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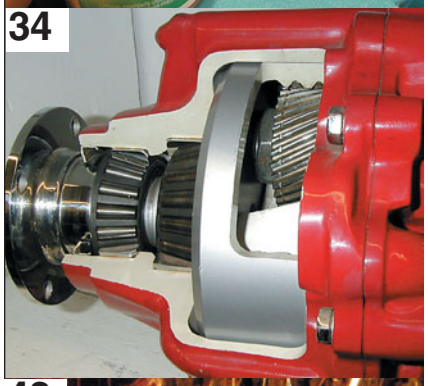
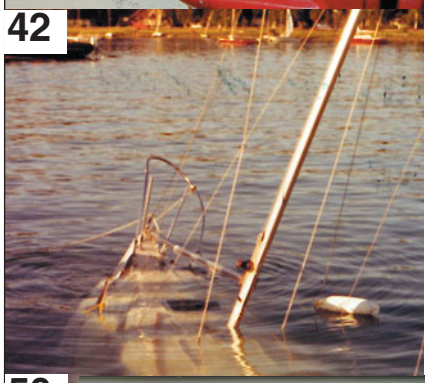




CURRENTS

Custom Canopy Amended

In the editorial process, a couple of errors crept into "Build a Custom Canopy," in DIY 2003-#3 issue. On page 45, Figure 9, the clamp and slide lock totals should have read 162 and 14 respectively.

Subsequent to the article's publication, tropical storm Isabel visited Chesapeake Bay and the author, Susan Canfield, cut away the professionally laid shrinkwrap cover to prevent damage to the support frame. Then, emboldened by the article titled "Honey I Shrunk the Cover," in this same issue, Sue saved money by rewrapping it herself. Before doing so, she added slide locks behind the Kover Klamps on the wind braces and compression posts to prevent the tubing from slipping and puncturing the cover during high wind and heavy snow load conditions. A corrected and amended version of Figure 9 is below.

Figure 9 Materials required for the author's 12mLx4.4mWx2.7mH (40'Lx14.4'Wx9'H) boat cover frame. Extended-canopy components are highlighted in blue, those unique to the freestanding support structure in red.

Structural Element	Lengths Conduit	Couplings	Clamps	Slide Locks	End Plugs	Rubber Tips	Pads
Ridgepole	6	5	8	0	0	0	0
Ribs	8	0	0	0	0	0	0
Rib Legs	16	16	0	0	0	0	0
Pocket Braces	8	8	16	0	0	0	0
Wind Braces	8	0	16	16	0	0	16
Skirt	8	8	18	0	0	0	0
Diagonals/Canopy	12	0	24	0	0	0	0
Vertical Supports	14	0	28	14	14	14	0
Center Posts	0	0	12	6	0	0	6
Diagonals/V. Supports	20	0	40	0	0	0	0
TOTALS	100	37	162	36	14	14	22

Marvel at this One

You published my inquiry in Talk Back Q&A, in DIY 2002-#3 issue, titled "Binding Cranky Outboards." I discovered the problem. After being winterized with fogging solution in the cylinders all winter long, I only ran the engine slowly for 10 to 15 minutes, then shut it down. I didn't use my boat for another three weeks. Even though the engine stopped smoking after the initial run, apparently not all the fogging solution burned off. An old timer told me I didn't bring the outboard up to operating temperature in that short run and the remaining fogging solution got "stiff." He advised me to spray Marvel Mystery Oil into the cylinders and let it sit a while. Then, with plugs out, I turned over the engine.

The DIY team also followed the instructions in the 2003-#3 issue to wrap a project boat. We burned through the film in a few spots, as evident by the taped areas in the photo, but overall a job well done for first-timers.

The engine struggled but broke free of whatever was binding it up. I put the plugs in, and it fired right up. A lesson learned. After sitting all winter, run the engine hard, bringing it up to full temperature, burning off all the oils and fogging solution that protected the internals. An initial shot of Marvel Mystery Oil wouldn't hurt either.

Rick Paluica, Westerly, Rhode Island

Plumbing With A Trap

The article titled, "Understanding Vented Loops," in DIY 2003-#3 issue, mentions to install, "if necessary, a U-trap (a.k.a. P-trap) in the intake line near the toilet to prevent a loss of prime at the suction pump…" What exactly is a U-trap?

Bas Blok, Schiedam, The Netherlands

Look under your kitchen sink at home and you'll likely see a U-trap installed in the pipe. One for boat use is exactly the same fitting.

Where to Buy Oil Sample Kit

Your article on oil analysis in DIY 2003-#3 issue is very interesting and informative. Is the sample kit shown on page 23 available commercially or are the tubing and vacuum pump items the author used only for illustrative purposes? I understand the new oil bottle, ID label and shipping container are generally furnished by the lab and included in the cost of analysis and report.

Weldon Burton via email

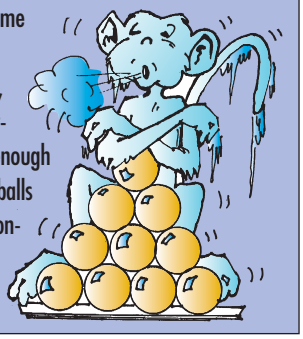
Larry Blais replies: All the supplies should be available from any of the various labs that do the analysis. Check your Yellow Pages under "Laboratories" or use "Oil Analysis" to search the Internet. The supplies shown in the article were purchased from my local Caterpillar dealer, which, like many engine dealerships, operates an in-house lab. The vacuum pump, tubing and tubing cutter are sold separately. The cost of the sampling kit, which contains the sample bottle, the new oil bottle, the identification label and shipping cylinder, also covers the cost of the postage, the analysis and the report.

Not Just For Landlubbers

In the heyday of sailing ships, all war ships and many freighters carried iron cannons. Those cannons fired round iron cannon balls. It was necessary to keep a good supply near the cannon but they had to find a way to prevent them from rolling about the deck. The best storage method devised was a square-based pyramid with one ball on top, resting on four, resting on nine, which rested on 16. Thus, a supply of 30 cannon balls could be stacked in a small area right next to the cannon. There was only one problem. How could you prevent the bottom layer from sliding or rolling from under the others?

The solution was a metal plate called a "monkey" with 16 round indentations. But, if this plate were made of iron, the iron balls quickly would rust to it. The solution to the rusting problem was to make brass monkeys. Consequently, when the temperature dropped too far, the brass indentations would shrink so much that the iron cannon balls would come right off the monkey. Thus, it was quite literally, "Cold enough to freeze the balls off a brass monkey."

— Author unknown



DAVID AIKEN

MEET THE DIY "NAVY"

A magazine is managed much like a ship. The "captain" of this magazine has the final say in most matters pertaining to the content, design and layout of each issue. Then, there's a boatswain, coxswain, a few midshipmen and a crew who, though they may not always agree, take orders from the officer in charge. Although, I'm not Horatio Hornblower (I'm hooked on the A&E TV series), the ship isn't a flagged vessel and the crew isn't a trained navy, except Sue Canfield, the writers who fill these pages are highly skilled marine professionals. Readers often ask me who writes for DIY, so below we present to you our "navy."

My lifelong love of boats of all kinds began in childhood at my family's summer cottage, where early experiences included running a home-built hydroplane, sailing a Sunfish and water-skiing. In my early 20s, I campaigned 505 and International 14 dinghies and raced yachts constantly in both club and offshore races while working for North Sails Toronto. After transferring to the North loft in Vancouver, British Columbia, I became involved with the local boat-building community. During a stint building aluminum yachts I mastered pattern making but then returned to Toronto as co-owner of the North Sails loft. I had purchased plans for the Chuck Paine-designed Frances 26, a double-ended cruising sloop and lofted the lines for the boat in 1978. Built of cold-molded cedar and epoxy resin to professional standards, "Nutcracker," was launched six years later. During this time, I worked at repairing wooden boats and later became manager of AMCO Canada, a large marine distributor. My writing and editing career took off while freelancing for Canadian and U.S. boating magazines, ultimately becoming editor of two Canadian magazines, "Boating Business" and "Boat Guide." Of building and maintaining boats, I find the former easy. Maintenance is the real dilemma and I knew other boat owners were as frustrated as I was with product quality and installation problems. My experience was the inspiration for "DIY boat owner" and with my partner, Steve Kalman, we launched this publication in 1995.

Patricia Kearns has made "messing about in boats" a career for 30 years. She founded Recreational Marine Experts Group in Naples, Florida in 2002 after holding marine industry positions as an assistant technical director at ABYC and executive director of the American Boat Builders & Repairers Association, respectively. Pat is a NAMS certified marine surveyor and her former surveying firm, Marine Associates is now owned by Susan Canfield, another DIY contributor. She authors and teaches courses on surveying, standards compliance and technical writing and writes and edits for boating publications. In 1996, the Marine Retailers Association Of America awarded Pat the Darlene Briggs Award Of Excellence, the highest professional honor bestowed on a woman in the marine industry. As a working sailor, Pat has held a U.S. Coast Guard 100-ton master's license with a sail endorsement. She is a "D" qualified senior skipper member of the U.S. Naval Academy Sailing Squadron, where she served as a civilian officer in charge on Navy 44 sloops. Pat handles all DIY's copy and technical editing and is our standards "keeper."

Peter Caplen is a mechanical engineer and British technical writer with nearly 30 years experience in building, renovating and maintaining powerboats. He writes for the leading boating magazines in the UK as well as in Finland, Denmark, Germany and Holland and, with this issue, now joins the DIY team. Peter's present boat is a Dutch designed De-Groot 40' (12.1m) steel flybridge cruiser. Home base is Devon, England.

With 35 years experience in servicing all makes of outboard and stern drive engines, DIY relies on Steve Auger for all our engine technical advice. Steve holds the position of service training instructor/Mercruiser product support specialist at Mercury Marine where he's been since 1989. Prior to this he was a driveline technician for 25'to 65' (7.6m to 19.8m) yachts and an OMC (now Bombardier) service-only dealer. On summer weekends, you'll find Steve and T&A Motorsports on the racecourse. In kart #61, sponsored by "DIY boat owner" Magazine, Steve finished the season in fourth place, even after a series of wrecks and equipment failures challenged his efforts.

Nick Bailey learned to sail at Kingston Yacht Club in Ontario, whose legendary junior program has produced many fine sailors. He was 17 when he acquired his first boat, a used Flying Dutchman. Crewing on offshore racing yachts followed dinghy campaigns. Nick's marine career began at C & C Yacht Sales, Toronto, where he rigged and commissioned new and used sailboats, and advanced to service manager. He transferred to Harbor Marine Services, C&C's service and repair division, which became Bristol Marine, the largest yacht service yard in the Toronto region. Nick is the service manager for structural repairs and refinishing. His passion is sailing rather than repairing yachts, although he is an expert in both areas. As co-owner of the wooden Thunderbird, "Looney Tunes," he races with his wife Wendy. A non-stop "do-it-yourself" project, this 41-year-old boat is the recipient of a great deal of his time and energy. Nick's "I've truly seen it all" writing style reflects his many years of hands-on experience in boat repair shops.

As a young apprentice to master shipwright Porter W. Benedict, Larry Blais learned boat design, construction and repair. Mentored also by his father, master mechanic, Captain Ken Blais, he completed most of the marine industry's diesel and gasoline engine certification programs and electrical schools offered by the manufacturers. After operating boatyards and engine shops for more than 30 years, where he trained and supervised scores of shipwrights and mechanics, the intense demand for his expertise compelled him to enter his own practice in 1992 where forensic failure analysis became his forte. He is often called upon to share his knowledge by teaching classes for the United States Coast Guard, Havorn Marine Survey and Shipwright School, Northwest School of Wooden Boatbuilding and University of Washington's Sea Grant Program. Larry is DIY's diesel engine specialist.

Susan Canfield is a retired U.S. Navy surface warfare officer and former U.S. Naval Academy navigation and seamanship instructor. Captain Canfield retired her Navy commission in 1993 and she embarked on an apprenticeship as a marine surveyor. She now operates Marine Associates in Annapolis, Maryland. She is a certified member of the National Association of Marine Surveyors (NAMS-CMS) and is accredited by the Society of Accredited Marine Surveyors (SAMS-AMS). A boat owner for more than 30 years and a liveaboard for 10 years, she currently sails her Tayana 37, "Aeolus." She is a popular speaker at various marine trade and recreational boating marine events and is an instructor for Surveying Fiberglass Boats, a five-day introductory course on marine surveying techniques and procedures for fiberglass boats under 65' (19.8m) offered by WoodenBoat School. Through Marine Associates, she also offers a five-day course for marine underwriters and claims personnel. Sue is a member of ABYC's Gas Detectors and Battery Chargers and Inverters project technical committees. Her article "Fire Onboard," in DIY 2002-#3 issue, won second place in the Boating Writers International Annual Writing Awards and was one of four honorable mentions for the Genmar Trophy, the highest award given to a boating writer.

Roger Marshall has been a contributor to various gardening, boat and sailing magazines, and newspapers in the U.S. and abroad since 1972. He is the author of twelve marine-related books and has another book, "Rough Weather Seamanship," soon to be released. For eight years, Roger has been the technical editor for "Soundings." He joins DIY as author of a new column, "View From The Stern." Besides writing, he is a designer of power and sailboats, first working at Sparkman & Stephens in New York, and then establishing his own yacht design studio in Jamestown, Rhode Island. As an independent designer, he has designed boats ranging from 15' dinghies to a 55' powerboat and an 85' schooner. Roger has raced sailboats at all levels, including 12 meters and Admiral's Cup boats, many world and national championships and the 1997 Atlantic Challenge from New York to Falmouth, England, placing third. He has cruised powerboats and sailboats in many parts of the world, especially the European, Mediterranean and North American coastlines. Roger built a 22' (6.7m) sailboat and has restored an 18' (5.4m) SeaCraft powerboat.

John Payne is a licensed electrical contractor, marine surveyor and technical author for commercial and recreational boats. His books include: "The Marine Electrical and Electronics Bible," "The Motorboat Electrical And Electronics Manual," "Electrics for Fisherman, Understanding Boat Electrics," and the "Great Cruising Cookbook." John is founder and tutor of The Marine Electrical School (www.marineelectrics.org), which offers online marine electrical courses. John commenced a seagoing career initially as a marine engineer and then electrical officer on a variety of commercial vessels. He has worked for several leading offshore oil drilling companies and maritime consultancy companies and been engaged in trials of the world's most advanced deep water drilling rigs. He has written maintenance and operating manuals for a range of projects including military helicopters, hydrographic survey vessels, submarine sonar systems and railroad high voltage systems. Once a competitive sailor, he is an experienced cruising yachtsman and has owned several sailing yachts and motor vessels. At present he lives aboard a 107-year-old Dutch barge and also cruises a 35' (10.6m) classic wooden sloop. He is regularly published in yachting and boating magazines in the UK, U.S. and Australia and frequently lectures on marine electrical and electronics subjects. John handles all DIY's electrical and electronics inquiries.

Peter Pisciotta holds a U.S. Coast Guard 100-ton masters license and has operated SeaSkills Personal School of Seamanship (www.seaskills.com) for five years. He specializes in teaching close quarter maneuvering and offshore seamanship skills, often accompanying clients on deliveries as they transition into a cruising lifestyle. He is a frequent presenter at West Marine Trawler Fests and Cruising World Safety at Sea seminars. SeaSkills is a member of the Safe Boating Council and is recommended by the National Association of Boating Law Administrators, the governing body for state boating license standards. Peter is a professional captain who has commanded an 85' (26m) charter vessel where he and a crew of five hosted up to 75 guests for San Francisco Bay excursions. Peter's boat handling articls are popular with DIY readers.

Shrink-Wrap Painted Hulls?

We asked Interlux to comment on the process of shrink-wrapping boats that have painted hulls and/or decks and received this reply from assistant marketing manager Jim Seidel.

"The problem with shrink-wrapping a painted boat is that sometimes the film holds moisture against the paint causing the paint to blister. We used to get a lot of complaints on this but haven't in a couple of years." Jim then polled the Interlux sales reps to find out how U.S. boatyards handled painted boats.

"The consensus was that yards are only wrapping boats down to the toerail rather than all the way down to the waterline like they used to. Some yards are putting Styrofoam along the perimeter band to give some breathing room. In south Florida, the yards put paper down first and definitely isolate the shrinkwrap away from the paint."

So if you have a painted boat, the advice is to keep the shrinkwrap away from the paint, only wrap it to the toerail, give it plenty of breathing room and use lots of vents.

Gotta A Trojan?

Trojan boat owners should check out the association website at www.trojanboatowners.com.

Paul Murphy, Barrie, Ontario

Re-examining Battery Charger Installation

In the article titled, "Charging to Spec," in the Electrical Column of DIY 2003-#3 issue, you mentioned "…connecting AC and DC ground to a common point." The author might want to rethink this procedure. AC ground should be separate from the DC system with its own ground (galvanic corrosion protection should also be installed). If there is ever a problem with the AC ground might not all DC systems become charged?

William J Lloyd via email

Kevin McGoldrick replies: AC main grounding bus should only be connected to the DC main negative bus at a single point. The wiring diagram on page 27 incorrectly shows the charger case ground connected to the AC grounding bus. The diagram should show the AC ground (G) of the charger connected to the AC grounding bus. You are correct that connecting the AC and DC grounding systems together at the charger case could create a shock hazard at the charger and other items connected to the DC grounding system.

[Ed: A corrected wiring diagram is available to print out on the DIY ONLINE home page at www.diy-boat.com.]

I read your recent article in Marine Maintenance on battery charger installation and found it most informative. In your installation wiring diagram, the ground common to both AC and DC connected to the shorepower ground was not connected through a ground isolation unit. It's my understanding that this is mandatory to do so to prevent electrolytic corrosion.

Joe via email

Kevin replies: Although the article didn't go into detail on this point you and a number of other readers raised this question. A galvanic isolator is a highly recommended safety device, though it's not required. If one is installed, it should be located on the grounding (green) AC shorepower conductor just after the shorepower inlet on the boat. The purpose of a galvanic isolator is to block very low DC current from traveling the AC grounding wire from your boat, along the dock and

Engine Problems Tops In Poll

"What is the major problem you are experiencing on your boat now?" was the question posted on DIY ONLINE for the past month. Of the seven choices listed, engine ranked top with 28%, closely followed by cosmetic with 25% and electrical with 18%. Nearly equal were canvas (10%), plumbing (8%) and sailboat rigging (7%). Only 4% of respondents choose electronics as their major problem, which perhaps lends credence to the reliability of current systems.

DIY boat owner the MARINE MAINTENANCE MAGAZINE

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Contributors: David & Zora Aiken, Steve Auger, Nick Bailey, Larry Blais, Susan Canfield, Roger Marshall, Kevin McGoldrick, John Payne, Peter Pisciotta

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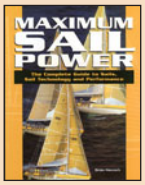
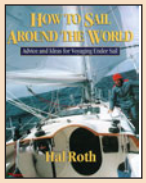
onto another boat connected to the same dockside AC supply, creating a galvanic cell. The boat with the least noble underwater metal in this cell will be the boat that is potentially most affected by corrosion. The amount and nature of the underwater metal on your boat and nearby boats connected to the same AC shorepower supply, the amount of DC current lost into the bilge due to bad wiring and such, the distance to other boats, the salinity of the water, speed of the current and other factors will all have an effect on the rate of corrosion observed. Is a galvanic isolator mandatory? No. Is it a good idea? Yes.

Winter Reading

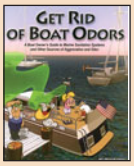
"Maximum Sail Power," by Brian Hancock (Nomad Press, 291 pages, hardcover), is an updated, comprehensive guide to sails and sail making. It details the latest developments in sails, sailcloth, sail engineering, hardware and sail trim for all sailboats, from dinghies to racing yachts and cruisers. A good resource for making sail choices for your boat.



Hal Roth's "How to Sail Around the World" (International Marine, 464 pages, hardcover) is a testament for ocean cruisers written by one who has logged 200,000 miles at sea and sailed around the world three times. This book deals with ocean voyaging from A to Z, from what defines a good cruising boat, to trip planning, to seamanship, to storm management, to equipment and provisioning, to dealing with foreign legalities. Even if you only sail around the buoys or daydream in an easy chair, this book is loaded with lots of tips and practical information that only years of sailing experience can muster.



"Get Rid of Boat Odors" by Peggie Hall, (Seaworthy Publications, 90 pages, softcover), also known as the "Headmistress," just may answer all the questions you have about toilets and plumbing but were afraid to ask. It discusses sanitation laws, choosing, installing and maintaining a marine sanitation system plus some great tips on odor elimination.



Product Support Exchange

I'm writing to inform all DIY readers of the outstanding service given to me by Seaward Products. I purchased a water heater second-hand from a local marine salvage yard. When the thermostat failed, Seaward Products sent a new one at no charge to me. Might I suggest that DIY publish an exchange between DIY readers who send in accounts of either poor quality service or great experiences in the marine industry?

Tom Dall, Jacksonville, Florida

A great idea! If you have experienced either excellent or very poor service with a manufacturer, retailer, repair yard, etc., email your comments to the editor at tech@diy-boat.com or send snail mail to: In the U.S.: JM Publishing, P.O. Box 617000, Dallas, TX 75261-9652; In Canada: JM Publishing, P.O. Box 118, Lindsay, ON K9V 4R8.

THE DAY THE BATTERY BOX EXPLODED

I was kneeling on one engine hatch and reaching into the other open engine hatch attempting to manually start the old 6.5kW Kohler generator. Suddenly, there was a thunderous boom. I was shocked, dismayed and in pain. The next thing I knew, I found myself flat on my back. My ears were ringing and I was cradling my right arm, which hurt and was tingling. I swore, and then did a quick inventory of my extremities. I still had all my fingers and they seemed to work okay. There was pain in my elbow, forearm and shoulder but they worked as well. All good news. Rolling over onto my stomach, I crawled over and peeked into the center compartment. There was no smoke. Good. No fire. Even better. The explosion was so loud I thought it might have blown a hole in the boat. I stared intensely into the bilge waiting for the little puddle to grow but the water didn't rise. Thank God for U.S. steel (my houseboat is steel). My next thought was that the generator battery had blown up. My eyes scanned the compartment where the battery lay completely intact! There was no sign of leakage or cracks. It was at this point that I realized I

WANTED

DIY reader David Prior is seeking replacement parts for Cinkel Spars, which ceased operations in the mid-'80s. We're not aware of any source. If you can help him, email the information to tryonboats60@hotmail.com.

Do you know of any boat junkyards? DIY reader Warren Denny is looking to purchase replacement gear for his older Sea Ray. Send information to him at warrendenny@hotmail.com

should not be able to see the battery at all. It's supposed to be in a battery box and strapped down to the mounting board. That's when I focused on all the debris scattered about the engine compartment. Small pieces of black battery box were everywhere. The high-density polypropylene plastic box had blown completely off of the battery. Then, I found the clue that put the puzzle pieces together. I spotted a small scorch mark on the negative battery terminal. It was still very hot. I took the negative lead and wiggled it. Yep, it was loose, too loose, surely the cause of the explosion?

