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DIY boat owner
the MARINE MAINTENANCE MAGAZINE

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Good Boatkeeping
Like Water Off A Boat's Deck: Here's a nifty way to add or enlarge deck drains and prevent the telltale dirty moustache.
By David & Zora Aiken

Departments

UPGRADE

WHAT YOU SHOULD KNOW ABOUT HOSE

Hoses are essential to keeping your boat afloat and operative but many boats are equipped with inferior, non-marine-rated hoses. Here's how to survey and upgrade your boat to comply with today's performance and safety standards.

PROJECT BOATS

7 YEAR REFIT

A stem-to-stern refit of a 1977 Chris-Craft 35 DC includes a complete redesign of the flybridge and extensive remake of the main cabin.
By Ray and Patricia Larstone

A GLASS ACT

Sheathing a classic woody in fiberglass and epoxy resin minimizes maintenance and prolongs the life of a dry-stored boat. Here's all the information you need from preparing the wood to applying the final coats whether you are doing the work yourself or hiring a professional.

Removing Coatings: This unique power tool strips paints, gelcoats and laminates easily, leaving an even, smooth surface ready for recoating or repair.

MAINTENANCE

TRAILER TIPS

If you are one of the thousands who trailer your boat, here's all the information you need to maintain and repair the trailer, improve the ride and handling, and find solutions to common servicing problems. Follow this advice from a professional and you won't be left high and dry.

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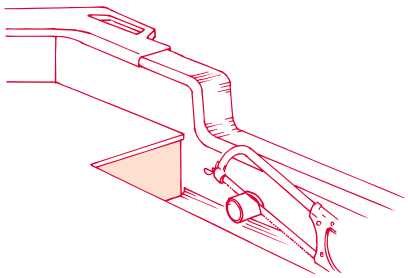
Talkback Q+A

Replacing Drain Tubes

Q: I have replaced my brass drain tube in my outboard engine but cannot seem to come up with a way to bend or flare the straight end so that it looks like the old one. Any ideas would be helpful.
Ed Pearce, "Seagames," Middletown, Delaware


ANNE-MARIE HENDRY

A: Most well drains are 19mm or 2.5cm (3/4" or 1") in diameter and the pros use a flaring tool (about $150) to curl the thin bronze lips into place. The generally accepted technique for the DIYer is to cut off the tube to the exact length, install it from the inside and seal both sides with epoxy or 3M 5200 or equivalent sealant to prevent water migrating into the transom core (usually plywood).
— *Jan Mundy*

Repainting Outdrives

Q: Any suggestions on getting paint to stick to the bottom end of an outboard motor? We have an older Johnson and tried to repaint it last year but the paint flaked off in large pieces.
Craig Upper, "Streamline," Port Colborne, Ont.

A: Engines produced in the '60s and '70s were made of an aluminum alloy coated with a zinc-chromate primer. The reason paint flakes off is due to the primer not adhering to the metal because of contaminants. Even skin oil from hands can contaminate the aluminum. It's impossible to duplicate the factory electrostatically applied finish, so the most cost-effect method is to clean, prime and paint. Sand it down to the bare aluminum, then apply a "drier" (i.e. MEK, acetone, acid etch) and wipe with a tack rag to extract contaminants. Apply an aerosol primer and paint, then coat with a clear enamel finish.
— *Jan Mundy*

Why Not Long-Term Diesel Storage

Q: I purchased my Yanmar 2GM20F seven years ago. It's still bolted to the shipping pallet. I intend to install it in the boat within the next few months but it will probably sit for another 2 years before it runs. The engine is dry, no oil or water. I can turn the crank quite easily by hand. Can I expect any problems when I go to start this engine and what could I do now to avoid them?
Ernie Pawliuk, Prince George, B.C.

A: Yanmar recommends that you add the correct oil to the crankcase and transmission, and fill the heat exchanger with antifreeze. Spray rust-preventative (i.e. Revive) on all linkages and into the air horn which helps to coat the cylinders and pistons. Injectors may be somewhat sticky, so Yanmar recommends before starting for the first time, prelube the engine by turning it over for about 15 seconds without the engine running (raise the decompression lever). Engines are normally warranted from commissioning, except engines held in long-term storage. Because of its age, it's unlikely Yanmar will honor your engine's warranty should anything go wrong during the first year of operation.
— *Jan Mundy*

Helm Seat Remake

Q: I plan to install a new helm seat on my boat's command bridge. The aluminum seat base has a diameter of 22.8cm (9"), however the fiberglass surface I'm mounting it on is slightly curved. Any suggestions on how to securely mount the pedestal?
Ross Woodhouse "Antiquity," North Vancouver, B.C.

A: This is the perfect type of job for a technique that is similar to pouring cement. It involves creating a form or dam around the area of the pedestal mount. Into this form you pour a mixture of thickened (filled) epoxy. Using the top of the form, remove the excess and create a flat, level surface. When the mix has hardened, you drill through using the pedestal base as a template and through-bolt. Since the base that you have created is mostly in compression, and the bolts take up the tension loads, you should eliminate flex and loosening. This method is explained in the "Good Boatkeeping" column in DIY 1998-#1. Use a structural, moisture proof epoxy resin (i.e. Epiglass, MAS Epoxy, West Systems, etc.) along with the proprietary high-density filler, not the filling-fairing type. The form must release from the finished pad. To do this requires the use of a release agent. Wax paper

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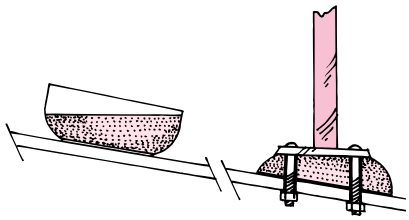
Q+A

works really well for small jobs like this. Line the inside lip of the form with the wax paper and it will prevent the epoxy from sticking to it.



There is an alternative to this method. You can pour the epoxy mixture into a plastic pail (or bowl) that has a diameter similar to your pedestal base. Once it cures you can pop it right out of the pail and then grind out the pad to fit the deck camber. Put some polyurethane sealant (i.e. 3M 4200) under this pad when you bolt the pedestal down and it won't leak. You should use a sealant around the bolts regardless of the method, as leaks through hardware installations are common.
— *Wayne Redditt*

Head Pumping Power

Q: I am replacing the Porta-Potty type MSD with a manual pump system. The location of the tank will require a 2.1m (7') hose run. Is there a practical limit of the hose distance from the MSD to the tank?

A: There is a practical limit to hose length, based on how hard you want to push the pump handle, but you won't come anywhere near it in a small to mid-size boat using a typical manually-pumped head. The theoretical limit, however, is based on the adverse hydraulic pressure (or "head") the pump can overcome. Since the commonly used piston pumps push the effluent instead of using suction to lift it, these small pumps can achieve a lot of pressure, limited only by how hard one pushes the handle or the pump's breaking strength. I've seen the results of people standing on the pump handle to ram-feed sewage into a full holding tank with a blocked vent. The heavy-gauge plastic tank inflated like a balloon and blew apart the plywood joinery surrounding it. Meanwhile the oblivious boat owner complained that the head was "hard to pump" and the bench seat housing the tank had fractured. Truly remarkable was that the pressurized tank, although set to explode, had not leaked a drop. Calculating the pounds per square inch of pressure being exerted on the piston, this boat's head pump seems to be capable of pushing water at least 21.3m (70') vertically provided one stands on the handle and nothing ruptures. If you suddenly have to overcome a lot of resistance...stop! There is a problem somewhere, most likely a clogged holding tank vent or hose.
— *Nick Bailey*

How Many Horses?

Q: My 1963 4.2m (14') Feathercraft aluminum runabout has no Coast Guard capacity plate. Is there a rule of thumb for determining the appropriate horsepower?
Lee Beall, Trussville, Alabama

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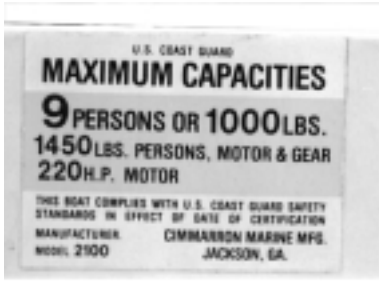
A: Without the capacity plate from the manufacturer you are put in a situation where the boat has to be put through some calculations and tests before you can determine the motor size. In most cases, you are best to find a similar (or identical) boat and match the engine horsepower. To actually determine maximum power capacity, the American Boat and Yacht Council recommends following a procedure that uses length, beam at transom, wheel steering (if used) and a chart of power maximums. They also recommend a maneuvering test that involves running the boat up to a normal cruise speed and making 90° turns without changing trim or throttle settings. This is repeated at higher speeds until the boat fails to negotiate the turn or does it at full throttle. This signifies maximum maneuvering speed. My recommendation would be to copy the setup on a similar boat. Any boat-engine combination will require fine tuning the trim angle, height on the transom, propeller selection and weight distribution variables to achieve optimum speed and efficiency.



— *Wayne Redditt*

Engine-Mount Flush Kit

Q: I am looking for a supplier of a flush kit tank that attaches under the engine cover of a stern drive so I won't have to hang over and use those silly earmuffs. Any suggestions?
Bob Sprague, Belleair Beach, Calif.

A: Mercury offers a sea hose for V6 and small-block V8 engines that goes from the thermostat housing down to the water circulation pump with a sleeve at the mid-point to which you attach a garden hose. Pull the drain plugs and water runs directly in the pump and drains saltwater into the bilge that's then pumped overboard. It's available from any Mercury dealer — part number 32-861590A1 for assembly; 22-861932A1 for flush kit.
— *Jan Mundy*

Why Hasn't Somebody Thought of This?

Q: I keep my 7m (23') 1998 Sea Ray Overnighter on a trailer. Recently, someone drained the tank dry. Does anyone make a stainless-steel locking fuel cap?
Jerry Uber, Collegeville, Penn.

Q+A

A: I've checked my resources and I'm not aware of a manufacturer of a locking cap for the typical fuel fill deck plate that is either slotted or drilled for a key or has a built-in pop-up key. Perko makes a replacement black plastic flange with key-lock cap that fits into a chrome-plated zinc filler (part #1399) for 1-1/2" hose, but you'll have to remove the existing deck plate-filler assembly. If you purchase this unit, I suggest you buy a spare locking cap (part #1324). Many years ago at the start of a boating holiday I made the mistake of giving the gas jockey the key, and both cap and key ended in the drink. Key was on a floater; cap was never recovered. Unfortunately, we didn't have a spare onboard and none of the local marinas carried one that fit.

— *Jan Mundy*

TECHNICAL HELPLINE

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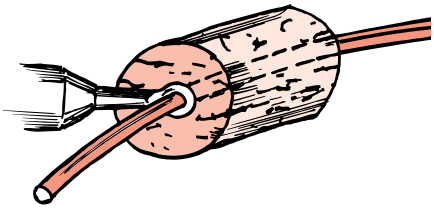
Tech Tips ✓

FIX-IT PONTOON LEAKS: When pontoon logs leak, you'll need to see a dealer to get the leaks fixed permanently, but here's a way to remove the water in the meantime. Buy a 6.3cm- (2.5"-) diameter cork and 1.8m (6') of 8mm (5/16") clear vinyl tubing. Drill a hole in the cork, the size of the tube, and pull about 15cm (7") of the tube through the cork. Seal both sides of the cork hole with silicone sealant. When cured, insert the cork in the hose end of a wet-dry vacuum. Insert the free end of the vinyl tube into the pontoon's top opening port and lightly feel for the bottom. A faint tapping noise as you move the tube up and down signals you're at the bottom. Now mark the exact spot where the tube clears the opening port and you'll know how deep to insert the tube when operating the vacuum. Water is removed by the vacuum without the risk of collapsing the pontoon since the tube lets air enter the hull and prevent a vacuum. Be sure the boat is level to extract the maximum amount of water. Pontoon logs also collect water simply through condensation. Using this gadget, any water accumulation can be removed without a costly trip to a dealer.
Bob Hamme, "Hurricane Bob," Lake Cumberland, Tenn.


ANNE-MARIE HENDRY

NO MORE SAGGING: During warm weather, roll-up plastic windows can sag badly, looking unsightly and possibly damaging the plastic. Purchase some 12mm (1/2") ID ABS tubing and roll the windows on that. Cut the pipe slightly longer than the windows and plug the pipe ends so they don't sink when they fall overboard.
Harold Hiemstra, Oshawa, Ont.

RECYCLE AFTER DRINKING: Refill empty wine foil bags with drinking water then place flat in the freezer. Once frozen, you'll have ice that lasts longer, drinking water as it melts and a very efficient foil blanket for your ice box when the bag is empty.
Dan and Sharon Murphy, "Murphy's Romance," Wilson, N.Y.

WINTERIZING WINDOWS: Acrylic (Plexiglas, Lexan, etc.) frameless windows shrink excessively in cold temps. As part of your winter lay-up procedures, loosen screws holding windows but be sure to retighten before spring launch. Frame windows are designed to float inside a rubber seal, so these will expand and contract with temperature changes. [Ed: We checked with window manufacturer Bomon and it highly recommends doing this procedure.]
Christopher Harcourt-Vernon, "QuickStep," Toronto, Ont.

TERMINAL SEAL: Corrosion from moisture intrusion is the main enemy of electrical terminals. Adhesive-lined heat-shrink crimp terminals, preferably clear so you can identify wires, are the choice of professional installers. But when these are not available or too expensive, slide clear heat-shrink tubing over the wire, write the circuit or wire number on white–out tape and wrap it around the wire near the terminal, then crimp. To secure, dab on some silicone sealant, then slide the tube over the identification label and terminal and shrink with a heat gun.
Gord May, Southbound Marine Electric, Fla.

CLOSE SHAVE: Tired of chasing wind-swept shavings and dust across the deck? Tape a large see-through plastic bag around the work area, then place the drill (sander or whatever tool you're using) inside the bag and against the work. The bag captures most of the mess. When working on a vertical surface, the bag contains the waste. On a horizontal surface, at least the waste stays in one area, making it easy to collect. Use adhesive tape to pick up any residue.
Larry Douglas, "M.Y. Seeker," Sequim, Wash.

PLASTIC WHIPPING: Before splicing or whipping a line, slide heat-shrink tubing over the line, do the splice, then slide the tube up and shrink with a heat gun. Or forget the rope whipping and use tubing to "seal" the ends of lines.

Tech Tips welcomes contributions from readers. If you have a boat-tested tip you'd like to share, send complete information along with your name, boat name and home port to:

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ShopTalk

HOW TO DRILL HOLES

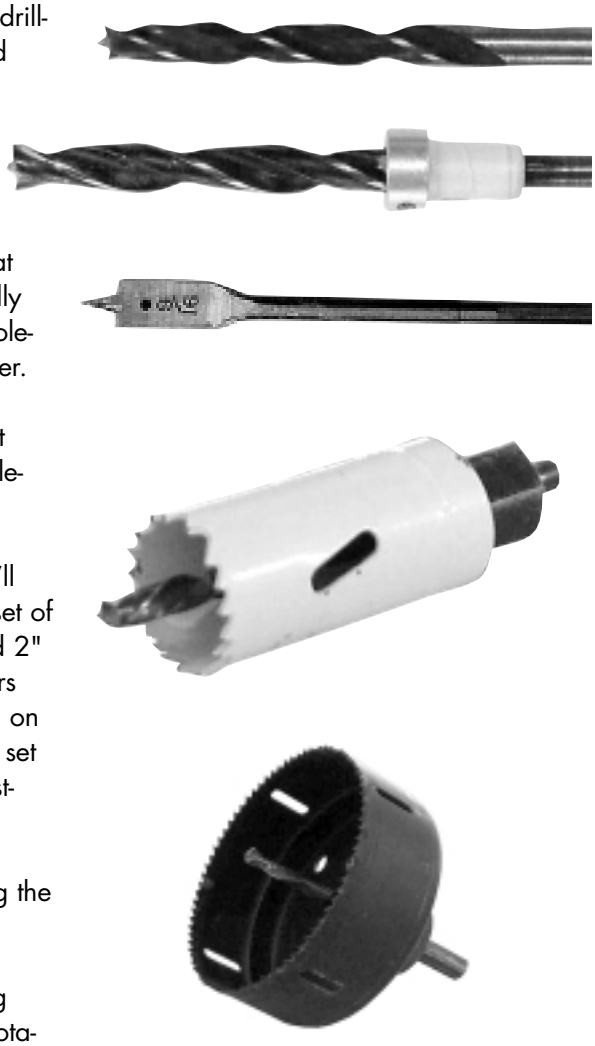
With the proper bits and drilling techniques, cutting clean-edged holes in fiberglass or wood, or enlarging existing holes is simple.

