels have one drawback, however. They increase drag slightly as vortices spin off the trailing edge of the keel and off the bulb. To help eliminate vortices, fins or winglets are often fitted at the aft end of the keel bulb. From what I saw when testing winglets in a flume tank, these vortices cause a lot of drag, almost like the drag from the tips of spinning propellers. If you've ever watched a World War II movie and seen a plane fly through smoke or a cloud you can actually see the vortices spinning like large circles off the end of the wingtips. By having twin winglets, the spinning vortices spinning off the end of the winglets tend to interfere with each other and cancel themselves out, effectively reducing their drag.

On the negative side, a long, thin keel blade with a lump of lead fixed to the bottom creates a huge lever arm. Conventional keel bolts cannot be spaced far enough apart to carry that load without a huge internal structure. Designers have ways to get around this problem, as shown in **Figure 2**. The first is to run the keel up into the hull and pin the keel blade transversely. This is probably the strongest method. Another approach is to weld a crosspiece to the top of the keel blade to space the keel bolts further apart.

The rudder on such a boat would also be long, moderately thin, around 6% to 8% thickness ratio, balanced and highly sensitive. With thin blades on both the rudder and the keel,

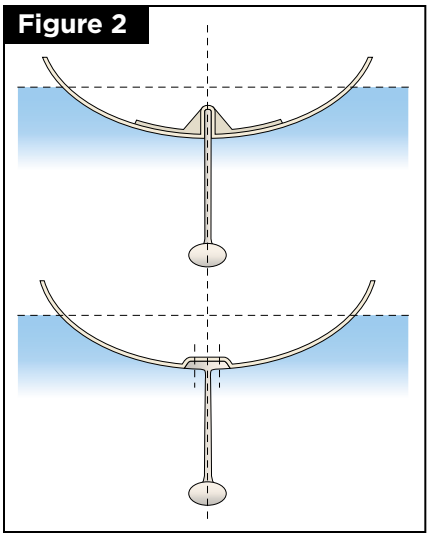
Figure 1



Joe VanVeenen

Elliptical bulb shape increases the leading edge without increasing draft.

Figure 2



Joe VanVeenen

Methods to support a long fin keel: (top) welded crosspiece on top of keel allows extended spacing of keel bolts; (bottom) built-in keel is pinned to hull.

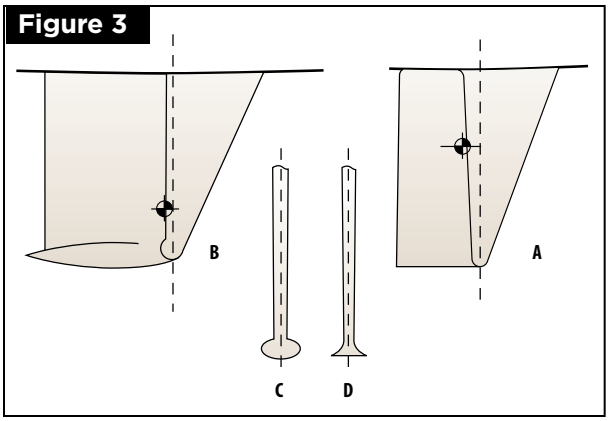
the boat would be sensitive to steer. However, if the rudder is turned sharply, the blades could lose lift and stall. Typically, long, thin rudders are made of carbon fiber because they do tend to bend as load is applied to them.

Cruising Parameters

On the other hand, a moderate displacement cruiser might have a longer, more conventional keel to give it a little more lateral profile and slightly less sensitivity to the helm. This would make the more conventional hull slower in light winds but less prone to veering at a mooring. This type of boat may also have a bulb keel with a longer keel chord. The idea is to get the center of gravity down and provide some end plate effect but still maintain enough lateral profile to help the boat sit at a mooring easily. **Figure 3** shows two keels, a conventional keel with no bulb on the right and a bulb keel on the left. The bulb keel has a much lower center of gravity as shown by the bullseye. **Figure 4** shows different types of bulbs and end plates.

A boat of this kind will probably have a balanced rudder (**Figure 5**) but the blade will be thicker to reduce its sensitivity for the cruising helmsman and to make it less likely to stall. Typically such a balanced rudder will have a pin near the top of the blade to stop seaweed and other debris from getting into the crack between blade and hull. If the

Figure 3



Conventional keel with no bulb (right) and a bulb keel (left). Bullseye marks the center of gravity of both keels, the bulb keel having the preferred lower position.

boat is a pure cruising boat, the rudder may have a skeg forward of it (**Figure 5**). Another type of rudder and one that has the best of both a balanced and a skeg rudder, are the ones shown in **Figure 6**. Though they can get caught on a pot warp they are reputed to give the best of a balanced and a skeg rudder's handling characteristics.

As you may have guessed by now, I am not much in favor of long keels, such as the one shown in **Figure 7**. In my opinion, they increase wetted surface quite dramatically, causing the boat to be slow in light winds. To give the boat light-wind capability, the designer needs to increase sail area over a similar keel and rudder configuration but that can put the crew at a disadvantage when the breeze pipes up and they have to reef earlier. On the plus side, a long-keeled boat can be made to heave to in inclement weather. However, since most sailors are out in bad weather less than half a percent of their total time on the water, it doesn't seem to make much sense to buy a boat best suited to conditions of that fraction of a percent of sailing but is a marginal performer the rest of the time.

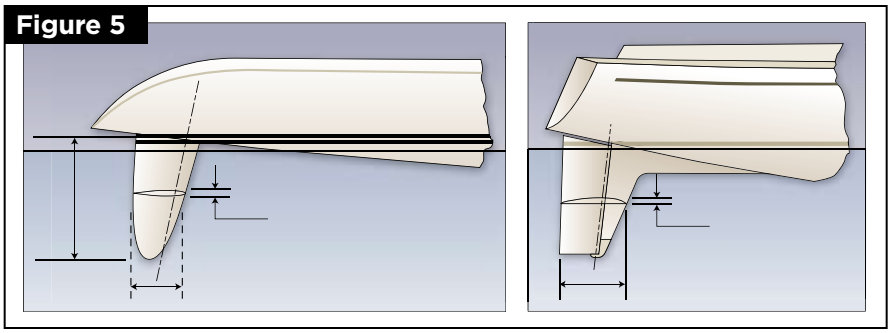
Keel Synergy

In the mid '70s, the keels on sailboats built by C & C Yachts were a swept back design but, over the next few years, the norm for the angle of the leading edge of the keel settled at around 35° to 45° with a vertical trailing edge. That was turned on its head in 1983 when "Australia II," an America's Cup contender and eventual winner, came along with a strange upside down keel with reversed leading edge angle. Reverse leading edges are not used on cruising boats because they tend to trap weeds and pot warps. Now, sweepback is nearer to the vertical, often at 30° or less. The trend is for smaller craft to have a more vertical leading edge while large vessels have a maximum sweep

Figure 4

Examples of bulb keels and end plates.

Figure 5

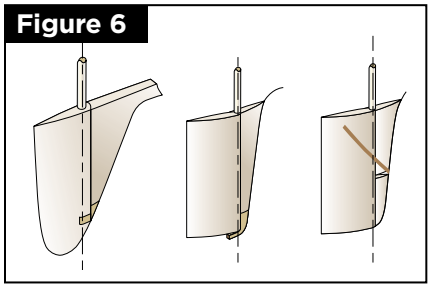


(left) Balanced rudder on racer is designed to increase sensitivity and reduce stalling. (right) Rudder with skeg is typical for cruising sailboats.

back angle of about 45°.

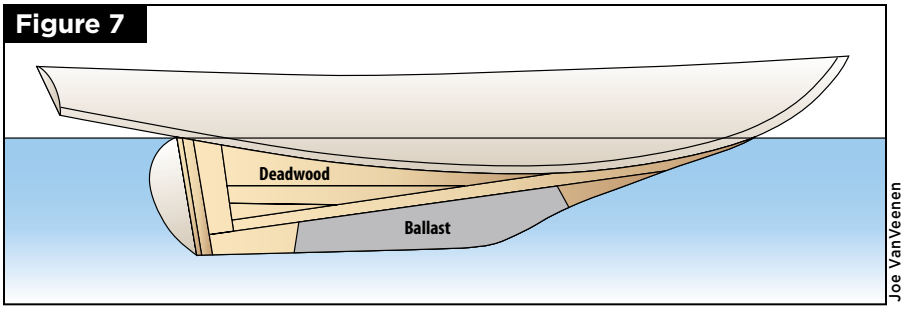
Keel thickness is usually around 10% of the chord length, with some high performance keels getting down to 6%, although the helmsman has to be very careful not to stall the keel when tacking. On a cruising boat, the keel thickness may be as high as 14% simply so the keel cavity can be used to carry the ballast. Thicker keels tend to stall less.

Figure 6



"Cross-trainer" rudders offer the best of a balanced and a skeg rudder's handling qualities.

Figure 7



Joe VanVeenen

Increased wetted surface of a full keel handicaps light wind sailing.

Trimming Keels for Optimal Speed

Using templates to fair a keel to the proper shape, size and thickness can bring dramatic performance improvements for some production boats.

Everything that makes a sail fast, its entry, chord shape and twist, also makes a keel perform well. Can you change keel trim? For the racing sailor, the keel configuration may be even more important than the sails and their trim.

There are as many reasons as there are boats that production sailboat keels aren't fair. The cost of a production sailboat ballast keel is a function of the tooling, quality of the ballast and the weight. Weight is the only portion that is controlled closely. Flawed original patterns or molds, sand castings, poor quality ballast and other factors contribute to an inaccurate keel shape, size or thickness. Cast iron keels are rarely symmetrical or fair, because they are molded in a horizontal position. The good news is that lead keels are relatively easy to fair to the correct properties with accurate templates and the proper procedure. Correcting flaws and fairing cast iron keels presents more of a challenge but it's possible.

What does the boat builder do to fair keels? The easiest and most widely used approach for fairing keels is to cover imperfections with fairing material. This process often results in a keel that is too thick and of unknown shape. If you never race your boat or don't care about performance, the keel filling and fairing approach works fine. If performance is a concern, fairing your keel with templates can positively impact your boat's performance.

In the '80s, in response to the requests of owners of J/22 and J/24 sailboats, Minnesota based Computer Keels Company (tel: 952/829-5670; web: www.compukeel.com) developed templates for a proprietary keel shape that would be allowable under each boat's class rules. The fine entry of the stock keel encouraged stalling-out as the wind speed increased. Computer Keels' redesigned, fuller forward keel shape allows sailing upwind over a broader range of angles without the keel stalling and significantly improves downwind performance. Today, templates to fair keels and to check keel alignment to the boat's centerline are available for more than 100 boats, ranging from popular production designs to custom boats.