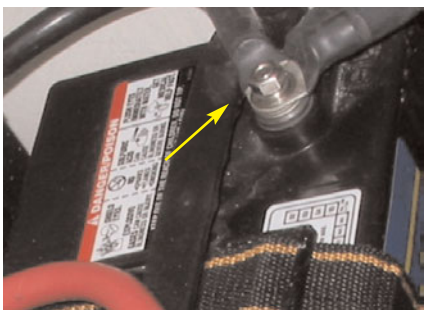
After much contemplation, here's what I think caused the unexpected explosion. The generator was cold and didn't want to start so it cranked too long before it finally started, depleting the battery. Once started the generator will put a heavy recovery charge on its cranking battery. As I was having cut-off relay problems with the generator, it would run only 30 seconds or so, then the breaker would pop and cut the

engine. The pop out breaker had an adjustment screw so I would make small adjustments, reset the breaker and hit the switch. The generator would again run a short time and kick off. I did this four or five times, standing in the engine compartment, right next to the battery box. By this time the battery must have been out-gassing hydrogen from the charging cycle. All the while, the multiple startings were heating up the loose ground connection on the battery terminal. The last time the generator started it ran for almost a full minute. Enough time for me to crawl out of the engine compartment and the battery to out-gas a fair amount of hydrogen. When the breaker failed again, I was on deck. I knelt down on the hatch and reached over to make my adjustment and pushed the button. The negative battery lead must have sparked inside the battery box and...kaboom! I was lucky in about a hundred different ways. I could have been in the compartment at the time of explosion. Sharp plastic pieces could have lacerated my skin.

I have heard about batteries that blew up, fell apart and caught fire but I never heard about a battery box being blown off the battery. What could have prevented this incident? There was a wing nut adapter on the battery terminals. Had I used a proper marine bolt-on type cable connector I would not be replacing the West Marine battery box and nursing a big bruise on my forearm. Go now and inspect all your battery terminals! Battery connections made with wing nuts will vibrate loose under normal boat motion. Make sure your cables are connected to the battery terminals with lug type connectors, that your battery cables are the right size wires and your connections are tight. Or you may not be as lucky as I was.

Mike Wolfe, River Queen Refit, Stockton, California

Log onto Mike's website for more adventures: http://home.inreach.com/wolfman/riverque.htm.



Battery terminals with locknuts will help prevent a similar accident from happening.

Fiberglass Repairs

Further to the Fiberglass Repair seminar DIY presented at Strictly Sail in St. Petersburg, Florida, we received these tips from two DIY readers.

Perfectly color-matched gelcoat requires much skill and there are a few aftermarket suppliers but most will require the purchase of a minimum quantity, normally too much for the DIYer. Donald Lacharite, Wildwood, Florida purchased gelcoat to match his Sabre from Mini Craft of Florida (Tel: 800/282 8244, Web: www.mini-craft.com). He received an aerosol spray can that covers about 12'to 14' (3.6m to 4.2m) sprayed. Apparently, Mimi Craft can color-match gelcoat from 300 boat builders as early as 1984. All it needs is the hull ID numbers.

Rather than use Duratec, a styrene-based reducer added to polyester resin before catalyzing, Gus Wilson of Green Cove Springs, Florida, prefers Patch Booster (US$65 per quart/946ml). This resin-based thinner speeds up cure time, eliminates halos and patch marks and gives a better gloss after buffing.

TALK BACK Q&A

HELP LINE 1-888-658-2628

The following is a small sampling of the numerous questions DIY receives from its Technical Helpline. If you have a boat maintenance question and are a subscriber to DIY boat owner magazine, the Technical Helpline is free. It's our way of giving something back.

Please send your questions to info@diy-boat.com. We try to reply within two business days, though it may take longer during peak times.

Interior Teak: Oil Versus Varnish

Q: I plan to varnish the interior of the boat for future mildew and mold control and clean up rather than reapply oil. Is this necessary? What teak cleaner and coating do you recommend should I decide to switch? I'm looking for a matte finish.

Rose Hansmeyer, "Sojourn," Bayfield, Wisconsin

A: We recommend using a one-part teak cleaner, such as Amazon One-Step Teak Cleaner. [Results of DIY's test of teak cleaners appears in the 1998-#2 issue.] Action is a little slower than the two-part cleaners (alkali and acid) but it won't do any serious harm to you or other materials. Another option is to use Cape

Ann One-Step Teak Cleaner, which is a gel formulation and excellent for vertical or overhead surfaces. You can apply an oil finish but need good ventilation to prevent mildew growth. The varnish finish would be easier to clean if mold did occur. Epifanes Rubbed Effect or Woodfinish Matte make nice interior finishes.

— Jan Mundy

No-Sand Bottom Primer

Q: When I docked my 2000 52' (15.8m) 520 widebody Harbormaster houseboat on a Kentucky lake, I used to clean the bottom twice a year but now that it's on the Mississippi where marine growth is bad, I need a bottom paint. I want to apply a no-sand primer and then a paint that is self-cleaning. What do you recommend I use?

George Hillebrand, "Get Over It," Alton, Illinois

A: To paint the bottom without sanding, use a no-sand primer, such as Interlux Fiberglass No-Sand Primer YPA200. According to Interlux assistant marketing manager Jim Siedel, there are two very important things to remember when using a no-sand primer. First, the bottom must be very clean. Any contamination from grease, oil, silicone, suntan lotion, wax, etc., must be removed or the paint and primer will not adhere. Begin by scrubbing well using Interlux Fiberglass Surface Prep YMA601 or an abrasive powder cleaner and a plastic scrub pad. Flush well with freshwater. Wipe a small area with a clean rag that has been wetted with Interlux Fiberglass Solvent Wash 202. Before the Fiberglass Solvent Wash dries, wipe with a clean dry rag. Change rags frequently. Continue this process until the entire surface has been cleaned. To be certain that wax and other contamination has been removed, run water over the surface. If the water beads up or separates, wipe the surface again with Interlux Fiberglass Solvent Wash 202. When the water sheets off, all contamination has been removed. Apply one, thin, continuous coat of Fiberglass No-Sand Primer using a 1/4" (6mm) nap, solvent-resistant roller or natural bristle brush. Apply in one direction only without overcoating. Wear protective clothing and clean up paint spatters immediately. Use waterless hand cleaner before the primer dries to remove from skin. Secondly, you must follow the overcoating times exactly. Because temperatures and humidity vary widely, Interlux recommends the thumbprint test prior to overcoating, which is described in the consumer product information sheet. If the primer feels tacky, and you can leave a thumbprint in the paint film without getting any paint on your thumb, the Fiberglass No-Sand Primer is ready for overcoating. Test the paint film in the area where you started applying the primer 30 minutes after starting the application. Continue testing every 15 minutes using the thumb test until reaching the ready-to-overcoat stage. Immediately, begin to apply your antifouling paint once the primer has reached the ready-to-overcoat stage. If you cannot leave a thumbprint in the No-Sand Primer or it's tack free, it's too late to overcoat and the primer must be removed.

Winterizing Exhaust Risers

Q: My boat's 454 Magnum engine (1992) is freshwater cooled. When I drained the risers to winterize, they contained antifreeze. I expected to find seawater in the risers? What should they contain?

Pat Hundley, "Reel Love," Baltimore, Maryland

A: There are three parts to a Mercruiser closed-cooled exhaust system. Starting at the top is an exhaust elbow, usually with a 90° bend, where seawater and exhaust are mixed and sent overboard. A rectangular riser extension in three sizes, 1.5", 3" and 6" (3.8cm, 7.6cm, 15cm) maintains the correct outside waterline-to-exhaust elbow height. Without exhaust risers, some boat engines would backfill the cylinders with seawater. These are both seawater and antifreeze cooled depending on the model. An exhaust manifold is the third component. This was antifreeze-cooled in the 1980s, seawater-cooled in the 1990s, and now antifreeze-cooled for 2003 and newer models. Knowing the serial number and model, it's simple to identify which system is on your engine by referring to an OEM service manual. Aftermarket manuals tend to be generic in this area.

— Steve Auger, Mercury Marine

What's Eating my Zincs?

Q: Two years ago my 36' (11m) trawler began suffering from galvanic corrosion while docked in a marina. The boat is fully bonded and I installed a galvanic isolator that has a shaft brush. The stainless-steel shaft sacrificial anode (zinc) currently burns off every six to eight weeks. The zinc bolts are eaten out of the zinc and then the zinc collar falls off. Large or small collars, two or four bolts, it makes no difference. My boat tests well protected for all metals with bronze being slightly over protected. What more can I do? I've completely gone through

the entire system to make sure all connections are electrically sound.
Larry K. Kingry, "Seawolf," Whittier, Alaska

A: Based on your comment that your zincs and/or the bolts that hold them in place "burn off" regularly, your problem is stray DC current, not galvanic corrosion. The stray current source may be internal or external to your boat; it's also probably intermittent rather than constant. If you have a silver-silver chloride half cell and multimeter, you can try to locate the source of the stray current (assuming it's on your boat) by following the directions in "Corrosion Control" in DIY 2003-#2 issue. If you don't have a half cell, you should employ an experienced marine electrician to assist you in identifying the stray current source and correcting the problem. You can access a list of ABYC-certified technicians working in your state at www.abycinc.org. Shaft zincs are typically installed with stainless steel bolts. Since stainless steel is more noble than zinc, the zinc anode will erode first. Shaft zincs fall off when the thinnest portion of either half of the collar (normally in way of the securing bolts) erodes away. A galvanic isolator is designed to block low-level DC (galvanic) current, i.e., less than 1.5V. Higher voltage stray DC current will not be completely blocked. Check to ensure that your galvanic isolator is operating per the manufacturer's owner's manual. ABYC's galvanic isolator standard requires that isolators be equipped with a visual operational status indicator. If your isolator is not so equipped, you may want to upgrade.

— Susan Canfield, Marine Associates

Calculating Gen-Set Wiring

Q: I'm rewiring my entire boat and have started the demolition of the AC power system. I plan to run new wire from the 7.5 kW Onan generator to two 120-volt, 30-amp AC source selector panels. This allows me to power the entire boat off the gen-set. The existing boat cable from the generator to the panel is 6 AWG and the length of wire required is no more than 12' (3.6m). Is there any reason why this wire has to be any larger than 10 gauge?
Frank S. Arnone, "Kismet," Apollo Beach, Florida

A: The present cable of 6 AWG has a rating of 45 to 50 amps; 10 AWG has a rating of around 30 amps. These are general ratings but it all depends on insulation types, which isn't stated. A 7.5 kVA gen-set has a "real" rating of around 6 kW at 0.8 power factor, making the maximum load 27 amps at 220 VAC. A cable rating of 10 AWG should be okay; 8 AWG would be more than

enough and 6 AWG is overkill with no advantage offered. In reality, you'll never take maximum output off the generator in any case and typically it's around 85%. Of course, with 110 VAC and not 220 VAC, the rating goes to 55 amps and you would need the 6 AWG cable.
— John Payne

Diagnostics for WOT Overheating

Q: The 5.7L Mercruiser V8 engine in my 1989 Mariner 2800 28' (8.5m) flybridge cruiser was rebuilt by a reputable mechanic 18 months ago. It has electronic ignition, four-barrel carburetor and freshwater cooling. The rebuild included replacing the manifolds and risers, cleaning and pressure testing the heat exchanger and the water jackets. The engine now runs all day at 2,800 rpm at speeds around 15 knots. If I throttle up to 4,200 rpm, it runs for around two minutes, and then starts to loose revs and heats up. If I don't throttle back, it simply dies. I don't believe it's a fuel-related problem as I always keep the tank full to prevent any condensation forming. How do I diagnose the problem? There are only 50 hours on the rebuilt engine.
Danny Wilson, "Picies2," Gold Coast, Australia

A: My first question would be was this problem present before the motor repair? If yes, the rebuild only fixed the consequential damage but not the cause of your motor damage. If this is a new problem since the rebuild, you'll have to find the source of the overheat condition. As with any diagnosis, I would advise you to check your maintenance items first. If you have a Mercruiser service manual, consult the troubleshooting section for advice by symptom, and then verify the ignition timing is not over advanced at speed (28° to 30° BTDC maximum at 2,400 rpm). Verify that your seawater supply is up to spec. Ensure that the closed cooling system has no more than a 50/50 ethylene glycol-to-water ratio as pure or too much glycol will cause overheating at wide-open throttle. This also means a seawater pump rebuild. If this has already been done, check your oil coolers for obstructions, such as chunks of old impellers or flotsam. If the boat is an Alpha One stern drive, the seawater pump is in the stern drive unit and the water pump may be pulling exhaust gas into the water supply (this is a bad thing). To verify that this is not the case, install a clear hose on the water supply line and run it up to the speed where you experience overheat. The waterflow should not have any bubbles. If there are bubbles you need a new water pocket cover in the drive unit. Since you've had your heat exchanger checked already, there may be a problem with a new manifold being defective but that is not normally the case so we will use instrumentation to try and locate the problem. Install a 0 to 30 psi pressure gauge using a tee fitting on the water inlet hose. At 3,000 rpm to 4,000 rpm the pressure should be at least 4 psi and no more than 10 psi. If it's below 4 psi, you have a restricted inlet or bad pump; if over 10 psi, you have a restriction in the outlet side of the seawater system, such as a cracked manifold, collapsed exhaust pipe or muffler element. If you have an inboard or Bravo stern drive, the engine uses a belt-driven seawater pump. These models run around 15 to 20 psi of water pressure at speed. Install a 0 to 30 psi gauge, same as above, and then pressure test the closed-cooling side by installing an automotive radiator pressure tester to the heat exchanger. The closed cooling system should run at about 15 psi constant. If the pressure drops, you have a leak in the closed-cooling system. In this case, the engine would be losing antifreeze. The heat exchanger cap controls the operating pressure of the closed-cooling system. Install a new cap.
— Steve Auger, Mercury Marine

Battery Selector Wiring

Q: I'm installing a Perko 8501 battery selector on my boat that has one engine and two batteries, one for starting the other for house loads. This selector has "One-Two-All-Off" positions. Where does the common cable attach? Which one is the ground? What is the starter?
Ken Heath, Peoria, Arkansas

A: Each battery positive cable goes to one of the battery input terminals. Usually, these are the terminals at each side. They should be marked. The center (common) terminal goes to the starter terminal. The house supply also goes off the common to allow selection of either battery. Check this with your multimeter between each input and common. There is no grounding connection on selector switches. *— John Payne*

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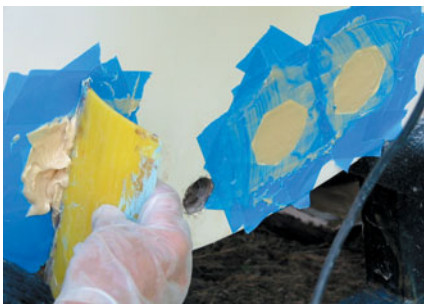
Plugging Transducer Holes

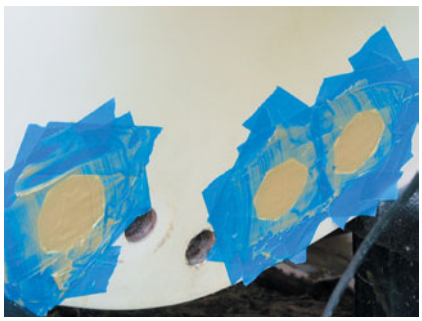
Q: I'm replacing the depthsounder and knotmeter on our Sabre 34MKI. I need to replace the existing transducers and the new transducers don't require holes as large as the originals. What is the best method to downsize the existing 2-1/16" (5.2cm) holes to facilitate installation of the new, smaller 1-5/8" (4.1cm) diameter transducers?

Paul Cournoyer, "Kaper," Portland, Maine

A: There are several ways of going about this. While you could grind out an area so you have a 12:1 angle, prepare a patch that duplicates the laminate on your boat and bond the patch in place, there is a simpler method. Having just completed this on a 22' (6.7m) powerboat, it's very workable and the least visible. Use a holesaw to cut a plug from a piece of marine-grade mahogany plywood. The plug will need to be the size of the hole diameter you need to fill. Tape the repair area, and then solvent wipe it and the hole. If you have access to the interior bilge, do the same and sand with 80-grit to rough up the surface. Mix up a batch of epoxy resin, coat the edges of the plug. Glue the plug in place with glue thickened to a peanut-butter consistency. The plug thickness should be slightly less than the hull thickness at the hole. Position the plug so it's slightly recessed on the outside. Using a rotary tool (e.g., Dremel) and a cone-shaped file, grind the outside edge to create a bevel. Solvent wipe and fill the cavity with epoxy resin thickened with a mixture of microballons and cabosil. Level the area flush to the hull using a large squeegee. Wipe, sand flush, and then apply two or three coats of unthickened epoxy resin. As your repair is below the waterline and you'll be applying bottom paint, you don't even need to gelcoat. But if I was, I would sand, and then brush or spray on color-matched gelcoat. Once cured, remove the masking tape. Retape the repair area moving out 2" or more. Solvent wipe, wet sand, and then gelcoat. I usually move the tape out in increments a few times to blend in the repair. To stiffen the repair on the inside, solvent wipe, and then wet the repair area by brushing on unthickened epoxy, and then wet out a piece of 6oz fiberglass cut to size, lay over the area and use a squeegee to remove air bubbles. Once cured, cut your new hole and you're ready to install that new transducer.

— Jan Mundy





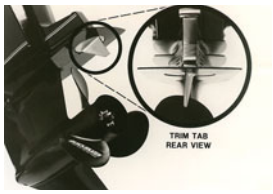
TECH TIPS

IMPELLER WRAP: When it's difficult to fit a new impeller into a pump, as one or more of the vanes seem to want to lie in the wrong direction, wrap a plastic cable tie around the impeller and with the tie slightly tightened, use your finger to coax the vanes to lie in the proper direction. Tighten the cable tie until the impeller is just slightly smaller in diameter than the pump housing, then slide the impeller into the housing and the tie is automatically pushed off.


DAVID AIKEN

Alan Porter, "Te Tiaroa," Victoria, British Columbia

OUTBOARD TRIM: If your boat is outboard powered and the steering wheel pulls to the right, turn the trim tab on the anti-cavitation plate to the left. Conversely, turn the tab to the left to trim left.



REEL DEPLOY: To facilitate line handling and stowage without tangles, wind small diameter lines, such as heaving or mooring lines, on a ski rope reel available at most marine and water sports stores for less than US$10. The ones I use are H-shaped, have a rotating handle in the middle, cranking handle on one end and hold about 100' (30.4m) of 3/8" (9mm) line.

George E. Thomas, Savannah, Georgia

WEIGHTED MESSENGER: When you need to feed lines or wires down a mast, a bicycle chain makes an excellent messenger, certainly better than a string of lead sinker weights.

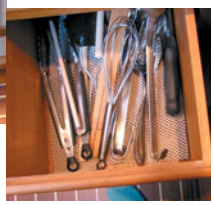
Andy Ulak, Wilmington, Delaware

HOSE WRAP: To prevent cables, hoses and wires from chafing where they pass through the bilge, bulkheads, lockers or under floors, slice a piece of hose in half and then slide it into the opening.

VINYL FIX: For filling and fairing mangled vinyl rubrails, use Pro-Form Products' PF 704 Flexible Parts Repair Kit, a flexible epoxy product designed for automotive bumper repair available at autobody shop suppliers. After filling, apply a vinyl spray paint. For refinishing white vinyl, use Capt. Phab #510 white vinyl paint.

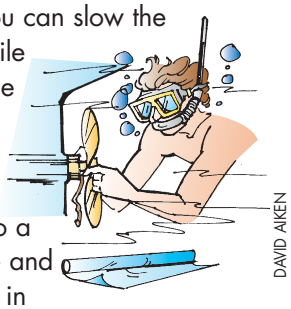
Nick Bailey, "Looney Tunes," Toronto, Ontario

RATTLE PROOFING: Line shelves and lockers with plastic non-slip sheets to lessen annoying rattles in drawers and hinder the movement of bottles and other small items.



NEVER COVER-UP ACRYLIC: Acrylic fabrics (e.g. Sunbrella) make for all kinds of durable, water-resistant covers but never lay another cover (e.g., shrinkwrap or canvas storage cover or tarp) overtop for the acrylic readily chafes through.

STUFF THE STUFFING: It's preferable to replace the stuffing box packing when your boat is out of the water but if you can no longer control the leak and don't want to haul out, you can slow the leakage while replacing the packing by rolling any putty like material into a cigar shape and wrapping it in kitchen plastic wrap. Dive under the boat and jam the plastic plug around the shaft, forcing it up the shaft tube. The plug will give you enough relatively dry time to replace the stuffing box packing.


DAVID AIKEN

DIY reader via email

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PRO SERIES

AFTER THE GROUNDING

Put your boat between a rock and a hard spot and repairs to keels and hulls can be costly. What appears as minor surface damage may be merely symptomatic of the bigger problems discovered after a closer look. DIY's repair specialist explains the steps involved from salvage to launch.

STORY AND PHOTOS BY NICK BAILEY

Running aground can be embarrassing, dangerous and expensive but even the most experienced boaters go bump on the bottom. It's an accepted risk of boating and another good reason to make sure your boat insurance coverage is what you think it is. [Ed: For complete details on this matter, see "Insurance: Don't Go Aground In Coverage," on page 42 in this issue.] If you have ever negotiated shifting sandbars on the ICW with a deep-keel sailboat, your journey hasn't always been afloat and you've kissed the bottom a few times. Provided you are not on a lee shore, being stuck on the mud bank or a sandbar usually does the most damage to your pride in your seamanship skills and the only other consequences involve a jolt to the crew and spilled drinks. The powerboater may notice no more than an odd vibration and mud churning in the wake as the boat roto-tills its way over a shoal. These gentle affairs don't often result in an insurance claim.

A claim filed under "collision with a submerged object" is reserved for more unpleasant things, such as hitting an uncharted rock during an exhilarating sail at hull speed under spinnaker, encountering a semi-submerged picnic table at 4,600 rpm or taking a wrong turn and steering your boat uphill onto a reef. Industrial pipes, sunken wrecks, shipping containers, belligerent whales and other unpleasant surprises lurk beneath the placid sea. Insurance company files record damaging encounters of the submerged kind with all of these but there is a special category reserved for accidental encounters with the shore and objects within a stone's throw of shore.

Damage resulting from the collision with an underwater object falls into three general categories: hull damage, running gear and damage from sinking. If keels are included in the first category, this type of damage occurs most frequently on sailboats and displacement powerboats. Running gear damage includes props, shafts, struts, rudders and sterndrives. In some cases, transmissions and engines suffer from the echoes of the shock to the boat's underwater appendages. These components often bear the brunt when a planing powerboat strikes something unexpected. Not immune from damage is the hull on a high-speed boat. The struts and rudders often rip holes open or get punched up into (and sometimes clean through) the hull. An eloquent surveyor once described the last category as the "free association of water with the interior of the vessel." Water (particularly saltwater) mixed with engine oil and battery acid is a destructive mix for interior furnishings and headliners, carpets, mechanical and electrical equipment as well as expensive electronics. It's the sinking, either full or partial, not the grounding damage that often leads to an insurance write-off. In other words, running your Searay 450 over a rock shoal is one thing; sinking 100' (30.4m) beyond is another. If you hit a rock hard enough to open up the hull, you might prefer to stay stuck on it.

Given the number of things that can be damaged in a grounding incident, the repair can involve all the different skilled trades found at a professional yard. This article will follow the course of some typical (and not too severe) grounding repairs at Bristol Marine.

TIP ON SOLID GROUND

Always and immediately report any suspected grounding damage to your boat to your insurance company. The company claim manager will be an excellent resource in helping you to determine the extent of any damage and will assist you in processing a claim if necessary. The company will also assign a surveyor to inspect the boat. Putting expert eyes on the case never hurts. No claim? No problem but get the insurer in the loop promptly just in case. Sometimes, damage related to a hard grounding isn't readily apparent and backtracking long after the fact just complicates the situation. Fess up to bumping the bottom and get the help you need to make sure the bump doesn't lead to a big headache that spoils your boating season and can drain your boating budget.

— Patricia Kearns

(top left) This small crack on the leading edge of the keel stub may indicate significant hidden damage. (top right) Preliminary grinding shows evidence of delamination where the keel stub meets the hull. (bottom) Tension fracture where the leading edge joins the hull on the same keel. This one leaked!

Several small core samples (note circular marks) are taken to guide the removal of delaminated sections of the floor grid.