By Wayne Redditt

Drilling holes to install hardware in fiberglass or wood can be intimidating, especially for the uninitiated. Three types of drilling devices that you'll need for onboard projects are lipped brad-point bits, spade bits and holesaws. General-purpose twist drill bits are useful for small holes, but for any holes larger than about 9mm (3/8"), are inconvenient and tend to chip fiberglass edges and "walk" on all surfaces.

Holes drilled for routing cables or wires are best done with brad-points or spade bits. Lips on the outer cutting edges score the material prior to it being removed by the bit. Brad-point bits are available in different grades of steel. The more expensive HSS (high-speed steel) ones will outlast the cheaper carbon steel types by a factor of 10 or more. Spade bits (i.e. Irwin Speed-Bore) are to my knowledge, only available in carbon steel, a material easily sharpened by simply filing the cutting surfaces when they become dull. If you do this, be sure to retain the clearance angles behind the cutting surfaces. A variable drill works best when boring holes in fiberglass as gelcoat chips easily. Start drilling at a slow speed, then increase speed as needed. To ensure a chip-free hole, some pros like to center punch (or use an awl), tapped lightly, the center of the hole or cover the area on both sides (if accessible) with masking tape, or do both, before drilling. I don't recommend using Forstner bits as they are drill-press only tools for wood and severly facture fiberglass.

Holesaws are the real workhorse of large-hole drilling. Sets include an arbor that houses a pilot drill, usually 6mm (1/4"), and one holesaw of a specific diameter. [Ed: purchase individual diameter holesaws, don't purchase the cheap single-arbor, twist-on, multi-size holesaw set.] For cutting most holes on boats you'll find a four-piece starter set of 5/8", 3/4", 1-1/2" and 2" holesaws. Different arbors are available depending on the holesaw diameter. A set screw allows some adjustment of the pilot drill to lengthen or shorten as needed. When threading the saw onto the arbor, it's important to prevent the larger bores from locking onto the arbor through rotation on the thread. Sets with locking devices that protrude through the collar on the arbor into the flange of the saw solve this problem. If you forget to lock and start drilling, it may be impossible to remove the saw later without destroying it.



Hole drilling tools of the trade: brad-point bits, spade bits and holesaws.

Large holesaws can be difficult to use safely, and manufacturers recommend using them only in a drill press. Severe torque reaction occurs if the saw is tilted during drilling and binds in the hole. If you are using a powerful, electric drill and don't have a strong grip, it may be ripped from your hands.

Nevertheless, they are commonly used freehand. As an alternative, I have found that a brace works great for large holesaws. The

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When cutting large holes freehand, to prevent sudden arm-buster wrenching when the saw binds, start the cut with the holesaw in a brace, then switch to a power drill to finish.

down side is the physical effort and slower progress that accompanies this method. Since starting the hole is the trickiest part of using a holesaw, consider beginning with the brace and then switching to your electric drill to finish. Larger holesaw arbors require a 12mm (1/2") chuck.

It's often necessary to enlarge an existing hole. This task is possible, if not easy, using a center-point bit. First, fill in the existing hole with some sacrificial material (usually wood). For smaller holes, use doweling or a plug whittled out of pine (i.e. seacock plug), inserted then cut to the correct length and five-minute glued into place, or whatever fills the hole and will remain in place long enough to cut the new hole. Now mark the center for the new hole. Center the point of the brad-point or spade bit, or holesaw pilot bit on this mark, than proceed to drill, confident that the drill follows the pilot not the existing hole.

No matter how careful you are, there almost always is a ragged exit surface when drilling through fiberglass, even when using a backing board (a wooden board clamped tightly against the surface where the drill exits). When you have access to the underside, drill from both sides, matching drill pilots. For example, consider drilling a hole for a 3.8cm (1-1/2") thru-hull fitting. Begin by drilling from inside the boat in a location that has adequate height for the seacock and easy access for installation and removal. On large holes of this size, first drill a 6mm (1/4") hole with a standard twist bit. Insert your holesaw pilot bit into the predrilled hole and slowly cut the hole, but don't drill all the way. Remove the saw, head to outside of the hull and find the pre-drilled 6mm (1/4") hole. Insert the holesaw and continue. The finished hole will be clean all through, without any fiberglass shards or splinters.

Practice drilling with bits and holesaws in scrap material before drilling your boat. Remember to check for hidden wires, cables or hoses before drilling any holes.

About the author: Wayne Redditt teaches boatbuilding, repair and restoration at Georgian College's Marine Technology-Recreation course in Orillia, Ont.

TIPS CURE FOR HOLESAW DRIFT

Holesaws have a tendency to wander once the pilot bit has drilled through the centering hole. As the holesaw cuts, the bit continues to enlarge the center bore and results in an inaccurate cut. To prevent holesaw drifting, either reverse the pilot bit in the arbor after drilling the hole, which can damage the bit's cutting edge, or preferably, replace the pilot bit with a rod (i.e. a cut-off twist bit) of the same diameter.
— Jan Mundy

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Electronics

CHARTING A BALANCED POWER SYSTEM

Here's how to design a proper electrical schematic so you can view your boat's entire system at a glance, pinpoint problem areas and avoid costly mistakes.

By Kevin Jeffrey

If you're in the process of upgrading your boat's existing electrical power system or installing one on a new boat, usually you'll go through the same step-by-step procedures. First, you'll likely research all the various electrical components on the market. Next, you'll narrow the equipment choices to gear that seems right for your installation and budget, typically with the help of an electrical system consultant or supplier. Once the major components are selected, it's not unusual for you to reach an impasse as you try to make sense of how all this electrical gear goes together.

You now have two choices: one is to give the job to a marine electrician; the other is to follow your do-it-yourself instincts and take the time to understand the system and its individual circuits. For the DIY approach, I suggest you create a visual representation of the power system before you purchase the equipment. A proper electrical schematic can highlight and force you to quantify all those subtle system components and considerations. It can also pinpoint problem areas and help you avoid costly mistakes.

Drafting the Power System

Your boat's power system is a compilation of electrical circuits and sub circuits. In an electrical schematic diagram the goal is to represent all major components, including wire paths and connection points. The more detailed you make the diagram, and as neat and clear as possible, the better your chance of installing the system properly.

In a DC electrical load circuit (**Figure 1**) electricity follows a wire path from a voltage source (ie. batteries) to an appliance load and back to the voltage source. A variety of electrical components such as meters, distribution and connection points, switches and circuit protection devices can also be in that circuit.

In an electrical charging circuit (**Figure 2**) electricity flows from a source of higher voltage such as renewable (solar, wind or water), engine-driven or shore-based chargers to the batteries, which are at a lower voltage, and back to the higher voltage source. If loads are drawn from the batteries while they are being charged, some of the charging current goes directly to the load.

To create an overall system schematic, you simply draw the various sub circuits and connect them. Start by making a list of your power system components. Begin with the house and start batteries. Next list the

Figure 1

SAMPLE LOAD CIRCUIT SCHEMATIC

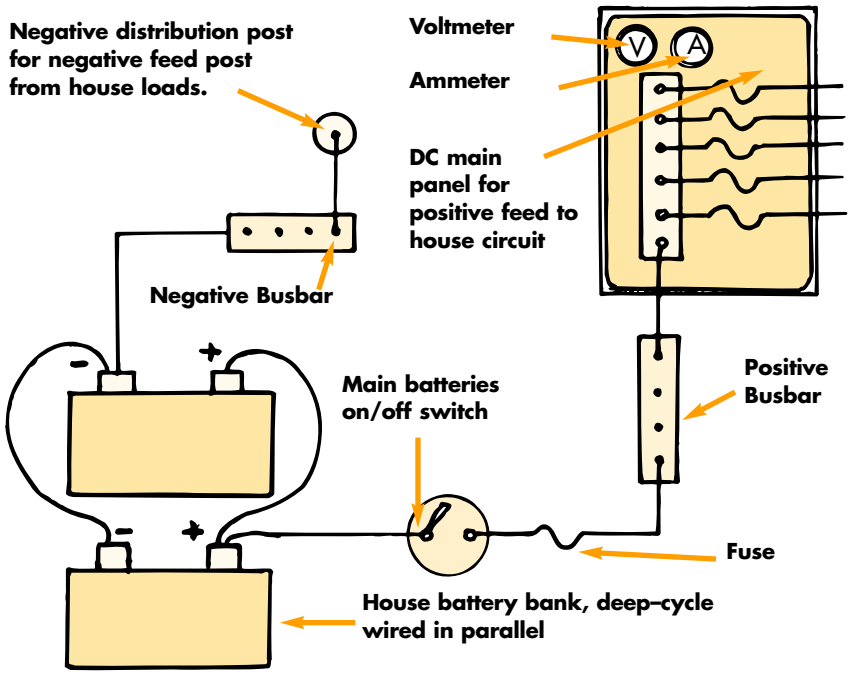

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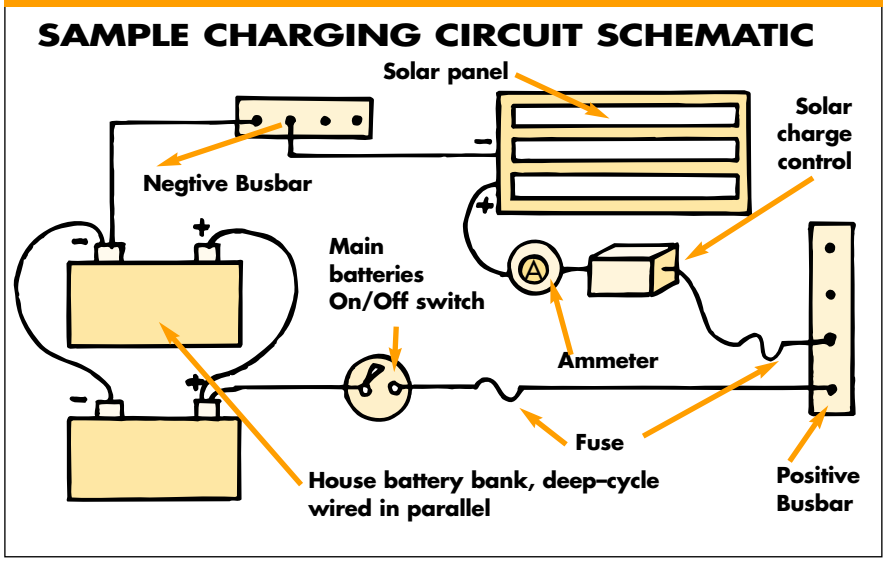
Figure 2



DC charging sources and their controls, including battery charger or an inverter-charger. This naturally leads to a list of all AC power sources, which might include a shorepower connection or a gen-set. Put on the list some way to monitor system performance. Follow this with a list of DC and AC electrical loads to see how they are connected in the system and to help you determine what type of electrical panels to choose. Make your component list as complete as possible, but don't worry — as you create the schematic other necessary parts of the system will become apparent. You can now start to rough out the system on a blank sheet of paper.

Completing the DC/AC Schematic

Let's list the components and number requirements for a hypothetical electrical power system, then create the schematic diagram (**Figure 3**) for it.

- 1 House bank of batteries
- 1 Starting battery
- 1 Main battery disconnect (On-off switch)
- 1 Parallel charging device (to keep starting battery charged)
- 1 Auxiliary engine with starter
- 1 Alternator with charge control
- 1 Solar charger
- # Circuit disconnects (On-Off switches as needed)
- # Circuit protection devices (fuses and breakers) as needed
- # Meters, as needed
- # Distribution busbars and posts (positive and nega tive connection points) as needed
- # System monitors, as needed
- # Bilge pumps, as needed
- # Heavy loads, as needed (i.e. windlass, DC holding plate refrigeration)
- 1 DC load panel
- 1 Inverter-charger
- 1 AC load panel
- 1 30A/120VAC shorepower inlet
- 1 Isolation transformer

(Continues on page 16)

TIPS

POWER CAD

For the computer literate, there are available technical drawing programs, such as KeyCAD, for diagraming power systems that sell for about $50.

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By John Mason

Our boat, like most, came with a lot of complex wiring not done to American Boat and Yacht Council (ABYC) standards, no wiring diagram and no labels. Some of the wiring was original, some added by the previous owners or their contractors. Most was adequately done but some of the wiring was (and is) downright dangerous. Wires disappear into nooks and crannies and tracing is quite difficult.

I was faced with making a record of the existing wiring before I could re-engineer the system and make the changes I needed. Drawing an entire schematic while tracing every single wire is simply too massive a task. I started with a patchwork of limited wiring diagrams done in pencil (they changed a lot). But I wanted a more maintainable record of the wiring and the changes I was making. I started a wire list on our laptop computer.

Wire lists are standard features in electronic manufacturing and they are easily implemented with a computer. I use a Microsoft Word table, but other word processing, spreadsheet or data base programs will work. The key requirements are the ability to sort the rows on the column entries and a good "find" function for the text.

My list consists of four columns and two rows of information per wire. The columns are "Wire Number," "From," "To," and "Circuit." The second row is a reverse entry. In this case, a "wire" is a continuous conducting physical segment with a named source terminal and a named destination terminal. A "circuit" is a functional, electrically contiguous path and may consist of multiple "wires" in series.

Column 1 (Wire Number): The wire number I use is a unique reference designator (number) for the wire. I use a five digit numbering system with leading zeros. For example: "00060" and add an "R" for the reverse path or "00060R." This gives me the sorting characteristics I desire. I simply started with "00001" and increase by 1 for each new wire, making no attempt to correlate a range of numbers with function. When I sort on this column, I can tell what new numbers are available for use and can check the forward and reverse listings for consistency.

Columns 2 (From) and **3** (To): These are named points of origin and destination with a sequence of wires on the terminal. For example: from "Alternator B+ Terminal (1 of 2)" to "F 0001 Alternator Fuse Input (1 of 1)". The sequence is reversed for the reverse path entry. I make some effort to have the primary line match the positive (+) to negative (-) current flow. By sorting on column 2 (or 3) I can see all the wires on a given terminal grouped together. I use a consistent name for each terminal so the points will sort out together. This often flushes out "mystery" wires which may represent a problem such as an unexpected load.

Column 4 (Circuit): This column entry box has four lines. The first line is a circuit name, such as "Alternator Charge Circuit," which is used for all wires in the same circuit. Sorting on this column allows me to see all the conductors in that path grouped together, so I can trace the circuit through fuses, connectors, etc. The second line describes the physical characteristics of the wire (e.g. "1 AWG red"), the third is for comments, and the fourth is the proper ABYC color code for the wire (most of our boat's wiring was not to code). [Ed: Refer to "DC Wiring Handbook" DIY 1998-#4 issue for complete wiring techniques, color codes, etc.]

This may seem a rather clumsy procedure for producing a less than fascinating document, but when troubleshooting or redesigning, a wire list is very handy. My list is up to 14 printed pages and contains perhaps 10% of the boat's wires. Primary use is directly from the computer screen, though I print it infrequently to have a hard copy for troubleshooting when underway.

About the author: Retired from the aerospace industry, John Mason lives aboard "Wanderstar," a Fast Passage 39, with his wife Diane. They have cruised extensively on the southern East and West Coasts of the U.S. and are now berthed in Fort Lauderdale, Fla.