Lead keels and cast iron keels require very different fairing processes. For a lead keel, the first task is to get the keel to the correct thickness using the supplied wraparound template and then grinding where needed. Next is to get the shape right, filling the low areas with fairing material. The final step is to get the surface smooth and then overcoat with the appropriate finish. Fairing a cast iron keel involves creating a hydrodynamic shape without having to grind away iron or increasing the keel thickness any more than necessary. The company's Universal Template Kit consists of 10 keel profiles that range from a very thin keel to a very fat keel. A template is made of the existing keel and then compared to the available profiles to select the profile that minimizes the fairing material added. The same Universal Template Kit works well for lead keels where a lack of keel design specifications precludes using the wraparound templates.

— Jan Mundy

The shape of the leading edge of a keel is also important. A parabolic leading edge is best. If you want to improve your keel's performance, make the leading edge parabolic and the first third of the keel very smooth. Having a smooth surface on the first 30% of the keel helps to improve laminar flow and lift in lighter winds.

The section shapes of most cruising keels use one of the shapes referred to as The National Advisory Committee for Aeronautics (NACA) wing sections that can be found in the book, "Theory of Wing Sections," by Abbott and Doenhoff (Dover Publications, ISBN 486-60586-8). For many years, designers used the NACA 0010 basic thickness form with a maximum thickness around 30% of the chord. Higher performance keels use a more laminar flow shape with a maximum thickness nearer the 45% chord line.

Today, there are many computer programs that can be used to design a keel or rudder. Wings 32, by Dave Vacanti, is one of the most popular. It can be found on his web site at www.vacantisw.com and costs US$295.

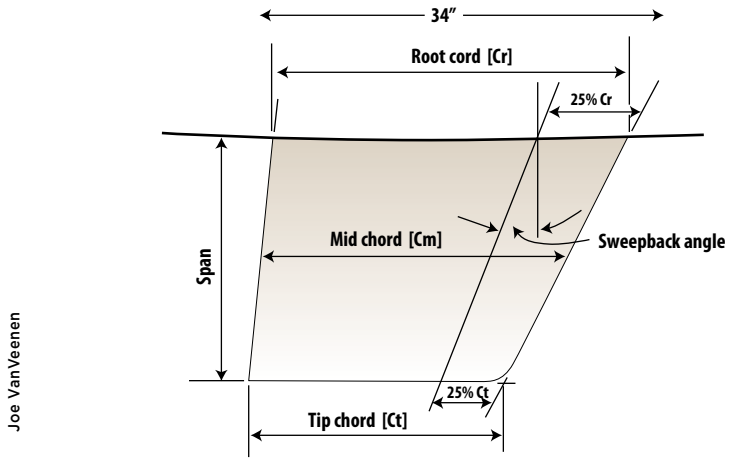
Keel design should not be considered casual sport for the boat owner or boat repairer. It's a very specialized part of boat design, with many potential pitfalls. For example, when I was on a team that oversaw the casting of a 15' (4.5m) long keel for a 12 Meter yacht, the keel plug had to be built slightly longer than specified because lead is poured hot and shrinks when it cools. The two or three inches of shrinkage could account for a fair amount of additional lead if it hadn't been allowed for. If you decide that you need a new keel design or rudder design, get an estimate from a professional designer rather than buying the program and doing it yourself.

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

Additional Reading

"Keel Conversions" in DIY 2001-#4 issue discusses fin-keel configurations and readily adaptable modifications designed to decrease draft and maximize stability.

Keel and Rudder Terminology



Aspect ratio	Often, sailors talk of the aspect ratio as the ratio between span and chord but, strictly speaking, it is the ratio of the span squared to the keel lateral area or (span)2/span x chord.
Balanced rudder	Rudder that has a little area forward of the rudder stock to make the rudder easier to handle. It makes the rudder more sensitive.
Bulb	Ballast package at the bottom of the keel.
Chord length	Keel length from the leading edge to the trailing edge.
Chord thickness	Transverse width of the keel (from side to side or transversely).
Keel bolts	Metal bolts that fasten the keel to the bottom of the boat.
Lateral area	Area of the keel when viewed from the side.
Quadrant	Quarter-circle shaped framework attached to the rudderstock and provided with sheaves to guide the rudder cables.
Rudder bearing	Support at the top of the rudderstock where it penetrates the hull. A bearing may also be fitted to the bottom of the stock when a rudder is installed on the trailing end of the keel or on a skeg.
Rudder stock	Metal tube or bar that runs through the rudder blade and through the rudder bearing to the tiller or quadrant or other drive mechanism.
Skeg rudder	Rudder with a skeg forward of the rudder. While the structure reduces sensitivity, it offers protection against pot warps and debris that might damage the rudder blade.
Span	Length of the keel from hull to keel bottom or, in designer terms, from root to tip.
Sweepback angle	Angle of the leading edge from the vertical. Because leading edges may be changed easily, most designers compare sweepback at the 25% chord line.
Thickness ratio	Thickness of the keel or rudder compared to the length of the chord. It's generally between 6% and 12%. The thicker the rudder thickness ratio, the less likely the rudder is to stall in a hard turn.
Winglets	Small, wing-like appendages attached to the bottom of keels.

Overheating: Causes and Prevention

Performance of a boat's cooling system is only as good as the weakest part. Early diagnosis and routine maintenance are key to a cool running engine.

Story and photos by Steve Auger

One of the most common and preventable inboard or sterndrive engine problems is overheating due to a lack of coolant or a cooling system failure. By understanding the relationships of the components that make up an engine cooling system and establishing routine preventative measures, you can eliminate most overheating problems.

In order to keep the engine running at an optimum operating temperature, the cooling system temperature is monitored by an automatic mechanical thermostat that controls the flow of water out of the engine block. When the engine is cold, the thermostat is closed and water in the engine block circulates until the coolant reaches the thermostat opening temperature at which point the cooling water is allowed to exit the engine. A small thermostat bypass passage allows air and a small amount of cooling water to escape the engine block while the thermostat is closed. Early carbureted inboards typically use a 140F (60C) thermostat, electronic fuel-injected engines use a 160F (71C) thermostat.

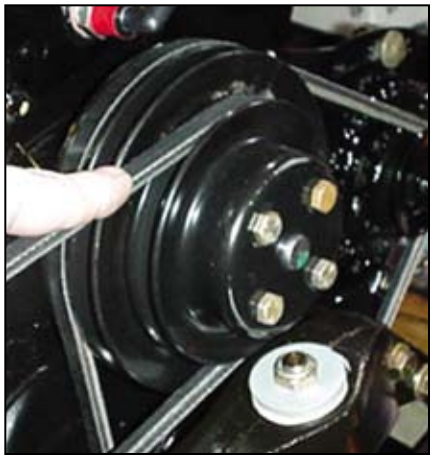
The water must remain in a liquid state to cool the engine. Water boils at 212F (100C) at atmospheric pressure, which is defined as 14.7 pounds per square inch or psi (1013.25 millibars) at sea level. However, if you raise that pressure by 15 psi, the boiling point of water is over 275F (135C). In order to achieve the required pressure of 10 to 15 psi, water pumps must maintain the minimum flow rate as stated later in this article. A cooling system has smaller outlets than inlets thus creating the required pressure. Block water pressure can be checked by installing a standard 0 to 50 psi pressure gauge on one of the block drains and running the boat at speed.

Marine inboard engines use one of two systems to cool the engine block and exhaust system. Most common (standard) is the seawater-cooled system also known as raw-water cooling. On seawater-cooled engines, the entire engine and exhaust system is cooled by the water in which the boat is being operated.

The other option is a closed-cooling system, also known as freshwater cooling. This system uses both seawater and a closed circuit filled with an antifreeze mix to cool the engine. A closed-loop system allows antifreeze to be pumped through the engine block (and sometimes the exhaust manifolds) until the antifreeze heats up to engine operating temperature. At this point, antifreeze is routed to a heat exchanger (marine "radiator") where the seawater pump is routing cold seawater through passages adjacent to antifreeze passages cooling the antifreeze before it's routed back into the engine to start the cycle over again. Closed cooling comes standard on premier products, such as the Mercury Horizon line of

To clean heat exchanger bundles, the author uses a 22-caliber rifle barrel brush installed in a cordless drill.

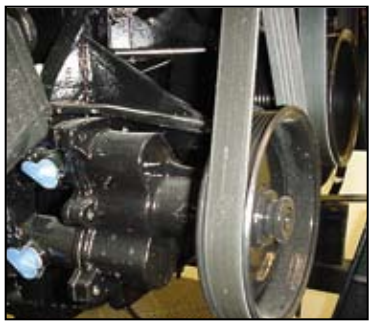
Broken water distribution pipe.



Every 300 operating hours or annually, whichever comes first: examine belts and hoses for leaks, chafing, cracks or delamination.

Placement of end cap on closed-cooling heat exchanger.

Level of antifreeze in closed-cooling recovery tank should remain constant. A drop in level means you have an antifreeze leak. If the level rises seawater is leaking into the closed-cooling system.



Belt driven seawater pump.

Keep water inlet holes on sterndrive clean. To clean, use a 22-caliber barrel brush.

inboards and sterndrives, however a seawater-cooled engine can be upgraded to a closed cooling system, e.g., a 2004 Mercury 350 Mag MPI Bravo engine can be upgraded to closed cooling with Mercury parts and accessories kit part number 865146a01 for US$3,000 or less. Closed-cooling conversion extends the service life of an engine because it promotes a better universal engine temperature and limits the corrosive effects of seawater on the engine block. Inboard and inboard-outboard engines use two water pumps that work together to provide enough water volume and pressure to keep the engine from overheating. One is the seawater pump, located in the sterndrive unit on lower horsepower sterndrive packages (Mercury Alpha, OMC Cobra, etc.). On Mercury Bravo, Volvo sterndrives and most inboard engines the seawater pump mounts low on the front of the engine, well below the boat's waterline, and it's fed by existing water pressure outside the hull during start up. The seawater pump then pushes seawater through the engine and transmission oil coolers on its way to the heat exchanger on closed-cooled engines or more commonly to the water circulation pump (the second pump) on seawater cooled engines. Once the seawater has done its job of cooling the engine, the seawater exits the engine via the exhaust risers where water mixes with engine exhaust to keep the exhaust system cool and quiet and is spilled overboard along with the exhaust.