Insurance and Damage Assessment

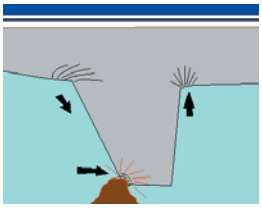
Once notified of a loss, the marine insurance company assigns an surveyor who may also act on the company's behalf to adjust the claim. "Adjusting" the claim simply means deciding what is covered by the policy and how much the check to you will be. Ideally, this individual is qualified to assist with salvage and transport arrangements that may be necessary. If a repair looks economically feasible within the insured value, the boat is delivered to a repair yard of your choice. If you don't know a good yard, the adjuster may be able to make some suggestions but the final choice is yours. At this point, you can authorize the yard to carry out the preliminary work required to determine the full extent of the damage, an exercise that is zkey to preparing a detailed repair estimate. By the way, this is a good place to emphasize an important operative word in the last sentence. It's the "you" word and it means just that. You are the boat's owner and you are the only person who can authorize repairs. That is not the surveyor's, insurer's or adjustor's call. It's yours and only yours.

On a damaged fiberglass hull, an accurate assessment of the extent of damage may involve examining for hidden laminate problems using by invasive tests such as taking core samples and carrying out local grinding to strip away surface layers. Some yards now use high-tech thermal imaging equipment that "see" through a fiberglass hull and detect delamination deep in the laminate stack. Other preliminary work may involve removal of running gear for assessment. Sometimes a prop or shaft looks okay at first glance but when checked with a dial indicator or set against pitch blocks it proves to be far out of true. This is particularly true in the event of contact with a submerged wooden deadhead or soft mud bank that leaves no jagged wounds on the prop.

Following a full assessment or, at some point later in the course of the repair, a repair price is agreed upon between the yard and the adjuster. This can be a fixed price or an approximate cost of repairs within a pre-arranged reserve that the insurer establishes to cover the claim costs. It's like a savings account set aside solely for your claim. Sometimes, damage is not discovered until the repair is well under way and the insurer's reserve takes this into account. Provided the repair price (plus, under some policies, the cost of salvage) is not over the net insured value, which is a percentage of the insured value of the boat that is established by the insurer (not a universal standard formula), the repair proceeds. Otherwise, the insurer may hand you a check for the insured amount and then take possession of the boat for sale to the highest bidder. Another option lets you keep the boat but give you a check for a lesser amount based on the value of the boat "as is." In this scenario, you may want to do the repairs yourself or you could sell the damaged boat and keep the proceeds.

What Damage to Expect

Deep-keel sailboats, obviously, run more risk of the unintentional keel meeting with the ground. All the damaged fin-keel sailboats pictured in this article hit rocks at speeds around 6 knots or less. To find and properly repair this kind of grounding damage requires an understanding of the physics involved and knowledge of how fiberglass structures respond to shock loads that exceed their design limits for enduring stress and strain. The impact damage to the tip of a lead keel is conspicuous but it's the least of our concerns. The most significant problems occur when impact loads are violently transmitted from the keel to the structure of the hull. As the leading tip of the keel hits the rock and forward motion suddenly stops, the keel instantly tries to rotate around the point of impact. But wait, there's a boat attached to that keel and the hull is prevented from rotating by buoyancy and inertia so the keel is yanked down away from the hull at its forward attachment and driven violently up into the hull at the trailing edge. This wreaks havoc out of sight below the floorboards, internal grid structures fracture or de-bond, main bulkhead secondary bonds crack or break, athwartship floor beams crack, the hull flexes and may delaminate or crack open. Floorboards no longer fit flush. Above the floorboards compression fractures appear at the base of the



Hulls attached to deep fin keels suffer characteristic tension fractures at the leading edge and compression fractures at the trailing edge during a grounding incident.

Grounding damage to the keel tip is minor but may represent more extensive, hidden damage.

(top) This sub-floor grid suffered fractures during a 3-knot grounding on a rock. (bottom) Close up of cracked grid.

galley modules. The companionway stairs no longer fit in place and the mast step has dropped. No wonder the standing rigging has gone slack.

After a bad grounding, the repair of some sailboats, particularly those with a deep glass keel stub, requires more than just repairing local damage. Extra work to reinforce and re-engineer the keel stub and internal structures beyond the original scantling is often required if the boat is ever to regain its original structural integrity.

During repairs the mast step and keel stub structure needed reinforcing beyond the original scantling to restore the original structural integrity.

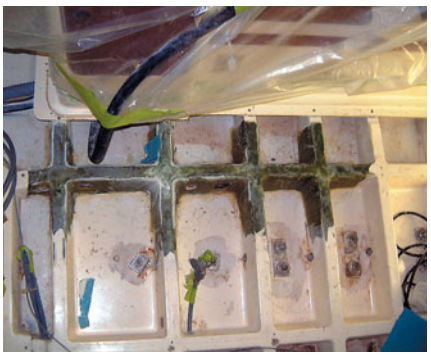
Handling and Prep

The rig is unstepped, the boat hauled out and cradled. Removal of damaged and delaminated material now begins. The best tool for this job is a full size 2,500 rpm to 6,000 rpm grinder with an 8" (20cm), 36-grit disc for buzzing away fractured exterior laminates on the hull and keel stub. A hammer and chisel are used to remove de-bonded tabbing in tight spots. An experienced glass technician can determine the condition of the laminate exposed while grinding. Damaged laminate shows white areas of fracturing from excessive flex and de-bonding and delamination between layers. The glass in the laminate has actually broken. Sound

Removing broken secondary bonds in tight spots requires a hammer and chisel.

The last bit of delaminated glass (whitish edge) at the keel stub to hull radius must be removed.

"She's a hurtin' unit." Wet and delaminated core must be removed and replaced.



(top) Delaminated floor pan has been ground away leaving the structural grid ready to be re-glassed to the hull. (bottom) Floor grid in early stages of new glass lay-up.

laminate is a uniform blue(ish) or green(ish) color. It may be necessary to peel back the outer skin and remove wet or delaminated areas of core. Once all damaged glass is uncovered and removed, the sound laminate is tapered back to form a high ratio scarf; 12:1 or more is typical. This ensures the bond between the new and old layers of glass.

After masking the interior with plastic curtains (e.g. 3M Ready Mask) to keep glass dust under control (It's a good idea to assist this effort by removing all personal belongings, upholstery and other items onboard that can be spared the repair effort exposures that are bound to generate dust), the damaged internal structure gets the same prep treatment with cracked grids and delaminated floor pans being ground out and scarfed to prepare them for layers of new glass.

Glass and Resin Choices

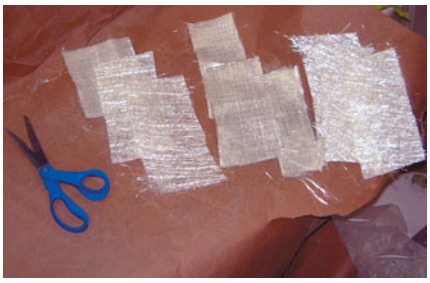
There are lots of different types of glass cloth but the majority of hull repairs are done with 1810 Stitchmat, a good, general-purpose cloth that combines 18oz roving (woven together at 0° and 90°) with a 1oz mat backing. Three layers stacked are equivalent to a laminate with six layers of alternating mat and roving, approximately 3/16" (4.7mm) thick. Smaller repairs and secondary bonds are better handled with a few layers of 1.5 oz. mat.

Most older production boats were built with polyester resin and this is still the simplest and most versatile material for use in conventional repairs. A skilled technician can adjust the catalyst mix to suit the ambient temperature and working time. For example, a quick gel is desirable when doing glass lay-up on an overhead surface. Conventional polyester resin also works just fine repairing newer boats built with DCPD (dicyclopentadiene) polyesters. These new polyesters reach a more complete cure than conventional resins so offer fewer unreacted polyester molecules as chemical bond sites for a new laminate layer. To compensate for this slight reduction in adhesion, cleanliness and good mechanical prep of the bonding surface, together with high scarf ratios is even more important but this is all in keeping with good standard repair practice.

1810 Stichmat, a good, all-purpose glass cloth.

More and more new boats are built using vinylester and epoxy resins. Vinylester handles a lot like polyester but can be more temperature sensitive and is used to repair polyester and for minor repairs, epoxy laminates. Conversely, polyester is used to repair vinylester laminates (with some loss in water barrier quality below the waterline) but is no good for repairing epoxy as it

A vacuum bag makes overhead work easier and gives superior glass-to-resin ratios.



(top) Cut and dry fit the new glass before mixing any resin. (middle) First layers on. (bottom) Layers are lightly ground in prep for subsequent layers.

(above) After filling and fairing, epoxy primer or barrier coating is applied. (right) New interior work is painted with air-dry gelcoat or epoxy paint.

does not bond to epoxy. Epoxy, however, does bond well to almost any existing laminate and is used where maximum strength and water resistance is required. Epoxy is more expensive and more difficult to work with. An overhead laminate repair using epoxy can't be done easily using the polyester "hot mix" trick. Instead, a vacuum bag is used to clamp the repair in place. Vacuum bagging yields a superior fiber-to-resin ratio.

Laminating

The arrival of more boats built using vacuum-bagged epoxy resins and advanced Aramid or carbon-fiber laminates requires repair yards to adopt new techniques and materials, but the traditional repair techniques of hand lay-up will never be obsolete.

Conventional glass repair work doesn't require exact duplication of the original laminate schedule, but it's important to put back at least as much glass as was ground away. Try to achieve good glass-to-resin ratios with careful rolling to squeegee away excess resin and diligent removal of trapped air (a.k.a. bubble busting). Glass patches built of several layers requires careful cutting and dry fitting of the layers before mixing resin. The smallest piece goes on first with each subsequent piece a bit larger to gradually overlap onto the perimeter of the scarf. This ensures the new-to-old bondline has contact between as many layers of glass as possible.

Once all prep grinding is finished, the repair surface is vacuumed or blown free of dust and wiped with acetone. It's then pre-wetted by applying catalyzed resin by brush or roller. Each new glass piece is also pre-wetted with resin on a nearby work surface and transferred to the repair where excess resin and air is rolled out with a bubble buster lay-up roller. Depending on the size of the repair it may be possible to apply more than one layer at once. With large repairs however, each layer is allowed to cure and is given a light prep grind before the next laminate is applied. This eliminates bumps and ridges and allows the next layer to go on smoothly.

With the structural lay-up completed, the surface is sanded to flatten the surface and prepare it for filling and fairing. A 1,500-rpm feath-

Keel dents shaped, filled and faired.

ering sander with an 8" (20cm) foam pad and 60-grit works best. Apply 3M Premium vinylester Filler following the instructions in DIY 2003-#1 issue (see "Steps to a Smooth Finish"). It's easy to work with and durable below the waterline. Below the waterline, the faired surface receives an appropriate barrier coating (e.g. Interprotect 2000e) or epoxy primer then painted with antifouling. On the interior tabbing and floor grid, the repairs are sanded and painted with an air-dry gelcoat.

Keel Repairs

Dents on the keel are shaped with a body file or big grinder fitted with a 24-grit disc. Lead dust and filings are very toxic. Wear protective clothing, goggles and use a respirator. Dents are then filled, faired and painted as any other part of the boat below the waterline. If there is a big crack between the hull and keel or leaking at a keel bolt it's necessary to remove the keel. [Ed: refer to DIY 2000-#1 issue for more details on this aspect of the job.]

The keel securing nuts (or bolts) are removed, the boat lifted slightly with a travelift or hoist. The keel should stay put while the hull lifts above it exposing a gap. If not, drive wedges between the hull or keel stub and the keel or ballast. It's not usually necessary to lift the hull completely clear of the bolts. Just enough space to slip a mini-grinder between to grind off the old sealant and chocking epoxy until both mating faces are clean. Reinstallation involves applying a fat bead of 3M 5200 sealant around each keel bolt only. This keeps water out of the boat. It's a big mistake (frequently made by amateurs) to goop the whole mating face with sealant. Believe me, you do not want a keel-to-hull load-bearing surface to be in any way flexible and all sealants are flexible. Epoxy is not a sealant and should never be used as such, but when applied to the keel-hull joint as a thickened paste (mix with colloidal silica to a peanut butter consistency) it makes an ideal high-strength chocking compound. Once cured, this thick layer of chocking epoxy spreads the loads evenly across the entire uneven keel-to-hull mating surface, except of course that donut of sealant around each bolt. But before the compound cures, the boat is lowered back down onto the keel and the keel bolts tightened to builder's spec with

A separation this wide at the keel-hull joint indicates the keel needs to be dropped and rebedded.

The keel-hull joint is cleaned and prepped for reinstallation with new sealant and chocking epoxy.

a torque wrench. The excess epoxy squeezes out and is neatly trimmed with a putty knife while still wet. An optional (but recommended) glass overlay followed by filling and fairing, completes the keel-hull joint. [Ed: refer to DIY 2003-#1 issue for complete filling and fairing procedures.]

There still remains the reassembly of the interior, shimming and reinstalling floorboards, hours of cleaning plus launch and rerigging. With luck there might even be a little bit of the sailing season left to enjoy.

About the author: Nick Bailey has spent 26 years in the boat repair business and is service manager of Bristol Marine in Mississauga, Ontario.

DIESEL

BREATHING PROBLEMS

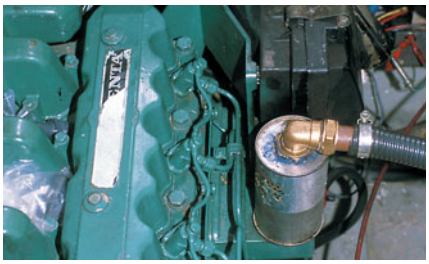
Crankcase fumes in the engine compartment and high oil consumption are often the first telltale signs of a worn engine. Here's a solution to the effect before you have to take the cure. It can also benefit healthy engines.

STORY AND PHOTOS BY PETER CAPLAN

Common problems with older diesel engines and those spending the majority of their lives on non-tidal rivers are that of high crankcase pressure and the resultant oily fumes in the engine compartment accompanied by high oil consumption. For older engines it's simply bore wear that causes the problem. For lightly used and river-based engines, it's glazing of the cylinder bores that prevents the piston rings forming a proper seal. This is due to many hours of running at low rpms and idling in locks with the engine never working at full power. The walls of the cylinder bores become polished, removing the fine criss-cross grinding pattern that occurs when the bores are finished following reboring.

The resulting high-oil consumption means increased running costs

Note how the crosshatch pattern on the unworn section contrasts with the highly polished worn section.

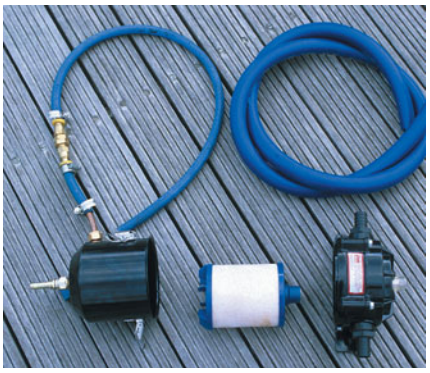


The original breather unit had already been modified with an overboard breather pipe that didn't solve the problem. The proximity of the breather and air filter box can also be seen.

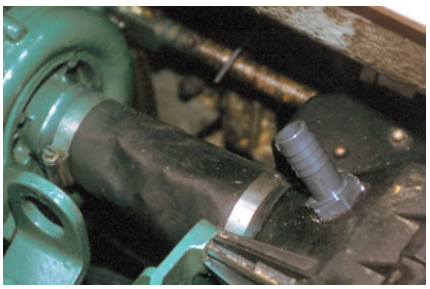
The pipe was removed and the filter unit taken out onto the dock where the casing was cut off leaving just the base and threaded spigot.

An aluminium plate was cut to size and fitted into the original base with epoxy adhesive and pop rivets. The plate was then drilled to accept a brass skin fitting hose barb of the appropriate size to match the hose barbs on the CCV. This was then fitted to the new base with a backing nut and sealing washers. The unit screws directly back into the engine breather outlet.

while the smelly fumes permeating the engine compartment find their way up into the accommodation. In extreme cases, notably the Volvo-Penta AQD40A where the crankcase breather is located right next to the air filter, the oily fumes



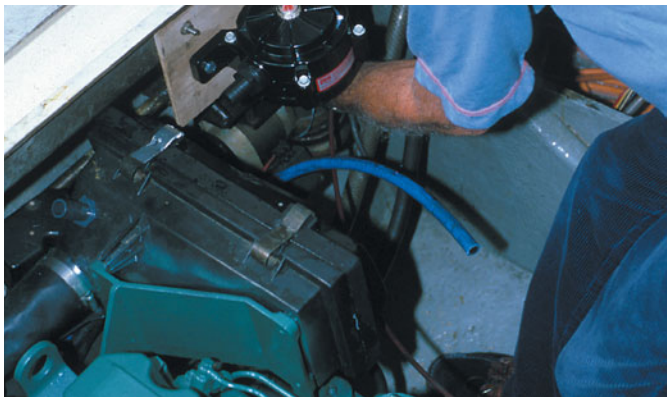
The CCV set consists of the main unit containing the oil separation element, pressure regulating valve and service indicator, the drain hose and non-return valve and the breather hose that is supplied in one section for cutting into two lengths as required.



Another skin fitting hose barb, this time in plastic was installed into the back of the engine air filter box, behind the element, so that contaminants by-pass the element. While plastic is okay for this fitting it would not stand the heat of being used for the breather outlet where metal is required.

The thru-hull hose barb backed up with a nut inside the air filter box.

contaminate the air filter element after only a few hours running, which makes it essential to change the element almost every month as it chokes on the oil fume laden air. Even Volvo-Penta agents have been known to admit that the location of the breather so near to the air filter intake can create the problem. Unfortunately, they have been unable to offer a practical solution. It would be unfair to say that the prob-

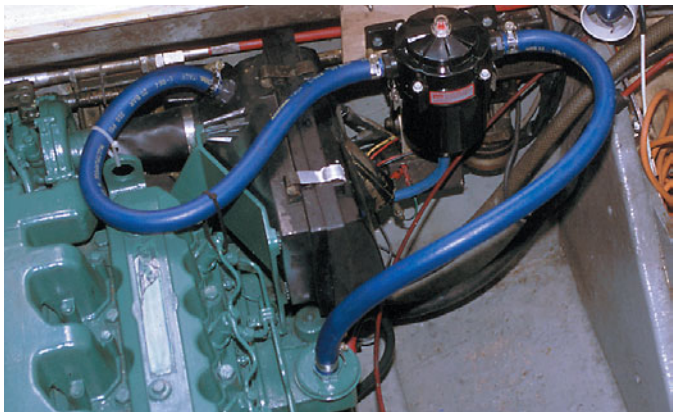


The CCV itself is fitted onto a bracket in a convenient position out of harms way but close enough to the engine to minimize pipe runs.

lem applies only to Volvo engines, as bore glazing is common to all makes when operated under the same circumstances. It's just that it becomes more of a problem on the AQD40A due to the breather and air filter proximity. Changing the breather filter element at the proper service intervals does little to mitigate the situation.

Ingenious boat owners have sought to eliminate the problem by blocking one side of the breather to divert fumes away from the air filter or piping the crankcase fumes directly to the outside atmosphere. Blocking part of the breather has no effect as the intake suction still pulls the fumes into the air filter element. Piping the fumes outside stops the air filter becoming clogged but increases the crankcase pressure, which may lead to oil leaks and an oily residue on the hull. In neither case will the effort do anything to slow oil consumption.

There is a remedy available that, while it won't cure the glazed bore problem, does prevent the escape of oil fumes and greatly reduces oil consumption. This is the Racor Crankcase Ventilation System (CCV), which is suitable for old engines but will also lessen the chance of oil leaks and may even reduce oil consumption on newer engines in good condition.



The final job is to connect the pipework and clip it into position. Note the drain hose that returns the collected oil to the sump. This runs across the back of the engine where it tee's into the sump pump pipe. It's proximity made it impossible to photograph the fitting.

How It Works

The way the system works is by lowering crankcase pressure using intake suction through a limiting valve. The oily fumes from the crankcase are collected in a sealed container that separates the oil from the fumes in a special filter element. The oil is then returned from the Racor element to the sump via a permanent drain that includes a non-return valve that prevents oil being forced up into the bottom of the Racor unit.

The remaining fumes and water vapor are passed to the engine manifold via a connection behind the air filter that ensures the fumes bypass the filter element to avoid contaminating it. On turbo-charged engines, the fumes and water particles, enroute to the cylinders for burning as part of the normal combustion process, also play a helpful role by helping clean the turbine blades. Incidentally, the water within the fumes actually improves combustion and does not harm the engine in any way.

CCV unit service is minimal. On average, the filter element requires replacement after 750 hours running. There is a red service indicator built into the top of the unit that should be checked regularly. This is activated when the filter is fully blocked and pops up inside the top of the unit under crankcase pressure. If this happens, replace the filter element and reset the indicator by unscrewing the clear cover and pushing the indicator down. The reset must be done following every activation.

Installation

Installing the CCV is well within the capabilities of the DIY enthusiast. The only area requiring particular care is the connection to the sump that allows the oil from the unit to drain back to the sump. Making this connection will vary from engine to engine and may mean simply removing the sump drain plug and replacing it with a pipe-fitting to allow either copper tube or flexible hydraulic hose to connect between the sump and Racor unit.

It's important to plan the installation before ordering the parts. There are several points to note before beginning the work, most of which involve observing common sense. The Racor unit itself must be mounted upright (or within 10° of upright) and above sump level to allow for efficient oil drain back. The unit and the plumbing (hose or tubing) needs to be kept clear of engine hot spots such as the uncooled exhaust sections and any pump or alternator belts or other moving parts. Units can be supplied in left or right hand fittings as there are "in" and "out" connections that must be properly oriented at the connections for the unit to function correctly. Some engines can be supplied with a new Racor air filter to connect directly to the CCV but, in most cases, this will only increase the cost, as it's straightforward to install an inlet into the standard air filter unit.

Again, depending on engine make and type, a crankcase breather adapter fitting can be supplied to replace the original filter unit or breather pipe. For most engines it is easy to adapt the original breather to suit the new Racor CCV.

Adapting the AQD40A breather is about as complicated as it gets since there is no off-the-shelf adapter to suit this engine and the size of threaded hole that takes the standard breather filter is large with a very coarse thread. The easiest option is to modify the original filter housing to accept the hose leading to the Racor CCV, as outlined in the accompanying photos.

The installation described typifies the problems likely to be encountered with this type of project but no two engines are the same and the layout of the equipment and plumbing will vary with a specific installation.

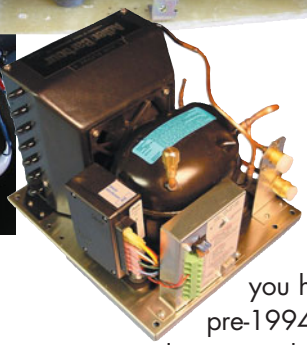
About the author: Peter Caplen is a mechanical engineer and British technical writer with nearly 30 years experience in building, maintaining and renovating mainly powerboats.

COOL EXPECTATIONS

Routine maintenance of a marine refrigeration system results in greater cooling power, maximum energy efficiency and longer-lasting food. Follow these steps to solve refrigeration problems before they occur.

STORY BY JAN MUNDY

Most marine refrigeration systems are ignored until they fail. Provided foods remain cold and it's making ice, there's no great urgency for you to inspect the refrigeration system when there are so many other maintenance jobs calling your attention. Often systems are buried in a locker or under a berth — "out of sight, out of mind." The day will arrive, probably during a heat wave, when you open the icebox lid and are greeted with the nauseating smell of spoiled food. This might have been prevented had you added refrigeration to your maintenance log.



(top) All evaporator refrigeration systems use a Danfoss compressor. (above) Sea Frost engine-drive compressor.