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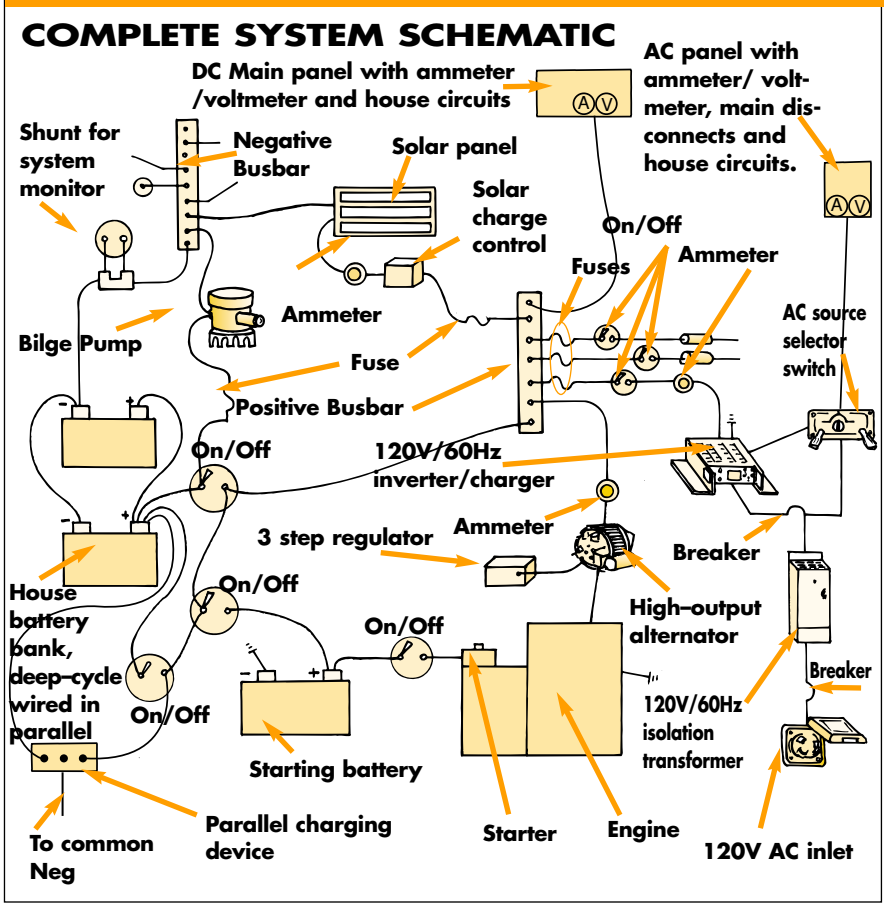
Figure 3



Begin by drawing the house battery bank. If the house bank is comprised of multiple batteries, draw each one and show how they are interconnected (series, parallel, or series-parallel). Now add the start battery and auxiliary engine.

Coming off the positive post of the house battery bank should be two connections: a heavy cable feeding the main battery disconnect and a small wire feeding the parallel charging device. On the battery side of the main disconnect tie in a feed to the bilge pump(s). This prevents the bilge pump from being accidentally turned off. [Ed: See DIY 2000-#1 for recommended bilge pump installations.]

Now locate positive and negative busbars for connecting all the remaining DC wires. The positive busbar feeds the DC load panel and the heavy DC loads, and provides a convenient connection point for the alternator, solar panel and inverter-charger feed. The negative busbar does the same for the negative wires. You can elaborate the schematic by drawing all individual circuits in the DC main panel.

Place fuses and on-off switches as needed to provide safety protection and flexibility. Heavy-duty DC circuit breakers can replace fuse and switch combinations if desired. Analog ammeters and a voltmeter are good for basic at-a-glance system monitoring. The addition of a shunt in the negative feed from the house bank allows for the installation of a system monitor that can accurately track total system performance. I usually recommend both for redundancy.

Now place the AC circuit in the schematic. Start with a shorepower inlet, feed this through an isolation transformer (optional), and feed both the inverter-charger and the AC main panel. Most inverters have an automatic transfer switch that sends

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AC current to the main panel, but the addition of a source selector switch allows you to bypass the inverter if desired (a good option for inverter maintenance or repair). The single wire shown in this schematic actually represents a three-wire cable for hot, neutral and ground. Make sure you properly size and specify all circuit protection devices, wire and wiring connectors. [Ed: Refer to DIY 1998-#4 issue for complete wiring specifics.]

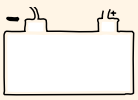
When creating the electrical schematic for your boat add as much detail as possible. Sketching all components, even the small ones, and circuits helps a supplier provide an accurate quote. It also helps you install the system properly and troubleshoot problems later on.

About the author: Kevin Jeffrey works as an independent electrical power consultant and is the author of "Independent Energy Guide" and publisher of "Sailor's Multihull Guide," now in its second edition.

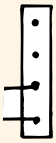
COMMON ELECTRICAL SYMBOLS

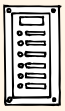
Creating an electrical schematic diagram should primarily be for your needs, not some professor in an electrical engineering course. General conventions should still be followed, however, to make it easy for others to understand and work on your system if needed. Some conventional schematic symbols are shown below.

Ammeter 

Battery 

Breaker 

Busbar 

Distribution Panel 

Fuse 

On-off Switch 

Resistor 

Shunt 

Voltmeter 

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Upgrade

WHAT YOU SHOULD KNOW ABOUT HOSE

Hoses are essential to keeping your boat afloat and operative but many boats are equipped with inferior, non-marine-rated hoses. Here's how to survey and upgrade your boat to comply with today's performance and safety standards.

Story and photos by Jan Mundy

Many boats built before 1990 and some after, were assembled from readily available materials, such as highly corrosive automotive wiring, inexpensive heater and fuel line hoses and household plumbing fittings, with little concern for boatbuilding standards, either mandatory or voluntary.

Nowadays, the installation of most boat systems are regulated by the Coast Guard, American Boat and Yacht Council (ABYC), National Marine Manufacturer's Association (NMMA), Lloyd's and others. Though some standards are voluntary and not always adopted by boatbuilders, you should adapt these when replacing or upgrading components. This ensures your boat will, at the very least, pass a survey or insurance claim if the surveyor or adjuster is standards-literate, and you can avoid failures by inferior products.

Attending a seminar presented by Bill Shields of Trident Marine at IBEX '99 (a trade show for boatbuilders), prompted me to inspect the hoses on my own early-'80s-built boat. What I found wasn't pretty and unsafe, especially engine hoses. If you haven't upgraded hoses on your boat lately, read on.

Non-approved automotive hoses installed in early '80s on author's 7.5hp diesel engine: (top) cheap, highly-abrasive corrugated fuel fill shown on right side; very thin-walled, non-Coast Guard-approved fuel distribution line; common heater hose for raw-water exhaust shown on left side. Note split hose wrapped over soft heater hose (left side) to protect from abrading on bulkhead. (bottom) Automotive heater hose connects to exhaust manifold. All hoses have since been upgraded to marine spec after researching for this article.

Hose approved for marine use should be Coast Guard certified, as required for gasoline-carrying lines, or constructed to meet minimum performance and quality standards. Though generally more expensive than non-marine-rated hose, using such products insures greater service life and safety. Consider these examples. When a raw-water-cooled engine develops a blockage and the engine overheats, an automotive heater hose would likely burst. Spill solvent on a cheap PVC hose and it quickly dissolves. A ruptured non-marine hose on an engine or gen-set raw-water connection, air conditioning, bilge pump, head and livewell intakes or any hose connected to a below-waterline thru-hull can sink your boat. Likewise for a leaking cockpit drain hose — should it rain and the bilge pump can't keep up with the water flow, the boat will surely sink. Non-standard engine exhaust hose with pinhole leaks can result in deadly carbon monoxide poisoning and possible flooding. Breach an unrated diesel fuel line or holding tank hose and you're guaranteed to have the contents dumped into the bilge, creating a very dangerous, or noxious, situation. Blow a non-certified gasoline line and the boat becomes an explosive shell.

Hoses for marine use are often labeled with the standards classification, either SAE, Coast Guard, NMMA, ISO, UL or Lloyd's; the manufacturer's identification number, usage, the year manufactured plus other classifications as specified for each particular application. When purchasing approved hose, also examine the construction: check that the hose ends have the

Certified hoses for use on boats: (top) Hard-wall ("R2" designated), wet exhaust and water intake hose, SAE J2006 rated; (middle) Coast Guard-certified fuel fill hose that meets fire resistance ("A") and lowest fuel permeation ("2") standards; (bottom) Certified fuel distribution and return hose meets fire resistance ("A") and highest fuel permeation ("B") standards. Gasoline-powered boats must have certified fuel hoses to pass a survey or insurance claim when done by a competent surveyor or adjuster.

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Upgrade

(left) Very soft, non-reinforced automotive heater hose commonly found in older boats and on author's boat for raw-water engine intake.
(right) Overtightening the hose clamp has resulted in the thin-walled automotive heater hose being crushed. A hose failure could sink this boat.

same inside diameter; examine the wall thickness as thin-walled hose easily kinks and has poor abrasion resistance; and check that it's reinforced with wire or synthetic yarn (usually polyester).

Now that marine-rated brand-name hoses are readily available, it makes good sense to purchase the best you can afford and of the proper material and strength rating. Since doing the research for this article, I've replaced all the automotive engine hoses on my boat and now have premium quality, smell-free head hoses. Next time you're onboard your boat, I suggest you inspect all the hoses and upgrade, based on the following specs, as needed.

Fuel Hose

Gasoline-carrying hoses on inboard and stern drive boats are the only ones that must by law meet Coast Guard standards. Look for hoses labeled "SAE J1527," or less common, "UL-1114." Labeling on fuel hoses also includes: classification of resistance to fire, either "A" for fire resistant, "B" for not fire tested (for outboard use only); and fuel permeation, either "1" which is the highest permeation requirements for gasoline distribution and return lines, or "2," a less-stringent requirement commonly used for gasoline fuel fill and vent hoses, and all diesel hoses. There are currently no mandatory standards for diesel or outboard engine applications.

Wall thickness of Coast Guard-certified fuel line hose (pictured) is more than twice the thickness of automotive fuel line.

HOSE DOS AND DON'TS

- Always buy certified brand-name hose, the best you can afford, and of the proper material and strength rating for its intended use.
- Hoses used for fuel distribution and return lines in gasoline inboard and stern drive engines must be Coast Guard certified.
- Always purchase smooth-wall hose. When used for engines, it reduces engine back pressure; for sewage applications, it's easier to clean and reduces calcium build-up; for water lines, water flows without any restrictions.
- Always install hoses over hose barbs, never attach to smooth pipe, and secure with all-stainless-steel clamps (for comparative information on clamps, see DIY 2000-#1 issue).
- Always use a wire-reinforced hose in a suction application (i.e. engine raw-water intake) to prevent hose collapse should the intake become clogged.
- Don't flush through the sanitation system alcohol-based antifreeze, toilet bowl deodorizers or petroleum-based cleaners as they destroy the components in sanitation hose that make it impervious to sewage.
- Never use household plastic hose fittings or nylon clamps. Install silicone hose only with clamps intended for such hose.
- Don't use excessive heat to facilitate attachment to hose barbs. Lubricate the inside of the hose with liquid detergent (never use Vaseline or other petroleum-based solution) and, if necessary, heat the hose end with hot water, hair dryer or heat gun to soften it, then lubricate it.
- Never grind or file hose barbs to ease hose attachment.
- Don't fit the hose to an adapter that is too small.
- Don't bend a flexible hose more than two times the hose diameter.
- Double clamp all exhaust hoses (an ABYC requirement). It's also good practice to double clamp all hoses connected to fuel lines, below-waterline thru-hull fittings, all heavy walled and stiff hose and any hose connected to a vacuum system (i.e. vacuum head).
- Tighten hose clamp screws only enough to hold the hose securely on the barb, but not enough to markedly depress or damage the hose cover.
- Install threaded pipe fittings with Leak Lock (available from refrigeration suppliers) or other quality pipe sealant. Don't use Teflon tape to seal threaded fuel lines.
- Use aluminum or stainless-steel fittings on aluminum tanks; brass on iron or steel ones.
- Inspect hoses regularly for leaks and deterioration and check clamp screw tightness, retightening as necessary.
- Use large cable ties to support hose every 30.4cm (12"), both vertically and horizontally.
- If engine runs dry, replace all hoses even if they look sound.
- Always close thru-hull seacocks when boat is unattended.

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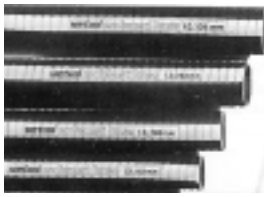
Exhaust Hose

Since 1999, flexible rubber hose, bellows and elbows used in wet exhaust systems must comply with SAE J2006 standards and be so labeled. This means that the hose is temperature-rated at 593°C (1,100°F) for two minutes, the equivalent of running the engine at full power for two minutes.

Wet exhaust hose should also be flexible, thick walled, and resistant to cold, heat, abrasion, antifreeze and oil. Various compounds are offered depending on application and your budget. The less expensive high-temp black 100% EPDM rubber withstands 121°C (250°F) maximum continuous. More expensive is 100% silicone hose with polyester reinforcement and molded silicone-EPDM blend withstands 176.6°C (350°F) maximum continuous. For extreme high-heat applications, premium-priced Nomex-molded or -reinforced 100% silicone rated for 260°C (500°F) maximum continuous lasts up to six times longer than economical black EPDM rubber hose.



Vetus double-steel reinforced rubber exhaust hose is very flexible, has Lloyd's Register of Shipping approval and rated for 100°C (212°F).

Additional labeling on some brands rates the product's flexibility: "R" for soft-wall, "R2" for hard-wall, and "R3" for exhaust connectors. Soft-wall hose, commonly used for straight connections, is reinforced with multiple yarn plies. Hard-wall hose is wire- and yarn-reinforced, preferably wire sandwiched between two plies. Flexible elbows and hose bellows with an "R3" rating easily mold into the tightest bends to compensate for engine movement, vibration, noise and misalignment, and reduce engine back pressure.

Engine Coolant Hose

Hoses that circulate engine coolant water must resist kinking, heat, antifreeze and oil. A heavy-wall, two-ply rubber hose, with or without wire reinforcing, is recommended, or substitute premium automotive black heater hose or blue silicone hose, both rated to meet SAE J20 standards. Some coolant hoses are also reinforced with synthetic yarn. For high-temp applications, Trident's Premium Blue Silicone hose has a maximum continuous rating of 287°C (550°F).

Extra thick-walled engine coolant hose (or for drain or sanitation uses) with wire helix between two-ply reinforcement has excellent flexibility and bend radius.

Raw-Water Pick-up Hose

Any hose connected to a thru-hull located below the waterline that

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delivers raw water to an engine, head, air conditioning and livewell should be the best hose purchasable. Don't rely on corrugated hose — a rupture could sink your boat. There are no standards for this hose, though it's recommended to use two-ply, wire-reinforced, heavy-wall rubber hose, the type used for engine exhaust (SAE J2006 R2 or equivalent). Such hose won't kink nor collapse under suction if the raw-water screen becomes clogged.

Potable Water Hose

According to ABYC and NMMA standards, water hoses must be food-grade or FDA-approved, usually PVC (polyvinyl chloride), preferably smooth-walled and opaque rather than clear as light encourages algae growth. Never use rubber hose as it imparts a foul smell in the water. Pressurized cold-water systems require reinforced hose for water distribution, typically a clear or white hose with red, blue and/or white

(top) White PVC smooth-wall hose commonly used for head and potable water applications; (middle) Premium choice odor-resistant, heavy- and smooth-walled, reinforced, premium black rubber sanitation hose; soft-wall portable water hose reinforced with multiple yarn plies, commonly used for straight connections.

polyester yarn tracers. Both pressurized and non-pressurized hot-water systems, where lines carry 60°C (140°F) water or higher, require reinforced rubber hose. Water tank fill and vent hoses commonly use smooth-walled rigid hose. Alternatives to hose for all applications are rigid household-type water pipe (different types for carrying cold and hot water) and piping systems offered by Whale and Flair-It. (For detailed information on installing and troubleshooting freshwater systems, refer to DIY 1997-#1 issue.)