Pressure and Volume

In order to cool an inboard engine effectively, the seawater pump must meet certain pressure and volume. Parameters are checked with the boat running at 4,000 rpm. For smaller sterndrive models with standard (seawater) cooling, such as the Mercury Alpha and OMC Cobra, usually with a shaft-driven seawater pump in the drive unit, the approximate volume equals 19 to 24 gallons (72L to 90L) per minute at 15 to 20 psi. Larger inboards and sterndrives or smaller sterndrives with closed cooling, usually with a belt-driven seawater pump mounted on the lower front area of the engine, typically measure 30 gallons (113.5L) per minute at 15 to 20 psi. Normally, the boat builder checks these requirements but, if the volume and pressure requirements are not met, an engine overheat situation is

only a matter of time. Make certain these requirements are checked, especially if your boat has been repowered or modified.

Maintenance Checklists

Below are the causes of engine overheating and prevention, starting with the most common.

1. Lack of maintenance

Before every use: Check water inlets for debris or obstructions.

After every use: If operating in salt, brackish or polluted waters, the seawater section of the cooling system should be flushed with clean freshwater.

Annually or every 300 operating hours, whichever comes first: Disassemble and inspect the seawater pump. Change impellers. Check all cooling system hose clamps for tightness. Inspect hoses for leaks, chafing, cracks or delamination. Be sure belts are tight and there are no cracks.

Annually or 300 hours, whichever comes first or after a major overheat problem: Inspect the water shutters in the exhaust system for damage or loosening. A broken water shutter can block the exhaust system, resulting in overheating.

Every 3 years or 300 operating hours: Clean the seawater section of the closed-cooling heat exchanger.

Every 2 or 3 years: Change the antifreeze in the closed-cooling system every 2 years for green antifreeze and every 5 years for pink.

2. Engine Mechanical

Improper engine set up contributes to overheating. Running an engine at below the recommended rpm due to an oversized propeller (too much pitch or diameter), a fouled boat bottom or excess weight from water absorption; incorrect ignition timing or incorrect firing order; lean air/fuel mixture and blown cylinder head gaskets are good causes for overheating. Complete a Propeller Recommendation Form [Ed: Available for the asking to DIY subscribers through our Technical Helpline] and have it analyzed for a suspect prop. There's not much you can do about an overweight boat (as opposed to a boat overloaded with people, gear, etc.), except to dry out the hull. A major tune up rectifies engine timing. Most inboard engines require a minimum 87 octane but consult your owners' manual for exact specifications. Using the correct octane fuel and properly servicing the fuel system, including checking for clogged carburetor jets, cures a lean condition. Damaged head gaskets usually occur after a major engine overheat. If you service the water pump, and the engine still runs hot at 3,000 rpm or higher, a cylinder leakage test will identify a failed head gasket. You can also install a clear hose between the thermostat housing and the exhaust manifold and, if the water in the hose has air bubbles at high speed, the problem is likely a blown head gasket.

Mercury water pump kits come complete with fasteners to convert a seawater-cooled engine to a closed-cooling.

3. Cooling System Components

Before every start: Be sure to open the seawater intake valve (this may seem obvious to some readers but it does get forgotten). Sea grass (marine vegetation) can grow long enough to completely obstruct the water intake. Keep it clean and power wash the hull and/or drive unit as needed.

Monthly: Inspect the seawater strainer for debris and clean as needed. Examine cooling system hoses and clamps. Tighten

Compare new impeller (top) to worn impellers below. Impeller with broken vane (left) has suffered from a blocked inlet or some other form of lack of coolant. When impellers that are not serviced the vanes take a set (bottom, right), which reduces the impeller's ability to maintain the correct volume of water flow required to cool the engine.

loose clamps and replace any damaged or deteriorated hoses. This is especially important when engine has had a major overheat, which can damage exhaust hoses and delivery hoses, causing the engine to continue to overheat even after replacing the water pump impeller. Defective thermostat is a reason for engine overheating. [Ed: For a complete discussion on thermostat testing, removal and replacement refer to DIY 2000-#1 issue.]

Monthly or if an overheating problem occurs: Check the coolant level. Low coolant level or incorrect ratio of water to antifreeze (closed-cooled engines only) contributes to an overheating condition. If the coolant level repeatedly drops, you have a leak. Have the system pressure tested to locate the source of the leak and repair or replace the failed component. Too much antifreeze-to-water ratio causes the engine to overheat at higher engine rpm. Always mix antifreeze and water at a 50:50 ratio. This produces a freeze point of around -35F (-37.2C).

Annually: Engine circulation pump fails due to a lack of use and usually starts leaking when recommissioning the boat after storage. Spraying the engine package with a corrosion inhibiting formula reduces the chances of failure.

Every 3 years: Replace loose or broken seawater pump drive belt.

Every 5 to 10 years: Exhaust elbow outlets are the exit points for the cooling system and can be blocked by corrosion or debris in the cooling system. Clean plugged outlets by removing exhaust elbows and sandblasting. Plan to replace exhaust elbows every 5 years in saltwater, 10 years in freshwater.

Most of the failures listed above can be avoided by adhering to a scrupulous maintenance program for your engine. Use the above checklists to develop an inspection schedule for your engine. Most engine manufacturers list maintenance recommendations in the owner's manuals. A better investment for the boat owner is an engine service manual as it contains a more detailed maintenance schedule as well as instructions for repairing failed systems.

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

POWERBOAT RIGGING

Better Handling the QL Way

A new, radical solution for adjusting a boat's trim angle is affordably priced, easily installed with standard tools, virtually maintenance-free and the ideal remedy for boats that are slow to plane and poor performers while cornering.

Kit, part number 3841717, includes two interceptor units and mounting fasteners, a control unit, control panel, two cables that connect the control and interceptor units, one cable between the control unit and control panel, plastic transom template and instructions in six languages. All components are easy to identify in clearly labeled, sealed bags.

Story and photos by Jan Mundy

How could two small chunks of plastic make a dramatic difference in the handling of a 22' (6.7m) trailerable walkaround boat with cuddy? I asked myself this question often while testing the Volvo QL Boat Trim System (BTS).

This 4,500 lb (2,041kg) cuddy with a modified-vee and a deadrise of 16° has the outboard mounted on a pipe bracket. Without the added buoyancy of an Armstrong or other outboard bracket, the pipe/outboard combination is a massive weight, loading the stern down and creating excessive bow rise, regardless of engine trim. A hydrofoil mounted on the outboard skeg improved planing speeds considerably but the boat still ran bow high, causing poor forward visibility. In cornering, the boat would dig in (list) and engine rpm dropped to where the boat came off plane. Coming out of the corner, the boat gradually gained speed and came back on plane again. Throttle down too fast and the stern dug in, burying the exhaust outlet on the engine, sometimes stalling it. Replacing the foil with Nautilus Smart Tabs (written up in DIY 2001-#2 issue) seemed like a good solution. These tabs self-adjust to changes in boat speed and the sea conditions. Though performance improved greatly to the hydrofoil, after a few seasons of use it become apparent that this boat was on the upper limit of their usefulness (these tabs are designed for smaller boats). A passive system was not going to fix this boat's trim problems nor improve the handling. Electric and hydraulic trim tabs, typically designed for larger boats, are considered overkill for small powerboats and were not, I thought, a necessity for our cuddy cruiser, until I test drove the Volvo QL BTS.

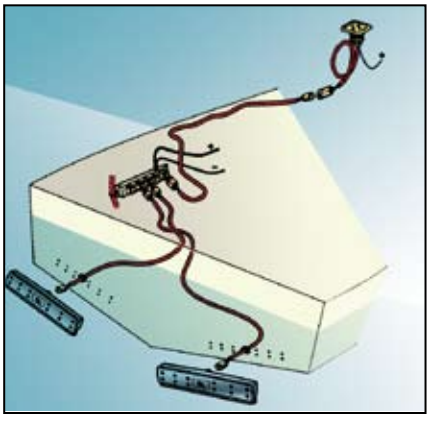
Volvo unveiled the BTS at a marine trade show last summer and the BTS earned the company an Innovation Award. Similar designs are found on megayachts but were not available for smaller boats, until now. Rather than extending a flat, nearly horizontal, plate aft of the hull, the BTS pushes a plate vertically downward, a drop of about 2" (5cm), into the flow of water. Water force on the small blade surface creates upward pressure on the hull bottom, thereby raising the stern and lowering the bow. (On conventional trim tabs, water pushes against the flat tab surface to create upward pressure.)

Two systems with either 12" or 18" (30cm to 45cm) "tabs" are designed for planing and semi-planing boats from 15' (4.5m) to 50' (15m), with maximum speeds to 50 knots. Each BTS is sold as a kit containing two interceptor trim units, one control unit, one control panel with LED trim indicators and three cables. For 32' (9.7m) and larger boats, two interceptors are daisy chained together (side by side). Interceptors are made of a non-corroding, composite material. For larger boats, optional control panels are wired in series to a maximum of four helm stations. Kits retail for US$670 and US$700.

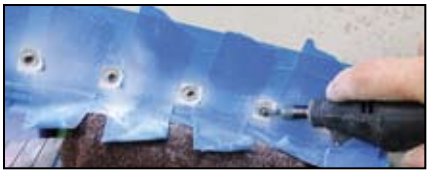
Installation

Before I could install the BTS, the old tabs were removed and the transom repaired. This involved scraping off the old sealant, grinding the edges of the existing holes, mixing up a batch of 3M Marine Premium Filler and filling the holes and then sanding the cured filler flush.

Four hours later the transom was ready but I took a break and read the installation instructions, which



Installation of single interceptors with one helm station.

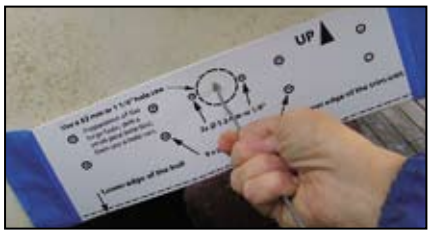


(left) Residue of 3M 4200 sealant is first cut off with a sharp utility knife, then scraped with a putty knife and then the area is sprayed with BoatLife Release and excess wiped off; Entire repair area is taped with 3M 2080 Safe Release tape and then wiped with acetone to remove contaminants; Using a Dremel with cone-shaped bit, edges of all holes are carefully beveled. (below) 3M Marine Premium Filler is mixed until one uniform color and then forced into the holes with a putty knife. Once cured, filler is sanded flush with gelcoat.

at first glance seemed confusing and why Volvo suggests you read all pages before beginning. There were a few installation hiccups, as noted below, but overall it was a very neat installation job, taking four hours to complete once I had collected all the needed tools.

Step 1
Template is positioned on the transom per the guidelines in the instruction manual. Positioning varies with engine type and chine location. Volvo recommends the farthest outboard position possible for optimum side-to-side control. This template locates the placement of the drilled holes for the interceptor unit, grommet and fasteners. Once sited, I fixed the template ends with tape.