Two different refrigeration systems are installed in boats and which one you have onboard will determine the maintenance steps. Refrigeration components include: a compressor, controller, thermostat, grill or "radiator" if an air-cooled system, water pump and strainer for water-cooled units, filter, flat plate or bin evaporator or a cold (or holding) plate fitted inside the icebox. Holding plate systems also include a condensing unit.

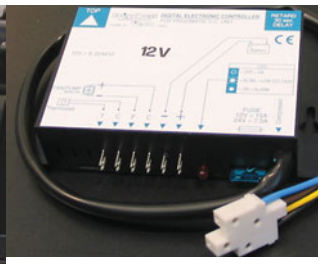
Servicing Key Components

All evaporator systems use a compressor to cool the evaporator and all are the Danfoss brand. This is a completely sealed unit. Should it fail, replacement is your only option. Refrigeration systems contain a filter/dryer that dries and filters the air to keep moisture out of the system. Change this filter annually. Inspect brushes (some units are brushless) every 500 hours or so and replace brushes before they become worn. Check your owner's manual for the location of the brushes and the recommended frequency for service.

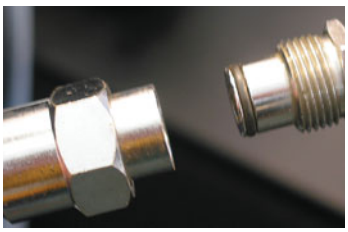
An electronic controller is found on many evaporator systems. It may fail but it is simple to replace. Pull off the wires, unplug the three or four-pin connector and install a new one (provided you have a spare). Older, pre-1994 controllers are no longer made and difficult to find.

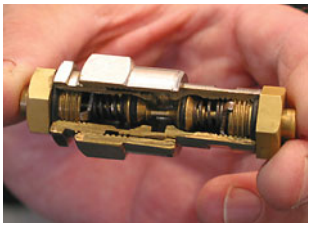
Spares are available from Frigoboat (www.frigoboat.com) and Adler Barbour, now called Coolmatic (www.waeco.com).

Check all wiring and terminals and service as needed. Be sure that all connections and mounting brackets are tight and there is no movement from any part. Manufacturers recommend replacing all hoses at least every 10 years and offer replacement hose kits. Again, check your owner's manual for specs. Some systems have a reset button. Check this switch if the com-



(left) Easy-on plug connectors permit a quick electronic controller replacement. (above) A pre-1994 replacement controller.





Two types of metal coupler connections: one has a spring-loaded piston, the other an O-ring.

pressor fails to start. Look for corrosion on the compressor housing. Saltwater can corrode aluminum casings, rot tubing and crack O-rings, creating a casing leak. Remove corrosion using Soft Scrub and a Scotch-Brite pad and paint any bare spots.

Frost that builds on the evaporator or the holding plate restricts airflow through the box. When ice gets 1/2" (12mm) thick, it's time to defrost. There are two ways to do this. Use an automotive windshield ice scraper or pour hot water on the surface to melt off the ice. Never use an ice pick, screwdriver or other sharp tool that can puncture the evaporator. After defrosting, squirt food-grade liquid grease (e.g., Pam) for easy ice removal next time.

Most systems include an analog or digital thermostat, two with separate refrigerator and freezer compartments, that mounts inside the box to control the temperature. Once set, the thermostat shouldn't need resetting. So, when the plastic turn knobs corrode and break off, either do without or purchase replacement knobs.

Holding plate systems have additional wear items. The belt adjustment on engine drive systems should be inspected routinely. Tension should be snug tight, just so it doesn't slip or squeal when the compressor starts up

Flare fittings can vibrate loose and leak.

Set the thermostat once and it's unlikely it won't need resetting.

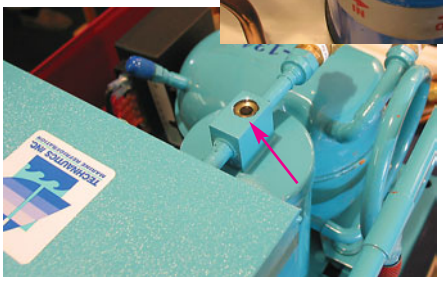
but not super tight like an alternator belt. After several years operating a refrigeration system in warm water, alkali scale builds up on the condenser. A compressor that runs longer than normal, uses more energy to exchange heat and creates excess heat are clues the condenser needs a thorough cleaning. On Glacier Bay units (www.glacierbay.com), the condenser is easily serviced. Remove end caps and then pass a wooden dowel through the tubes. Sea Frost (www.seafrost.com) recommends using this cleaning method for its condenser: remove the zinc, plug the bottom hole, remove the top hose and add 6oz (177ml) of a 5% to 7% muriatic acid solution. When foaming stops, reconnect the hose, open the thru-hull and start the engine. Run the engine for a few minutes to flush the system. Now, shutdown the engine, close the thru-hull and reinstall the zinc.

Leak Checks And Recharging

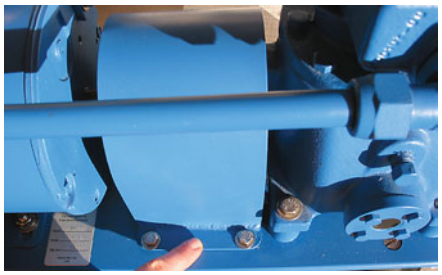
Connection leaks are the most common causes of failure. A gradual decrease in cooling performance, a system that cycles repeatedly or a build-up of frost over one area on the evaporator are all good indicators of a slow coolant leak.

All compressors produce vibration. Rubber dampening mounts help to isolate this vibration but often this isn't enough. Vibration can cause leaks at metal fittings where copper tubing connects to the compressor.

Leaks are easy to locate. If you suspect a leak, apply a soap-water solution and watch for bubbles forming on these connections. Use a flashlight and a small mirror (e.g., dental mirror) to examine the underside of



Some units have a sight glass for a quick scan of charge levels.



To access the elastomeric pad that cushions the motor and coupling to the compressor on Glacier Bay's holding plate system, remove the four bolts then the cover, slide the coupler back and replace the pad.

A thin layer of frost covers the entire evaporator surface when a refrigeration system operates at peak efficiency.

Recharging kit must always connect to low-pressure port.

connections. Also, wipe all connections with your finger. As oil is always circulating in a refrigeration system, where oil is present, there is a leak. Tighten the fitting just 1/16" (1.5mm) of a turn and then check for leaks. Don't over tighten. You want to tighten it just enough to stop a leak, not until it can't turn. Some older units have metal-to-metal fittings that tend to leak from contraction and expansion. These must be torqued as specified in your owner's manual. Other fittings have rubber O-rings that typically don't leak. Flare fittings also leak and should be finger tested frequently to check for oil residue.

Sea Frost and Technautics (www.technauticsinc.com) holding plate systems incorporate a sight glass for checking the charge level. When first starting the system, it's common to see bubbles or foam in the sight glass but they disappear after the condenser warms up. A sight glass that doesn't clear after running for 15 minutes indicates low refrigerant and a possible leak.

Older Glacier Bay systems have an elastomeric pad that cushions the motor and coupling to the compressor. Change this pad, which is located under the cover, every two to three years. Newer Glacier Bay units have vibration isolators to prevent vibration from being transmitted from the compressor to the connections. These isolators have corrugated bronze tubing and sometimes break. Carry spares onboard and if one breaks, unsolder the ends and install a new one. At this time, the coolant must be recharged.

All refrigeration systems must be recharged after fixing a leak. Older systems contain R12, which can only be evacuated by a certified refrigerant mechanic. Compressors now contain 134A, the same earth friendly refrigerant used in automotive air conditioners. You no longer need a mechanic to recharge a refrigeration system. Purchase a charging kit at Kmart, Wal-Mart or most auto parts stores. Locate the service ports on the compressor (they all have them). Attach the refrigerant charging hose to the port on the low-pressure side, open the refrigerant can and start the compressor.

If frost extends onto copper tubes exiting the evaporator, then the system is overcharged.

(top) Regularly inspect sacrificial zincs on a keel cooler. (bottom) Coolers without zincs have a grounding strap to connect to the boat's bonding system.

Always charge from the low-pressure side, never from the high-pressure side. If you're not sure which one to use, hire a technician to do this job. Put in 1/4 of the can and then check the charge. Refrigeration systems with sight glasses make charge checking easy. Add refrigerant in 1/4-can increments and run the compressor until bubbles not longer appear in the sight glass.

Charge Levels

A system operating at peak efficiency has an even layer of frost on the entire evaporator or holding plate. A partial frost line indicates an undercharge condition. If frost creeps down the copper lines, then the system is overcharged. When this occurs, lightly depress the valve in 5-second intervals to gradually release refrigerant. Continue doing this until the frost line is no longer visible on the copper lines. A higher charge results in higher operating temperatures. Moisture on the compressor housing or rust build-up on a metal base indicates one of two conditions: that it's been overcharged or undercharged for many years. Overcharging can cause compressor lines to sweat. A compressor that is warm to the touch may be the result of an undercharged system.

Cool Running

All refrigeration systems use either air or seawater to remove heat and cool the compressor.

Air-cooled units have a wire grill or a radiator-like unit mounted on the compressor. Dust, lint and pet hair can restrict airflow and cause the compressor to overheat. Keep the grill clean to obtain maximum cooling efficiency. At least once a year, clean with a brush, compressed air or a vacuum. Do this carefully to prevent damaging the grill or the delicate radiator wire. Fans fail, so carry a spare one, which is a standard 4" (10cm) computer box fan available at Radio Shack.

If your refrigeration system is water-cooled, you should pack a replacement pump. Routinely check seawater strainers and clean as needed. Check hoses and all connections for corrosion. Replace any suspect parts, especially on pumps mounted below the waterline.

How do you keep foods cold with a water-cooled refrigerator when you haul out? Here's a tip from Frigoboat. Mount a portable battery-operated fan so it blows air across the compressor. This should keep it humming for a few days until you relaunch. Caution: Never use a fan if the compressor is mounted in an area that requires ignition protected electrical devices (e.g., engine compartment). Few, if any, readily available household-type fans, will be provided with this critical safety protection.

Certain refrigeration systems utilize a keel cooler mounted below the waterline on the hull. Some units have a sacrificial zinc anode, which should be checked frequently, or at least when you inspect drive train anodes. A keel cooler without zincs usually has a bonding strap to connect to the boat's bonding system or

(top) Keep condenser grill or radiator free of dirt and dust. (bottom) When a fan fails, shown on the left in this photo, replace it with a readily available computer box fan.

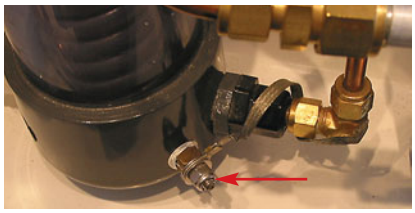
the battery negative to prevent stray current corrosion. Check the bonding strap and make sure all connections are tight throughout.

All engine drive systems that are seawater cooled have a sacrificial zinc in the condenser. Remove and inspect the zinc monthly. Replace every six months or sooner if inspection reveals excessive wear.

Performance Enhancements

If your refrigerator box has a drain, plug it. The drain was put there to drain off melted ice, but your refrigeration system, like a household fridge, has minimal moisture build up. Since cold air sinks, the drain becomes an escape duct for cold air (bad) and a passage into the bilge for any moisture that condenses or contents' spills (smelly). Plug the drain opening with a rubber or soft wood plug or silicone sealant or cover it with duct tape.

Where tubing exits the box, make sure holes are well sealed. If the box is divided into refrigerator and freezer compartments, check that the divider is entirely sealed.



Seawater-cooled holding plate systems a bonding strap on the condenser to prevent corrosion.

An infrared thermometer is a wonderful tool for finding refrigeration and air conditioning air leaks or reading engine temperatures.

Lightweight and thin, vacuum panels offer the best insulation for your icebox.

When excessive ice forms on the evaporator or holding plate, or the compressor runs longer than usual, warm air may be gaining entry under the lid or through the door. Check the gasket for air leaks between the top of the box molding and countertop, or along the door. To do this on a front opening door, slide a bill or piece of paper under the door and observe if the gasket grips it all the way around. Another method is to shoot an infrared thermometer at the door or lid. You can also use this device for checking engine temperatures and air conditioning leaks. Replace gaskets as needed. Consider replacing a poorly insulated lid with a Ready-To-Mount hatch from Glacier Bay. Consisting of a vacuum insulated panel, hatches are available in three sizes for top or front-opening installation.

It's good practice to stir up the air inside the box to eliminate cold air settling at the bottom and possibly freezing delicate foods. A Fridge Mate battery-powered fan, available at marine stores, circulates air to give an even temperature and better box efficiency.

Poor box insulation is a common problem with refrigeration systems. Many boxes are inadequate, which greatly reduces cooling performance. Technautics and Glacier Bay offer thermal insulation panels that are easily retrofitted inside an existing box with sufficient space. Technautic's 1" (2.5cm) thick panels are equivalent to 4" (10cm) of closed-cell urethane foam insulation; Glacier Bay's Barrier Ultra-r vacuum insulation panel apparently delivers R-50 per inch (per 2.5cm) insulation value, the equivalent of 10" (25cm) of closed-cell urethane foam.

Take the time to add these service procedures to your maintenance log. While I cannot guarantee you'll always arrive at your destination with cold steaks, chilled beer and frozen ice cream, these preventative measures certainly increase the odds in your favor.

ELECTRICAL

ENERGIZE YOUR DC SYSTEM WITH POWER TO SPARE

Is choosing the right battery a test of your brainpower?

The average life of a car battery is 48 months. The average life of a marine cranking battery in recreational marine use is only 22 months. Marine batteries can last much longer if you make a few wise decisions about their selection, installation and maintenance.

STORY AND PHOTOS BY LARRY BLAIS

Replacing a battery in a car is a simple matter. The car's manufacturer has determined the appropriate type, shape and capacity, and published these specifications. So all you have to do is decide what quality of battery you are willing to pay for. Recreational boats, on the other hand, are rarely equipped with batteries adequate to the power hungry "gotta have" extra equipment that most of us think we need to enjoy boating. So, we approach the task of having to buy new batteries with some disdain, sometimes because the old ones either didn't last as long as we thought they should or as long as we were told they would.

Capacity And Usage

If you need a battery for a small runabout with an outboard motor, deciding on a battery will be a relatively simple task but if you have a yacht with multiple engines, several radios, radar, refrigerator, inverter, etc., then the decision becomes more complicated. Let's start with the simplest application and work our way up to the more complex.

Any small boat that just needs a battery to start the engine and run some navigation lights from time to time can probably get by with just one Group 24 or 27 battery. Check with the engine manufacturer for its recommended minimum cold cranking ampere (CCA) rating required to start your engine and buy a quality marine battery with enough CCA capacity.

ABYC standard E-10 defines cranking performance (also referred to as marine cranking amps at 32°F/0°C or MCA at 32°F/0°C) as "the discharge load, in amperes, that a new, fully charged battery at 32°F (O°C), can continuously deliver for 30 seconds and maintain a terminal voltage equal to or higher than 1.20 volts per cell." The standard further states that, "Cranking batteries shall have at least the cold cranking performance rating (CCA at O°F/-17°C) or marine cranking performance rating (MCA at 32°F/0°C) amperage required by the engine manufacturer." For added peace of mind, consider adding a second battery of the same type and size. In any case, one battery or two, install a marine battery selector or On/Off switch. Although ABYC (E-9 and E-11) does not require these switches unless the battery output rating is at least 800 CCA, it's still a good safety practice.

Adding an electric trolling motor? You'll probably need a separate deep-cycle battery dedicated to its service. After a day of trolling, this battery can usually be at least partially recharged by your engine's alternator if a battery isolation diode or selector switch is installed. If your boat has more than one engine, each engine should have it's own cranking battery with a CCA rating appropriate for the engine's need. Here again, adding a second battery or an emergency cross-over switch or a selector switch that would connect a cranking battery from the other engine would be prudent.

If you operate lights, radios or other DC equipment without the main engine running (such as when at anchor or while under sail) or depend on a DC-powered bilge pump, then you may need a separate "house" electrical system energy source. This system is independent from the engine electrical system and has its own battery(s). House batteries should be true deep-cycle batteries that can tolerate deep discharge cycles between charging cycles. These batteries are rated in ampere hours (Ah). Because of the internal construction of these batteries, they rarely have the high ampere capacity to crank an engine and they can be damaged trying to do so. Likewise, cranking batteries, because of their internal construction, will not tolerate sustained discharging like deep-cycle batteries can.

DC-to-AC inverters put very heavy demands on their host boat's batteries. For a 12-volt inverter to supply 10 amps at 120 volts, it must draw over 100 amps from the batteries. To supply 20 amps, it would draw over 200 amps and so on. Having a dedicated inverter battery bank might be very wise.

A good quality 235 Ah golf cart battery can produce a continuous 75 amps for about 2 hours, 40 amps for about 4 hours, 20 amps for about 10 hours and 10 amps for about 25 hours. Since these batteries are only 6 volt each, two batteries must be connected in series to produce 12 volts and another set of these batteries connected in series may have to be connected in parallel to the first set to safely produce enough amps for sustained use of the inverter.

Battery manufacturers are constantly looking for ways to satisfy the

consumer's needs. It would seem that a combination cranking/deep-cycle battery would be great idea. With the exception of a few very high-end batteries, most dual or combination starting/deep-cycle batteries are simply a poor compromise between a cranking battery and a deep-cycle battery and have not proven to be very good at either task. Be aware that some battery manufacturers have simply added handles and stud-type terminals to their standard cranking batteries and have sold them as marine deep-cycle batteries. Needless to say, they don't last long.

Pick One, Just One

Today, there are three distinct types of batteries available. They are flooded acid (a.k.a., wet cell), gelled acid (a.k.a., gel cell) and absorbed glass mat (AGM). Each type can be designed and constructed for either engine cranking or deep-cycle applications.

Flooded acid batteries are by far the most popular and generally seen as the most cost effective. Commercial vessels use them almost exclusively. Flooded low-maintenance batteries have filler caps and a lead-antimony/calcium dual alloy or hybrid plate formulation that helps reduce gassing. Flooded maintenance-free batteries are sealed and have a lead-calcium/calcium plate formulation that helps the hydrogen and oxygen gasses recombine back into water rather than needing to be vented.

The gelled acid batteries lost popularity very quickly partly because they require special low, slow recharging rates. Many gel cell batteries have been destroyed by being charged at the normal rate for a flooded battery. Sealed valve regulated lead-acid (VRLA) gel cell batteries are usually spiral wound and use a thickening agent like fumed silica gel to immobilize the electrolyte. The pressurized cells help hydrogen and oxygen gasses recombine back into water. They can withstand a deep discharge but not temperatures over 100°F (37.8° C) due to "thermal runaway." They work best at an ambient temperature of 72° F (22.2° C). They generally produce less cold cranking amps than other batteries. Gel cells require longer recharging times at lower charging voltages. Of all the sealed batteries, the gelled acid battery is the least tolerant of the heat found inside most engine rooms.

The top plate is from a heavy-duty deep-cycle battery used by railroads. The middle plate is from a popular deep-cycle battery used to power electric golf carts. The bottom plate is from a high-quality marine cranking battery. The plates in a typical car battery are more than 30% thinner than the plates in a high-quality marine cranking battery. The thinner more porous plates are more easily damaged. [Ed: One of the many reasons marine batteries are more expensive than automotive.]

The AGM battery has not faired much better, often due to improper installation. Sealed VRLA AGM batteries have a very fine fiber boron-silicate glass mat between their plates that absorbs and holds the liquid sulfuric acid. The pressurized electrolyte starved cells help hydrogen and oxygen gasses recombine back into water rather than needing to be vented.

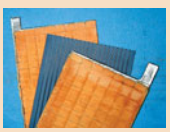
Ventilate And Contain

Batteries must be protected against saltwater as this, mixed with electrolyte, produces deadly chlorine gas. Batteries also need to be protected against extreme temperatures.

The Pickled Amp

Lead-acid batteries have seen few major changes since they were first developed over 100 years ago. The most common became known as a "wet cell" or "flooded acid" battery. Most U.S. manufacturers use flat plate technology in their positive and negative plate designs for this battery.

Lead grids serve as the supporting framework for the active, porous material pasted to them. Lead oxide (PbO), sulfuric acid (H2SO4) and water are blended in a mixture to the approximate consistency of stiff mortar cement. Once the grids are covered with this blend, they are cured in an oven.



Plates are then stacked; alternating positive and negative plates, separated with thin sheets of electrically insulating, porous spacers.

Enough plates for one cell are jigged together so all the positive plates can be soldered together (in parallel) with a torch.

Then the negative plates are soldered together (in parallel).

After the soldered plates have cooled they are checked for connection penetration and cleaned of any loose lead that might short out the plates. Plates are now slipped into the case.

Each cell will produce approximately 2.11 volts. The only way to increase the voltage is to connect cells together in series (negative to positive). Three cells in series will produce about 6.3 volts.

Six cells in series will produce about 12.6 volts. Once the lid is on and sealed, the battery is filled with diluted sulfuric acid and ready for charging. During the initial charging, the lead oxide in the positive plate is converted to lead dioxide (PbO2) and the lead oxide in the negative plate is converted to sponge lead (Pb). When fully converted, the battery is called "formed." After the spent electrolyte is replaced with fresh diluted sulfuric acid, the battery is given a finishing charge.

When underway, the temperature in boat engine compartments can exceed 120°F (48.8°C). A flooded battery loses half of its service life for every increase of 15°F (9.4° C) over 80° F (26.7° C). A hot engine compartment is not a good place for any battery.

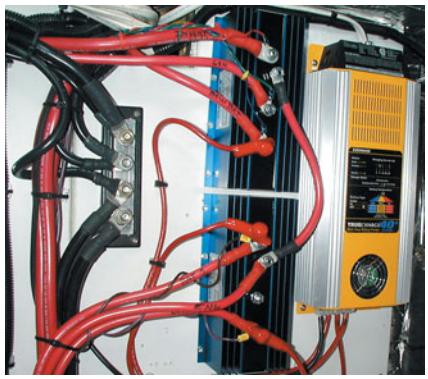
All batteries need ventilation, even sealed ones, as they have pressure relief valves that will open if the battery is worked hard enough. Batteries, especially batteries connected to an inverter, can produce explosive hydrogen gas that should be vented to the outside of the vessel. Some modern yachts are built with power ventilation ducted right into the battery boxes, blowing the fumes overboard.

A battery On/Off or selector switch should be installed in the positive battery cable. It should be placed where it can be turned off without opening the engine compartment, just in case the compartment is aflame and opening the compartment would fuel a fire with an influx of oxygen. Select a switch with enough capacity to carry the current required without overheating the contacts. Overheated battery switch contacts often result in high resistance that keeps the battery from receiving a full charge and high resistance connections that overheat are a source of fire.

Tips For Longer Battery Life

Normally all batteries "age" as the active positive plate material sheds due to the normal expansion and contraction that occurs during the discharge and recharge cycles. Eventually, this sediment builds up in the bottom of the case and can even short out the plates of a cell. The "aging" process is accelerated when the battery endures heat, vibration, overcharging, positive grid growth, positive grid metal corrosion, negative grid shrinkage, freezing, buckling of plates, loss of water or sulfation. Sulfation occurs when a battery drops below a full charge for long periods and hard lead sulfate crystals fill the pores in the plates.

Screw-down covers that hold these batteries securely in place, even in rough seas. They also cover the terminals so nothing metallic can short-circuit them.



Smart chargers and battery isolation diodes allow the alternators to charge multiple batteries.

Always wear protective glasses to protect your eyes in the unlikely event of an explosion when working with lead-acid batteries. [Ed: Read "The Day the Battery Box Exploded" on page 7 for a first-hand account of a battery explosion.] Battery plates need to be covered at all times to prevent an internal battery explosion or sulfation. Avoid overfilling, especially in hot weather, because the heat causes the electrolyte to expand and overflow. In an emergency, use rainwater rather than reverse osmosis or tap water because rainwater doesn't contain calcium or magnesium. Using tap water to refill batteries can produce calcium sulfate crystals that fill the pores and coat the plates. Don't add battery acid except to replace electrolyte spills.