Bilge Hose

Cheap multi-flex corrugated hose, the stuff with the equally spaced molded cuffs, is the worst option for bilge pump intakes or for connecting pumps to thru-hulls. Sure it's resistant to oil, water, easily bends around tight corners and lasts a long time. But kink it and the hose cracks. Chafe it and it punctures. And the corrugations and cuffs reduce water flow by 30% and higher. (For more information on bilge hose and water volume, refer to DIY 2000#1 issue.) Most quality boatbuilders have replaced corrugated hose with a more durable nearly-as-flexible smooth version.

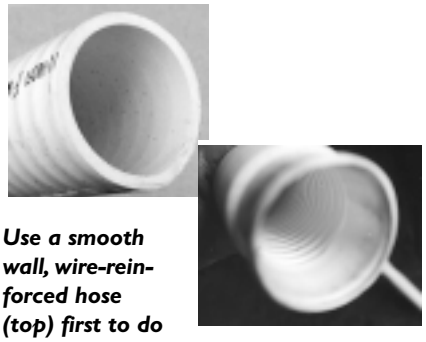
Cheap multiflex corrugated hose collapses in suction applications, ruptures easily and reduces water flow by up to 30%.

Drains

Flexible, heavy-walled rubber water intake hose that doesn't kink or abrade is recommended for cockpit, sink and shower drains. Alternatively, you can use smooth vinyl or PVC tubing, depending on the installation.

Sanitation Hose

Sanitation hose on boats must contain sewage that is about 30 times more concentrated, especially vacuum-type toilets that have very low water content, than residential sewage. This is not an easy task. Such hose must be flexible, kink-resistant and more importantly, odor-resistant. Often the only type offered in marine stores, and commonly installed on boats, is food-grade, smooth-walled white PVC. Not the best selection as odor permeation is commonplace — before upgrading, I replaced cheap head hoses every season as part of my spring commissioning chores.



Use a smooth wall, wire-reinforced hose (top) first to do the job before selecting the cheaper, corrugated hose (bottom).

Stink-resistant alternatives, but not readily available, are gray anti-bacterial hose and the smooth, heavy-walled, premium-grade, less odorous, black rubber hose. Either is a better choice than conventional PVC hose, but about twice the cost, however, they won't need replacing as often. Some boat owners have had good success with Schedule 40 or Schedule 80 pipe, supported every 1.8m (6'). Installing short hoses, minimizing connections and limiting use of Y-valves that can trap sewage also helps to reduce odor-causing problems. (For step-by-step head and holding tank installations and troubleshooting, refer to DIY 1997-#2.)

Although there are no recommended standards for sanitation hose, it's often labeled with the type and manufacturer. Knowing this information helps to identify your replacement options.

Ducting

Factory-supplied flexible vinyl ducting used for heat and air conditioning systems punctures easily. Better to replace it with more durable, heavier-walled ducting.

Propane

Hoses used onboard for propane appliances must comply with UL 21 and must be assembled with swaged end fittings. All installations must comply with ABYC A1. ⚓

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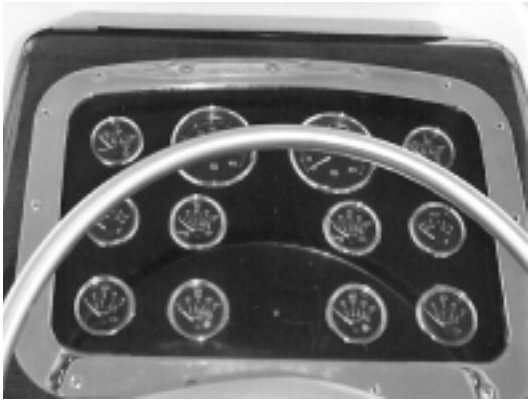
Engine TroubleShooting

INSTALLING ENGINE MONITOR GAUGES



With the investment you have in your boat and its engine, it's cheap insurance to have the right gauges to monitor it properly.

Call them meters, instruments or gauges, they are the windows to the vital signs of your engine. By monitoring them you can be assured that barring a mechanical anomaly your engine's most important requirements — fuel, lubrication and cooling — remain fully operational. Without gauges, you'll probably never know, until it's too late, of any developing problems that could result in engine failure.

While the original compliment of gauges on your boat is likely adequate, you can benefit by adding additional gauges to closely monitor engine and drive-line performance. Adding additional temperature and pressure monitoring points will result in longevity and dependability. For powerboats, instruments such as fuel flow meters (GPH) and exhaust gas pyrometers (EGT) can help you cruise your boat more efficiently.

Most engines, in addition, have audible alarms that partially duplicate the functions of some of these gauges. Unlike alarms that alert you to what has happened, instruments reveal subtle changes and show trends that can alert you to things that will happen. Worn impellers, for example, gradually display an increase on a temperature gauge or a decrease on a water-pressure gauge (for outboards). Bad injectors will show up quickly on a pyrometer. Once you have become familiar with the correct position of your gauge pointers or numbers, even a small change will alert you to keep a close watch or take the necessary precautions.

Packaging Gauges

It's relatively easy to add additional instrumentation, however, there are some important things to consider. Gauges must be matched to the appropriate sender with regards to range of scale and resistance values. Simply said, an 80 PSI (5BAR) oil-pressure gauge will require a sender rated for 80 PSI that has the same resistance range as the gauge. This range is measured in ohms from the "zero" position to full scale (i.e. 240 to 33 ohms). There are some industry standards, however, that can be confusing so pay close attention when ordering your parts.

If you wish to have two gauges (flybridge and lower station) you must use a dual-station sender or install a sender for each gauge. A dual-station sender will only service two of the same gauges. Don't mix brands or ranges. If you connect a second gauge to a single-station sender you will get a false reading on both gauges.

Sending units for temperature and pressure are available in several configurations. Besides single and dual station, some manufactures offer standard ground (where the sender is grounded through the engine block), and floating ground, which does not ground through the engine block. Floating ground senders have two terminals. One for the gauge and the other is connected to a common ground off the engine. They are often used on aluminum or steel boats to separate the electrical system from the machinery and hull.

When adding gauges consider the unit's location, lighting and viewing angle. Many panels come with blank gauges which is a logical place to add a gauge. If you are going to monitor a gauge, it must be easily viewed. Sun glare, mounting angle, wire runs and depth of installation are important factors to consider. Digital gauges are inherently more accurate than

TIPS *ENGINE READOUT*

Don't rely on your engine alarms unless you want an engine rebuild. Look at your gauges and know your engine's normal operating parameters.

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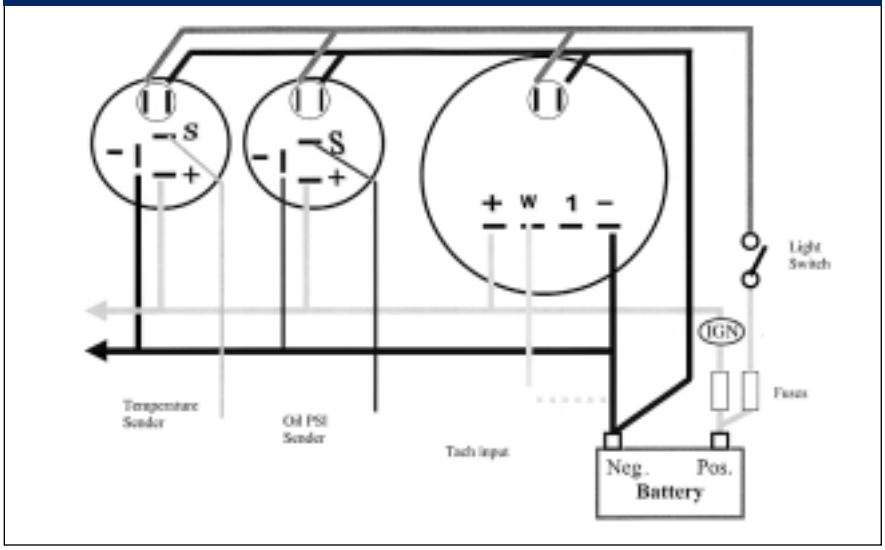
TYPICAL WIRING INSTALLATION.



the analog needle type but are more difficult to read in bright sunlight (LED) or low-light levels (LCD). Analog displays are easier to read because you just have to watch for a change in needle position rather than remember the previous digital readout.

Common instrument diameters are 5.2cm (2-1/16") for the small units like pressure and temperature, and 8.5cm (3-3/8") for larger units like tachometers and synchronizers. There are also some 10cm (4") units to be found. Remember that these are the cutout sizes. The front bezels are larger and vary by style and or manufacturer. The dimensions should be clearly stated on the instruction sheet.

Depending on the size, age, and origin of your boat, you may have a 12-, 24- or 32-volt system. As most gauges are 12 volt, 24- and 32-volt systems use a common voltage reducer or individual dropping resistors for each gauge. It's important that you know your system voltage when you order your instruments.

Mechanical or direct-reading gauges are an alternative to electrically-driven units. It's common to see mechanical gauges in the engine space on larger vessels mounted near the engines while electrically-driven ones are installed at the helm, which can be some distance from the engine room. Remember when comparing a mechanical gauge in the engine room to a helm unit that the location of the monitoring point can greatly influence the readings. One unit might be sensing before a cooler or filter and the other after, which will show a different value.

Inside view of outboard dash gauges and a cluttered wiring job. Non-factory supplied hourmeter, trim and water-pressure gauges completed the add-on package.

Installation Guidelines

Installing most gauges is easy. Before cutting a hole be absolutely sure there is nothing critical behind it and what you intend to put in it will not interfere with cables, steering pumps, bulkheads etc. It's not too difficult to cut a hole but it can be very difficult to patch it!

Where possible, mount gauges into spare holes on the instrument panel (just pop out the blanks) or using a holesaw drill a hole adjacent to the panel, being careful not to disturb existing instruments and wiring. Measure twice then cut. [Ed: For drilling techniques see "Shoptalk" on page 10.] Seal the hole with a silicone or polysulfide sealant. Secure gauges from behind the panel with the supplied bracket. Don't overtighten. Depending on the dash or bulkhead thickness, it's often necessary to cut (use a hacksaw) or custom-fit the bracket.

Most sending units have a tapered pipe thread (NPT) and should seal without tape or compound. Pipe tape should never be used on standard ground systems as it can isolate the sender body from the block (ground). A small amount of liquid pipe dope is acceptable if necessary to prevent seepage. It's also advisable to be very careful when using tee fittings or extensions as they can crack from vibration.

TIPS **SURF THE NET**

Most of the major aftermarket instrument manufactures — Faria, Gaffrig, Teleflex, VDO and others — and many distributors have web sites that have instructions, frequently asked questions and contact numbers for assistance.

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A better method for oil-pressure senders and alarm switches is to use a short, high pressure hose to remote mount them on a common block or tee fitting just off the engine. This will eliminate vibration and prolong the life of the senders/switches. Using a tee fitting for temperature sensors is not advisable as the ends of these sensors must be immersed in the flow of the liquid to be measured. A tee can cause an air pocket and give false readings. [Ed: For detailed instructions on installing a water-pressure gauge, see DIY 1997-#1.]

Wiring

Most small gauges (except voltmeters, ammeters, etc.) have three connections plus the lighting circuit. The terminal designations may vary by brand but the principal is the same. Each gauge needs battery positive(+, I or P,), Ground (-, Neg or G) and the sensor input, which can be "S" or in the case of European gauges "G." Lighting requires 12-volt from the panel lighting switch and a ground, which in some gauges is common to the gauge ground. A separate lighting ground is best but not all instruments are made this way. A good way to test for insufficient ground is to simply turn on the lights. If the gauges move even a little you have a ground issue.

The new instruments can be paralleled to the existing gauges with respect to the positive (usually a purple wire) and negative (black wire) and in the case of adding a second station gauge (color varies). The power going to any panel should be on a circuit breaker (preferred) or fused. Most gauges (less lighting) use only about 100mA at 12 volt. Check the amperage just to be sure the circuit can take the additional load.

Use marine-rated tinned wire and quality connectors to connect gauges. ABYC recommended practice is to use 18 AWG or larger wire for instrument hookups. (Remember the wire gets larger as the AWG number gets smaller.) For a neat installation, follow the color code on the existing panel. [Ed: For wire color coding, gauges, determining wire runs, etc., refer to the "DC Wiring Handbook," in DIY 1998-#4.] Use a quality crimp tool with heat-shrink terminals or use heat-shrink tubing to resist corrosion. Be sure to label all wires so they're easily identified if (when!) there's a problem.

After you have completed your installation take the time to learn and document the normal operating ranges of your new as well as existing instruments and watch them regularly while underway. Good instruments along with regular maintenance always pays off in trouble-free cruising.

Thanks to Larry Douglas, Robert Hess and Will Heyer, technical service manager of VDO, for their assistance in compiling data for this article.

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PROJECT BOAT

7 YEAR REFIT

A stem-to-stern refit of a '77 Chris-Craft 35 DC

Story and photos by Ray Larstone and Patricia Stephenson

Nothing was wrong with "Winrush" when Ray Larstone and Patricia Stephenson purchased the 11-year-old 10.5m (35') Chris Craft DC in 1988. Hull and deck were structurally sound, engines were running fine, although the many hours logged pointed to a much-needed overhaul. Just after five years of cruising the cool waters of Lake Huron and the North Channel (a popular cruising area), they decided extensive remodeling was in order. What was needed was a redesign of the boat's upper deck, a project that evolved into an extensive remake of the main cabin.

In September 1993, "Winrush" was hauled out at Harbor Vue Marina, located on Manitoulin Island in Lake Huron. Engines and transmissions were removed and sent to shops nearby for complete rebuilding, then reinstalled the following spring. Because of accessibility, this work was completed prior to starting the deck renovations. During the next six years, a custom hardtop replaced the original flybridge, resulting in a new helm station, redesigned cabin entrance, galley upgrade, rewiring of AC and DC systems and extensive cabin remodeling. First-rate materials, skilled workmanship and painstaking attention to detail resulted in an estimated $22,090 price tag. Here's their story.

(Before) Chris-Craft with original flybridge bimini canvas.

(After) Custom-fabricated hardtop with glass-enclosed "cabin" gives additional living quarters.

Another boating season ends and we haul out on Manitoulin Island, removing flybridge canvas and windshield in preparation for the yet-to-be constructed hardtop. After extensive and precise measuring with the help of a drafting teacher, the finished sketch (**Figure 1**) along with the windshield less the side panels was delivered to Stanley Machine and Boat Works in Parry Sound, Ont., to manufacture an aluminum hardtop (rather than fiberglass to minimize the weight). A mistake in the original sketch and some misunderstanding resulted in a 25cm (10") stern overhang added on to the total length. Now the overall length was 4.6m (15'6"), not the planned 4.5m (14'8"). After finding this out we decided to move the extra overhang to the front to give us more shade in the helm area. The sides and stern extend to align with the boat's gunwales for added protection when it rains. As the original windshield was always much too low for comfort, the new hardtop was raised 21.6cm (8-1/2"). We hadn't resolved how to bolt the hardtop to the bridgedeck, instead leaving the engineering to the experts at Stanley Machine.

On the inside, the top is flat which gives 1.9m (74") standing headroom in the center and slightly higher towards the sides since the rear deck floor has a slight roll to the outer edges. On the outside, a slight curve enhances water run off. Framing is 6.3cm by 3.8cm (2-1/2" by 1-1/2") L-shaped aluminum angle. Sheathing on the outer top, left and right undersides is 3mm (1/8"); thicker 4.7mm (3/16") material on the underside for the front and rear sections. Remaining undersides are covered with 6mm (1/4") fir plywood and painted. Rear support posts are 3.8cm by 7.6cm (1-1/2" by 3"), spaced 12.7cm (5") apart.