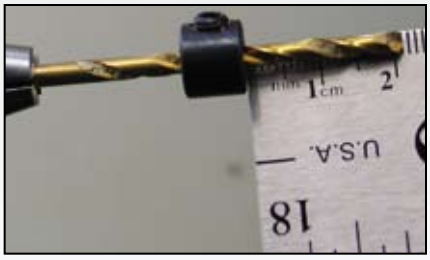
Step 2
After checking that there are no obstacles on the inside of the transom, I drilled the center hole for the grommet using a pilot bit smaller than the holesaw mandrel. Because the drill bit was too short to extend through the foam that filled the lower bilge, I inserted an aluminum

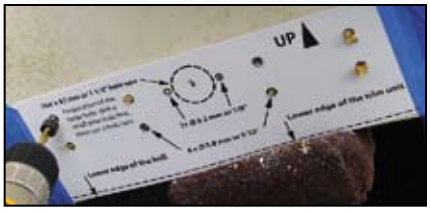


rod, which I keep in my toolbox for such jobs, through the hole and foam. The sole access to the interior on this boat is through the aft cockpit locker and, luckily for me, the rod just cleared the top of the foam on both sides; any lower and I

would have had to dig through the foam to find it.

Step 3
Rather than mark all the fastener holes and then remove the template, I drilled directly through the template using the suggested bit size. Attached to the bit is a drill stop set at a depth of 20mm plus the 1mm thickness of the template or about 7/8" (measurements are in metric), the required drill depth for the interceptor and grommet fasteners.





Step 4
Centering the hole for the grommet with a 1-1/4" (32mm) holesaw is next. Holding the drill perpendicular to the transom ensures the grommet mounts flush. (A bevel gauge held against the drill housing helps to set the proper angle.) To obtain a clean-cut edge, it's normally best to drill the hole from both sides. Since it was impossible to reach the transom from inside the bilge, luck was on my side again and the holesaw cut cleanly through the transom, cutting deep enough to allow just enough clearance for the grommet. Punching beyond the cut hole through the foam with a wooden dowel opened a 1" (25mm) gap to route the plug and cable. I like to countersink all drilled fastener holes with a countersink attachment. This prevents gelcoat cracking and increases the surface area for sealant bonding.

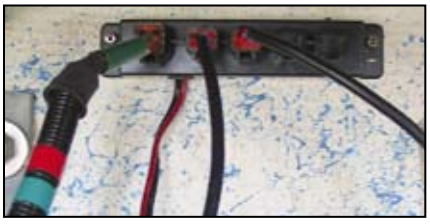
Step 5
Feed the cable with the plug socket end through the center hole until the grommet is about 4" (10cm) out from the transom. Dry fit the grommet, which should fit perfectly in a hole cut with no uneven edges. It's necessary to spray the cable with a soapy water solution so the grommet slides easily onto the cable casing. Turn the grommet so the "Up" mark faces up and twist the cable so the plug fits into the grommet.

Step 6
After solvent wiping the mounting surface to remove contaminants, the grommet and matching surface on the transom are well caulked with 3M 4200 or equivalent. Now push the grommet into the hole and line up the two pre-drilled holes and then fasten with the supplied screws and tighten. Rather than clean up the excess sealant, it is left to aid in sealing the interceptor. At this point, pull the cable out so the plug protrudes about 4" (10cm) from the grommet.

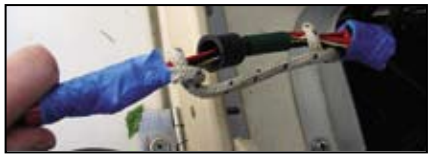
Step 7
"Grease" the inside of the grommet with soapy water so the plug slides easily without twisting in the grommet when mounted. The Interceptor has a thick integrated gasket that waterproofs the unit, except directly above the grommet. Apply ample sealant around each of the screw holes and the grommet neck as illustrated in the instructions. Press the plug into the

corresponding socket in the interceptor until a "click" sound is heard. Line up the plug with the grommet and push the interceptor into position, aligning the screw holes. Drive the supplied screws into the predrilled holes, just seating each screw. Set the drill clutch at "15" and then alternately tighten each screw. (You risk stripping the stainless-steel screw heads if you don't set the clutch to free wheel when tightening fasteners.) I tightened the screws in the order marked 1 through 8 on the photo below. Masking all edges is an unnecessary step as shown in the photos as excess sealant passed through the gasket only above the grommet.

Step 8
The control unit fit nicely on the inside of the transom, just under the deck and accessible through the aft cockpit locker door. Though this was a dry location, I still caulked the fastener holes before attaching the unit. A long stretch and I fished the cables from the bilge and then inserted the plug ends into each corresponding socket and listened for the "click." This installation used the sockets marked "P1" and "SB1" for the interceptor cables and "AUX" for the cable to the control panel.



Step 9
Next, route the cable forward to the helm under the cockpit floor. A messenger line fed through the gunwale during a previous wiring installation makes short work of this job. Just tie a few half hitches on the cable, wrap both with tape and then feed the end through while pulling from the helm.

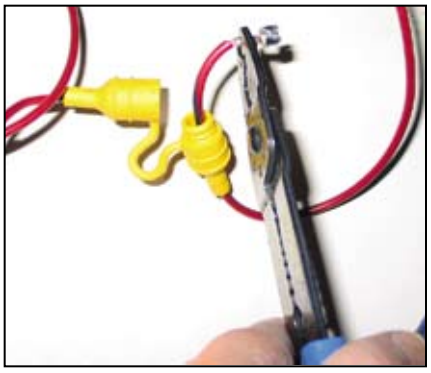


Step 10
The helm location for mounting the panel should give the driver good access and visibility. The template in the instruction manual has incorrect measurements so I used the panel gasket as a position guide. Check for wiring and other obstacles and then, using a holesaw, cut a 2" (52mm) hole. Dry fit the panel (I needed to file the edge as it was too tight) and install. Although the kit includes a machine cut gasket, I opted to coat the fitting with sealant for extra insurance. I'm not a big fan of rubber gaskets and the helm had already endured water damage to the fiberglass laminate because of improperly bedded gauges. Thread the plastic nut and tighten while holding the panel in place so it doesn't turn.

Step 11
Push the plug into the socket until it "clicks." The instructions recommend connecting the red positive wire from the panel to the engine wiring harness, specifically the start lock. Since it is impossible to connect to the ribbon cable on the Mercury Keyless Ignition system,

I connected the red power wire to the last spare fused switch on the waterproof accessory panel to the left of the steering wheel. Rather than an automatic on/off operation in sequence with engine starting, these blades are manually operated at the switch panel, which prevents damaging the blades if accidentally lowered while on the trailer.

Step 12
Lastly, connect the 22 AWG power supply cables from the control unit. These cables are long, likely longer than you'll need. I connected both the positive and negative wires directly to the appropriate battery posts. (I'll install a master switch and buss bars sometime later.) Terminal connections were waterproofed with heat-shrink tubing and an 8-amp inline fuse inserted into the positive wire.



Step 13
System calibration is next but, as the tabs sat on the edge of the trailer bunks, this waited until launching the next day. Once off the trailer, I closely followed the calibration instructions. If the panel didn't light up as instructed, an error code would appear. It's good practice to calibrate the interceptors prior to every trip to be sure the blades are not clogged with debris or barnacles.

Step 14
Four buttons on the control panel operate the interceptors either in parallel or separately. Unlike conventional controls that

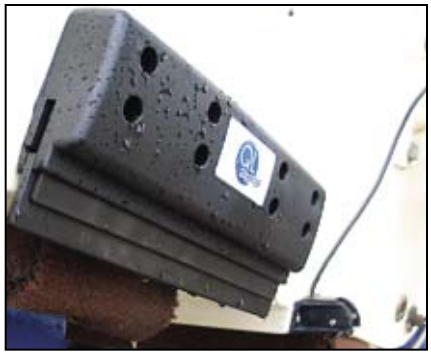
show trim tab positioning in degrees as well as percentage of deflection, the BTS control registers blade positioning in incremental steps. A green LED at the top indicates both blades are fully retracted; a yellow LED at the bottom shows they are lowered. Pressing the right or left buttons for one second moves the LEDS one more step down to compensate for a list to starboard or port.

Sea Trials

The moment that the DIY test team had waited for had arrived. I throttled up and held the bottom button on the control panel to retract the blades. The boat lurched ahead with a barely noticeable bow rise. There was no step to get up on plane. The boat stayed nearly level from a stop position to planing at speed. This boat always ran bow high but now the horizon appeared on a level plane whether the boat was

at rest or at wide open throttle; the effect was beyond our expectations. Results of the timed runs were astonishing. Time-to-plane numbers in seconds read 4.9, 4.8, 5.1, 4.7. Planning speeds in mph were just as amazing: 14.9, 15, 15.2, 15.5. (Remember, this is a stern-heavy cuddy not a performance runabout.) Even more impressive was that the boat held a cruising speed of 21.6 mph while solidly on plane, compared to 30 mph with the previous set up. While

the boat still didn't corner like a tournament bass boat, for the first time it stayed on plane, averaging a low 20.4 mph rather than the engine dropping rpm and stalling in corners. To see how the boat handled in waves, we drove in circles (besides, cornering was now fun) to stir up the water. Cutting boat speed to reduce pounding while driving into the waves, the new blades kept the boat on plane, resulting in a bow-low attitude, which reduced pounding. We didn't have a fuel flowmeter to check consumption but it's logical that getting on a plane quicker and maintaining a plane at lower speeds is sure to improve fuel economy. Volvo claims additional benefits of faster response, less drag and less



chance of damage from debris, being stepped on or when loaded on a trailer, provided they are always fully retracted.

With the boat loaded for cruising (I had removed all gear for winter storage) handling should be comparable and I can correct for any off-center loads with the port and starboard list buttons.

This simple device improves boat-operating efficiency and handling safety. Boat's plane earlier and more consistently and gain stability in cornering. With the proper trim angle there's also the promise of fuel savings. Enjoy the ride!

About the author: Jan Mundy is editor of DIY.

Readers' Boats

Remake of a **Classic Sloop**

Smitten by the sleek lines and pedigree of a 40-year-old Pearson Vanguard, this couple purchased the boat in good faith, then spent a few long months on repairs, upgrades and equipment additions getting it cruise ready.

Story and photos by Dave and Barb Heilman

When we first saw "On Location," our 1965 32' (9.7m) Pearson Vanguard it was buried under 2' (61cm) of snow and had been on the hard, uncovered for three years, braving the winters in Northern Wisconsin. As previous owners of a 1971 Pearson 26, there were only a few builders in the 30' to 36' (9.1m to 11m) range that we would consider and this boat was at the top of the list.