This boat needs to be protected against acid spilling from the battery. A drip tray might help but a battery box is better. Note how these boxes attach to the boat by external screws. Never drill holes through the bottom of the boxes to fasten them down as this gives any leaking acid a path to leak from the container.

Use an hydrometer to measure the specific gravity (SG) of the electrolyte in flooded acid batteries. This reading tells you the battery's degree of charge. SG readings should not differ more that .030 between the lowest and highest reading. Use the following table to determine the battery's degree of charge.

100%	1.265
75%	1.225
50%	1.190
25%	1.155
Discharged	1.120

Always charge with a "smart" or "float" charger. An inexpensive, unregulated trickle charger can destroy a battery by overcharging it. Battery isolation diodes (also known as split charging diodes) allow the

(left) Note the black powder on the front of this engine. It formerly was part of the alternator belt. The belt pulley sheaves have rust pitted so badly that they are eating up the belt to the point that the belt is so loose that it's slipping. Sometimes sandpaper can smooth the pulleys. Sometimes the pulleys have to be replaced. If not attended to soon, the belt will fail. (right) This belt pulley is in better shape but is too loose and needs to be tightened until it deflects only about 5/16" to 3/8" (7mm to 9mm) when pushed with one finger.

If the electrolyte levels in non-sealed wet batteries (with filler caps) are above the plates but low, allow the battery to cool to room temperature and add only distilled, deionized or demineralized water to the level indicated by the battery manufacturer or to within 1/4" to 3/8" (6mm to 9mm) below the tops of the filler tubes, vent wells or splash barrels.

To use a hydrometer, simply hold the hydrometer vertically and squeeze the rubber bulb to force the air out. Now put the rubber tip into the electrolyte through the battery filler hole and release the bulb. The electrolyte is sucked up into the hydrometer allowing the float to ride freely. Read the SG at the point the surface of the electrolyte crosses the float markings. The SG reading should be between 1.100 and 1.300. Squirt the electrolyte back into the cell from which it was taken and record the reading. Repeat the process for each individual cell. Rinse the hydrometer with water when you've finished.

alternators to charge multiple batteries. These diodes have an inherent voltage drop of .6 volt to 1 volt that prevents them from fully charging the batteries unless the alternator output voltage is increased to compensate. If your alternator regulator doesn't have an external adjustment, you may still be able to increase its output by installing a diode with the same voltage drop in the regulator sensing wire between the alternator and the regulator. This way the alternator "sees" the reduced voltage and increases the alternator output accordingly.

Clean and tighten any loose hold-down clamps, battery terminals and connectors. High resistance in a cable connector can keep the battery from receiving a full charge. Remove any corrosion with a brass wire battery brush by brushing the corrosion away from you. Take care to avoid poking yourself with the brush as a wound from the brush could lead to a serious infection. Neutralize heavy corrosion with a mixture of 1lb (.45kg) of baking soda (bicarbonate of soda) to 1gal (3.78L) of warm water. Be sure to keep this mixture from entering the battery cell where it can neutralize the acid. Treat the terminals with corrosion-inhibiting formula. Clean the battery top to eliminate conductive paths created by dried or wet electrolyte and to prevent corrosion.

Check alternator belt pulleys for corrosion and the belt for proper tension. A slipping belt prevents the alternator from properly charging the battery. Without being fully charged the battery will sulfate and lose capacity.

Most of the defective batteries returned to the manufacturers during the free replacement warranty period are still serviceable. This strongly suggests that an undiscovered problem with the electrical system was what prompted the replacement of the original battery in the first place. Had this problem been discovered and corrected, the battery may not have even needed replacement.

ENGINE TROUBLE SHOOTING

TRANSMISSIONS: Gear Maintenance and Fluid Analysis

Proper installation, operation and maintenance are the keys to marine gear longevity.

STORY AND PHOTOS BY LARRY BLAIS

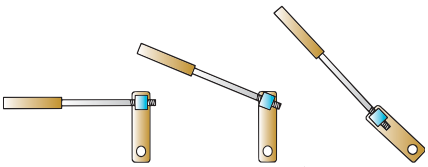
Marine gears are far too often neglected until they suddenly fail to engage, begin clanking and howling or shudder to a stop, leaving you adrift at the most inopportune moments. By then, the cost to make the needed repairs is usually astronomical.

When the engine and gear were first installed, the alignment to the propeller shaft should have been properly accomplished but boats change shape over time and proper alignment must be maintained to prevent vibration and side loading of the marine gear's output shaft. Some transmissions cannot tolerate much side loading, particularly those with aluminum housings. Checking propeller shaft alignment at least once a year is encouraged. And don't forget to look at the mounts. [Ed: See DIY 2002-#1 issue for step-by-step engine alignment procedures.)

Check the shifting linkage to be sure that the transmission is shifting all the way into each gear. With a single lever control that operates the throttle as well as the shift, the linkage should fully engage forward and reverse before advancing the throttle. For maximum transmission life, shift the transmission only when the engine is running close to idle.

Like most vibration absorbing motor mounts, rubber cushions this mount. As the rubber deteriorates, it could allow thrust and torque to move the transmission out of alignment with the propeller shaft. This mount is not captured and if it separates, the engine could move far out of position. It was standard on many Bayliner boats with Hino engines.

Also check the angle of the shift linkage to the shift lever. In neutral, the linkage should be perpendicular to the lever. On several Velvet Drive transmissions, the shift cable was originally installed over the top of the engine causing the linkage to approach the lever from above. Some had a high enough angle that, with a strong enough jolt, the lever would fall past center and lock the transmission in gear.



(left) Lever position is correct; (middle) this is not good; (right) Very bad as lever is over-center.

High water in the bilge can be very damaging to engines, transmissions and drive train components, especially if its saltwater, which is very corrosive.

Bolted to the engine's flywheel is the drive plate, which carries the engine's power to the input shaft of the transmission while dampening the power pulses from the cylinders and absorbing the shock of shifting. In the best of conditions, the drive plate has a finite life. The steel spring type probably has the shortest life. Newer designs like the ones using Teflon pads last much longer. The number of cylinders and their size, whether the engine is a 2 cycle or 4 cycle, if the engine is running rough, idled for long periods or shifted at high revs, all effect the lifespan of the drive plate and how well it can protect the transmission from these energy pulses.

Marine gear oil should be drained and renewed at least once a year and even more often if the transmission sees little use. If the gear sees heavy usage, the oil may need to be changed based on the hours of operation. Any filters should be renewed as well. Between changes, the gear oil should be checked and the proper level maintained. Some gear oil levels are checked with the dipstick fully seated, some with the dipstick resting on the top of the threads, some while running and some not.

Over time, the copper tubes and solder inside the oil cooler wastes away and the cooler starts to leak. This occurs more rapidly in saltwater. Heavy alloy coolers are fitted with zinc anodes to help protect the metal from corrosion but the zincs must be checked regularly and, to be effective, must be replaced if wasted more than 20%.

Gear oil analysis, like engine oil analysis, is very valuable in detecting early signs of trouble. Oil analysis (as discussed in DIY 2003-#3 issue), performed at regularly intervals, would help establish any trends that might alert you to impending failure.

Continues on page 36

The transmission fluid in the oil analysis sampling bottle on the right tested positive for water contamination.

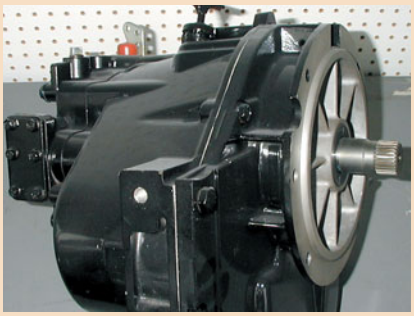
Shifting linkage: Here is a set of hydraulically actuated clutch discs that were damaged from slipping because of low fluid pressure to the servo. While this can happen if the fluid pump is damaged, in this case the shift lever was not traveling all the way into forward so the shift control valve was not fully open.

Popular Gears

Velvet Drive is probably the most recognized manufacture of marine gears in North America. Built by Warner Gear Division of Borg-Warner until becoming a division of Regal-Beloit in 1995, these servohydraulical multi-disc gearboxes have much in common with automotive automatic transmissions.

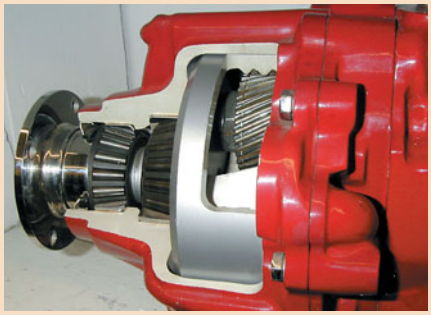
The 70, 71 and 72 series Velvet Drives use a simple in-line planetary gear set for reverse gear and have proven their versatility and strength behind everything from small auxiliaries to turbo-charged Detroits.

The 1:1 direct drive (no reduction gear) is the simplest of the 70s series and is usually found in high horsepower, lightweight powerboats. When counter-rotating propellers are needed for twin-engine installations, one engine must be made to run backwards.



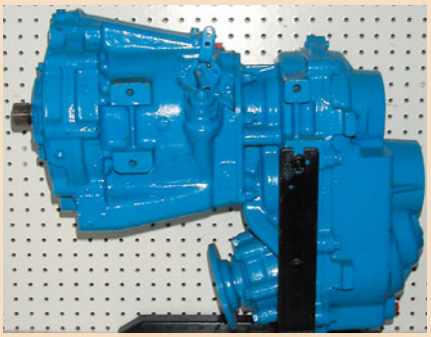
The 2000 series Velvet Drive is not an in-line transmission but is a multi-shaft type transmission with one shaft above the other and reverse gear provided through an idler gear. All multi-shaft type transmissions load the bearings and gears more heavily than in-line transmissions because the bearings are pressed against their races by the torque as the teeth of the pinion gear push against the teeth of the driven gear. Because these units generate more heat, they are often equipped with a cooler even when an in-line transmission behind the same size engine is not. A clogged cooler or a cooler with film buildup on the tubes can lead to overheating and internal damage.

This 70s series variant incorporates a CR2 drop-center reduction gear in the tailpiece. Note that the output shaft comes out offset below the axis of the input shaft. This allows the engine to be installed with less angle and, with the addition of an idler gear, this unit can meet the need for a counter-rotating propeller without the engine having to run backwards. These units were very popular in trawlers when tagged behind Ford-Lehman diesel engines.

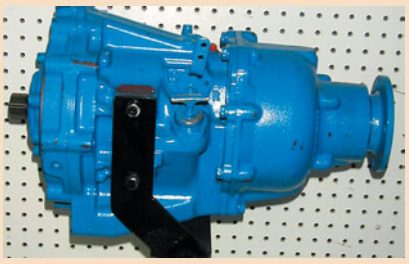


The CR2 drop-center reduction gears can be seen in the cut-away of the tailpiece. One word of caution about this unit. The reduction gear pinion nut is known to loosen, causing major damage to the gears. Improved methods of securing the nut have been developed and all CR2 units should be checked and updated.

The V-Drive unit uses herringbone bevel gears to obtain the down angle of the propeller shaft and, by using sprockets and a silent chain instead of the two upper gears, this unit can meet the need for a counter-rotating propeller without the engine having to run backwards.



This 70s series variant incorporates a V-Drive reduction gear that allows the engine to set closer to the stern, directly above the propeller shaft.



This 70s series variant incorporates an in-line planetary reduction gear in the tailpiece for slower propeller speeds. Note that the input and output shafts are on the same axis. Again when counter-rotating propellers are needed for twin-engine installations, one engine must be made to run backwards.

The 5000 series Velvet Drive is a down angle, multi-shaft transmission specifically designed for twin-engine applications that require nearly horizontal engine installations. Its full reversing feature eliminates the need for opposite rotating engines. The 5000V is the V-Drive variant.

Zahnradfabrik, the forerunner of ZF, was formed in 1915 by Count Ferdinand von Zeppelin to build the gearboxes for his dirigible air

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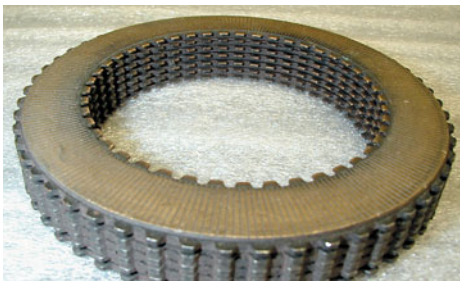
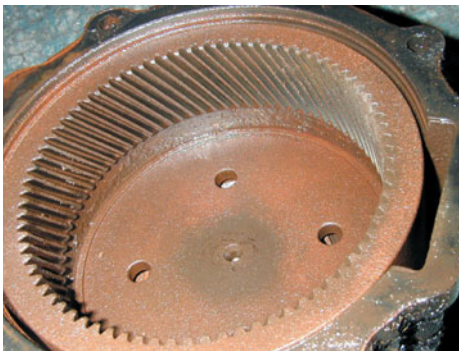
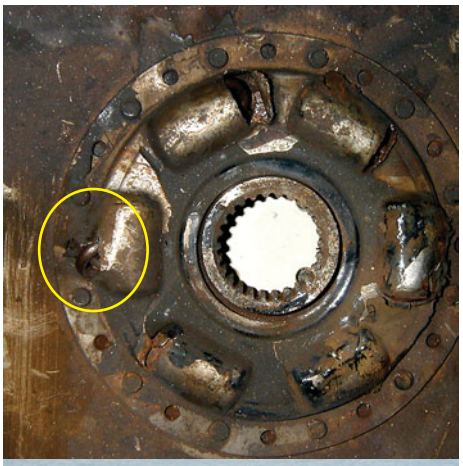




Lubrication: (top left) Heat from friction has fused these clutch discs together. (bottom left) This CR2 Velvet Drive has been badly damaged by saltwater contamination that was caused by a leak in the oil cooler. This rusty transmission would have tested positive for traces of water and sodium back when the cooler was barely leaking and before major damage had occurred. The Spectrometer analysis of the oil, as discussed in DIY 2003-#3 issue, would have revealed any abnormal wear metal concentrations and the particle count analysis would have found any abnormal quantity of particles larger than 5 microns.



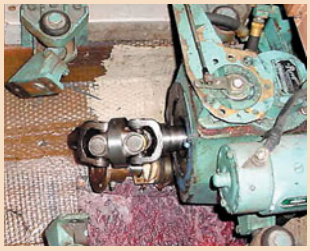
High bilge water level: (top right) The life of this drive plate was cut short by exposure to saltwater that was allowed to flood into the bilge through a leaking hose. As the damper springs rusted and weakened, they lost their capacity to dampen, causing the springs and plate to fatigue and break up. Note the broken springs protruding from their sockets in the plate. This plate rattled at idle, foretelling impending failure and an astute boater had it checked before it disintegrated completely. (bottom right Note the rust on this propeller shaft flange. The water level in the bilge was allowed to rise high enough to submerge the shaft coupling. The surface where the transmission seal rides became so rust pitted and rough that the seal wore and the transmission fluid slowly leaked out. The transmission was badly damaged from the lack of lubrication and the resulting heat from friction.

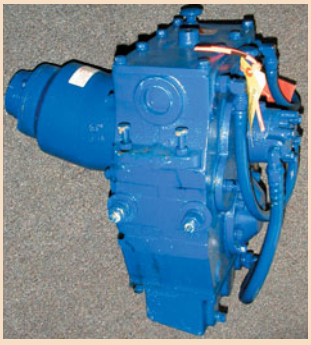
(continued from page 35)
ships. Today ZF holds the claim of being the largest manufacturer of transmissions in the world and includes Hurth, which it acquired in 1990. Most ZF marine transmissions are down angle multi-shaft transmissions that allow the engine to sit high and nearly horizontal.

The Kanzaki KM series drop-center, two-shaft constant mesh, servo-cone clutch transmission has been the standard gear shipped with the Yanmar GM series of diesel engines. Kanzaki is a wholly owned subsidiary of Yanmar.

Twin Disc has built manually and hydraulically shifted marine gears. The HN-9 shown here was a manually shifted, dry clutch gear built for Detroit Diesel to bolt up to the 6-71s that powered the US Navy landing craft on D-Day. Support for this gear was through Detroit Diesel. Later Twin Disc transmissions, such as the MG-506L and MG-506R, have hydraulically actuated wet clutches.

This is a Paragon PV series marine gear with the V-Drive section removed. It utilizes universal joints on the input shaft to down angle the propeller shaft. The universal joints have a limited life and should be replaced periodically (depending on the application) so they don't fail causing major internal damage.





This Walter V-Drive usually mounts separately from the transmission and is coupled to the engine by a short shaft. Like the Paragon PV series V-Drives, it utilizes universal joints on the input shaft to down angle the propeller shaft.

About the author: Larry Blais is a master mechanic, master shipwright and marine surveyor who specializes in surveys that involve marine forensic analysis. He teaches classes for the United States Coast Guard, Havorn Marine Survey and Shipwright's School, University of Washington's Sea Grant program and hosts workshops in diesel care for the Northwest School of Wooden Boatbuilding.

ELECTRONICS

GETTING A FIX ON RADAR

Practice makes perfect when it comes to accurately interpreting the range and bearing of landmarks and boats on your radar screen. If you have radar onboard, follow these tips to maximize your navigational skills.

BY DAVID ANDERSON

Radar is an invaluable tool. There are many times when having an eye that pierces darkness and fog makes all the difference, provided you have a good radar set and the skills to use it to its best advantage. The process of learning to use radar involves several steps. Besides understanding, in basic terms, how radar works, you need to learn how to use radar for simple piloting or chart navigation and then incorporate that knowledge into your routine navigation. Arguably the most important aspect of radar use is accurate interpretation of the images you see on your radar screen, especially the moving "targets." This allows you to evaluate the risk of collision and maneuver safely according to navigation rules. Continuous use and practice will achieve decisive interpretation.

Radar works by sending out microwave pulses and detecting signals reflected back from "targets" around your boat. What it's not is a television camera. On the radar screen, the user sees only blips or echoes of the targets, not realistic representations. Consequently, it takes practice to read a radar screen and to interpret what is really out there. You can teach yourself by practicing in good visibility. Compare how nature, the appropriate chart and the radar image fit together. You will find that there is usually quite a lot missing in the radar image owing to the one-sided illumination of the surroundings of your boat at the center of the display.

Targets and Antennas

The maximum range scale specified for a radar unit has more to do with power output than how far it can see targets. If the target is over the "radar horizon," you won't see it, no matter how much power you are broadcasting. Radar range is slightly farther than visual or geographic range due to the refraction of microwaves. It can be calculated as follows: Maximum radar range (NM) equals 1.2 x [÷ h (ft) + ÷ H (ft)], where h is the height of the antenna in feet and H is the height in feet of the land mass or target boat.

For example, if your antenna is mounted at a height of 12' above the water and you are looking for a vessel that is say 60' high, then it will faintly appear at a distance of about 13.5 nautical miles. Thus even if you have a 24- or 36-mile radar, you need to be looking for something higher than 60' or you won't see it from your antenna. If you mount the antenna on a spreader, say 20' above the water, you gain an extra mile. If you opt for mast mounting, at a height of say 30', you gain another mile. However on a small boat at sea, an antenna of this height will be rocking so much from wave action that much of this elevation is wasted. For most small craft pole mounting an antenna at a height of 9' to 12' is perfectly adequate and avoids carrying extra weight aloft from the long heavy cable.

Minimum Range

Minimum range is a more subtle computation, having to do with the pulse length and processing of the microwave signal but there is also a geometric element, which arises from the shadowed region that lies below the beam pulse.

The vertical width of a typical radar beam is about +/- 15° from the horizontal. If the antenna is mounted at height h, the beam first strikes the water at distance of h / tan (15°) feet. For a 30' antenna, this is 30/0.268, 112' or about 37 yards from the antenna. With a 12' antenna this distance is reduced to 44' or 15 yards from the antenna. So on a typical small craft, even one with a high-mounted antenna, this is not really a limitation.

The electrical limitation on minimum range is 164 yards for each microsecond of pulse length. Most radars switch to shorter pulse lengths at lower ranges, with something in the order of 0.12 microseconds being typical for ranges less than 1 mile. This translates to 0.12 x 164 or about 20 yards from the antenna but enhanced signal processing usually doubles this electronic limitation.

The lowest range scale on many radars is 0.25 miles or, 0.125 miles or 220 yards. Often the last 50 yards or so is filled with so much noise that these pulse length and height considerations are not the actual practical limitation to minimum range.

Radar Resolution

Resolution is a measure of how well two nearby objects are resolved or separated on a radar screen and comprises two separate factors: bearing resolution and range resolution.

The typical horizontal width of a radar beam is about 6°. This means that any two objects separated by less than 6° will be smeared together (unresolved) into a single target. The same pulse will hit both of them. As it turns out, the tangent of 6° is 1/10, so if two adjacent objects located a distance D away are to be resolved into separate targets on the radar screen they must be separated by a distance of at least D/10 from each other. For example, two boats seen 5

miles off, must be 0.5 miles apart or they will appear as one. Similarly, if the entrance to a harbor is 0.2 miles across, it will not be seen as an opening (when headed straight toward it) until you are within some 2 miles of it. It is a good idea to become familiar with bearing resolution and these relationships by making your own measurements with a chart in hand to see how it works with your radar.

The pulse length of a radar signal determines range resolution. A microwave travels at the speed of light, that is 186,000 miles per second or 328 yards per microsecond. If two objects in line (same bearing) are separated by less than one half a pulse length, then the nearest target will still be reflecting signals from the end of the pulse when the farther one starts to reflect signals from the front of the pulse and they will appear as one object. To be resolved, two objects at the same bearing must be separated by more than 164 yards per microsecond of pulse length. Typical pulse lengths vary from 0.1 to 1 microsecond. You can select pulse length in some units but, in most small craft units, it's done automatically when you change ranges.

In one unit, for example, on a 3-mile range, the pulse length is 0.3 microseconds and on a 4-mile range it is 0.8 microseconds. Consider the case of two close vessels (say a tug and tow) separated by 100 yards at a distance of 2.8 miles. On the 4-mile scale they will appear as one vessel (resolution 131 yards), but on the 3-mile scale they will show as two distinct close vessels (resolution 49 yards). This is something to practice using your radar unit. You will need to look up the pulse lengths used for the various range scales in the specification section of your radar manual. Needless to say, you must also tune your radar for best resolution. For example, if the gain is too high it will smear out the targets.

Decoding Echoes

How well a landmark shows on radar depends on its range and bearing. The key issue is the height of the land and the resolution of the radar. Isolated targets like other vessels, buoys, small islands or drilling-rigs are easier to interpret than large irregular landmasses. At longer distances, isolated targets all appear as simple dots or small line segments. As they get closer, the target size increases but, unless the object is big and fairly close, the "size" of the echo on the screen is not a measure of the actual size of the target.

The shape of the target also influences acquisition or contact distance. Round and pointed bodies reflect only a small part of the incoming energy back to the scanner. The same applies to surfaces inclined towards the horizontal, such as the windscreens of some motor yachts.

When you are moving, the motion of any targets on the screen is relative motion, not true motion. If you are moving towards a stationary buoy at 5 knots, it appears on your radar screen as the buoy is moving towards you at a speed of 5 knots. The only stationary target on a radar screen is one that is moving in exactly the same direction and at the same speed as you are.

Preventative Maneuvers

You must first decide whether or not a target poses a risk of collision and then you must determine what the circumstance is that leads to this risk. For example, it's fairly easy to determine a target moving straight down your ship's heading line on a collision course, but is this a vessel you are going to run into from astern or a target headed full steam right for your bow? For targets closing in on a diagonal track the analysis is a bit more involved. Finally, you must decide what needs to be done to avoid a collision.