On a cold late-winter weekend, we began assembling and bolting the hardtop in place. With front sides bolted to the deck, and original windshield dropped into place, we removed the stern deck railing and stanchions and installed the sup-

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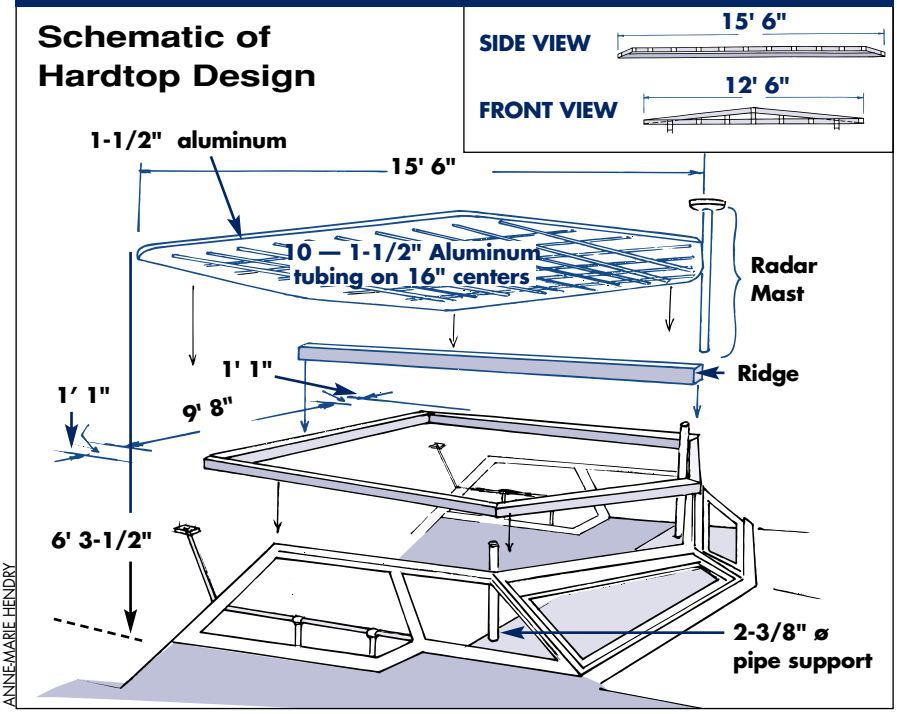
Aluminum hardtop temporarily supported on deck.

Original windshield dropped into front opening in hardtop.

Figure 1



port posts. At this point, the hardtop was secure. During the next month, we finished bolting the front below the windshield, and constructed the lower side panel frames made of 2.54cm (1") square aluminum tube.

It took another month to finish the lower and upper side panels which were sheathed in 6mm (1/4") mahogany plywood covered with off-white vinyl automotive fabric (purchased at an auto glass supplier). Ditto for the stern panels that concealed the rear posts. Inside, 8mm-(5/16"-) thick cedar boards covered the side panels and rear posts were covered with 12mm (1/2")

With rails removed and support posts bolted in place, framing work started to enclose the aft deck.

Vinyl-covered plywood closes in the space between the vertical support posts and the side.

mahogany plywood stained and varnished.

Next, new stern panel framing was constructed of 7.6cm by 19mm (3" x 3/4") mahogany and we fastened 19mm (3/4") square mahogany strips to the framing using #6 pan-head screws. To this we fastened 19mm (3/4") mahogany plywood which was stained with red mahogany paste filler inside and out and varnished. On the interior side was screwed another 19mm (3/4") strip. To align with the cabin stairs, we changed the location of the new doorway.

View of starboard side panels and stern panel with stained and varnished door.

View from inside looking aft.

Inside enclosure shows port side and stern panel. Note sliding windows.

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This required cutting the raised area of the fiberglass floor at the stern to install a level step plate. Two pieces of 12mm (1/2") mahogany plywood laminated together formed the door, with one piece cut 12mm (1/2") oversize to hold the glass. The original door handle and lock were reused in the new door.

Installing the rear and front sliding windows necessitated cutting mahogany boards and dadoing the edges to fit over the glass, then caulking in place (**Figure 2**). Again, 7.6cm (3") framing was cut to make the window openings and 19mm (3/4") strips were used to sandwich in place the rear stationary glass and sliding stainless-steel tracks. To protect the wood, interior and exterior were coated with marine varnish.

To match the red mahogany stain, we repainted the blue waterline and striping with Interlux Rustic Red (#4391). A new stainless-steel ladder connected the top to the aft deck, allowing access to the top-mounted antennas. Finally, the old cabin door was then removed and by mid-June "Winrush" was back in the water and ready for a summer of cruising with no troublesome canvas, Plexiglas windows and resulting dampness.

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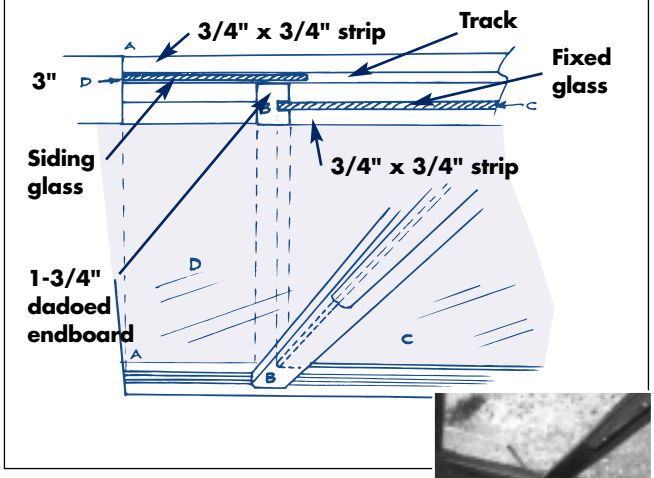
Figure 2

Details of Starboard Side Window



ANNE-MARIE HENDRY

Details of window track and dadoed framing.

Rebuilding the Helm

Fall of '95 and "Winrush" is back in dry dock. We've removed the old helm station, all electronics, old steering hub and cable back to the steering arms, and completely gutted and trashed all 12-volt wiring and components including the breaker panel.

During the next eight months we installed four new eight-circuit breaker panels. Overkill, perhaps, but the old 35s were not equipped with enough breakers to handle all loads and we wanted each piece of equipment on a separate breaker. Should a breaker trip, we would know exactly where to look to solve the problem and not spend extra time troubleshooting the entire system.

Next task was a new helm area. We prepared sketches of the new helm and chart table, carefully taking measurements from the existing helm for a pattern. The design ideas came from a few boats, mostly the lower helm on a Carver 42-footer. Framing for the helm, table and top lifting panels consisted of 19mm (3/4") painted fir plywood. Inner frame of helm (**Figure 3**) measures 10.8cm (4-1/4") high with 19mm (3/4") plywood top panels for

Original helm station on 1977-vintage Chris-Craft.

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a total height of 12.7cm (5"). Both outer side panels are 19mm (3/4") mahogany, 12.7cm (5") high. A gauge box appears as a separate unit. It measures 72.4cm by 20cm wide by 15cm high (28-1/2" by 8" by 6") and sits on two parallel 3cm by 19mm (1-1/4" by 3/4") stringers. A removable top made of 12mm (1/2") mahogany plywood and faced with gray-marble arborite gives easy access. All gauges are original, except two voltmeters that were added on before to replace the original idiot lights.

Ahead of the gauge box, mounted between the two parallel stringers, sits the original compass. A lift-up panel measuring 58.4cm by 73.6cm (23" by 29"), allows easy access to wiring. Behind the gauge box is a 20cm by 11.4cm deep (8" by 4-1/2") storage area for binoculars and other gear. A sloped panel in the front holds two breaker panels that control all navigation electronics, ignition switches, trim tab lever, two transmission-gas levers and spotlight control panel. (Spotlight was relocated above windshield for better performance.) This panel also lifts up for easy access to wiring and steering cables.

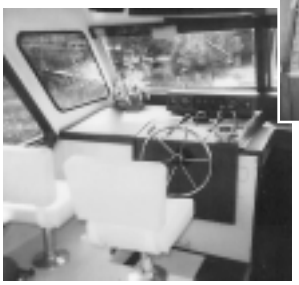
Older Chris-Crafts have a recessed floor at the helm for the driver to stand in, but we always found the steering wheel too low and raised it several inches to a more comfortable height. Wheel hub center is now 71cm (28") from the top of the new storage area built below the helm (added later). We used the original stainless-steel wheel after having it rewelded, but installed new Teleflex steering hub and cable. An upper console above the helm for electronics storage measures 77.5cm wide by 38cm deep by 35.5cm high (30-1/2" by 15" by 14"). It has two shelves with the lower one designed to drop down for better access to the VHF radio and depth sounder. Purchased oak doors, stained to match, complete the cabinet. The radar unit was relocated to the left of the console and is easily read from the helm.

The portside chart table (**Figure 4**) features a storage area for charts that measures 63.5cm by 60cm by 11.4cm (25" by 23-1/2" by 4-1/2") including lift-off top panel. A stationary front panel slopes slightly and measures 63.5cm by 48cm (25" x 19"). All top surfaces and sides of the upper console are covered with burgundy marblestone Naugahyde.

A storage area for lifejackets, measuring 83.8cm by 55.8cm by 40.6cm deep (33" by 22" by 16"), filled in the well below the helm. Using plywood from the original seat as a pattern, we built two identical new seats and had them professionally recovered. Relocating the helm seat 10cm (4") forward of the original mounting has much improved driver comfort.

Opening the main cabin to the new enclosed upper deck meant building a new entranceway. Since we had never built stairs, we visited our local library and signed out some books and a video on how to measure, plan and build stairs (**Figure 5**). Measuring proved difficult as our Chris-Craft featured a step-down well at the salon entrance. We ended up with six, 63.5cm- (25"-) wide steps extending down to just ahead of the starboard engine hatch. Three inner stringers, made of 19mm (3/4") mahogany strips and cut to fit each stair tread were attached to top edges for extra strength and support.

Using a reciprocating saw, the entranceway was cut in a semi-cir-

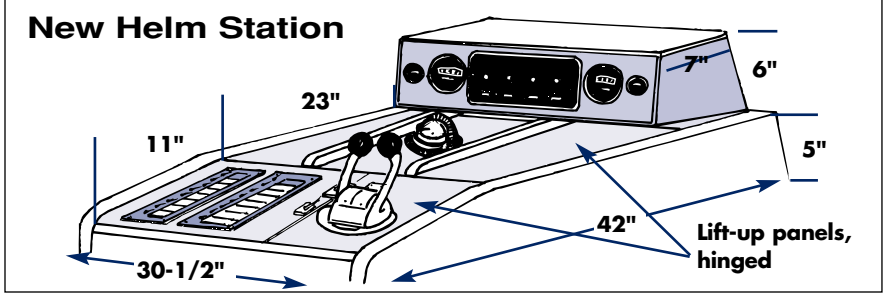


Overhead electronics shelf.

Renovated helm with compass, new controls, gauge box and breaker panels installed.

(right) Top panel opens for easy access to wiring. Note neat and orderly wiring job.

Figure 3



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Storage compartment for lifejackets built into well below driver's seat.

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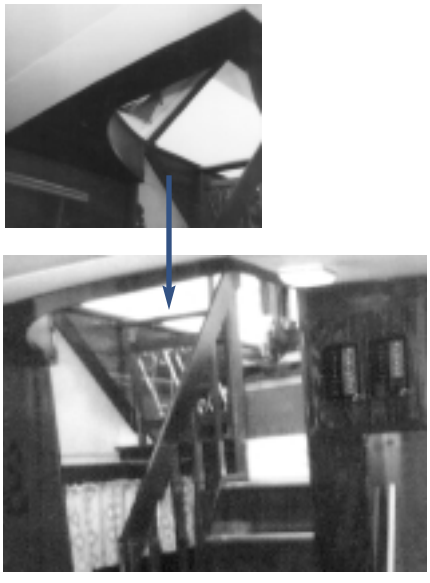
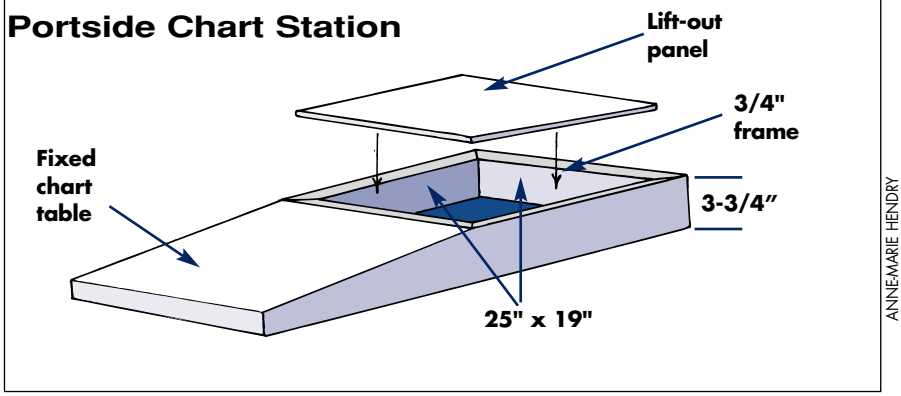
Original companionway.

Dash and entranceway finished with Naugahyde and arborite, handrail and custom filler piece added.



View from below with newly installed electrical cabinet , breaker panels and wiring chute. (top) Headliner constructed of fir plywood, stained and varnished, completes entranceway.

Figure 4



cle, starting at the original hatch opening towards the starboard side of the hardtop, then straight down to the floor and across to the existing floor well. This meant cutting into the closet area of the aft cabin and the bulkhead adjoining the helm. The floor well provided a straight-edge reference point to square the entranceway. Stairs were then fitted and bolted in place from behind the mirror (first removed) in the aft cabin. Finishing included attaching mahogany moldings, railing and a wrought iron filler piece. For added strength and support, two layers of 19mm (3/4") fir plywood laminated together then covered with arborite and Naugahyde to match the helm station formed the new dash over the entranceway.

Cabin Modifications

Down below against the bulkhead and under the helm we constructed a new 89cm by 43cm by 22.8cm (35" by 17" by 9") cabinet with a 21.5cm (8-1/2") square chute with two vertical baffles to conceal wiring. Two 12-volt breaker panels mounted neatly onto the left door. These panels run all house loads, bilge pumps and fume detector. Batteries were relocated under the chute and cables routed up to two battery switches located inside the cabinet. Compared to the original wiring nightmare that once occupied this space, there is now very little wiring.

THINGS TO CONSIDER

Before contemplating extensive renovations, ask yourself these questions: How long do you intend to keep the boat? Is the boat solidly built? Is it seaworthy? After spending lots of money, will you regret it later on? Changes may result in a custom-looking boat that no longer resembles other sister boats. And customizing doesn't guarantee you'll recover your money when you decide to sell. If renovations are poorly done, you may very well devalue the boat.

Should you decide to proceed, first plan your design on paper, then make cardboard, paper or plywood patterns. It's worth the time and effort (cost savings too!) to shop around for quotes and options. Major refits are easier on the budget if you're handy with tools and have spare time: one quote for our custom hardtop made of fiberglass (not strong enough to walk on) without side curtains, totaled $18,500, including a windshield raising kit and installation, compared to our do-it-ourselves price of $10,000 and no-charge labor (see "DIY Renovation Bill" on page 32).