Our first rule of thumb for purchasing an older boat is that we must truly love how the boat sails. Second, the boat must be safe. Third, and by no means less important, we must love how it looks (or can look). Of course, time and the cost of ownership is also a consideration. "On Location" met all of these requirements nicely. However, we also knew that any older boat is a refit candidate, even if the boat has been refit many times before. Our goal was to sail, not to refit an older boat but, as anyone who buys the perfect 40-year-old boat knows, there are continual upgrades and upkeep needed to meet their changing sailing styles and lives. So, when we met "On Location," we fell in love and planned to have a long-term relationship of mutual tender loving care.

The Pearson Vanguard had the lines we adore and they were accented by lots of teak trim. The added bronze touches and beautiful spruce boom and spreaders were a plus. If you're familiar with older Pearsons, most of the interior was originally finished with a tacky, vinyl-covered pressboard. This was a bad imitation of light oak. To the builder's credit, it did not cut corners with the boat's construction, exterior hardware or brightwork. The boat's previous owner had totally redone the interior with cedar and teak. Red cloth cushions replaced the originals, which had been aqua vinyl. At our initial pre-purchase inspection, we found the interior to be esthetically pleasing.

Negotiable Details

Although we did not hire a surveyor, we did do a complete check of every little nook and cranny, every hose, every inch of the boat, inside and out. Our previous experience with older boats (this is our fourth) made us feel comfortable doing our own survey. Also, we have always been lucky dealing with owners who are overly honest about the inadequacies of their boats. One major concern was the original Atomic 4 engine. As there was no way to put the boat in the water and test run without a great deal of added expense and time, we had to trust the owner's assurance that it ran as promised. [Ed: Beware the "an old granny sailed this boat on sunny Sundays" sales pitch. Purchasing a used boat can be risky business without a thorough professional survey and, if you expect to be able to insure the boat, you'll be required to prove its insurability with a survey by a surveyor accepted by the underwriter.]

Classic 1965 Pearson Vanguard.
"The result of all our work is a boat that draws a crowd wherever we go. Although most of the other sailors in our homeport are familiar with our boat, a recent trip to Sheboygan, Michigan, is an example of what we have come to expect when we travel. Before the docklines were tied, there were four sailors on the dock wanting a closer look at this classic beauty."

This has definitely proven true. In fact, since we had no previous experience with an inboard engine we were reluctant to try to start the engine before relaunch. The previous owner told us that while the fuel was three years old it did contain his special mixture of Marvel Mystery Oil, a lead substitute, Stabil and Heet gasoline antifreeze and a water inhibitor

January 2003: Our first look at the future "On Location." Navigating the snow at the helm is "captain" Barb.

and should start and run well enough to get us from the launch area to our mooring. So we launched and hoped for the best. We pulled the choke and pressed the starter button. The engine started and purred like a cat. All we have done since then is to keep using his special mixture of additives and each spring, we drain the water out of the water separator, change the plugs and change the oil. We see no reason to replace a perfectly good engine.

Deck work begins with removal of all hardware.

Overall, we found very little wrong with the boat, except two small soft spots on the deck, chalking of the deck paint and general deterioration of brightwork finishes on the exterior. Also, the boat lacked essential (for us) backing plates under all lifeline stanchions and deck hardware. In retrospect, we were somewhat blinded by our infatuation with the boat, as well as our naivety about deck repair. Although we did negotiate the price down from US$19,500 to US$17,000, based on the deck problems, it did balance out somewhat in cost, not counting our time investment.

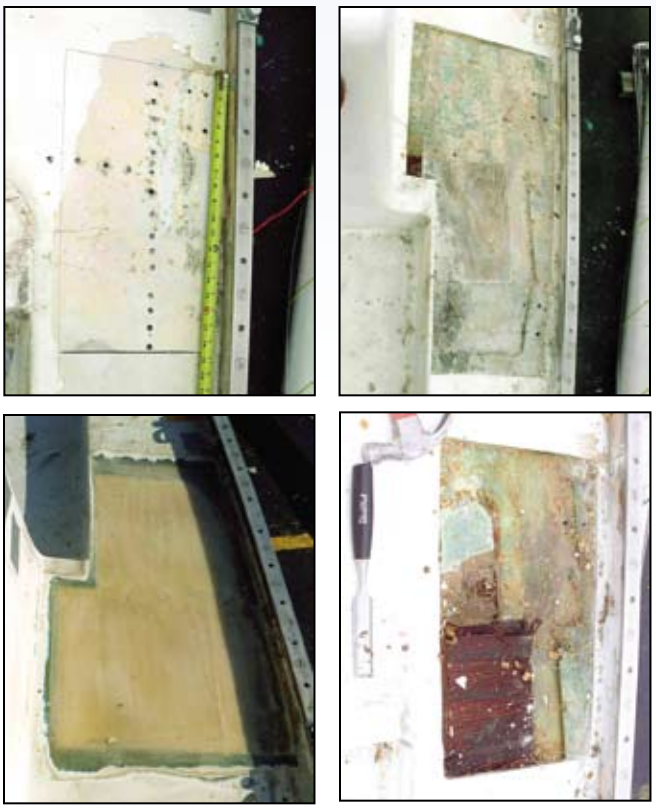
This was January 2003. Three months later we had the boat transported by a professional boat mover the 360 miles (579km) to our local marina. Being optimistic, we set the launch date for the end of April.

Repairs Before Launch

We began our true survey as we made lists of things that had to be done, what should be done and what would be nice to do. The “had-tos” related to the deck. As we had no knowledge of deck core problems and repair, we first had to educate ourselves about this process. The results were not pretty, as we now know that “small” soft spots can indicate major problems with deck core integrity. The condition of the deck suggested that the whole deck needed refinishing, as did all the brightwork. Since we also wanted to reinforce stanchions and other deck hardware with improved backing, the only viable solution was to totally strip the deck of all hardware and brightwork. This task took two people two full days.

Launch date was moved back to early May but the real launch date evolved to mid-June. We began the work in earnest. All brightwork was brought to our studio’s camera room where it was stripped of all old finish. Any damage was repaired and then refinished the wood with two coats of Cetol Marine Light and four coats of Cetol Gloss. Each spring, we give all the brightwork a light sanding followed by two more coats of Cetol Gloss.

Three year’s exposure to the harsh Wisconsin winters (a good reason to cover-up in the winter) had left the deck in very poor condition. Severely chalked paint stained the recently painted topsides. In addition to this, there were the two soft spots along with numerous areas of cracking and blistering. Having no experience with this problem, we consulted the repair staff at our marina for advice. Their opinion was that some sort of material had been applied over the original non-skid deck surface and that this was starting to let go. They felt the only real option was to grind the deck down below the gelcoat and start over, which they would be happy to do for a cost of about twice what



Wet deck repair: (clockwise, top left) Pilot holes drilled in deck to determine extent of wet core. The small area got larger with every drilled hole; Outer skin and core removed from area of core repair; Removing the wet core; New foam board in place with one layer of System Three resin.

we paid for the boat! A call to the previous owner net zilch as the deck refit was done before he bought the boat eight years before. So, at this point we turned to the same source for advice as we had for the brightwork, namely the magazine and it's free Technical Helpline and, in our opinion, one of the web's best owner's groups, pearson-vanguard.org.

After much research in past issues and online, we decided on the following course of action. First, wash the deck with a strong detergent and then give the deck an acetone bath to make sure all traces of grease and oil were gone. Next, we cut away the gelcoat from the two areas of soft deck and removed the entire wet core, replacing it with one of the newer foam core materials (i.e. Divinycell, Klegecell or equivalents). By covering the foam with mat and resin, we were able to level the repaired area with the older section and then we sanded the entire deck with a belt sander and ground out all of the areas where cracking and blistering occurred. Jamestown Distributors recommended using System Three resin, a pre-mixed system that's a no brainer for first-time users of epoxy resin. Once set, it sands easily and is compatible with Awlgrip fairing compound. Next, we faired, sanded, faired, sanded, faired, sanded and then we faired and sanded some more. Two coats of primer and four coats of non-skid paint later we were finished. We reinstalled all the deck hardware with 1/4" (6mm) aluminum backing plates. A year later, the repairs seemed to be holding up quite well.

Interior Refinements

Pearson made two interiors for the Vanguard, the standard layout that was big on seating but short on storage and berths and the dinette, which was short on seating but slightly better on storage and much better on berths. The interior of "On Location" started life as a dinette version and had evolved to a hybrid of each, with the goal being a comfortable cruising environment for a couple that rarely, if ever, would have overnight guests. It's a boat that will drink six, feed four and sleep two.

New replica cockpit coaming emblem of cast bronze.

All exposed interior areas of the hull are covered with a thin layer of foil insulation followed by white cedar strips, fitted into place. The result being an interior that remains cooler or warmer longer as well as having a more pleasing and bright appearance. A custom louvered door for the rope locker gives the vee berth a more finished look. To complete the wood interior look, all bulkheads are covered with Western Red Cedar strips. All wood is finished

Brightwork was stripped then coated with Cetol Marine Light followed by Cetol Marine Gloss.

Launch day, June 2003.

with a mixture of equal parts gum turpentine, spar varnish and linseed oil. Each spring, this finish is wiped on the wood, allowed to set for a couple of minutes and then wiped off.

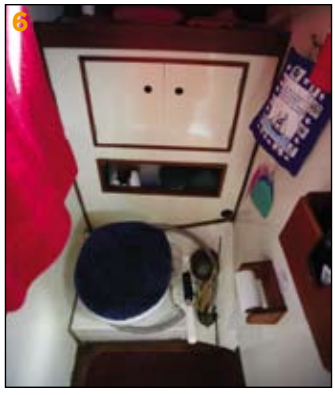
Some time in the boat's past, the owner removed the sink and its plumbing in the head, as it was redundant with the galley sink only two steps away. At that point, the toilet was replaced and the cabinets were refinished. The hanging locker was divided and shelves installed to make the space more usable. A handmade cherry-wood table with fiddles replaces the original pedestal supported dining table.

In the galley area, the original icebox and cabinets were removed and the sink moved aft. This area now includes a small settee and open shelves with removable fiddles. A non-pressurized alcohol two-burner stove replaced the original pressurized alcohol fueled two-burner stove with oven. This change allowed space for an icebox as well as dry storage areas behind and below the stove.

Where once was the starboard quarterberth, we now had additional dry storage that is accessible from both above and in front. A new bulkhead made the starboard cockpit locker an ideal sail storage locker. At this time, new breaker panels were installed as well as a cabinet for the radar and GPS just aft of the starboard port lights.