Underway, radar has two basic uses, position fixing or position confirmation and collision avoidance. The variable range marker (VRM) and the electronic bearing line (EBL) are the tools that enable these to be tasks to be undertaken with confidence. The EBL provides the bearing to a target, while the VRM indicates range to the target at that particular point in time. As time goes by, it is easy to see if you are gaining or losing range and bearing to the target. Are you on a collision course with another vessel if you maintain the same bearing but continue to close range? Is the current or tide sweeping you to the wrong side of a channel buoy even though your compass heading implies that you are heading for the correct side of the buoy? The EBL and VRM will provide you with the answers.

About the author: David Anderson, a professional engineer, has sailed most of the world's oceans and currently operates Stand Sure Marine (www.standsuremarine.com)

[Ed: For clarity, the measurements in this article were not converted to metric units.]

CONTACT DISTANCES

Typical contact distances for a radar scanner mounted 12' (3.6m) above the waterline in nautical miles (NM).

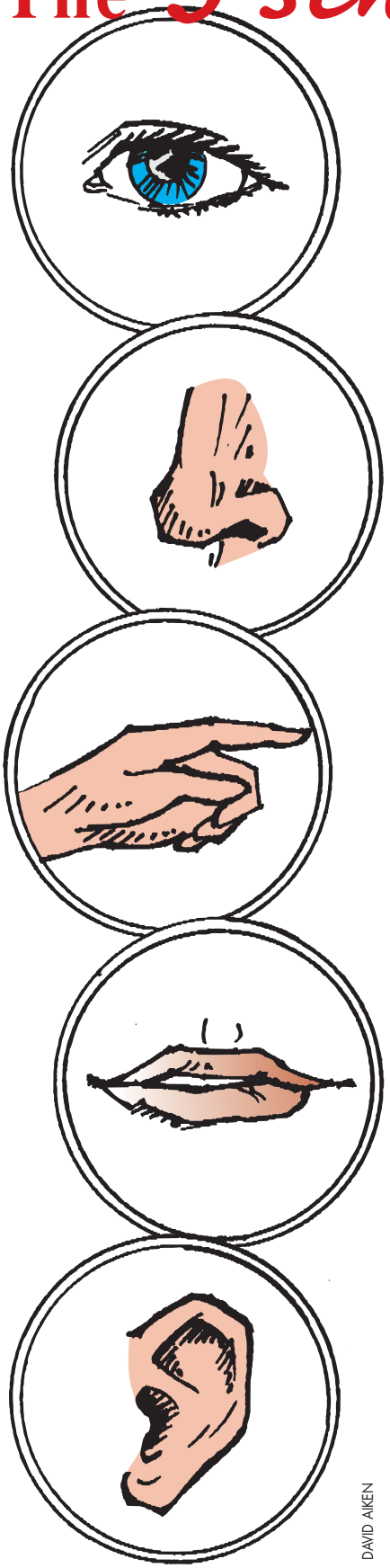
SHIPS	
Tankers, bulk carriers, cruise liners	9 - 12NM
Freighters	6 - 9NM
Lightships, large buoys with radar reflectors	4 - 7NM
Trawlers, coasters	3 - 6NM
Metal-hulled boats	3 - 4NM
Wood or fiberglass boats w/radar reflectors	2 - 4NM
BUOYS	
Large with reflector	3 - 5NM
Large without reflector	2 - 3NM
Medium sized fairway buoys	1 - 2NM

ICE

Ice to windward is hard to pick up because the cooled air bends the radar beam upwards. Smooth ice does not produce an echo and neither do ice floes. With your radar antenna mounted at a height of 12' (4 m) above the water you can expect to pick-up icebergs and pack ice at a distance of 2-9 NM. Growlers are likely to be seen out to about 2 NM.

— DA

The 5 Senses of Boat Maintenance



DAVID AIKEN

If you seek to be a competent do-it-yourself boat owner, practice your diagnostic skills by inspecting your boat and its systems regularly. Train your senses, attend seminars, keep service manuals and reference books onboard, and read DIY.

BY SUE CANFIELD

As a boat owner, your five senses are your most important maintenance tools. These tools will be of little benefit, however, if you're unable to recognize the significance of what you're seeing, hearing, feeling, smelling and yes… tasting. Recognition typically requires the practical application of knowledge plus experience.

Sight

Of the five senses, sight is the tool most frequently used. When you notice gelcoat cracks in your boat's deck molding, however, you're unlikely to recognize their significance if you're not familiar with typical gelcoat cracking patterns and what causes them. Unless you understand the basics of fiberglass boat construction and how core damage can occur, you're likely to ignore visual evidence of deck leaks (presuming they're not above your berth). Likewise, knowledge of the corrosion characteristics of marine metals is critical to visual problem recognition.

Hearing

Is your hearing attuned to the sound of deck or hull delamination during percussion testing? Do you sound your boat's cored moldings annually? Do you know what to do when the engine temperature alarm sounds? Would you recognize the sound produced by a broken engine mount? Familiarity with your boat's installed equipment and owners' manuals can be a big help in interpreting observed symptoms.

Touch

As a diagnostic tool, our sense of touch is hard to beat. Consider just a few examples: electrical shock, wiring that's warm to the touch, dampness, excessive vibration, loose fasteners, inoperative thru-hull valves, stiff cockpit winches and "fish hooks" in the standing rigging. I recently impressed a prepurchase survey client by remarking as we stepped onto the boat's foredeck, "Let's take a look belowdecks first; this boat feels like a leaker." Sure enough, the bilge was full of water, the interior joinery was mildewed and streaked with water stains and high-ambient humidity belowdecks had corroded numerous metal fittings. My client couldn't figure out how I'd known what we'd find. "It's not rocket science," I explained, "a foredeck that's noticeably soft underfoot is symptomatic of deck core damage due to water intrusion. Any water in the deck core is likely to eventually drain into the boat." My client didn't buy the boat.

Smell

Your sense of smell is a potentially life saving diagnostic tool. Consider your ability to detect the odor of explosive vapors in the event of a gasoline or propane leak or the telltale scent of overheated electrical wiring prior to the outbreak of a fire. Since most boat owners' sense of smell is "always on," the Coast Guard doesn't require manufactur-

ers to install gas vapor or smoke detectors in recreational boats. However, on boats with inboard gasoline engines and/or propane systems, a gas vapor detector increases the margin of safety. If you or anyone in your family has a poor sense of smell, a gas vapor detector should be considered essential safety equipment. Smoke detectors are not manufactured specifically for the marine market. If you install one, check with the manufacturer first to determine its suitability.

Your senses won't help you detect carbon monoxide, however, since it's both colorless and odorless. If your boat has an inboard gasoline engine, install a carbon monoxide detector as recommended by ABYC. Thanks to ever improving technology, marine carbon monoxide detectors currently on the market rarely, if ever, generate false alarms. For a list of UL marine certified gas vapor and carbon monoxide detectors, visit www.ul.com/marine.

Your sense of smell is also an excellent tool for identifying a number of less hazardous conditions, e.g., diesel fuel leaks, mildew, blistering on the hull bottom (styrene odor) and permeated waste tanks and/or hoses.

Taste

Taste should be the boat owner's tool of last resort. If no other indicators are present, you can always sample bilge water to help you determine its source, e.g., salt or fresh. If your sense of smell is poor and you don't have any litmus paper at hand, taste the fluid draining from a blister on the hull bottom to help you decide if it's an osmotic blister (acidic) or just a paint blister (basic). Personally, I limit onboard taste testing to gastronomic issues, e.g., freshly baked chocolate chip cookies.

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

[Ed: Past articles that provide step-by-step details on many of the procedures discussed here are available as back issues and on CD-ROM. For a complete editorial index, log onto DIY ONLINE at www.diy-boat.com and click on "Archives."]

INSURANCE: Don't Go Aground in Coverage

What you don't know about your boat's insurance policy can hurt you. The policy is a contract of rights and responsibilities, yours and theirs. Does your boat insurance policy say what you think it means and mean what you think it says? Read on and then examine your policy for your insurance "rules of the road."

BY PATRICIA KEARNS

Insurance is intended to provide monetary shelter against the bad luck life can dish out. You can buy an insurance policy to protect, secure, insure, cover, etc. just about any contingency. The concept is pretty simple but there are some principles that are necessary to understand when selecting an insurer for your boat. Having insurance makes us comfortable. Unfortunately, the comfort bubble of insurance coverage usually bursts when there is a claim. So, how comfortable are you with your boat's insurance coverage?

Read your policy now! Going through the claim process is a topic for another writing but you will find your rights and responsibilities that deal with a claim well defined in your policy. Each party to the contract (insured and insurer) has rights and responsibilities under the policy terms. In Florida, where I reside, hurricanes can leave little standing except the language of a boat policy that is cast in stone. That's when you'll read those words and you may just weep.

Rules Of The Game

Boat insurance is a fairly recent product in the inventory of insurance products but "marine" insurance is one of the oldest forms of insurance coverage known and it is different from other forms with which we are so familiar. Marine insurance has its roots in ancient shipping traditions. Unlike car, health, home and life insurance, the big difference with marine insurance is that it's unregulated. The regulators in marine insurance are the competitors for your business.

"For sale. Excellent condition."

"But it wasn't on the chart!"

"Bad day at the park."

"Need a lift?"

"Laundry day."

"A little top heavy, eh?"

"Gone fishing."

"But they said to meet at the park!"

"Thought I'd take a shortcut."

ROBERTSON & ROBERTSON INSURANCE, BROKERS FOR SKIPPERS' PLAN

An insurance contract of any kind is a betting game. The insurance company (insurer) bets you (insured/assured) won't have a loss; you bet that you will. You and the insurer make an enforceable agreement to these terms, which becomes the "policy." The stake is your boat (and you) and there are no winners. If you think winning the bet by having your policy pay off to losing a boat to accident damage, a storm or theft, you're in for some real emotional pain. Most boaters truly love their boats and these losses trigger strong emotional reactions. Nevertheless, if, in this betting game, you do lose your stake, you also win the bet. So, when placing your bet, make sure you know the stakes and the rules of the game. That education begins with the purchase of an insurance policy and that's not always, "elementary, my

dear Watson."

A common misconception is that all insurance policies are the same. They are not. The differences can be critical to your insurance experience. Don't wait to notice those differences until you are reporting a claim under your policy coverage.

Knowing what kind of coverage to purchase, from whom to buy it and how to assess your risk is a sophisticated process for the boat owner. Rule one? Deal with experts. Be sure that your broker or agent is knowledgeable in boat insurance. Cars, houses or RVs are not like boats where many more risk-underwriting variables are involved and you are one of them. When an insurance company makes the decision to accept the risk of insuring your boat, it also agrees to accept you, the boat owner, as a risk. Part of the basis for that acceptance is what you tell the company about yourself on the insurance application. Terms of coverage vary with your experience, the boat's condition and the area where you use your boat. Watch out here because such coverage doesn't necessarily convey when you take the boat out of its usual (and contractual) area of use.

Withstanding Isabel's Fury

When Hurricane Isabel swept through Chesapeake Bay in fall of 2003, waters rose 7' (2m) and higher in a matter of minutes. When the flood receded nearly 24 hours later, many boats in dry, or in this case, wet dock, floated free off their jackstands and cradles or floating debris knocked over the supports and the boats toppled over.

One boat in the civilian marina at the Naval base in Annapolis remained fixed, upright in its stands, on account of preparations by its owner and some luck. DIY reader, Mike Gartland, used a fixed anchoring system to successfully stabilize "Alaskan Poor Boy," his Catalina 36. Mike set two taut lines from each side at the bow and stern using rope, chain and block and tackle (shown in the photo) to ring anchors present in the cement pier. Mast halyards led to rope tackle attached to other anchors. Old fire hose placed under the lines along the deck rail lessened any chafe. Two anchors set off the stern dropped

straight into the water at the pier wall. And when the water began to recede, Mike trudged through knee-deep water and replaced the jack stands that had been knocked out by floating debris. Within a week of the storm, Mike launched the boat and he and his wife headed south for a winter sojourn in the Caribbean.

— Jan Mundy

The Players

It's important to understand the roles of the players in the game. It's easy to confuse the roles of the broker, the agent, and the insurer (carrier). The agent or broker and the carrier (underwriter) are not one and the same. An agent usually contractually represents one or more specific companies and is primarily focused on selling the product — insurance. A broker shops the open market of carriers in search of product with your best interests in mind. This differential is a big issue when it comes time to process a claim. The agent or broker may assist you in beginning the claim process but he/she is not going to hold your hand. The carrier (insurance company, underwriter) assigns someone to handle your claim that represents the insurance company's best interests. They should deal fairly with you but they are acting for the carrier who is the producer, the "manufacturer" of the insurance product.

You've now picked an agent or broker you trust and must address the risk factors that will be covered by the policy you purchase. Some of these factors include the type and value of the property (boat), liability, named hazards (perils), personal injury and limits of navigation and specific exclusions to coverage. This list is, by no means, to be considered all-inclusive. Read the policy terms before you sign the premium check.

Roll The Dice

How much is your boat worth? Arriving at values can be difficult and often involves the need to obtain a disinterested opinion from a marine surveyor or appraiser. Having your boat properly valued is critical to establishing a premium and processing a claim. It's common to request a survey before a carrier will issue a policy. Who pays for this survey? You will, in most cases where a policy is being issued for the first time.

Boats are valued in two ways: agreed and actual cash value. Agreed value is just that. You and the company agree on a value for

Making a Claim

While claim handling is a topic of its own, here are a few things you can do now to help yourself when you need to make a claim under your policy.

- Make a photo or video record of your boat and store it safely off the boat.
- Keep meticulous records of maintenance and upgrades.
- Inventory all your boat's equipment and list the model numbers and year of manufacture.
- Engage a surveyor on your own behalf to review your boat's value periodically and to inspect it for compliance with safety standards.
- Tell the truth if you have an accident. No matter how it happened, the damage is probably covered. Too many boaters are embarrassed to tell on themselves but insurance is there to help us through even our moments of capital stupidity.

—PK

the boat in the event of a total loss and the sum remains the same regardless of the passage of time or until it's time to review the condition and value of the boat at the underwriter's discretion. Actual cash value (ACV) is based on the value of the boat at the time of the loss and established at that time, just like car insurance. Is there a black and white, right or wrong choice here? Not really, it depends on what risks you want to assume. Just don't presume the former when your coverage may be the latter. Premiums for ACV coverage are usually lower but it could turn out to be a "pay me now or pay me later" situation. Place your bet.

There is no "normal" for factoring deductibles. It's usually a percentage of the value of the boat and that can vary depending on where you are when that loss hits. Deductibles are determined under many formulas, one of which is navigational area. Your policy deductible may be 2% when you are boating in Chesapeake Bay but when you untie the lines for a sail to Bermuda, it could be an altogether different story. Know before you go. The higher the deductible, the lower the premium. You may have to consult with your mortgage lender on this matter. The holder of a loan on a boat has rights to having its interests fully covered. By the way, this can come up when you have a loss. In the case of a large loan that represents a high percentage of the value of the boat, the lender is listed as the primary loss payee and you'll be discussing the payout of any claim proceeds with the lender if you sustain a major loss.

Know Before You Pass Go

What's covered in your policy? The answers are found in the who, what, where, when and how of the coverage language. The "who" is you or the authorized operators of the boat. The "what" is the boat itself. The "where" is the limit of navigation. If you're covered for a specific body of water or other boundaries, you may not be covered if lightning strikes when you're "out of bounds." The "when" is critical in many

Picking up the Pieces after a Hurricane

The lights have been turned off. The SWAT team of marine insurance adjusters and surveyors from the BoatU.S. Marine Insurance Catastrophe Response Team has gone home. Both the lucky and the unlucky boaters everywhere can share in the lessons learned during the team's post-Hurricane Isabel recovery efforts. While there is still work ahead to recover from Isabel's onslaught, such as holes to be patched, rubrails repaired, interiors replaced, the following tips will help get you back on the water, faster, with less hassle, after the next storm blows through.

First things first: The first step for any boater whose vessel has been damaged by a storm is to call your insurer. This is the most important call you'll make as you begin the process toward a smooth boat recovery and repair effort. Deciding to speed up the process by negotiating with on-site ambulance chasers, those fly-by-night salvers such as trucking and crane companies who often appear, disguised as angels, after major storms, can result in delays, or worse, more damage to your boat, which may not be covered by your policy. By calling your insurance company and having them negotiate and steer your course to recovery, you'll ensure that salvage costs are covered and that repairs are made on schedule in accordance with accepted standards.

Triage: When significant storms occur, most marine insurers embrace the triage concept, a hospital ER-like approach targeting initial recovery efforts on vessels with the most damage and those that are at risk for more damage. Sunken boats take priority, as do boats that can cause environmental damage or create other hazards such as fire and explosions. So, if your boat is scarred and bruised but safely high and dry in the back corner of the yard, be patient and understand that action will be taken as soon as the worse cases are stabilized. That doesn't mean, however, that your insurer is off the hook. A good marine insurer will communicate frequently with boat owners to keep them aware of the status of their claim. Also, as with the case of Isabel, where thousands of boats were damaged, marinas and repair yards were swamped. Many facilities had to first focus on getting back on their feet themselves, before they could commence any boat repair work.

Protect your boat and its belongings: After the storm, most marine insurance policies require that, if it's safe to do so, boat owners should protect their boat from further damage. The most common example of this is covering a cockpit with a plastic tarp to prevent rainwater intrusion and additional damage to wiring, engines or structural elements. This $20 Band-Aid can shorten your boat's recovery by days or even weeks and expenses related to protecting your boat against more damage are generally covered in your policy under what's called "sue and labor."

Pull your papers: Before the storm, remove any official ownership documents from your boat. This is one time you don't want to endure delays by having to get duplicate registrations or other papers, a factor that caused a more than a few headaches this time around for some owners.

Is your boat loan paid off? In a similar paperwork vein, nearly a third of all Isabel claimants were delayed payments because their insurance company had not previously been advised that the loan was paid off and bank lien removed. Don't let paperwork as simple as this slow down your road to recovery. Getting a check with the bank's name on it is another form of damage that is easy to avoid.

Pick your boat insurance company carefully: For most of us, insurance is simply a matter of paying a premium but, when major storms occur or other perils descend, the performance reaction of insurers that specialize in recreational boats often outshines the multiple-line insurers. Why? When big storms hit, insurers with multiple lines also have other claims, such as homes and autos, to service. Specialized marine insurers, like BoatU.S., can focus solely on the boats they insure and they also have the expertise that's necessary to give you the fastest possible recovery.

— Tips provided by BoatU.S.

areas. Some policies provide for a winter lay-up period or restrict navigation in hurricane season. If your boat is restricted and you decide, on a nice day in January, to go for a sail and you go aground, damaging the props, you'll probably have a weak argument for your case for coverage. Sinking during a winter freeze when the policy stipulates that your boat be on the hard will be a stormy lesson in coverage language. The "how" of the coverage is what caused the damage. This is a highly misunderstood area of coverage but it's never a mystery in policy language. If your policy coverage is "all risk," you are a lucky insured; however, this may warrant some interpretation of "risk." If your policy names specific perils (hazards) as not covered, you'd better know what they are now. What if a muskrat eats the stern drive bellows and the boat sinks? What if corrosion consumes your chainplates or other metal parts onboard? What if an engine seizes up from lack of lubricant?

Pass Go And Don't Collect

Be sure you know what constitutes "depreciation" in your policy coverage. This is a huge factor in recovering your losses. You are usually only entitled to reimbursement of the costs to restore the boat to the condition in which it was prior to the loss. If your cushions, sails, engine, electronics, etc. were not new, they may be subject to a depreciation schedule.

Jackpot

Are there bargains in boat insurance? Only you can determine what is a "bargain." Your value as a risk is a highly subjective one to an insurance carrier and the more your agent/broker/carrier knows about you and your boat, the better. If you were to "insure" your own boat, then you value the boat and identify all the risks. Where you go, when, with who, etc. is your decision. If that's okay with you, then insure yourself. When you ask someone else to share those risks, like a banker who lends the money to buy the boat, the rules change as the players spell out their rights and responsibilities. It's up to you to read and understand the rules.

My personal and professional experience has been that marine insurers bend over backwards to be fair in determining coverage. They know their rights and responsibilities yet they want satisfied customers. Satisfaction guaranteed, if you know your rights and responsibilities.

About the author: For her entire 30-year career, Patricia Kearns has been "messing about" in boats. She founded Recreational Marine Experts Group (RMEG) in Naples, Florida in 2002 after 10 years in marine industry positions as assistant technical director at ABYC and executive director of ABBRA (American Boat Builders & Repairers Association) respectively.

— ENGINES VS THRUSTERS —

TRICKS FOR TIGHT TURNS AND PERFECT LANDINGS

Close quarters maneuvering in a boat can be challenging. Wind and/or current can override your best efforts to point the bow in the right direction. Put confidence back in your boat's steering success with these tips on using prop wash and prop walk when handling boats with single and twin engines. Better yet, add a thruster and maneuvering becomes a cakewalk.

STORY AND PHOTOS BY PETER P. PISCIOTTA

Twin screw boats are legendary for their maneuverability in close quarters. The ability to "split the gears" by placing one engine in forward and the other in reverse to spin the boat in place has always been secretly coveted by confounded owners of single screw boats. Installing a thruster enhances control of a single screw boat and adds a skilled "hand" to a twin engine boat but does it close the maneuverability gap entirely? Are there other considerations?

A helmsperson can only control a boat's rudder(s) and propeller(s) to maneuver. There are only a few basic tools available for turning: the rudder, rudder-prop wash, prop walk and offset thrust from engines. Turning the wheel positions the rudder to deflect water flow and the boat turns. The slower the boat is going the more difficult the turn because there is less flow for the rudder to deflect. Engaging the prop forces more flow past the rudder than if the boat is just gliding through water thus magnifying the effect of the rudder. This is known as rudder-prop wash. If you want to accentuate the turn while minimizing headway, remember to put the helm hardover before putting the gear in forward. Prop walk is the tendency of a rotating propeller to crawl sideways in the direction of rotation. Though it's only noticeable in reverse as rudder-prop wash overwhelms prop walk in forward rendering it invisible. This effect varies widely depending upon the boat but cannot be ignored by single engine operators. Interestingly, prop walk can be effectively used on twin engines though few helmspersons do so. Offset thrust only relates to twin engines. When putting the starboard engine in forward, while leaving the port in neutral, the boat veers to port. Likewise, put the port engine in reverse and the bow swings to port. Combining the two maneuvers by "splitting the gears" — starboard in forward, port in reverse — creates a spin ("turning on a dime").

All these tools have one thing in common. They provide direct control of the stern but indirect control of the bow. The addition of a bow thruster provides control of both ends of the boat, clearly a sizeable advantage for a single engine boat with a thruster.

Prices of thrusters have dropped dramatically while performance and reliability have improved. Thrusters have become easily available in the recreational boat market in the past 20 years. According to Will Heyer, sales manager of Maryland-based Vetus (www.vetus.com), a leading thruster supplier, sales have nearly doubled each of the past five years with no end in sight. Once the sole domain of large, single engine trawler yachts, thrusters are now being installed on powerboats under 30' (9.1m) and cruising sailboats.

Twins Or Thruster?

A twin engine boat is ambidextrous. Prop walk is an immutable force pulling the stern sideways in one direction when in reverse. Single screw operators quickly learn to heavily favor the preferred side. On twin engine installations, the propellers usually counter-rotate to cancel each other's effect out. In the hands of a moderately skilled helmsperson, prop walk of one engine or the other can be called upon to assist a turn in either direction. The boat has no favored side, either being equally functional.