— *Ray Larstone*

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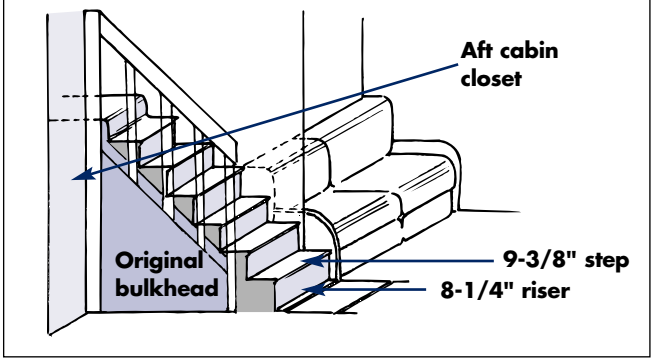
Figure 5

Details of Entranceway and Stairs



ANNE-MARIE HENDRY

Just prior to launching for the 1996 season, we relocated to the portside a full-size refrigerator (replacing the original under-counter fridge) and microwave. (Original mounting on the starboard side of a smaller fridge, microwave, gen-set and stove gave the boat a noticeable list. The boat now floats level after altering the weight distribution.) This meant resizing countertop and cupboards. After removing the old under-counter fridge on the starboard side, we covered the hole temporarily with 8mm (5/16") cedar. "Winrush" was now ready for another summer of cruising.

The following year, nothing much more was done to the boat, except having new curtains made for the enclosure and some maintenance that had taken a back seat during renovations.

Next season, we installed a new AC panel on the starboard side where the old DC/AC panels and storage area were located. This resulted in a new storage area with two shelves, an open illuminated top shelf, and AC panel on a flip open door for easy access to wiring.

Removing the original counter fridge left a large storage area against the hull — a perfect place for the shorepower cable. Our 30A cable now enters on the starboard side through a deck plate and is stored in a locker. All doors including the original galley cabinet

(right) Electrical cabinet and 12-volt breaker panels for house loads. (top) Wiring and dual battery switches inside cabinet.

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doors were changed to pine louvered doors, stained pecan and varnished. On the portside, adjoining the new fridge, we added a cabinet with two shelves and louvered door to stow canned goods.

Prior to the renovations, we had developed two separate water systems: one system draws directly from the lake and feeds the hot water tank, shower and galley and bathroom sinks; the other system draws from the

Before: Original storage area after removing under-counter fridge.

After: New custom cupboards on starboard side with new AC panel housed in left locker.
(right) AC Panel drops down for easy wiring access.

DIY RENOVATION BILL

There would have been significant savings had we not rebuilt the engines and transmissions, but at what future expense? Our original plan to install removable canvas on the sides and stern, rather than a "hard" enclosure, also added considerable expense. By redoing the wiring without rebuilding the helm station and opening the cabin to the upper deck enclosure, we also added to the price. It's best to purchase quality products. To skimp by saving a few dollars on inferior items may cause you more grief later on.

Rebuilding engines and transmissions	**$6,700**
Hardtop enclosure: custom fabricated aluminum top and sides; window glass and stainless-steel tracks; mahogany, cedar and plywood; vinyl automotive fabric; stainless-steel and brass screws; paint; sealant; miscellaneous hardware; custom aft ladder.	**$10,000**
Custom helm, Console, Entranceway, Rewiring and Electrical cabinet: mahogany, pine and fir plywood; cabinet doors; arborite; Naugahyde; paint, stain, varnish; stainless-steel and brass screws; rotary helm and 63.5cm (25') cable; 4 Morse control cables; 2 ignition switches; 4 12-volt breaker panels; miscellaneous hardware; miscellaneous wire, terminals, cables, etc; professional wiring installation, labor only.	**$3,500**
Enclosure Custom Curtains	**$500**
AC Power System and Water System: new AC panel; miscellaneous cabinet hardware; stain and varnish; wire, terminals, etc.; single lever faucet; water pump; hose, clamps and fittings; 57L (15gal) polyethylene tank.	**$800**
Galley and Storage Cabinets: 19mm (3/4") plywood shelves; mahogany and pine trim; 8mm (5/16") cedar sheathing; teak louvered doors; pine louvered doors; miscellaneous cabinet hardware; paint and varnish; used 100-volt full-size refrigerator.	**$590**
Total	**$22,090**

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Before: Original storage area with sliding doors.

Walk-through cupboards and coffee station (right).

water tank and connects to a single tap near the galley sink. A shut-off valve operates both systems from a shore water system. Since the original water tank was much too big and its integrity in question, we installed a smaller plastic 12.5L (15gal) tank forward in the bilge with water inlet and hose relocated on the port side deck near the shore water inlet and routed behind the canned goods cabinet.

Alterations

After some use, renovations often require modifications. In 1999 we rebuilt the entranceway steps to facilitate access to the starboard engine. New burgundy carpeting was cut to fit and placed down (all one piece) but not stapled. Though we prefer the look of varnished wood, the upkeep can be overwhelming. So this spring we painted white the lower panels of the enclosure below the windows, and the door and side upper outer panels the same russet red color as the hull stripping.

It took us seven years, but we now have a boat with systems that we know thoroughly from top to bottom, and have all the confidence that it will give us good, if not great service, until we no longer desire to go cruising. ⚓

About the authors: Ray Larstone, a retired marine surveyor and former autobody shop foreman, and first mate Patricia Stephenson, previously owned a '77 Chris-Craft Catalina before purchasing "Winrush."

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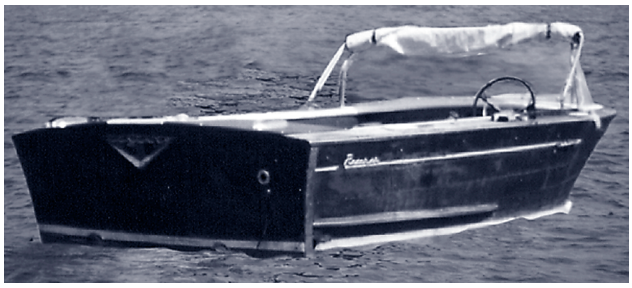
SUIT OF GLASS FOR A CLASSIC WOODY

Sheathing a planked wooden hull in fiberglass and epoxy resin minimizes maintenance and prolongs the life of a dry-stored boat. Here's all the information you need from preparing the wood to applying the final coats whether you are doing the work yourself or hiring a professional.



Story and photos by Jim Shotwell

Shop restoration jobs last winter included a 5.1m (17') Century Resorter, a classic mahogany speedboat, built in 1963 by the Century Boat Co., Manistee, Mich., of batten seam construction with mahogany planking on sawn frames. The owners intended to use the boat on an inland lake and there would be long stretches of a month or more when the boat would be stored on a covered lift out of the water. My concern was the wet-dry cycling the boat would receive. Planked wooden boats need water to prevent planks from excessive drying and separating that cause leaks and deterioration. The best solution was to encapsulate the hull bottom in epoxy resin and fiberglass.

There are different methods used to apply fiberglass to a planked wooden hull but the desired outcome is much the same; namely to ensure the waterproof integrity of the hull. The first step is to laminate 5mm, 5-ply marine-grade Okoume plywood to the bottom from the center of the boot top down to the keel. This creates a near seamless structural base to apply epoxy-saturated fiberglass cloth followed by several coats of epoxy resin. When completed, the boot top stripe conceals the transition from plywood to the mahogany-planked topsides. As always, I tracked the time and cost from start to finish. Here's how it's done.

PREPARE THE HULL

The hull must be dry before coating. Fortunately, this boat was stored inside for an extended time. If wet, there are several ways to quick-dry a hull. One method is to enclose the boat in a tent and apply heat and/or fans. [Ed: Refer to DIY 1995-#3 for additional hull drying methods.]

To assure adhesion of the initial coat of epoxy the bottom needs to be "wooded." This involves removing all coatings down to bare wood either by scraping and sanding, or with a chemical paint stripper. Repair or replace any damaged planking and replace any missing plugs (bungs). Follow with a thorough sanding with a random orbit sander and 80-grit paper. This roughens the surface for a good bond without the need to sand any finer.

Mask the hull at the boot top and cover the topsides with plastic. We use 3M Scotch 233+ masking tape (green tape) because it performs well with most coatings and in all types of weather.

To assure a fail-safe bond between the hull planking and the plywood overlay, we sealed the bottom with epoxy resin mixed with slow hardener. This primer coat prevents the mahogany planking from drawing the resin from subsequent coats of thickened epoxy and creating a resin-starved laminate.

Mix resin and hardener and apply the prime coat with a roller then tip off with a disposable foam or bristle brush. Start by mixing small batches until you become familiar with the resin's working time and pot life, and your application abilities.

Install The Ply Overlay

Unlike boats constructed of plywood using either traditional or stitch-and-glue techniques, planked boats are designed and built with little regard for embellishing the hull. This means simply that a plywood panel does not easily bend to the Century's design hull shape.

We cut then dry fitted the 5mm plywood, laying four separate panels per side on the bottom, two on each side from the chine to the boot top and one on the transom. The

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After removing all bottom paint, replace or repair any damage to the original planking, then sand with 80-grit paper in preparation for the first coat of epoxy resin.

upper edges of the side and transom panels are beveled 8:1 to hide the transition between plywood and mahogany planking. [Ed: Refer to DIY 1999-#4 for plywood beveling techniques.] All holes for thru-hulls, rudder, propeller shaft strut, shaft log and bolts are drilled oversize to enable them to be "potted" after installation. The technique of potting holes in plywood prevents water from entering the plies if the finished coatings are compromised. This is done by drilling holes oversize, filling with epoxy thickened with 50% wood filler and 50% cabosil, then redrilling the holes to accommodate the thru-hull fittings.

Plywood is held tight to the planks with stainless-steel staples placed 10cm (4") on center. Some areas with extreme twist require additional temporary fasteners. We used #6, 12mm (1/2") pan-head screws where needed. Predrill plywood for these temporary fasteners to save time during the final installation and drill 3mm (1/8") "vent" holes between each to allow excess resin and air to escape. Careful prep work makes the actual permanent installation quite straightforward.

Coat the underside of the plywood panels (the side

Boatbuilding apprentice Dale Phares tips off the unthickened epoxy resin prime coat with a foam brush.

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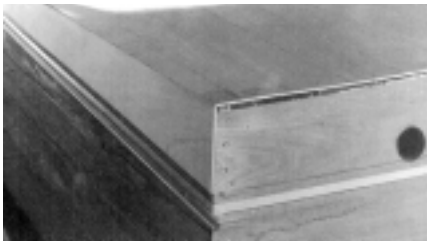
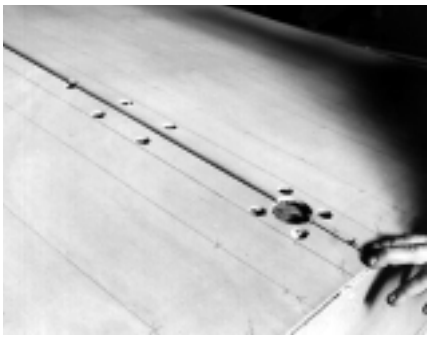
SAFETY FIRST ALWAYS

- ✓ Always read all product labels before opening.
- ✓ Always wear safety glasses, disposable gloves and protective clothing.
- ✓ Always have good ventilation.
- ✓ Always use a respirator with an organic vapor cartridge when sanding epoxy.
- ✓ Always clean spills on the skin [or clothing] with white vinegar, then soap and water.
- ✓ Always wash thoroughly after working with epoxy, especially before eating or smoking.
- ✓ Always call a physician in case of ingestion.

against the hull) with unthickened resin and slow hardener. Now apply catalyzed epoxy resin thickened with a 50-50 mix of wood filler and cabosil mixed to a ketchup consistency to the mahogany planks where they contact the plywood. Spread the thickened mixture with a notched trowel. Set the panel in place, match the alignment marks and fasten. Continue in the same manner until



Plywood is dry fitted and marked for realignment during permanent installation.



All holes in the plywood are drilled oversize for "potting."

all bottom panels are in place.

Remove excess glue, dress the chine edges with a block plane and continue in the same manner with side and transom panels.

Preparations for Laminating

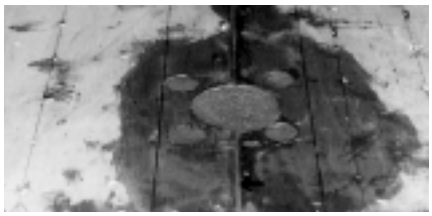
After the epoxy has cured remove temporary fasteners and fill all holes and staple dimples with the same 50/50 thickened epoxy mixture. Allow this to cure, roll the chine and transom bottom edges — fiberglass cloth will not lie over a sharp edge — with a wood rasp or router, and sand all with 80-grit paper.

Applying the Cloth and Tape

Plywood seams receive a layer of fiberglass tape to add extra protection to these areas. Cut the tape to size first and stack it in an orderly fashion. Coat the areas to be taped with epoxy resin mixed with slow hardener, set the tape in the resin, wet it out and use a fiberglass laminating roller to remove any air bubbles. As soon as the tape reaches a B-stage cure apply another coat of resin-hardener mixture to fill the weave of the tape.

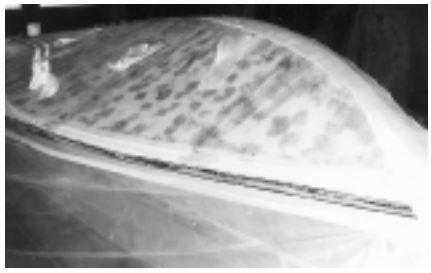
Sand the tape with 80-grit paper, feathering the edges, then remove dust with a vacuum. Apply an unthickened coat of resin-slow hardener mix with a roller and tip off with a brush until there is no danger of runs or sags (resin begins to set).

Plywood mating surfaces are coated with resin to prevent drawing resin from the thickened mixture and forming a resin-starved joint.



Holes are potted by filling with epoxy thickened with a 50-50 mix of wood filler and cabosil.

Filling all vent holes and staple dimples.



Add a layer of fiberglass tape to seams for extra protection to these critical areas.

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Final Coats

After epoxy has cured overnight, but not more than 30 hours, we applied the final layer of fiberglass cloth using the dry method. To do this, lay the cloth on the hull 96cm (38"-) wide material covers the keel to the boot top), trim as needed, and brush smooth with a clean shop brush or clean rag. Pour a small amount of catalyzed resin in the center of the cloth. Spread the resin with a plastic squeegee, working forward then aft from the center. Start with small batches and increase

TIPS — EPOXY USE TIPS

- ✓ *Remove masking tape when epoxy is in the B-stage cure — the intermediate stage of curing, not yet fully cured but yields to pressure when touched lightly. Don't wait until fully cured.*
- ✓ *Use a slow-cure hardener. It substantially increases working time and pot life making application less stressful.*
- ✓ *When coating with epoxy resin nurse it until it goes to the B-stage cure. This prevents the time-consuming job of sanding to remove runs and sags that may appear after initial application.*
- ✓ *When applying resin with a disposable bristle brush, make it stiffer by cutting the bristles back with scissors.*
- ✓ *Clean up as you go. Removing uncured epoxy is much simpler than sanding after it's fully cured. Use white vinegar or denatured alcohol, it's much healthier than acetone.*
- ✓ *Many people have developed a reaction to latex gloves. This includes me, so I use latex-free and powder-free gloves.*
- ✓ *Resin-starved spots in fiberglass tape or cloth appear white rather than translucent.*
- ✓ *Allow fiberglass tape to fully cure then sand the edges to feather them to the hull.*
- ✓ *Cured epoxy often leaves sharp spikes, especially along cloth edges, that can scrape skin. A high quality pair of leather work gloves protects hands when sanding.*

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PROJECT BOAT

Saturate the cloth by squeeging from the center in both directions.

the amount as you become experienced. When one side is satisfactory do the same on the other. Continue checking the laminate as it begins to cure, carefully tipping off with a brush as needed to eliminate runs and sags. As soon as the laminate will support it (B-stage cure) apply the next coat to fill the weave. Three coats applied "green on green" should suffice; apply additional coats as needed to produce a smooth surface. [Ed: My preference is to apply three coats, then let resin fully cure, sand with 120-grit to remove any surface imperfections (dust, dirt, etc.), then apply two finish coats.]