The port quarter berth was also removed and replaced with the following: two fiddled shelves that run from the dining area to the new bulkhead installed at the forward end of the port cockpit locker; a DC refrigerator and, just to the starboard side, two small storage bins.An opening port light was installed just above this area at the cabin's aft bulkhead. Two house batteries now live in an area below the quarter berth on a piece of marine plywood that was glassed to the hull. [Ed: Always install batteries in acid-proof boxes or trays with hold-down straps and terminal protections.] These batteries are charged by both an 85-watt solar panel mounted to the stern rail and, when the engine is running, a high-output alternator. The engine start battery is located in the original battery compartment and charged by the alternator only. There is a two-position battery isolator/selector switch along with Heart Interface monitors that let us know the system is healthy. The cockpit locker has been divided into two sections with the forward compartment holding tools, a Zodiac life raft and a ditch bag. The aft compartment is for line and reserve anchor storage.

The aft section of the salon was modified by raising the engine compartment cover approximately 6" (15cm) to the new countertop height that now occupies the space where the original quarterberths were. This made a much more friendly access



Interior refit shows (1) cedar strips lining the vee berth and cabin sides; (2) new dinette table and cushions; (3) starboard galley with new icebox, sink, stove, storage and forward seating area; (4,5) starboard countertop and icebox, new circuit breaker panels on aft bulkhead and custom cabinet above for GPS and radar, and redesigned port quarterberth with battery storage locker underneath shelves; (6) modified hanging locker; (7) new head.

Photos courtesy of Mark McEvers, owner of "Vagabond," Pearson Vanguard hull number 355.

Original interior: (top) View forward of original interior with starboard galley and port dinette. (bottom) Port and starboard quarterberths and companionway details.

to the engine. Also, the additional overhead room for the engine made for lower temperatures in the engine compartment. This is important because many Vanguard owners have had problems with ignition coil failure due to excessive heat in the engine compartment. We have not had to move our coil away from the engine onto the bulkhead, as many others have had to do to combat the problem. Two small opening port lights added to the forward end of the cabin top step down improve lighting and ventilation below. All cabin lights were replaced with Alpen Glow fixtures, two of which have red LED chart lights.

Finishing Touch

One exterior change that was purely cosmetic was the reinstallation of the Pearson cockpit coaming emblems. These factory emblems were pot metal and had deteriorated beyond reclamation. When we unpacked some boxes of stuff that came with the boat we found the original emblems. Both were broken into several pieces but one of them had all the parts. We sent the parts to Bristol Bronze, where they used the pieces to make a mold and then cast three new emblems of bronze.

The cost of repairs and equipment upgrades reached US$19,000 (see DIY Bill of Materials on page 60). Was it worth it? If you purchase a mostly original, in fair condition, mid-60s Vanguard expect to pay around US$10,000. To bring it to the condition similar to our boat, expect to invest another US$20,000, depending on your taste and budget. Your can have a classic 40-year-old 32' (9.7m) yacht like the Vanguard, in pristine condition, that can take you anywhere in the world and turn heads wherever you go for about US$30,000 or a new 32-footer for US$100,000 or more? It's your call.

Future Delights

As we draw closer to the possibility of selling our business and having more leisure time, there are some things we may want to do in order to live aboard part of the year and possibly do some bluewater cruising. At the top of the list is a new mainsail with a flaking system that works, if there is such a thing. I need to finish and install a cherry wood cabinet, install a good cabin heater, air-conditioning system, smaller and opening portlights in the salon, solar shower system and the boom gallows that came with the

DIY Bill of Materials

Interior Remodeling

The previous owner did the remodeling of the interior, to the best of our knowledge, over two off-seasons. He first developed a plan and materials list. Then, one season he spent doing the work with the materials cost (no hardware) being just over US$1,000.

Exterior Restoration

With us working on alternating days, Monday through Friday, and both of us working on weekends we did this work. We started in mid-April and finished in late June, a total of 10 weeks. Prices quoted are 2004 material costs in U.S. dollars.

1 gallon (3.78L) of Cetol Marine Light	$95
1 gallon (3.78L) of Cetol Marine gloss	$120
1 gallon (3.78L) of System Three resin	$69
1 gallon (3.78L) System Three filler	$18
1 gallon (3.78L) System Three hardener	$94
Fiberglass woven matt	$15
Foam board deck core	*A
5 gallons (18.9L) marine-grade stripper	$250
Sandpaper and nylon stripping pads	$100
5 gallons (18.9L) acetone	$50
5 gallons (18.9L) mineral spirits	$70
Several rolls of blue painter's tape	$84
3 badger hair paint brushes	$60
1 gallon (3.78L) Awlgrip fairing compound	$47
2 gallons (7.5L) Interlux deck primer	$160
2 gallons (7.5L) Interlux non-skid deck paint	$224
1 gallon (3.78L) Interlux 333 thinner	$38
1 6' (1.8m), 3/4 by 5' (19mm by 1.5m) teak board	$95
3 cast bronze cockpit combing emblems	$225
1/4" (6mm) aluminum backing plate material	*B
Various grinding wheels for a power drill	$25
1 gallon (3.78L) brass polish	$72
1 gallon (3.78L) Interlux bottom paint	$185
Disposable rubber gloves	$25
3M 101 polysulfide caulk	$36
2 gallons (7.5L) Awlgrip topsides paint	$368
Miscellaneous	$175
Total	$2,700

(Remember the marina's estimate for just the deck work!)

*A We got a break here as the marina had just completed a large job and had several scrap pieces of 2" (5cm) material that they gave to me. I cut and ripped them down to the correct size of 1/4" (6mm) and then sanded to a bevel that worked on the side deck.

*B I had a piece of 1/4" (6mm) thick aluminum on hand that I cut down.

Equipment Upgrades

Apelco VHF radio	$200
Garmin GPS unit	$699
Raytheon Radar	$1,140
Datamarine Depth sounder	$239
Navico Tiller pilot	$649
Pioneer AM/FM/CD player receiver	$269
20 gallon (75L) holding tank	$119
Igloo 12-volt DC refrigerator	$130
Raritan PH11 Marine toilet	$350
Two brass cowl vents	$450
Two teak storage boxes	$400
Magna Propane grill	$249
Bronze builder's plate	$50
Teak cockpit grate	$500
3 cockpit cushions with self-draining foam	$500
85-watt Shell solar panel and controls	$1,000
Breaker boxes, three panels	$479
Alpen Glow interior lighting fixtures	$480
ABI bronze, double action windlass	$2,363
Bronze boat hook with mahogany handle	$165
Two-burner, non-pressurized Origo alcohol stove	$570
Four-person Zodiac liferaft	$2,500
Ditch bag (self-made)	$200
Medical kit (self-made)	$200
Danforth Compass	$130
Boom preventer	$120
Boom gallows *C	$200
Water pump	$200
In-line fuel filer	$5
In-line fuel/water separator	$85
Balmar High-output alternator/regulator	$400
Heart Battery monitor	$370
Battery isolator/switch	$35
3 deep-cycle 12-volt marine batteries	$390
PSS shaft seal to replace stuffing box	$250
Electric fuel pump	$85
Crankcase ventilation kit	$80
3 blade stainless-steel propeller	$149
Electronic ignition	$100
Total	$16,500

*C For bronze fittings only as the wood arch was hand-made by us.

boat but has never been installed. We need a teak mast step box with storage for winch handles and sail ties and a companionway sea hood. We need to refinish or replace the cabin sole and make the hull-to-deck joint watertight. (This is an issue on all Vanguards.)

About the author: Dave Heilman is a professional photographer and former canoeist until he meet his to-be wife Barb, who had owned a Newport, then a Cape Dory and now sailed a Pearson 26. When it came time to move up she had two guidelines: no bleach bottles and the boat had to talk to her the very instant she set foot on board. The Heilman's cruise "On Location," a 1965 32' (9.7m) Pearson Vanguard, from their homeport of Manitowoc, Wisconsin.

Different Strokes

Continued from page 39

All brightwork on "YNOT," a reworked 1950s Wilbur Storter runabout beautifully crafted by the LeDonne family of Pittsburg, Ohio, was finished following the Awlgrip System III Brightwork Finish.

hours to cure before applying another two or three coats and repeat until eight coats are applied. When cured, lightly sand with 320-grit paper and apply two light coats of Awl-Brite Plus. By combining the two varnishes, Awlgrip System III Brightwork Finish achieves the traditional color of a spar varnish with the fast recoat, long-term durability and easy-to-repair properties of a three-part acrylic urethane. Refer to the application instructions for the manufacturer's specifics on cure and recoating times. The one drawback to using these products is their toxicity, which requires wearing a full-face fresh-air supplied respirator. Any imperfections in the final finish are easily buffed (see "Maintenance Tricks," next page).

Bristles Vs. Foam

Best results are achieved using badger hair brushes or throw-away poly-foam brushes (the best are made by Jen Mfg.). Your tool of choice depends on what you are most comfortable using. Scott likes foam brushes on flat surfaces, applying varnish in his "thicker the better" method, but uses bristle brushes on detailed areas. Doug prefers quality natural bristle brushes. "Foam brushes are good for tipping the varnish but bristle brushes give you better control of the thickness of the applied varnish and they have enough stiffness to properly pull the varnish." Ideally, you want to apply varnish 3 mils thick,

Additional Reading

"Varnish Ding and Scratch Repair," DIY 2001-#2 issue
"Varnishing Techniques," DIY 1998-#3 issue

with a total base of 10 to 12 mils after eight to 10 coats.

Regardless of the tool you choose, you'll need an assortment of sizes from 1" (25mm) to 4" (101mm). Apply varnish with firm pressure, moving the brush with the grain and feathering out the stroke. Use the tipping method, lightly stroking the surface with the brush held at a 45° angle, to remove any air bubbles.

Good quality bristle brushes are expensive. Keep one reserved for varnish only and before using, dry clean the brush by flicking the bristles back and forth to remove dirt and other grime. After completing the job and cleaning the brushes, Doug advises storing them wet by suspending them in diesel fuel or kerosene. "Diesel is oily enough to keep bristles soft and keeps the brush clean." Before reusing, rinse the brush two or three times in solvent. Change the diesel bath once or twice a year.

Maintenance Tricks

Varnished wood doesn't have to be high maintenance if you master these trade tricks. Regardless of the varnish you choose, apply the suggested number of coats to achieve an effective level of UV protection. The more the better, according to Scott. "If it's a 180' (56m) yacht and the customer is looking for a royal finish, we apply 16 coats of one-part urethane and we advise the application of three more coats every six months." How often a varnish needs recoating depends on latitude. Traditional and one-part varnishes normally need recoating annually in southern climates; every two to three years in northern regions. Two-part varnishes lasts four years or longer. Loss of gloss is the first hint that it's time to recoat.