Clearly, twins allow indirect control of the bow. But in some high wind, high current areas this may

not be enough. Thrusters enable very small crews (e.g., an older cruising couple) to handle relatively large vessels much more comfortably and with more confidence, especially in unfamiliar places or unusual berth configurations. If docking is routinely stressful for skipper and crew, chances are the boat will be used more when equipped with a thruster. In this situation, a bow thruster becomes an investment in boating pleasure rather than a cost.

Bow Versus Stern; Electric Versus Hydraulic

A thruster is merely a motorized propeller producing lateral thrust. It's controlled either by buttons or a joystick and is mounted either at the bow or stern. A bow thruster is more effective than a stern thruster for three reasons. First, the rudder and running gear already give the helmsman control of the stern. What's missing is control of the bow (more on this later). Second, the bow typically has a shallower underwater profile making it more susceptible to wind deflection. Third, under the influence of a thruster, a boat tends to spin around its deepest section, almost always the stern where the running gear is located. A bow-mounted thruster creates a longer, more effective lever-arm than a stern thruster. The further forward, the better the performance. The single advantage of a stern thruster is ease of installation. A stern unit is less expensive to install because it's mounted on a bracket, rather than the way bow thrusters always are in a tunnel.

Of course, installing both a stern and bow thruster enables the boat to move perfectly sideways, a feat even twin engine boats cannot duplicate. Since bow thrusters outnumber stern thrusters by a wide margin, the rest of this article concentrates on bow thrusters.

Power to the thruster motor can be either electric or hydraulic. Since few recreational boats under 50' (15m) have hydraulic systems, electrically powered units are the most popular choice because they are less expensive and less complicated to install. Hydraulic thrusters do have some distinct advantages. Unlike electric

(left) Tunnel-mounted bow thruster in planning hull; (bottom left) Older-style stern thruster; (below right) New design of stern thruster includes a short tunnel.

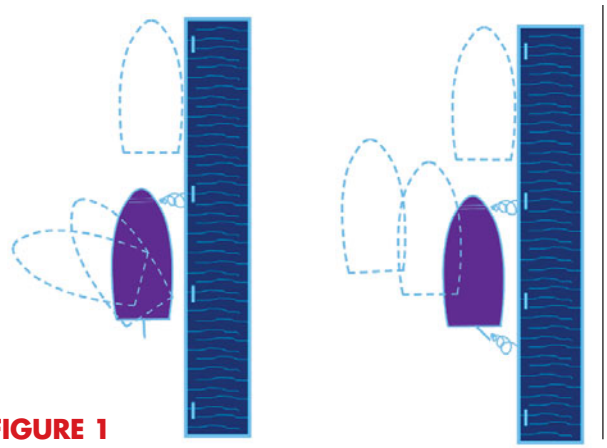


FIGURE 1

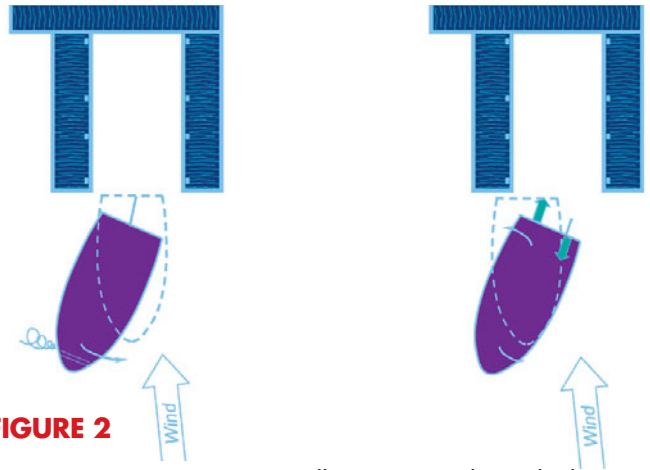


FIGURE 2

thrusters that are either on or off, hydraulic thrusters have proportional thrust. Barely nudging the joystick induces mild thrust; pushing it all the way achieves maximum thrust. Plus, hydraulic thrusters are continuously rated whereas electric thrusters are duty-cycle rated, generally around 5 minutes per hour (formerly 2 minutes per hour), after which time they may overheat and trip the circuit breaker, never at a convenient time.

Thruster Control

Thrusters are simple to operate. Move the joystick left and the bow moves to the left and vice versa. Below are a few simple rules for using a bow thruster.

Rule 1: The faster the boat is going, the less effective the thruster becomes. This means it's best used when stopped or nearly stopped, not underway.

Rule 2: Electric thrusters have a limited duty-cycle, around 5 minutes per hour, more than enough unless the thruster is woefully undersized. Once tripped, the unit is inoperable until it cools and resets. (Manufacturers promise continuous-duty electric units are on the market horizon).

Rule 3: Thrusters are usually best when "pulsed" in several second increments rather than continuously activated, otherwise too much turning momentum may be built. It's easy to add more.

Rule 4: Joysticks are more intuitive than button controls.

Rule 5: For safety purposes, thrusters turn off automatically after a predetermined period of time, usually around 30 minutes.

Rule 6: Test your thruster in both directions before you need it.

While there are probably several unique ways to use a thruster, almost all are intuitive. One notable exception is pulling away from a side-tie (**Figure 1**). While simply rotating the bow out until it's pointed in the desired direction works, a bow thruster when used in conjunction with the engine enables the boat to veer away from the dock, almost sideways. The key is putting the helm over toward the dock and using alternating bursts of thruster and engine. This gets both ends of the boat moving away from the dock.

Learn to use the thruster and the engine simultaneously. The left-graphic shows the rudder hardover toward the dock. Synchronized use of both engine and thruster enable to boat to move almost sideways.

Backing a boat is where a bow thruster really excels, especially when adverse influences are in effect (**Figure 2**). To control the bow, the twin-engine boat operator needs to split the gears (shown in the right side of the illustration) to lever the bow around. Rather than pivot near the stern as the thruster-controlled boat does, the twin pivots much farther forward. The result is the twin tends to creep sideways much more. This alone is a compelling advantage for a thruster, especially in areas where docking is traditionally stern-to or Med-moored.

With a thruster, the boat will pivot close to the stern making backing procedures very intuitive. Even when the wind comes up the thruster controls the boat where the twin will creep sideways.

The Maneuverability Gap

A single engine boat with thruster and twin-engine configurations each have close-quarter strengths and weaknesses. Singles still have a favored side due to prop walk whereas twins are equally nimble, though few twin operators really maximize their capabilities. Thrusters are probably easier for the average helmsperson to master than twins because they are so intuitive. Thrusters really shine in backing a boat, so a slight nod in maneuverability may be their due.

Low cost and improved performance of thrusters has solved one of the primary disadvantages of owning a single screw boat — maneuverability. Controlling the bow is an important advantage for all boats, not just singles.

About the author: Peter P. Pisciotta, founder of The Trawler Institute, is a USCG 100-ton licensed vessel operator and owner of SeaSkills Personal School of Seamanship (www.SeaSkills.com). Peter is conducting DIY seminars on docking skills and techniques at the Pacific Sail Expo and the Pacific Powerboat Expo in April. Check DIY ONLINE at www.diy-boat.com for dates and show times.

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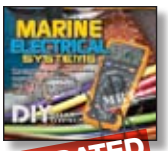

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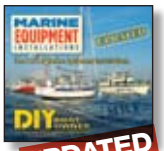

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STORY AND PHOTOS BY JAN MUNDY

Is your boat looking rundown? Are you tired of the same 'ol gal? Other than changing the hull color, an expensive proposition, you don't have a lot of options. Before you start searching for a new boat, consider a graphics makeover. New graphics can modernize your boat, perhaps add more color or totally transform its appearance.

(above) Original 12-year-old graphics.

Four of 12 Raceline designs emailed to us.

A search on google.com directed me to Raceline Digital (www.racelinedigital.com), a firm specializing in digital graphics. Its website offers 120 digital designs in more than 70 standard colors, plus metallics, some shade shifters (changes color in light) and textures. We emailed Raceline a profile photo of our boat and in a few days received an email with a dozen layouts of sample patterns superimposed on our photo. This was slick — patterns from conservative stripes to four-color racy checkerboards, waves and grids. So many choices made it difficult to select one pattern. We opted for a moderate design, then determined the length of the longest piece and placed our order for a 15' (4.5m) set. A 20' (6m) graphics package is the most common and averages US$400 for a set (both sides). Raceline ships each order with step-by-step application instructions.

Applying graphics doesn't demand a lot of skill but, like painting or other cosmetic details, it requires specialty tools and procedures to achieve professional results. So, when Raceline Digital's owner Chris Martino offered to apply our graphics, we jumped at the opportunity. What follows here is the fine art of applying graphics, as demonstrated by Chris.

Each piece is labeled port or starboard and number in the order in which they are applied, as indicated in the instructions. Graphics are mounted on a paper backing and covered with a peel-off paper premask.

Quality vinyl sold for boats should be 3.5ml thick film. It's a better choice for boats than the thinner, 2ml vinyl, commonly used on motor vehicles. Though the thin film, which is more expensive, is glossier, it's not as durable and rips easily. The compound curves on boat hulls crave the flexibility of the thicker film.

Tools and materials to install graphics include: a squeegee, sharp knife, masking tape, color marker, clean rags, methyl hydrate (or other cleaner), dish detergent and a couple spray bottles.

Prepare the "lubricant." Fill 1qt (946ml) spray bottles with warm water and add 1/2 teaspoon of dish detergent. Shake well. Use the suds sparingly. Too much soap and the graphics take longer to dry; too little soap and the graphics stick permanently, making it impossible to align them.

Working on the port side in the area of the hull where the graphics will be applied, clean the hull with odor-free methyl hydrate to remove dirt, salt and other residue. Dry install the graphics, hanging the piece labeled A on the hull, which is usually the longest piece, followed by B and, in our case C, as we had selected a three-color design. Line up the registration squares on each piece and then temporarily tape the ends to the hull. Since these graphics stick to the hull with 1/8" (3mm) gap between sections, rather than lying on top of each other, alignment isn't critical. It's unlikely anyone will notice if a piece is slightly askew.

Check the height position using the waterline as a reference point. Look for any imperfections in the gelcoat, such as scratches or dents, and reposition to cover. Avoid running graphics over any sharp hull contours (e.g., chines, strakes). Once satisfied with the placement, remove all but the largest piece.

Mark a line on the premask, extending onto the tape at both ends, using a washable marker. At the starting end, in this case the stern, cut the tape on the premask just in from the edge to prevent scratching the hull with the knife.

Graphics are installed using the wet "hinging" method. Both the hull and sticky side (underside) of the graphic are liberally sprayed with the soap-water solution. This prevents graphics from sticking immediately on contact and allows easy alignment. Fold any layer longer than an arm's length into two or three sections and apply one section at a time. At least two people are needed to lay graphics: one person to hold the working end of the premask; one to peel back the backing and cut off the excess and spray the hull and underside (sticky surface) of the graphics. Having another helper do the spraying is a great asset.

Chris folds the 15' (4.5m) long layer in half, peels off the backing and then cuts off the scrap. Mating surfaces of the graphic and hull receive a thorough soaking with the soapy water solution before laying the graphic on the hull. Graphic is shifted to match marks on tape. Starting at the hinge point and working towards the end, Chris squeegees this layer to remove air bubbles and smooth the vinyl. An up/down stroke, rather than sideways, prevents the formation of large air pockets. Holding the squeegee at a 70° angle he applies pressure just over the newly laid vinyl and registration squares.

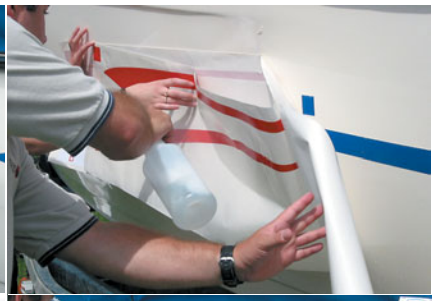
As soon as the premask begins to haze, about 5 to 15 minutes, depending on the ambient temperature, it's removed. Do a test first: pull the premask and, if the vinyl lifts, let it "cure" for a few more minutes. Premask is pulled slowly at a 45° angle to the hull.

One edge of the squeegee has adhesive-backed loop Velcro. This edge is used to remove any air pockets after removing the mask. This felt-like material is less aggressive and won't scratch the vinyl.

With the first half of layer A down, Chris sprays the hull and the graphics, then peels off the backing and cuts off the scrap. Place the graphic on the hull, line up the tape marks and then squeegee. During this step, keep the premask wet over the entire layer. This allows the vinyl to move freely while "squeegeeing" (a new word for your DIY vocabulary) so it doesn't adhere to the hull. Should the premask dry too soon, it's very difficult to pull it off the vinyl.

Layer 1 completed. Hull is wiped down with a clean towel to remove excess water. Do this gently to avoid catching a corner and lifting the graphics before they are fully cured. Chris waits a few minutes to the premask to dry before attaching the next layer. Note vinyl registration squares.

Layer B is dry fit, matching the squares on both layers and taping the ends. Chris draws a line through the tape and cuts the tape on the premask at the stern end as with the first layer.



Layer is folded in half, backing removed to the hinge point and excess cut off. Moving quickly, Chris drenches the hull and sticky side of the graphics with the spray solution, lays the graphic on the hull and aligns the tape mark on the end. Vinyl is smoothed then squeegeed. More water is applied when the premask starts to dry before completing the squeegeeing.

Steps are repeated for the remaining (bow) half. Chris peels off the backing, soaks the adhesive side of the vinyl and hull and then places graphics on the hull so the squares and tape mark line up.

Premask is gently pulled in a vertical motion to remove the bubbles and creases. Only this layer and the registration squares are squeegeed.

Premask is slowly pulled off as it begins to haze. Vinyl is smoothed so it doesn't lift up.

Second layer down, one more to go. Again, this layer is towel dried and cured for a few minutes before applying layer C.

The last layer is short enough to apply in one piece. Dry fit, line up the registration squares, tape, mark and cut the end.

Repeat the same steps. Here DIY's circulation manager, Britton Hardy, holds one end of the graphic while Chris peels off the backing and cuts off the excess, drenches the hull and adhesive side of the graphics and then positions it on the hull, aligning the registration and tape marks. Gently spread the premask to remove air bubbles and then squeegee just the graphic. It's not necessary to squeegee the registration marks. Premask is removed when it begins to dry (haze). Registration squares are now peeled off. This completes the portside graphics.

Starboard side graphics are applied in the same manner. It's not necessary to dry fit the layers. Just take measurements from the completed side using stanchions, thru-hulls, vents, etc. as reference points.

Small air bubbles will evaporate in a few days. To smooth larger ones that don't disappear, poke a tiny hole in the side of the bubble using a very sharp, fine-tipped knife and push the air into the corner. A hole poked in the middle of the bubble will form a crease.

Job completed. We wait 48 hours before launching to ensure the adhesive fully bonds to the hull.

PROJECTS

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

1

BRIDGING THE AC GAP

7

During an upgrade of his boat's AC power system, this owner discovers that it doesn't meet ABYC standards. Find out where the system fell short, and then take these refit procedures aboard your boat for a reality check.

BY KEVIN MCGOLDRICK

One of the many projects scheduled for the refit of my aging 36' (10.9m) Luhrs sedan cruiser was to replace the AC wiring system with one that meets modern American Boat & Yacht Council (ABYC) standards. The first step in this project was replacement of a broken and charred shorepower inlet. The current edition of ABYC E-11, the standard that covers requirements for AC and DC electrical systems on boats reads as follows: "If the location of the main shorepower disconnect circuit breaker is in excess of 10' (3m) from the shorepower inlet or the electrical attachment point of a permanently installed shorepower cord, additional fuses or circuit breakers shall be provided within 10' (3m) of the inlet or attachment point to the electrical system of the boat. Measurement is made along the conductors." This important requirement is intended to limit the hazard related to a length of unprotected wire if in service. Lacking this critical protection, a short circuit or other line failure could lead to fire. My boat's system was clearly not in compliance and I suspect others of its generation also lack this life and property saving safety feature. On my boat, the distance to the distribution panel is over 20' (6m) when measured along the cable. Although the standards permit the breaker to be installed anywhere within the first 10' (3m), it's best to locate it close to the shorepower inlet to protect as much wire as possible inside the boat. Blue Sea Systems (www.bluesea.com) sells a small 30-amp AC double-pole breaker with a reverse polarity indicator that works well in this situation.

The first obstacle to overcome was determining where to install the breaker so that the maximum wire protection could be achieved by locating the breaker as close as possible to the wire's point of connection at the shorepower inlet. Since the breaker is not ignition protected, it cannot be installed in a space containing or connected to the engine or fuel tank compartment where electrical components are required to be ignition protected. The best option was the space adjacent to the aft cabin bulkhead where the

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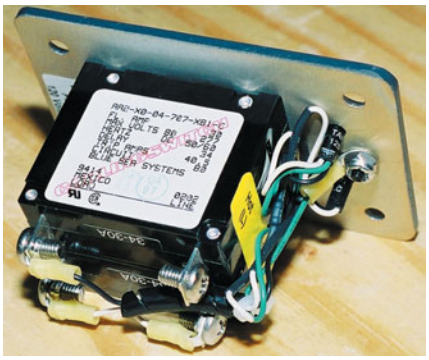
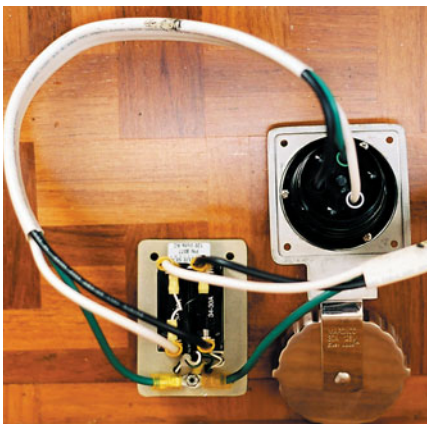
The remote breaker mounted on the aft cabin bulkhead. Note the back of the shorepower inlet visible through the cutout. An outlet will be fitted later within the cutout.

Back of the breaker panel showing which breaker protects the hot side (black wire) and which protects the neutral side (white wire).



Note the words "Load" and "Line" at the bottom of the breaker label indicating which side of the breaker is connected to the shorepower inlet (Line) and which is connected to the distribution panel (Load).



A completed wiring test fit before installation.

shorepower inlet enters my boat. There, I was able to mount the breaker less than 8" (20cm) from the inlet. ABYC requires that connections normally carrying current must be made in enclosures to protect against a shock hazard. The void area where I installed the breaker and panel is inaccessible and I felt the potential for electrical shock was minimal and I didn't enclose the breaker. This is not the best solution and proper enclosures should be used whenever possible. [Ed: ABYC standards are performance based and are not prescriptive about the method for compliance on any given issue. The intent is to achieve the level of safety that the standard requires. As long as the intent of the standard is met, the method of compliance is relatively moot. That is the beauty of a performance-based requirement. It does not limit ingenuity and/or technical advances that meet the need.]

Mounting the panel is easy with the supplied template and a jigsaw. I've used only quality marine-grade cable throughout the rewiring of my boat. This cable is manufactured with multiple strands of copper that result in a conductor that is highly resistant to damage from the ordinary vibration and shock loads that a boat experiences in normal service. The copper strands are individually tinned to increase their corrosion resistance. The use of solid copper wire (e.g., Romex, wire used in buildings) is prohibited under ABYC standards, as its construction is not suited to the marine environment. It's not flexible enough for the dynamic exposures of boat motion and its outer insulating jacket is not sufficiently resistant to the chemicals, fuels, oils and corrosives always present in the atmosphere. A building is generally firmly anchored to its ground space and solid conductors are fine for a structure that is not constantly subjected to vibration and where the wire can be uniformly supported and protected from the weather. My boat's AC system wiring was entirely solid copper wire, which was my main reason for bringing the system up to modern standards. A minimum of 10 AWG cable should be used for a 30-amp shorepower connection. The wire connections were made using marine-grade crimp fittings and a purpose-made crimping tool. The tool I use is manufactured by Anchor (www.anchorproducts.com) and costs about US$60. It's designed to crimp wire sizes up to 10 AWG. The crimping tool has a ratcheting mechanism that forces you to apply the right amount of pressure to create a secure connection. The tool crimps the fitting in two places (at the barrel and support sleeve) in one squeeze of the handle. I used ring fittings at all connections. Ring fittings or captive spade fittings provide a secure connection and should be used whenever possible and should always be used on wires carrying over 20 amps.

Wiring the shorepower inlet to the breaker panel is straightforward. First, make sure that all sources of onboard AC power are disconnected. That includes

shorepower cables, inverter-chargers and gen-set. Three wires connect between the shorepower inlet and breaker panel: the hot wire, normally black; the neutral wire, normally white; and the grounding wire, normally green. The breakers are labeled to show where the hot and neutral wires are connected. There are indicators that show where the "Line" and "Load" wires connect. "Line" refers to the wiring coming from the shorepower inlet to the breaker; "Load" is the wiring from the breaker leading to the AC distribution panel on the boat. Only the black and white wires connect directly to the circuit breakers. A screw located at the top of the breaker panel has a small green wire attached to it. The green grounding wires from both the shorepower inlet and AC distribution panel connect there. Be sure to support all cable runs between fixtures every 18" (45.7cm).

Working with any shorepower system can be dangerous and potentially fatal. If you are unsure of your skills hire a qualified marine electrician, preferably one who is ABYC Certified.

— Kevin McGoldrick is a marine surveyor and freelance writer located in Long Island, New York. His website (www.mmsurveying.com) features information on getting the most out of your next survey.

BUILD A CUSTOM HELM

9

An owner's patience and the willingness to rework a job until it's perfect results in a more functional and impressive looking teak veneer helm console for this Egg harbor.

STORY AND PHOTOS BY MICHAEL S. MYERS

This project really began when I bought "Wendy Lynn," a 38' (11.5m) Egg Harbor. It had an adequate helm console with an instrument pod at the helm station but some of the instruments didn't work and were outdated. The engine gauges were black faced with white letters and someone had painted the chrome trim rings black. The console was functional but not very pretty. One great feature was that the whole unit was hinged to the top and you simply opened it to access wiring and instruments.

A refit was catalyzed into action when I was lured to a really good deal on a radar unit. When a friend who was building a 31' (9.4m) boat decided to sell one of two radar units, a new one with a 4' (10m) open array and still in the box, I couldn't refuse the US$1,600 price tag. I cut a hole in the instrument panel and fit the radar in it but the new radar did little for the appearance of the panel. Rather than rush the job, I decided to build a new console and then install the radar.

The only woodwork I had done was rough framing and a little house molding. While I was prepared to buy whatever was needed and to learn what I needed to know, I decided that the most important factor in the project's success was time. I adopted the philosophy that I would take whatever time it took and build the thing as many times as it took to get it right; extremely important prerequisites when you really don't know what you're doing. Nevertheless, my initial designs (in my mind) had made compromises towards the familiar square shapes that are much easier to build than rounded shapes.

Fortuitously, just as I was about to begin, a magazine published an article on consoles. It had a picture of a beautiful wood unit with nice curves where the top met the sides. Mine would be teak with all the grain running fore and aft except for the edge banding.

Basic Framework

The design process began with measuring the existing console and instrument pod (**Figure 1**). The side profile was important because I wanted to match the existing hinge setup and the height was about right. The length needed to be exact to fit in the molded, grooved top.

Next step was to cut out cardboard blocks for the engine instruments and electronics (GPS, fishfinder and radar). These were shuffled around on a cardboard

Existing console and instrument pod at the flybridge helm station has hinges on the back for easy access and servicing.

Frame takes shape. Note curves on sides and sloping front.

face. The instruments drove the design of the console's face. Another important consideration was that my fishfinder was extremely difficult to read if viewed at anything other than a right angle; a few degrees to the side and the screen washed out. Thus, the face of the console had to curve around the captain's chair. I knew the radius from the helmsman's head to the console so I incorporated that as much as possible.