The author sands tape edges in preparation for the final fiberglass cloth laminate. Note the respirator and

About the author: Jim Shotwell builds, repairs, restores, buys and sells wood, classic and antique boats at his shops in Pennsylvania and Maryland. He teaches boatbuilding courses and writes about hands-on boatbuilding, restoration and repair.

DIY REPAIR BILL

TIME

My boat shop is heated so no time was lost to the weather. If these conditions are not available it could affect the time and cost to complete a similar job. Here's a breakdown of the tasks and hours to complete.

Scrape and sand bottom wood to bare	27.75
Repair damage to the planking	31
Cut and fit plywood panels	27.5
Resin coat, install panels, fiberglass tape and cloth	81
TOTAL HOURS	167.25

COST

Cost for supplies varies with your choice of materials (I use MAS epoxy resin, hardeners and fillers) and location. These costs are in U.S. funds, less sales tax, and based on my shop prices.

5mm, 5-ply Okoume marine plywood	$179
Fasteners	$35
Fiberglass tape and cloth	$124
Epoxy resin, hardener and fillers	$285
Sandpaper	$28
Roller covers and brushes	$24
Masking Tape	$10
TOTAL COST	$685

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A new bottom for the old Gal. She's now ready for bottom paint.

WHEN YOU NEED TO REMOVE...

When removing bottom paint or fiberglass for osmosis repairs, an alternative to sand or baking-soda blasting, grinding, disc sanding or chemical paint removers is to have the surface peeled. This method involves removing a controlled amount of material using a tool that resembles a hand-held power planer. In one pass, the "peeler" cuts a 10cm- (4"-) wide slice of a predetermined thickness. It can remove bottom paints, topside paints, varnish, epoxy and fiberglass laminates.

I watched as Claire Dumouchelle of Clare's Mobile Marine (519/734-7043 or claresmobile@hotmail.com), removed the outer laminate below the waterline for an osmosis repair on a 5.4m (18') runabout. Two hours later, the job was completed without any mess or dust (all residue is collected in a Shop Vac). The resulting finish was impressive — an even, smooth surface that requires only light sanding and degreasing before recoating or repair. No filling or fairing. Powerboats with strakes take longer and these areas need to be hand finished, while smooth-hulled sailboats are apparently easier and faster.

Except some hand fairing at the strakes, peeler leaves an even, smooth surface, ready for recoating or repair.

Peeling is expensive: price per foot for powerboats up to 9m (30') in length is $25 and $23 for sailboats up to $40 for 50-footers. But when you factor in clean-up time, labor and materials for filling and fairing, it likely saves money and time in the long run.

— Jan Mundy

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Maintenance

TIPS ON TRAILER MAINTENANCE

If you are one of the thousands who trailer your boat, here's all the information you need to maintain and repair the trailer, improve the ride and handling, and find solutions to common servicing problems. Follow this advice from a professional and you won't be left high and dry.

Story and photos by Jan Mundy

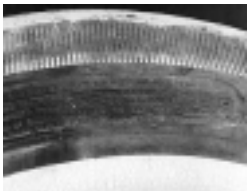
Regardless of the distance you travel towing your boat, just a minute's drive to a ramp nearby or a cross-country trip, if you don't maintain the trailer, inevitably, you'll be beached but hopefully, not stranded on a roadside. Trailer maintenance often is relegated to the bottom of the list or postponed until next season, likely because after servicing your boat and engine you're eager to be afloat.

There is a lot of misinformation on the maintenance of trailers and components. To separate the facts from the fiction, I asked a nearby trailer specialist for advice. Bob English, owner of English's Trailer Sales, sells and services all makes and models of commercial, farm and recreational trailers. His specialty is trailer repair, fixing about 1,000 of them a year. Though not everyone may agree with his opinions, with 12 years experience servicing trailers, he knows what fails and what lasts.

Follow these guidelines to maintain your trailer before things fail.

Tire Fatigue

Tires on boat trailers rarely need replacing due to roadwear. While tire threads may look nearly new the sun's UV rays can dryrot an unprotected tire in eight years or less. Owners of RVs know the importance of covering tires, but boaters don't, probably because marine retailers don't sell tire covers.



How do you know when to replace tires? First, closely inspect your tires. Early stages of dryrot damage are barely visible (top) compared to a severely decayed tire (right) that on a hot summer's day driving at highway speeds would likely blow within minutes of use.

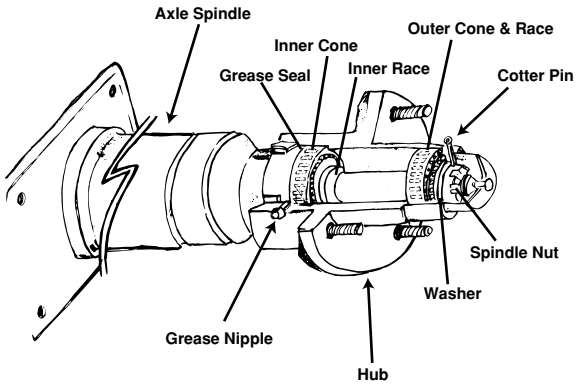
Many new trailers are now standard-equipped with radial tires. Though more expensive than bias-ply tires, they can withstand more heat and support more weight. When upgrading, English always recommends radials and preferably tires specially built for trailers (i.e. Carisle brand).

Check tire pressure when tires are cold since hot tires increase pressure, depending on distance traveled. Traveling 150km (93miles), for example, increases pressure by about 3kg (7lb).

Hub Upkeep

During a long trailering trip, whenever we stop, I make it a habit to feel the wheel hubs, reasoning that a warm hub could spell bearing trouble. Certainly this is good practice notes English but hubs are always warm and when really hot the cause could be an overheated brake drum caused by a sticking brake or something other than bearings. The only sure way to check bearings is to either spin the wheel or holding hands on the rim, twist the tire feeling for any sideways movement. A slight grinding sound or a wheel with play warns of

Components of Wheel Hub and Bearings



ANNEMARIE HENDRY

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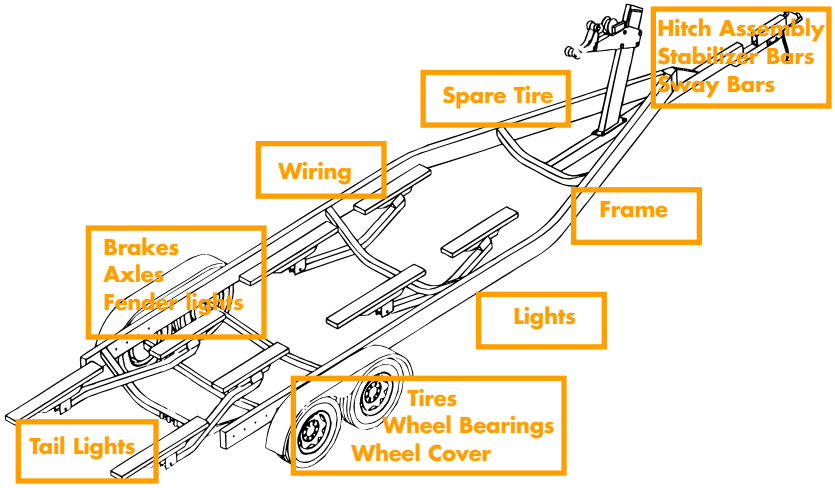


imminent bearing failure. When a bearing fails it seizes, the tire stops turning and, if towed, will blow to pieces.

Lack of lubrication is the primary cause of bearing failure.

Rather than run bearings to failure, English advises to repack bearings once a year, regardless of the distance traveled. When packing bearings, don't just apply grease to the rollers. Rather, place a glob of grease in your hand and keep dipping the bearing into the grease until grease flows out the other side. (Professionals use bearing packers.) Put a little smear of grease on the outside then insert into the cup.

Bearing Protectors Or Not

Bearing protectors are widely used on all sizes of boat trailers. These devices fit tightly over the hubs, replacing the dust caps, and automatically lubricate bearings. When launching and loading, positive grease pressure prevents water from seeping into the hub causing bearings to corrode and fail. An accessible grease fitting allows refilling without disassembly. But often this task is too frequently done as some owners faithfully grease the hubs everytime before launching. Grease builds up and starts to overflow onto electric or surge brakes. Wheels begin to smoke, then brakes may fail.

Some manufacturers now offer protectors with sight glasses, custom grease fittings and other aids to help determine correct grease levels. But for safety reasons, provided you service conventional bearings annually, English prefers non-protected hubs for trailers with brakes.

"Bearing protectors are a good system for small boat trailers with just a hub, but for trailers with brakes, if you overfill with grease, you may lose braking power.

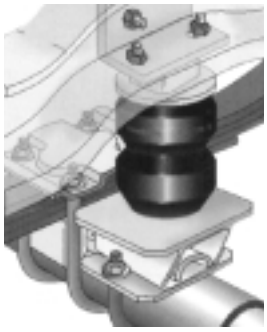
"Additionally, new trailers are equipped with better grease seals where bearings fit over spindles to block water from entering the hub," explains English.

English also recommends using only Kendall or Penzoil grease, mainly because when it gets hot it doesn't melt.

Suspension Booster

For maximum performance and safety, all trailers are designed to be towed level. With trailer hitched to your vehicle, stand back and eyeball the hitch angle. If the trailer sits too high at the front, tongue weight will be too light. This condition transfers weight and extra wear to the back axle, a situation more critical on tandem trailers, and the trailer is apt to sway. Conversely, a too-heavy tongue weight results in the rear of tow vehicle and front of trailer positioned downwards. With heavy loads, this angle is more pronounced. A tow vehicle that rides low enough on the back end to raise the front suspension results in skiddish steering and perhaps front-end sway. Adjusting hitch angles requires either aft or forward shifting of gear in the boat, moving the load in the tow vehicle or repositioning boat on the trailer.

Balancing tongue weight is a simple task with small boats but more complex with larger rigs that often requires add-ons. The best devices to equilize weight when towing heavy boats with a pickup truck are load boosters. Easily mounted between the truck frame and the axle, these solid rubber "bumpers"



TIPS — AFTER LAUNCH, DRY OUT

During long drives wheel hubs heat up and bearing seals expand. While launching causes water to migrate into the hub, parking the trailer allows the hubs to cool down and seals contract to trap water in the bearings which leads to failure. To preserve bearings after launching, don't immediately drive to the parking area. Instead, drive around the block to dry all components in your trailer's braking system.

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10 BEST OPTIONS

There's a lot to consider when buying a trailer. This checklist will help you make the right decisions to match your towing needs. (This assumes you've already sized the boat package to your tow vehicle.) Most of these add to the selling price but cost-cut now and you'll likely have higher repair bills in the future.

- ☑ Choose radial tires rather than-less-expensive bias-ply.
- ☑ If used in saltwater, choose galvanized frame and rims to retard corrosion.
- ☑ Do you need a braking system? If yes, electric or surge? When more than one person will be driving, better to choose surge.
- ☑ Does it have bearing protectors? If yes, is there a way to monitor grease levels?
- ☑ Check frame construction. As tubing comes in much different wall thickness, comparing weights of similar trailers is a good indication of construction quality.
- ☑ Examine overall construction details. If a welded trailer, do the welds form an even, thick bead? Is it wired with moisture-proof terminals? Do the lights meet legal requirements for your locale?
- ☑ Does trailer capacity equal total carrying load plus a 25% safety margin. A trailer one size larger is only approximately an $800 option.
- ☑ Do you need stabilizer or sway bars?
- ☑ Purchase tire covers.
- ☑ Purchase a trailer-mounted spare tire carrier and tire.

— *JM*

support the extra hitch weight. This means the truck remains level, doesn't sway or bottom out on the springs. When unloaded, the rubber bumper doesn't touch the frame so the ride is unaffected. Sold in pairs, prices start at about $199.

Stabilizing the Load

If the trailer starts to sway when towing, reduce speed. If sway is caused by too much tongue weight, then rearrange items carried in the boat to move weight aft or move the boat aft on the trailer. If, however, it's a factor of wanting to drive fast, then you'll need to stabilize the trailer.

Stabilizer bars lift up the rear of the tow vehicle and transfer the weight onto the front tires. Because of this weight shift, English recommends their installation when towing with all large front-wheel drive vehicles. Stabilizer bars also double the capacity of a hitch. Add bars on a hitch rated for 226.8kg (500lb) tongue weight and 2,268kg (5,000lb) pulling capacity, for example, and values increase to 453.6kg (1,000lb) tongue and 4,536kg (10,000lb) towing capacity. Proper setup involves first measuring the distance between top of tire and fender of the tow vehicle, unhitched. Now hitch up and connect the stabilizer bars and lift the rear of the tow vehicle just enough without compromising tongue weight. Ideally, English recommends the measured tire-fender distance after attaching bars to be about 5cm (2") less.

Gain Control

When traveling at highway speeds, if you encounter trailer sway when passed by transport trucks or large charter buses, or when you hit rough pavement, reduce speed. If handling becomes a safety concern, consider adding a sway bar. Usually one bar is sufficient, though you can add two, to eliminate most trailer sway. Be sure to remove or unlock bar when making sharp turns, like pulling into a driveway, or you'll damage the braking mechanism inside the bar.

Braking Power

Some areas require all trailers carrying more than 1,380kg (3,000lb) total load or gross vehicle weight (GVW) — weight of boat, engine, fuel, gear plus 25% safety factor — and as little as 453.6kg (1,000lb.) loads in some areas, to be equipped with brakes, either electric or surge.

For driving and towing ease, the most popular choice for boat trailers is surge brakes. These are foolproof, require no driver adjustment and automatically set braking power. But this also limits driver control — the only way to get more braking power is to stop sooner. Surge brakes work on pressure. A ball coupler slides back and forth in the housing and applying tow vehicle brakes pushes on a pin that goes into a master cylinder mounted on the trailer frame, activating trailer brakes. The quicker you try to stop, the more force is applied. Since backing up automatically puts pressure on the trailer brakes, units have on the hitch either a lock-out slide (pictured above) or require inserting a 12mm (1/2") pin (not included with the brake unit). You'll find information on brake disengaging in the hitch operating instructions; another reason to read your owner's manual. Newer surge braking systems are free-backing and don't require inserting a pin or moving a lever when backing up.

Electric brakes are preferred

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Maintenance

when towing large loads. A cab-mounted controller allows precise adjustment for driver handling and road conditions. Though setup is more complicated than with surge units, electric brakes when properly adjusted offer the utmost control and braking power.

Braking systems are not service-free and require routine servicing. Inspect surge brakes when repacking wheel bearings, periodically clean brake components, lubricate sliding parts and adjust as needed to ensure maximum braking power. Electric brakes are more complicated, yet easily serviced by a skilled do-it-yourselfer. In some areas, however, this work can legally only be performed by a licensed brake technician. Personally, there are certain systems that for safety reasons, are better off left to the experts and I consider

Make sure total load weight doesn't exceed trailer capacity or you'll overload the axles.

(top) Did you know you need to release this surge brake unit by inserting a 12mm (1/2") pin (left) when backing up?

brakes one of them.

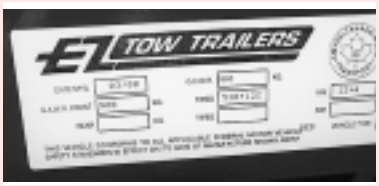
Electrical Components

Most problems with trailer lights and wiring are a result of poor installation. Carefully inspect wiring terminals and replace all butt connectors and any corroded ones with marine-rated terminals, preferably heat-shrink, or moisture-proof connections with heat-shrink tubing. Use plastic holders to support wiring as needed so it doesn't droop and replace all steel holders before they corrode.