The hardness of the two-part urethane varnishes allows easy removal of brush marks, bristles, hand prints or other blemishes using 3M Perfect-It III. This all-in-one rubbing compound removes defects and then restores the coating to an ultra high-gloss finish. For the ultimate finish, spray it on the surface and wet sand with 1,500-grit wet/dry sandpaper. To restore gloss, just lightly wet sand with 2,000-grit paper or machine buff with a lamb's wool pad. Be careful not to apply too much pressure, especially around corners, or you'll remove more film than necessary but you can always reapply. This is a tedious process that requires patience and practice but you'll end up with a great finish. "It comes out just flawless, like the top of a grand piano," says Scott. Scratch repair is also easier with a two-part varnish. Just sand out the scratches and reapply the varnish. To maintain the finish, the LeDonne family recommends weekly washing with a mild cleaner (e.g., Awlwash) and never applying wax.

Even though the amount of time and effort expended in varnishing brightwork directly reflects the beauty and durability of the final finish, you can take some shortcuts. It's a matter of comfort level. Purchase a product you like, put on your favorite tunes, take your time and enjoy yourself. When properly maintained, varnish lasts years. If varnishing doesn't fit into your lifestyle, you can always paint or replace the wood with maintenance-free Starboard (I love this stuff) or stainless steel (railings and handholds).

About the author: Jan Mundy is editor of DIY.

PROJECTS

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

APPRENTICING IN OSMOSIS REPAIR

A good moisture meter, lots of patience and six weeks of your own labor is all a DIYer needs to tackle a blistered bottom repair.

9


Talkback Q&A

Outboard Duty Cycles

What Won't Catch Bass

Sound Fix for a Wet Transom

Wiring Battery Direct

At the time I bought my 1990 Cadorette 210, I was relieved to see that it showed no signs of hull bottom blistering. That was 2001 and, at the end of the season when I removed the boat from the water, I saw tiny blisters on the hull below the waterline. Since I had read articles about this, I recognized the problem immediately. I monitored the progress for the next two seasons and each year the blisters became slightly larger. It was time to make a decision to repair it myself or have the boatyard repair it for me.

The most difficult part of beginning this repair was learning what was really involved. Most of the people I questioned felt that this is a job for a professional. The pros at the marina where I keep my boat estimated $4,000 for the job. They also suggested that they could sandblast the hull and then I could complete the repair myself. I jumped at the opportunity, seeing it as the best of both worlds.

In the fall, the yard hauled and blocked the boat. I removed the trim tabs and transducers to prepare the hull and the yard sandblasted the bottom. [Ed: See note at end of article advising against sand blasting.] Now the only thing to do was to wait out the hull drying process.

In the spring, I purchased a moisture meter to read the level of moisture in the wetted surface laminate. After taking baseline readings from the hull above the waterline, I found the readings were relatively elevated and uniform over the bottom with the exception of the transom, where the readings were much higher, with the highest readings around the are where the trim tabs were mounted. I contacted the DIY Technical Helpline for advice on dealing with the transom. They suggested various methods from removing the entire inner skin to expose the wood core, to drilling holes 1/8" (3mm) in diameter at regular intervals, drilling from inside of the boat to ventilate the core. The only way to truly repair the transom would be to remove the inner skin of fiberglass from the transom, remove the wet plywood core, install a new core and replace the inner skin. [Ed: This procedure is documented in DIY 1998-#4 issue.] However, this would be a monumental task. In my particular case, I did not feel this was necessary, since I could see no signs of the transom being in any danger of structural failure (i.e., no spider cracks, etc.). Therefore, I drilled the holes. Then I left fans blowing on the area for several weeks. I also tried various other methods of drying this part of the hull including a hair dryer, injecting the hull with acetone and tenting the area. It took several weeks but the meter readings came down and I was now ready to begin the repair work

The first step was a freshwater washing to remove water solubles, then a wipe down with acetone to remove any contaminants and moisture from the surface. It was necessary to mask-off the area to receive the barrier coat. I used the line created when the marina sandblasted the hull as my guideline and placed the tape 4" (10cm) above.

Now began the actual process of barrier coating the hull. The first step was to prime the surface. I was using the Sikkens system so the first coat was Sikkens Epoxy Heavy Coat, a two-component epoxy adhesion primer. I was not sure exactly what to expect when I first opened the can. Would it be sticky like glue? How quickly would I need to apply it? It comes in two cans that are proportioned so that you simply mix them together and then thin out the combined product by 10%. (Mixing the epoxy heavy coat in small batches would have increased the working time and made it much easier to apply.) This primer was applied using a roller for most places but, in tight areas, I used a brush (around the strakes for example). This took about four hours. The end result was a surface that felt rough to the touch. I assume this was to give the next step in the process some “tooth” to adhere to.

Next step was to fill the imperfections in the hull where the blistering was exposed by the sandblasting with Sikkens Epoxy Finishing Filler, another two-part epoxy. Using a plastic applicator, I applied a thin coat of filler over the area that was masked, scraping off the excess as I went. This filled just the low spots. Again, I was not sure what to expect from this filler. Would it dry fast like body filler and begin to kick off halfway through a coat? Actually, I found application to be very easy. The first coat filled the majority of imperfections. After a 24-hour drying time, I sanded the high spots with a random orbital sander and 80-grit paper, then I applied the second coat of filler, let it dry and sanded once again. By now, the bottom surface was nearly 100% fair with only small imperfections. Two more coats of filler followed, then a final sanding. At this point, I was

happy that the surface was fair.

Another coat of Epoxy Heavy Coat Primer was applied but this time I mixed it in smaller batches. I found this worked better than mixing the two cans together all at once. The final phase with the Epoxy Barrier Coat GP was now applied. Five coats of this coating were applied in succession, ensuring adequate drying time between coats. I applied it with a brush and a roller in the same method as the primer, though the barrier application seemed to be a little easier and smoother. Each coat required 24 hours of drying time before applying the next coat. Five days later, the barrier coat job was completed. The surface was primed again in preparation for the application of the antifouling paint.

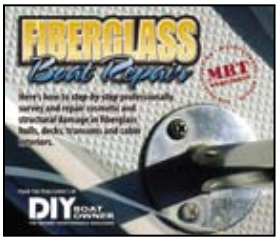
Once the hull blocking was relocated from its initial position supporting the hull, it took another 10 days to prime, fair and barrier coat these small bare areas since they had to go through all the application and drying cycles of the process. To cover the entire bottom surface with antifouling paint, it was necessary to move the hull blocking again to expose the previously obstructed areas. The bottom repair job was complete and I reinstalled the transducers and trim tabs.

I would do a few things a little differently if there were a next time for this job. First of all, I would have bought the moisture meter in the fall when the boat was first sandblasted and monitored the drying process more closely. I think it would be wise to take measurements weekly to see how the drying is progressing in all the areas of the laminate. Had I done this, I would have seen the problem in the transom core much sooner. This would have allowed me to take action much sooner to facilitate the drying process.

On the whole, it wasn't a difficult job to complete, although it was very time consuming. Would I do it again if I found I had bought another boat with this problem? I would but it's important to note that the aptitude you need the most to complete this job correctly is patience and six weeks of your own labor.

— Scott Hartill has been cruising Ontario's Trent Severn waterway for 10 years. He is an avid do-it-yourselfer who enjoys the challenges that go along with doing all his own maintenance and repairs and frequently consults DIY's Technical Helpline for assistance.

[Ed: Sand blasting to remove contaminated laminate is risky business, often requiring great effort to restore a fair bottom surface. The preferred method is baking soda blasting, which is less intrusive, or better yet, peeling that removes a controlled depth of gelcoat and/or glass laminate, which results in a smooth, even surface for the relamination and barrier coatings. In addition, any particle blasting is now being strictly controlled by environmental regs. DIY has numerous past articles on how to professionally repair blistered hulls, available on the MRT Series "Fiberglass Boat Repair" CD-ROM. For a complete list of topics in past issues log onto www.diy-boat.com and click on "Index 1995-2007" or call toll-free to 888/658-BOAT (2628) for a printed copy.]



RENEW INTERIOR TRIM

If the "bunny fur" in your boat's cabin or the trim panels in the cockpit have lost their appeal, you can update the look without breaking the bank. You have nothing to lose but a drab interior.

9

You can spend a fortune on trimming materials for cabins or you can use the less expensive carpet materials on the market today and produce a smart look and durable finish that lasts for years. For cabin interior soft trim, I use foam-backed carpet with a ribbed weave as it's inexpensive, very durable and has amazing insulating properties, even when applied directly to painted steel, which is notorious for condensation problems. These properties make it ideal for use on fiberglass.

Step 1
A new forward bulkhead was cut and bonded into position to provide a watertight barrier between the anchor chain locker and accommodation area.

Step 2
I cut a section of carpet to fit and, after coating the bulkhead with flooring adhesive, applied the carpet. Experience has taught me that vinyl flooring adhesive is ideal for this job. It's non-toxic, agreeable to use and available from most carpet sellers. It also allows for adjustments during fitting since it's not a contact adhesive. The next section was the large area of the port side hull. The slow-drying flooring adhesive allowed time to cover the whole area in one session without fear of its drying too quickly.

Step 3
The front of the platform that was constructed to hide the water tank fill fitting and takeoff was covered in the same manner and the newly varnished top fitted ready for adding a trim strip on the front.

The next job was to line the cabin overhead beneath the foredeck as this area had been covered with carpet glued directly onto the fiberglass. While the hull surfaces inside were smooth and looked good with carpet over the surface, the underside of the foredeck molding was reinforced for strength and many bolts

fastening the various deck fittings were protruding into the line of vision (visible in Step 1). The prerequisite for a neat headliner or any upholstered panel is ensuring that the plywood panels fit perfectly before beginning any upholstery work. For this size panel, 3/16" (4mm) ply is ideal as it's light enough to handle and easy to cut accurately.

Step 4
I rely on exact measurements of the area, transferring these onto a sheet of plywood and then cutting everything slightly oversize as a safety precaution. With trial and error, dry fitting and then trimming, both panels fit satisfactorily with a 1/4" (6mm) gap all round to allow for the thin foam sheet and vinyl covering to be wrapped over the edges for a neat finish.

Step 5
Upholstering panels is easy and requires only a pair of scissors and a staple gun. A layer of 1/2" (12mm) foam gives the finished panel some depth. The foam is first cut to shape allowing a couple of inches all round the panel. The excess is pulled over the edges and stapled onto the back of the panel. Be gentle with the foam to avoid splitting it as you wrap and fit it while stapling.