The first thing actually built was a mock-up of the helm station platform upon which the existing and the new console would rest. This set out the length, width and angle of the existing base. With that done, I began to build the console framing (**Figure 2**). The frames were made of 1/4" (6mm) plywood and determined the overall shape of the console; a flat vertical back, rounded or crowned top, 4" (10cm) radius curve from top to sides and a sloped, curved face. I built the internal frames three times, six times each counting the ends, each time refining the final design, before I was content. I decided that I had to get the framing right because I was essentially going to assemble the console to the frame.

Prep

I purchased a sheet of 1/4" (6mm) teak veneer plywood for the large exterior pieces: front, back, sides and top. A piece of teak veneer that measured 12" (30.5cm) wide by 8' (2.4m) (much more than was really needed) was cut for the curve where the top met the sides. A 1/2" (12mm) thick by 8" (20cm) wide board, 7' (2.1m) long would make the edge banding (trim) along the top and sides. Total cost about US$115. I had no idea how to make veneers and no idea how to cut the lumber into the shape of the banding needed. I owned a jigsaw, skill saw, a small block plane and various other common tools and I bought about US$60 worth of various style clamps, a Japanese wood saw for US$9, (extremely fine cutting tool that cuts on the pull rather than on the push), some very fine jigsaw blades (US$9) and a utility knife set (US$7).

Closely spaced cuts in the plywood allowed it to bend to the curve on the frame.

Since I didn't know what I was doing, if construction permitted, each phase of the work would begin on the back and on the least visible side (starboard on my boat). I planned to mount the veneer first, then the back edge banding, followed by the back face panel cut in (actually butting to the bottom of the banding). The front banding was next. The final touch was to cut in the front face panel again, butting it to the bottom of the banding. The toughest task was the sides-to-top curve. This had to be situated so that, when the veneer was added, it was flush with the surface of the front and side panels. Accurate dimensions were critical. The frame for the curve was made using some 1x6 fir scraps in my shop. To that I would attach curved plywood and face that with the veneer.

Assembly

Plywood was scored with a skill saw set for very shallow cutting (**Figure 3**). I wet it and, at first, noticed that it remained stiff. But after a few minutes it loosened up nicely. So, I cut some curved cradles, put the wetted plywood in the cradle and weighted it with a piece of pipe. Meanwhile, I cut the plywood sides and top and glued them. Next, after making lots of shims from the veneer, to get the finish surfaces to match up, I cut and placed the curved plywood in between the top and the sides and glued it in. As the frame and various panels were glued together, I reinforced the connections by mixing epoxy and laid in tabs to the joints using lightweight fiberglass matting (multiple layers).

Next came the veneer. I wanted to use epoxy to glue it on but that would take long clamp times and my ideas of how to clamp the curved surface were few. I decided to use contact cement instead. The veneer was first wetted and set in the cradles beforehand, using the same method as the scored plywood. So treated, the veneer took on a nice curve. I cut the veneer to size with my utility knife, being very careful not to cut off too much. I had no idea how to measure such pieces, so one edge was cut and the piece held into place while I marked other edge. I cut slightly oversize, then filed, sanded and whittled until the veneer fit perfectly where it joined the top and sides but was left to overhang the front and back.

Application instructions on the contact cement can said to apply 25 psi to the whole surface after mating up the pieces to get proper results. I wasn't sure that my structure would hold up to that, so I beefed up the curve framing with fiberglass cloth saturated in epoxy resin before laying the veneer. Instructions also said to coat the pieces until it dried to a semi-gloss surface. The plywood base took two coats but the veneer seemed to soak it up; it took four. Typical instructions say put the piece in place and start pressing from the middle out. On the curved piece, I didn't think this would work. I aligned one edge with the veneer, made contact and pressed from that edge to the other. The 25 psi was applied with a wallpaper roller.

After trimming the veneer back with a jigsaw, followed by filing and sanding, it was time to do the edge banding (trim). The back was fairly simple since there was only one curve. One cut piece incorporated the crown of the top and curves on the sides. This was fabricated by simply holding the board flat against the console back and marking it, and then gluing it in place. Next, two straight pieces were cut for the vertical pieces on each side. All pieces were cut slightly oversize, which allowed for final fitting by planing and sanding. End butt connections were cut with the Japanese saw.

The next step was to cut the back panel to fit inside the edge banding. Since I needed a perfect fit, I first made a pattern of 1/8" (3mm) tempered hardboard. Once completed, the pattern was traced onto the teak plywood. Again, the cut was oversize and trimmed variously with the plane, sanding and filing. Next, came the edge banding on the face of the console. Again, the curves were the problem. The top edge was banded first, extending to the start of the side/top radius. The sides were then cut and glued on in the same fashion as the top edge, extending to the side/top radius. The problematic gap in the curve remained. The angle on the top edge, at the butt of the banding, was vertical but the angle on the side edges was sloped. The final curved pieces were made by shaping the wood with a Dremel, then a file, then sandpaper. Each curve on the face was actually made from two pieces. Once the backs of these pieces (where they attached to the console) and end butt joints were good, I shaped the front sides of the banding (**Figure 4**).

The face panel was made like the back with a tempered hardboard template and the finish piece cut to fit. The problem here was getting the bottom of the curved face to sit flat on a sloped surface. I rough cut this first, then elevated the whole thing about 3/4" (19mm) and ran a block with pencil attached along the edge to mark it. The end result was a perfect fit.

Final Finishing

Before cutting the holes for the instruments, I applied a couple of coats of varnish (**Figure 5**). This was so that if I slipped, hopefully it would scratch the varnish and not the teak. I replaced the original digital tachometers with VDO analog units (my preference) and I installed a new Raymarine 750 fishfinder. The old fishfinder and digital depth

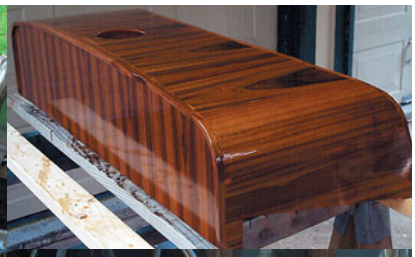
Attaching edge trim. To reinforce the frame before gluing on the veneer, it was sheathed in fiberglass cloth with epoxy resin.

gauge, neither of which worked, were left in place rather that removing them and covering the holes.

Once the console was about 90% complete, I decided that the old helm switch panels needed to be replaced as well. The existing ones were black plastic with etched white lettering. The previous owner had made them and done a great layout job getting all the labels and switches just right but the face of the plastic was failing. I decided to make some out of the remaining teak plywood and orient the grain running the same way (fore and aft). These were easy to lay out but the work was time consuming and tedious. Along the way I trashed some non-functional trim tab indicators and relocated my VHF radio there for easier access. I selected toggle switches with rubber, screw-on boots to replace the old push/pull switches. Ten switches and new chrome momentary horn button cost about US$65. Making the two switch panels was easy. Transferring the electrical connections and supporting the radio took the better part of two days. With all equipment mounted, the console was installed onboard in about 45 minutes by simply screwing on the old hinges and transferring the wiring. The radar installation took an extra half day and works great!

The finished console (**Figure 6**) reinforced one precept, which was that my original philosophy of no-matter-how-much-time and no-matter-how-many-times it took to get it right worked for me. It just takes a lot of patience, lots of spare time and a compelling desire to do a professional-looking job.

— Mike Myers is a construction consultant who enjoys purchasing used boats and then adding his personal touches and improvements. The Egg Harbor is his second large inboard boat. He kept his first boat 10 years and says this one is his last boat.



Multiple coats of varnish gives new console a mirror finish.

Solid teak trays and veneer panels replace plastic ones on the dash to complete the job.

INCREASING THE EFFICIENCY OF HOT AIR HEATING

4

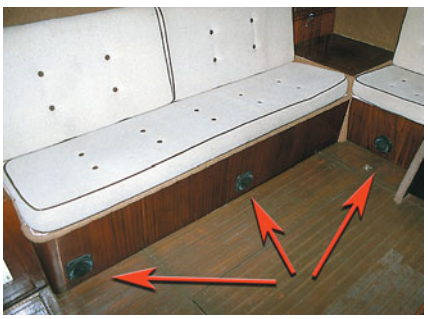
BY PETER CAPLAN

There are two easy steps to improving any basic hot air heating system: prevent heat being wasted and provide additional warm air outlets for improved heat distribution in the main living areas.

Poor heating performance is usually due to heat loss through the ducting. Ducting transports the hot air from the heater to the outlets within the accommodation. If heat is lost through the walls of the ducting behind bulkheads and within lockers, the warm air output into the accommodation is greatly reduced and fuel is wasted heating unused spaces. The obvious and simple solution is to insulate the ducting and, where it runs through storage lockers, protect it from damage by boxing it in.

(top) When ducting is run through a locker it needs to be protected and insulated. A simple plywood case built into the locker is ideal. (middle) Pack insulation around the ducting to completely insulate it. (bottom) Lid is screwed down, both insulating and protecting the ducting.

Ducting not requiring damage protection is insulated by wrapping insulation around it and covered with plastic sheeting secured with cable ties. The insulating material isolates the heated ducting from the plastic sheeting wrap, which is used simply to keep the insulation tidy and contained.



Standard installation kits generally provide one outlet for each accommodation area. In large or well-used areas, such as the salon or wheelhouse, the addition of extra outlets significantly improves the overall heating as the additional outlets allow a greater volume and better spread of warm air. The difference made by adding two additional outlets, as shown, is quite phenomenal as the volume of hot air entering the area is effectively tripled. This makes for a faster initial warm-up and creates a higher ambient temperature, which causes the thermostat to reach its setting and cycles the heater down sooner, saving fuel.

— Peter Caplan is a marine surveyor, boatbuilder and freelance writer based in the U.K.

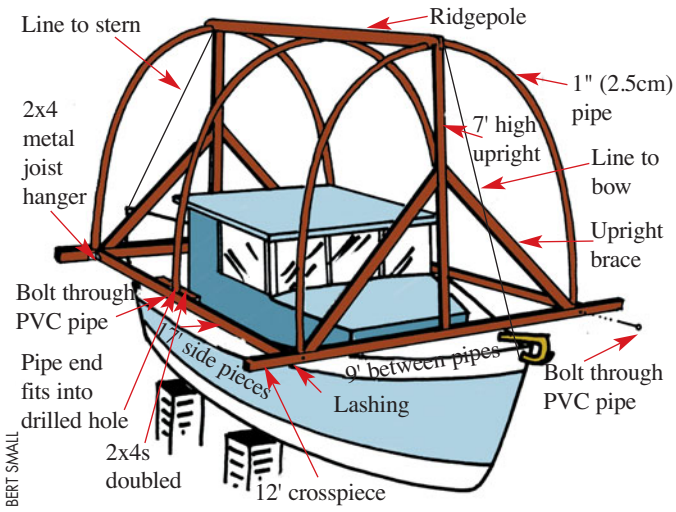
SIMPLE SHELTER SOLUTION

6

Boat cover frame made with 2x4s and PVC pipe is easily modified to fit most boats.

BY BERT SMALL

My solution to winter boat protection is a simple deck-level shelter. This design protects the boat from the elements and also provides access to the boat for winter work. It's easily modified to suit most boats with only an adjustment for boat type and size and local conditions. On the Northwest coast, where winters are mild, snow or rain rolls off the dome shape but should it gather, a poke from inside with a broom or paddle allows it to drain away. In heavy snow areas, you'll want to beef up the frame for added strength; perhaps closer spacing of the frame stations and using larger, 1-1/2" (38mm) PVC pipe. Although the frame ends at deck level, for all-round protection, the cover could extend down to ground level and be either pegged or weighted down with sand- or water-filled water jugs or sand bags.



Materials consisted of 2x4s, 1" (25mm) PVC pipe, one large tarp (or use shrinkwrap) and necessary hardware, bolts, nails and joist hangers for my 22' (6.7m) boat. For larger boats, consider substituting 2x6s for the crosspieces and ridgepole. Not all dimensions are specified in the schematic. Some, such as height, vary depending on the boat but the principle remains and can be scaled up or down to suit. Metal joist hangers simplify attaching the crosspieces to the sides. Where holes are drilled on the crosspieces and sides to accept the pipe ends, the 2x4s are doubled for added strength. (Using 4x4s would eliminate this step.) Attach lines from the ends to the bow and stern to add more rigidity to the structure or to form a tent to completely cover the boat. Lash the crosspieces to the gunwales and deck cleats with heavy-duty line for extra security.

— Bert Small restored "Sea Eagle," a 1940 Navy lifeboat converted into a pocket cruiser by a previous owner. A watercolor painter, Bert uses his boat as a summer studio when cruising the Gulf Islands.

Ed: Step-by-step shrinkwrapping techniques appear in DIY 2003-#3 issue.

MAKE A DINGHY BRIDLE

5

A proper towing bridle attachment makes dingy towing trouble free. Follow these instructions to fashion one for your boat.

BY SHEILAH VAN NOSTRAND

Towing a dinghy can be a hair-raising experience in the best weather. The action gets quite absorbing when wind and waves kick up, especially if using a single line rigged from the dingy to the mother ship, as many boaters do. You'll have better success if you have the proper towing setup from the dinghy to your boat.

To make a custom bridle, you'll need: two lengths of nylon double braid (Line 1 and Line 2); one length of lighter nylon about 1/2" (12mm) in diameter for the security line (Line 3); one heavy-duty stainless-steel O-ring large enough to pass a swivel eye snap through; four

stainless-steel swivel eye snaps; and whipping twine. Double braid isn't perfect, but it's the best choice for a towline. It's stronger than three-strand twist, doesn't kink, has enough elasticity to cushion shock loading and doesn't cause a backlash hazard. All that to the good, it doesn't float. Three-strand twist stretches too much and could deliver a dangerous backlash should it break. While polypropylene does float and is highly visible (in bright neon colors), it has little elasticity to absorb the heavy shock loads to all fittings, is stiff to handle, chafes easily, is subject to sun damage and has less strength than nylon braid or twist of the same diameter. When choosing O-ring and eye snaps, make sure they are capable of sustaining the loads anticipated.

Assembling The Bridle

Estimate the distance between your boat's stern and crest of its wake at maximum cruising speed (**Figure 7**). Cut Line 1 to a length approximately two-thirds of this distance. Secure a swivel eye snap with a back splice and/or whipping twine to both ends of Line 1. Cut Line 2 equal to or longer in length than Line 1 and then make eye splices or secure swivel eye snaps to each end. This allows for adjusting the length of the towline. Measure the lighter security Line 3 at least 12" (30cm) longer than the sum of Line 1 plus half the length of Line 2. Attach a swivel eye snap on one end and either a snap or a spliced eye on the other end.

Bridle Prep

You're now ready to set up the bridle. Do this with your boat at the dock or anchored, engines off. Secure one end of Line 1 to the towing ring on the tender and the other end to the O-ring. Inflatables commonly require a bridle to be attached to side rings fed through the bow ring for stability and to better distribute the load. Contact the manufacturer or dealer for towing specifications. Secure one end of the security Line 3 also to the tender towing ring. If this ring is too small to accommodate both snaps, add a stainless-steel chain link connector. Tighten the threaded closure with pliers.

Pass one end of Line 2 through the O-ring and secure eye splices (or snaps) to the port and starboard stern cleats creating the "V" of the bridle. This line slides freely through the O-ring when towline length is adjusted. Pass the other end through the O-ring, then to a stern cleat. Choose the side on which you are least likely to be docking to avoid dingy interference.

Towing Basics

With lines prepared as described above, lay out the lines in loops on the aft deck and keep the tender hauled close to the stern. While the helmsperson idles forward, the crew gradually pays out the towline.

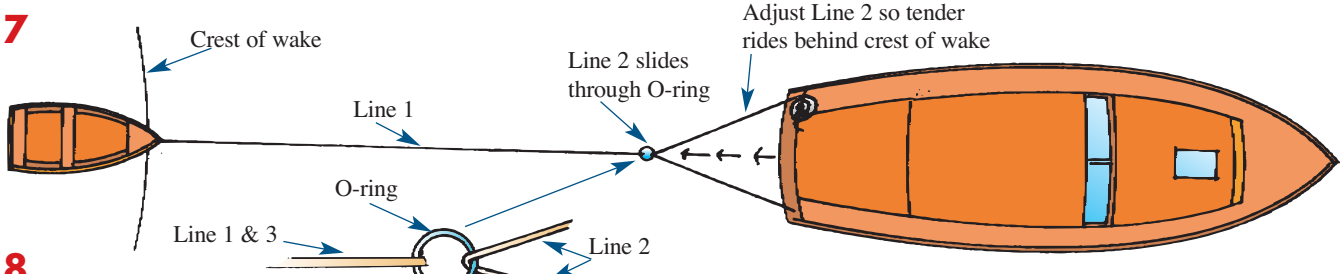
Adjust the length of the towline at a stern cleat each time boat speed is changed so that the tender rides just behind the crest of the wake (**Figure 8**). Riding in this position, there is minimal strain on the towline and fittings and less chance of capsizing the tender. You'll also need to adjust the security line, which always should be slack so it doesn't bear any weight of the tow. In the event that either of the tow lines part, the security line prevents the loss of the tender.

When reducing speed while towing, shorten the towline for better handling and to prevent the line from sinking and fouling your underwater running gear. Swing wide around buoys and river bends so the tow has room to follow. Keep a close watch on the towed boat so you can make the appropriate adjustments to match the sea conditions.

Don't tow your tender with the motor attached to its transom. Try to avoid towing a tender in rough weather. In these conditions, it's safer to secure the tender on davits or on deck. When making towline adjustments, never detach the line ends. A tender on the loose is a hazard and can be difficult to retrieve. Lastly, inscribe your name, address, phone number, boat name and VHF call numbers in a conspicuous location on the tender.

— Sheilah Van Nostrand is first mate aboard "Dream Catcher," a 34' (10m) Tollycraft.

7



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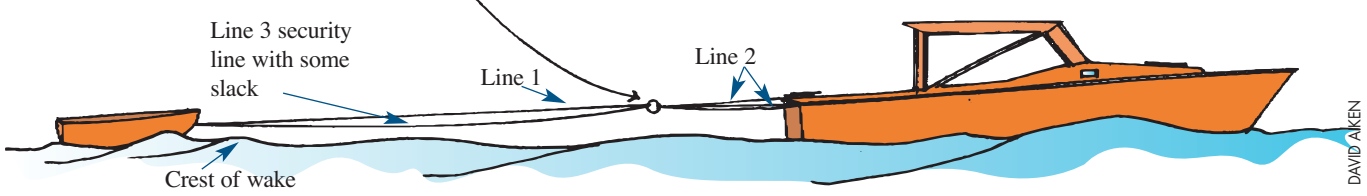

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you need. Using your portable computer, you'll be able to access everything. Of course, curling up with a good computer isn't quite the same as opening that dog eared manual.

4 For bunk flats in a sailboat, consider using canvas with a 1" (25mm) cushion rather than a 1/2" (12mm) piece of plywood. For six bunks the weight saving will be quite high and the bunk occupants will be more comfortable.

5 Also on a saiboat, consider using Aramid standing rigging and Spectra running rigging to save weight aloft.

6 Most people anchor for relatively short periods of time, so when selecting a lunch hook for your bow roller, look for the lighter types of newer designs that can do the job.

7 Instead of using heavy anchor chain, consider a nylon anchor line. You'll save a considerable amount of weight with the added benefit of improved shock-absorbing capability on the rode.

8 Keep only the spares that you know you can use on the boat. There's no need to carry a spare head gasket set and a couple of spare pistons if you don't plan on rebuilding your engine at sea. If you are going to change the engine oil at sea, by all means keep extra oil onboard. But, if you cannot reach the sump drain plug without dismantling the boat, why bother. Just keep enough oil to top up the engine.

9 Check through your tools and keep only those that fit the bolts on the onboard equipment. Why carry a complete set of metric wrenches when only one bolt on the entire boat is metric?

10 You may not think about it, but keeping the bilges dry and emptying the sump and other wastewater tanks can remove up to half a ton of weight from a 40' (12m) boat. This weight loss can decrease fuel consumption considerably.

When thinking up your weight saving ideas, be sure not to compromise safety. Don't leave your man-overboard ladder or liferaft ashore to save weight. Your VHF radio and lifejackets should always be onboard. The idea is to reach that state of balance where your boat is safe but not overweight.

Displacement, then, is something that we all need to understand to ensure that we don't add too much weight to a boat during a refit. If your boat floats above its designed waterline with much reduced freeboard, raising the boot stripe is a Band-Aid fix until you concoct a suitable diet plan.

About the author: Roger Marshall is a naval architect and author of 12 books on sailing and yacht design. He has a boat design company in Rhode Island and is the vice-president of Boating Writers International. Roger joins DIY with this new column.

View from the Stern

DISPLACEMENT, POUNDAGE AND OTHER WEIGHTY MATTERS

Heavy boats are slow, slow boats can get you into trouble and really slow, heavy boats can get you into really big trouble. Put your boat on a diet and lighten its load. Here's some advice from a lean thinker.

BY ROGER MARSHALL

DAVID AIKEN

How heavy is your boat? Suppose its designed weight is 10,000lb. (that's 4,535kg, 4.5 long tons, 5 short tons or 4.54 tonnes). Simply put, it means your boat displaces 10,000lb. Back in ancient Greece, Archimedes figured this out by sitting in his hot bath. When he eased himself into his filled bath he said. "If this bath is filled to the rim and I, weighing 200 pounds (91kg), sit in it, the water spilling over the edge of the bath will weigh 200lb." For Archimedes, the proof of this theory was so revealing that he is reputed to have run down the street stark naked yelling "Eureka!" which is Greek for "I have it!" Of course, many Greek women might not have agreed with him in his moment of revelation.

But even though the concept of displacement has been known for centuries, many amateur DIYers still have little idea what displacement means. Instead, they load on the weight, putting a heavier four-stroke engine on the transom instead of the two-stroke outboard calculated in the original design, installing a larger fuel tank or a large cooler, adding bookshelves, a dinghy or extra anchors to their sailboat.

When looking at weight savings, it helps to consider your boat and its performance. Obviously putting a ferroconcrete boat on a diet isn't going to save a lot of weight relative to the boat's performance. Lightweight boats, especially older ones have probably gained a lot of weight over the years and could stand to go on a diet.

Perhaps it's time for the DIYer to put his/her boat restoration project on a diet? Make it lighter, more fuel efficient and faster instead of lugging all that weight around. How can you do that? The first step is to look at lighter weight options, such as lighter bulkheads, lighter anchors, a rope anchor line instead of chain, lighter cored or laminated woods instead of solid teak, perhaps a lighter engine. Of course, there are many boat owners who don't want increased performance or lighter weight. But for those that feel the need to diet, here is a list of 10 points for losing some of that poundage.

1 If you are replacing a non-structural bulkhead, consider using a honeycomb-cored bulkhead instead of a solid plywood one. A 3/4" (19mm) plywood bulkhead weighs in at around 45lb per cubic foot (20.4kg per .03 cubic meters), while a honeycomb-cored bulkhead weighs about 4lb per cubic foot (1.81kg per .03 cubic meter). In addition to the weight advantage, another advantage of a cored bulkhead is that you can push tiebars and electrical conduit through the middle of it so that they are not visible. Cored material can be used for other fabrications. You can make furniture out of it for a substantial weight savings. For example, the polished teak and holly cabin sole on my sailboat is cored and weighs about 8lb (3.6kg). I can lift the largest panel with one hand. A plywood sole with teak and holly would weigh around 50lb (22.6kg).

2 When looking at engines, include the transmission weight and look at weight versus horsepower and weight versus torque comparisons. You may find that you can gain significantly more horsepower for the same weight with a different engine package.

3 You might consider using CD-ROMs or pocket CDs instead of manuals onboard. On a U.S. aircraft carrier they saved about 90 tons of weight when all manuals were converted to CDs. DIY offers it's entire editorial archives on CD-ROM and you can get remaining data on your boat's gear off the Web and burn a CD with everything

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