Step 6
Next, cover the foam with the material of your choice. I used a white vinyl to give a bright finish to the cabin. The vinyl is dealt with in the same manner except the staples are closer together to provide a uniform straight edge along the sides of the panel. Corners can be tricky and a little experimentation may be required. The basic corner folds can be seen in the photo.

Step 7
Inside corners are more difficult to deal with than outside corners, as the material must be stretched around the corner without tearing. This is one reason I use vinyl as it has good stretch properties. The corner folds showing at the edges will be hidden from view when the panel is fitted into position.

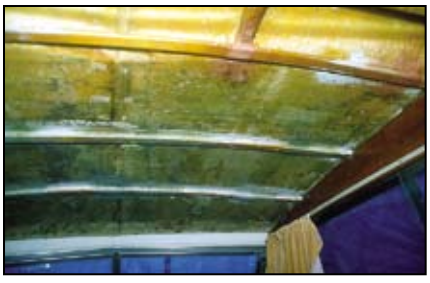
Step 8
Panels are now ready for fitting. Mark out a pattern for the fasteners before drilling the holes otherwise a haphazard pattern might

spoil the uniformity of the panel's appearance. I use plain white plastic grommets to match the vinyl. If you are using a patterned material, purchase plain grommets available at fabric shops and make your own or have an upholstery shop produce matching covers. The gap at the top edge of the panels will be trimmed with a simple folded carpet strip. Foam and vinyl are available from upholstery suppliers. Check the Yellow Pages or Web for your local upholstery supplier.

Step 9

The cabin headliner was covered in a ribbed carpet with varnished beams screwed up to hold it in place. While I like carpet on hull sides and vertical surfaces, it doesn't look right on the headliner. So all was removed and the carpet discarded.

Step 10



Beams were bonded to the overhead using fiberglass mat and resin to act as bearers for the new ply supported headliner. Whenever possible, I try to recycle timber to avoid additional expense. If you are not familiar with fiberglassing techniques, System Three offers epoxy resin pre-mixed with the necessary structural fillers that makes a strong putty of the proper consistency and only requires the addition of a hardener. It can be troweled over the mating surfaces of the overhead and the beams, which are then pressed together and the edges nicely filleted. Ensure surfaces have been well abraded with 80-grit sandpaper to give a good key before starting and support the beams until the glue (or fiberglass) has cured.

Step 11

The headliner plywood panels were carefully measured, marked and cut out following the same procedure as for the foredeck overhead. They were cut so that the joints half way overlapped the new beams. A screw with an oversize washer just set into the beam made a good temporary clamp while making final adjustments to the size.

Step 12

PROJECTS WANTED

If you would like to share one of your own boat-tested projects, send your articles to DIY PROJECTS via mail or e-mail. Include a brief explanation and photos and/or sketches (don't worry, we'll redraw the art). Also, please include your mailing address and a daytime phone number or email address. If we publish your project, we'll send you between $25 and $150, depending on the published length.

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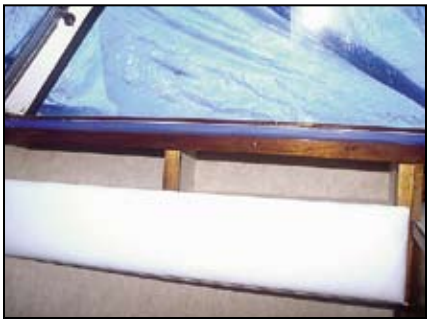
The headliner posed additional complications as it had to fit around the toilet compartment and the companionway hatch and required several more trial and error fit and trim steps than the foredeck liner.

Step 13
Perseverance does pay and a good fit was achieved at all points.

Step 14
The final finish really brightened up the accommodation and gives a smart, modern appearance.

Step 15
The seat backs that cover the storage shelves along each side of the hull were covered in a grubby grey material that was far beyond restoration.



Step 16
Recovering them was very easy compared with the headliner panels as, once the old material was removed, I found the foam to be in good condition and simply recovered it with matching white vinyl and the same method used for the cabin headliner.

Step 17
The final cabin trimming involved the bunk faces that were originally trimmed with varnished wooden strips. While looking very "yachty," their 60s style did not blend

well with the softly furnished, contemporary image I sought.

Step 18
The answer was to sheath them with 1/2" (12mm) plywood sealed with a PVA sealant and then cover with matching carpet. The bunk tops were covered with the same foam-backed carpet. It's not only a quick and easy way to smarten up well used wood but also greatly reduces condensation and mold formation beneath bunk cushions.

Step 19
Having completed the trimming of the cabin, I moved out into the cockpit to see what could be done with 30-year-old wood that had been left to the elements with very little maintenance. Although the upper plywood panels had numerous scars and screw holes where unspecified equipment had been added and removed over the years, it was still in perfectly sound condition. The wooden trim strips had faired much better and were reusable after careful stripping and sanding. Below gunwale level there was no interior paneling, only the bare hull so new plywood panels were required here.

Step 20
New lower panels were cut from 1/2" (12mm) ply with access hatches to provide additional storage and given two coats of wood sealer (alternatively, use epoxy resin), as they are exposed to the elements albeit beneath vinyl trim.

Step 21
The original upper and new lower panels are covered in white vinyl but, this time, without any foam backing that, being in the cockpit, would be constantly damp. When using vinyl directly on timber, it is important to ensure that the surface is perfectly flat otherwise small lumps spoil the smooth finish. Both vinyl adhesive and staples adhere the material to the plywood. Coating the wooden

finishing strips with wood sealer, i.e., oil, varnish, etc., transformed the cockpit.

While putting trim panels onto ply panels is easy and gives a professional look at low cost, the many different permutations of style and taste of owners means I can only provide a basic guide to the techniques involved and my own ideas. With a little care and some relatively low cost materials, cabins and cockpits can be fresh and clean looking again.

— Peter Caplen

Refinishing Aluminum Hardware

This original single lever control was over 30-years-old and looked about ready to crumble but its mechanical function worked perfectly and the corrosion was only on the surface. After a careful cleaning, it was sanded smooth and given a coat of self-etching aluminum primer, followed by two coats of epoxy primer, lightly sanded to give a smooth surface. A very heavy coat of two-part polyurethane paint was then flowed onto the surface and left to cure for several days. The final result is pretty impressive.

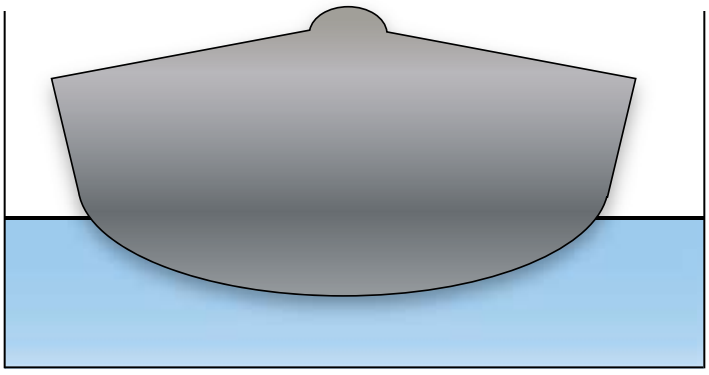
— Peter Caplen

View from the Stern

A Case for Round-Bottomed Hulls

Vee-bottomed boats are easier and less expensive to build and better performers on the water than round-bottomed boats…aren't they?

By Roger Marshall



Some traditionalists feel that round-bottomed boats are graceful reminders of a bygone era. Though these boats tend to be a little slower than vee-bottom boats, they have a softer ride. Round-bottom boats also tend to be better sea boats, handling wave impacts with more grace and comfort than flat or vee-bottomed boats. Water is a sticky substance that resists boat hulls moving through it. On a round hull, it's quite possible that the lessening of the wave impact is due to water migrating up the side of the boat, rather than being thrown clear as occurs with a hard-chined hull. While this makes for a softer ride, it also makes the boat slightly slower as it plows through the water instead of skimming the sea's surface as in a planing vee-bottomed boat. During World War II, the German Navy patrolled the English Channel in round-bottomed boats the British called E-boats, while the British Royal Navy patrolled in cold-molded, hard chine hulls of the type made famous by the U.S. Navy's PT boats. In the same sea conditions, the slightly larger E-boats had an easier time of it in winds over 40 knots.

The rounded chine feature that gives the hull its softer ride is also the factor that helps slow it when stepping onto a plane. Because water can flow around the round bottomed hull shape rather than break clear, the boat is slower to plane than if it had a chine. One solution for builders is to run the spray rail all the way aft rather than ending it about 40% of the hull length from the bow. Water then starts to move up the hull but the spray rail breaks it free and contributes some additional lift to the planing surface. That design compromise often makes the ride a little harder.

A disadvantage of a round-bottomed hull is that it tends to slide all over the ocean when cornering unless it has some form of skeg to give it directional stability. Typically, this skeg runs from somewhere near the bow, aft along the centerline to the propeller and also serves to protect the prop. The skeg adds wetted surface and puts a slightly higher load on the engine but, unlike a chine hull, the prop is reasonably well protected against damage from grounding and flotsam and jetsam.

The building procedure for a round-bottomed hull is slightly more elaborate than for building a chine hull. The round-bottomed wooden hull of yesteryear was often built using longitudinal planks fastened with screws. Today, it might be built using strip planks or cold-molded veneers for the hull sheathing. For example, in a recent round-hull design from my office, the hull mold was made of three layers of 1/8" (3mm) plywood glued and stapled together. In contrast, a plywood chine hull would use a sheet of 3/8"(9mm) plywood. A real advantage to using the cold-molding technique is that the round-hull boat is almost a monocoque shell that gives it incredible strength. This is unlike a chine hull, which must have reinforced joints at the chines and often needs reinforcing in the middle of flat plywood panels. In short, there is no structural strength in the curvature of a chine hull, whereas a round hull has quite a bit of intrinsic structural strength. In turn, this inherent strength allows a slightly lighter structure for a round hull compared with a chine hull.

When afloat, a rounded hull has slightly less form stability and is more tender than a chine hull (see below).

Rounded hulls tend to roll at rest and when underway under certain sea conditions, which can result in queasy stomachs for some on board. As a result, most boats have chines, a keel or stabilizers to dampen rolling.

Apart from the odd car topper, cruising sailboats and displacement cruisers, the round-bottom hull form has seen its heyday. Older wooden yachts made by Elco, Matthews and Trumpy, aluminum car toppers from the '60s, KMV and Windy fiberglass boats are just a few examples of round-bottom designs that have disappeared, replaced by planing and displacement vee-hulls with better top end speeds and improved fuel efficiency.

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