Make sure all lights work and meet the legal requirements for your area. Trailers more than 2m (80") total outside width (fender to fender) must have a minimum of five lights, including the tail-signal lights, across the back. Some states and provinces also now require single amber lights, usually mounted on fenders, to mark trailer's widest point. Even if this isn't mandated, English recommends refitting such lights to outside corners of fenders, especially when towing wide trailers with narrow vehicles. "It's comforting to see your trailer's outside corners in the sideview mirrors when passing or being passed."

DETERMINING TRAILER CAPACITY

Trailer manufacturers are legally required to mount a capacity plate, usually on the frame, that displays serial number, tire data, date manufactured plus the maximum gross weight per axle. Pictured in this photo is a capacity plate for a single-axle trailer. The maximum gross axle weight rating (GAWR) is 408kg (900lb). Plates on tandem trailers display GAWR for both front and rear axles. If this example was a tandem, both the GAWR Front and GAWR Rear would show 408kg (900lb) for a combined GAWR of 816kg (1,800lb), or the maximum total load the trailer is designed to carry.



Total load is referred to as the gross vehicle weight rating (GVWR). This translates to the total weight of the boat, motor, tankage contents, gear and everything sitting on the trailer (i.e. spare tire). Trailer specialist Bob English recommends after estimating the GVWR to add a 25% safety margin. A 2,268kg (5,000lb) GVWR, for example, requires a trailer with the equivalent total GAWR as minimum, but a better choice is a 3,175kg (7,000lb), or one axle size larger. The cost difference is only about $800 more; the safety value is the price of your boat.

— JM

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Projects

EASY-TO-MAKE PLEXIGLAS HOLDERS

By Dennis Angle

Plastic materials make very attractive shelves, equipment holders, racks, tables, instrument panels, tank inspection hatches, portlights, companionway doors, even cockpit storage boxes. Acrylic, Lexan, Plexiglas and polycarbonate are some names of "plastic" materials available. (Lexan, a bulletproof polycarbonate, is normally reserved for portlights and other structural applications.)

Holders made of scrap Plexiglas are economical and simple to make.

Plastics can be expensive, especially in larger thicknesses. When you only need a couple of feet, one alternative is to locate some scrap material. A good source of Plexiglas is the local hockey arena. The white plastic covering on the boards is about 6mm (1/8") thick and very easy to remove. The plastic itself is about 11mm (7/16") thick and frequently broken into pieces during the games. Each piece might be (4 to 10 sq. ft.) in size. Most of the black puck marks can be removed with a glass cleaner and some hard rubbing. It isn't as clean and shiny as new, but the price is certainly attractive, and if painted will look flawless.

New Plexiglas comes with sides covered with a protective adhesive paper film. Leave this on until you finish cutting. Then use the blowtorch to bend the piece or clean up the edges.

You can mimic this on scrap material by putting masking tape over the cutting lines. It will minimize any scratches from the jigsaw or table saw. It also makes it easy to draw lines on the tape to mark where cuts and holes are positioned.

Plastics are easily cut with any type of hand or power saw. Small pieces of plastic up to 4.7mm (3/16") thick can be cut with a knife or awl. Score the plastic, running the knife seven or more times against a straight edge. Clamp the plastic with the scored line hanging just over a table edge and apply a sharp downward pressure to break the plastic. Use a plywood-cutting blade (14 teeth per inch) and a sharp one — a dull one creates heat which can fuse the plastic to it. Using a variable speed saw run at a slow setting gives a clean edge and prevents melting of the plastic. For circular saws, use a metal cutting blade with at least 6 teeth per inch. Practice on waste material before making critical cuts.

Plexiglas is simple to bend to create a wide variety of holders for a handheld radio, foghorn, flashlight or knife, flare gun and other items seldom used but essential to know

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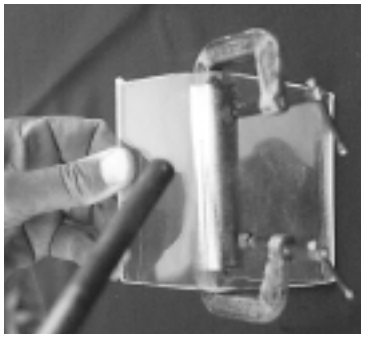

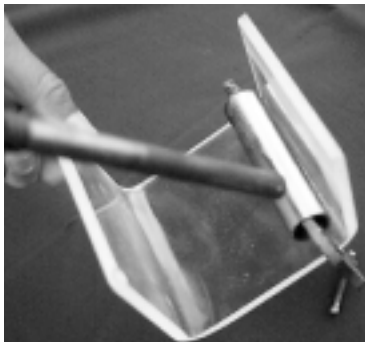

To bend plastic, heat gently with a propane torch and bend it around a pipe held in place with C-clamps to get an even, round curve.

where they are when the need arises.

Bending Plexiglas with a propane torch is easy but requires patience. If the material starts to bubble or flame then you are applying too much heat. Heat both sides gently, waving the torch over the part you want to bend. Try to bend the Plexiglas as you are heating it. Getting a straight bend is tricky — best to hold one edge in a vice. A better method is to bend it around a pipe held in place with C-clamps to get an even, round curve. Wear gloves, safety glasses and keep a fire extinguisher handy just in case. Once bent, let the plastic cool naturally. Heat, gently applied, also melts scratches on Plexiglas so they aren't as noticeable.

To make a radio holder, make a cardboard template including the cutout for the radio. Trace the outline of the template onto the paper-covered Plexiglas (or onto masking tape). Drill a starter hole for the jigsaw blade and cut the radio hole, then cut out the holder. TIP: the thicker the plastic, the slower the feed. Remove the paper backing (or tape), then bend the two corners using a pipe as described above. Sand the outside edges and carefully melt the plastic with the torch to remove scratches. Firmly clamp the holder and drill slightly oversize holes for the mounting screws. Drill slowly without applying too much pressure on the drill to prevent the plastic from cracking; a drill press works best. Install with pan head screws but don't overtighten or the plastic will crack. [Ed: Some users prefer machine screws, drilling a pilot hole 1/32" smaller than the screw size, then drill and tap the hole.] For an attractive maintenance-free finish, paint the holder with primer followed with two coats of polyurethane paint.

About the author: Dennis Angle is a computer science professor at Mohawk College, Ont., and sails his CS30 on Lake Ontario.

ADJUSTABLE CAMERA MOUNT

By Robert Hess

Although all the fixed and video cameras made now are built using metric threads, the tripod mount on the bottom of cameras is still a 1/4" NC (American coarse) thread. By mounting a stainless-steel clamp — the same as an exhaust pipe muffler clamp — with a 1/4" NC thread on a bow or stern rail, and cutting off one of the threaded pieces sticking out past a nut, you can use the thread sticking out past the other nut to mount a video camera on the camera tripod mount. If you don't tighten the clamp too much you can move it around to aim the camera.

About the author: Robert Hess specializes in marine engine repairs and his articles appear frequently in DIY.

PROWLER-PROOF YOUR BOAT

By Cheri Southward

Motion sensor alarm

When onboard and fast asleep, you're extremely vulnerable to the possibility of callers coming aboard undetected until you awake, which may be too late.

An inexpensive, portable motion sensor alarm from Radio Shack (part number 49-425) announces intruders with a 90dB alarm. Compact in size, it measures 11.4cm by 3.8cm by 7.6cm (4-1/2" by 1-1/2" by 3"), up to 9.1m (30') range and 60° detection angle. We have used this device on two different boats, mounting it once on the companionway hatch, the other on a small block of wood to mount where needed. You can switch this device to chime mode, a feature that is useful so as not to alarm invited guests. Operated by a 9-volt alkaline battery, which seems to last a long time, it costs US$24.99, making it both affordable and practical.

About the author: Cheri Southward and partner live aboard "Jazz," a CSY 37 currently cruising Florida.

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KEROSENE-TO-PROPANE HEATER CONVERSION

Dr. Alan Porter

We cruise in Victoria, B.C., where the climate allows us to boat year-round, even in the winter provided you have a capable cabin heater.

Our '76 vintage sailboat came equipped with a pressure kerosene Force 10 heater bolted to the forward cabin bulkhead. The fuel pressure tank, located in a cockpit locker, required frequent hand pumping. The heater itself demanded preheating with alcohol before it would first light, throwing out black smoke and a bad smell. It had to go.

Being a cheapskate, I didn't want to spend the $400 for a new propane heater, so I looked for a simple and inexpensive way to convert my existing heater to burn propane gas.

I found a simple one-burner camping stove in a department store. The burner unit looked very much like the kerosene burner it would replace, so I purchased it for the grand sum of $20. The base and the pan holder were no use to me so I threw them away. At first I thought about running a pipe from the main propane tanks in the cockpit, but this would involve the purchasing of pipe, fittings, adapters, etc, plus all the extra work of installing them. Instead, I simply connected the disposable 16-ounce bottles that are commonly used with propane torches. This arrangement

Before

After

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produces 7,500 BTUs of heat, quite enough for the average small boat cabin.

Safety precautions necessary with this type of heating include a propane detector, carbon monoxide detector and a flue vented to the outside, all of which my boat already had. [Ed: A review of CO detectors is scheduled for DIY 2001-#1 issue]. In addition, adequate ventilation should be provided and the unit should never be left burning unattended.

About the author: A staunch do-it-yourselfer, Dr. Alan Porter and his wife Carol sail "S.V. Te Tiaroa" in the cooler Pacific waters.

SIMPLE DEVICE FOR 9-VOLT POWER

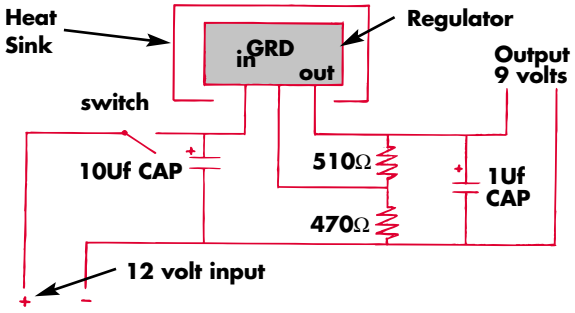
By Donald L. Boone

So want to listen to music onboard on the portable radio but the batteries are dead. Well if you had a voltage reducing circuit this wouldn't be a problem. This device cuts the boat's 12-volt power supply down to 9 volts, this being the popular voltage used in many portable radios, cassette and CD players, fish finders or other electronics that operate on disposable batteries. I've put these inside radios and electronic keyboards. I've also placed them behind my master fuse and switch panel with a connector mounted through the panel surface to be used with different apparatus as needed. Building a voltage reducer is easily done, requires little skill, and costs are minimal. Here's how to build one.

For tools you'll need a small soldering iron, solder, needle-nose pliers, wire cutters, perhaps a small hand drill, some patience and the parts listed below.

You'll also need a small screw with a nut to fasten the regulator and heat sink to the PC board. Then with your

Schematic of Voltage Reducer



ANNE-MARIE HENDRY

long nose pliers bend the parts so they go through the holes in the circuit board, but don't bend them up to the component body which can potentially damage the electronic part. Allow some distance, perhaps 6mm (1/4") or so between the part and the bend. Be sure that the connector leads from the regulator and doesn't touch the metal of the heat sink.

With the component ends sticking out the other side of the circuit board, solder them together as indicated in the circuit diagram. Some cases may require adding a section of 24 AWG wire to fasten components together. This condition would depend on how close you placed them on the circuit board. If one piece of wire passes over another wire, use insulated wire or attach plastic sleeving. The 12-volt side of this circuit connects to the boat's 12-volt power supply. The 9-volt leads connect to the positive and nega-

Parts along with part numbers (PN) and U.S. prices from Radio Shack's 2000 Catalog are as follows:

•Heat sink PN 276-1363	$.99
•Voltage regulator PN RSU 10911048	$1.49
•PC board, PN 276-158 (board size varies depending on your ability and experience)	$2.39
•Resistors 510 Ohm, PN RSU 11344793, pack of five	$ .49
•Resistors 470 Ohm, PN 271-1317, pack of five	$ .49
•Capacitors 1 Uf, PN RSU 11930443	$ .49
•Capacitors 10 Uf, PN RSU 11938982	$ .49
•Pre-tinned 24 AWG (marine grade)	$1.79
•Connectors, marine grade, as needed (To connect to power sources, I used PN 270-025, but type depends upon location of the circuit board when assembly finished.)	$2.50
•Switch SPST*, PN 275-624 (*single-pole, single-throw switch to turn incoming power on or off as needed)	$2.79
Total parts	**$13.91**

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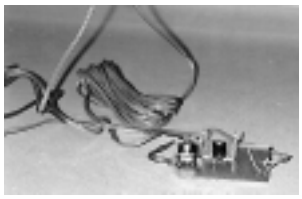
tive side of the battery pack connectors inside the electronic item.

The circuit shown can be mounted onto your switch panel with a DC outlet plug available to run power through a cable to your choice of electronic items. It can also be mounted inside some larger items like an electronic piano keyboard that has room to accommodate the switch. The circuit board can also be placed inside a plastic box with power leads going to a switch panel, and to the electronics item of choice. Finally, you can eliminate the switch on the circuit board and just use the smaller circuit. This allows a wider range of items, and possible mounting of the circuit inside the case.



It takes only a couple of hours and a few parts available from an electronics supplier costing $14 or less to make a voltage reducer.

About the author: A writer, author and avid cruiser, Don Boone has written two boat-related books, "Engine Medicine" and "Simple Boat Projects." He and his wife Lyn live aboard their sailboat, spending winters in Puget Sound and summers in the Gulf Islands of British Columbia.

BARGAIN-PRICED HELM SEAT

By George Van Nostrand

When we bought our 10m (34') Tollycraft aft-cabin cruiser, it had a flybridge with wheel, controls and a comfortable seat. It also boasted a complete lower helm but no helm seat.

In preparation for living aboard, I decided the much-needed seat should slide, as it must also double as additional guest seating. Fortunately there was enough clearance under the floor where the hole would be cut for the support post hole. This finished post measures 43cm (17") from the top

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of the post to the floor in the down position, and 74cm (29-1/2") in the up position. Be sure to calculate the height of the seat slide and the seat itself to decide on a workable height in high and low positions.

I purchased a used seat and a Dutch-made Zwaard-vis adjustable extension table post (US$75). From a 9cm (3.5") length cut from a piece of 2-7/8"OD aluminum tubing purchased at a scrap metal yard, make an adapter to fit the top of it to accommodate the standard seat slide unit. If the inside diameter of the tube is slightly too large to fit the post, insert metal shims and center it in place. Seal the lower end with putty, then mix up some thickened epoxy resin and pour it into the space between the post and adapter. Let cure overnight. Total cost with a used seat was US$100, more if you're purchasing a new seat.

About the author: George van Nostrand and wife Sheilah recently returned from a year-long cruise in "Dream Weaver," embarking from Lake Ontario, down the Intercoastal Waterway to Florida and return.

COOL TIPS FOR CHILLING REEFERS

By Harvey Berman

The easiest way to control air temperatures in your boat's refrigerator is to add dividers, especially in the freezer section, then install a fan to circulate the air and make a cover to keep out the hot air. This keeps the coldest part of the fridge at a practical temperature, while the rest of the box gets the cold air required to keep other foods chilled.

Purchase some light-duty plastic, such as the type used for picture framing glaze. This is about 3mm (1/8") thick and easily scored with a utility knife. Bend the plastic backwards until it snaps, leaving a clean, workable straight edge for gluing. Now assemble the divider to fit the freezer section. Don't make your divider too high since you want the cold air to spill over to cold-air feed the fridge bottom. Use a 5-minute epoxy or Crazy Glue to cement the divider together. To reinforce the joints, I glued old inexpensive clear disposable pens into each corner. After testing the box temperature, it may be necessary to drill some large holes in the divider to allow more cold air to spill into the fridge section. Since materials are cheap, you may discover a better way to construct the divider, so don't be too concerned about discarding your first one and building a new one.

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Easily assembled, low-cost materials for improving refrigerator cooling efficiency.

An important addition to all refrigerators is a cube fan. This 7.6cm by 10.1cm (3" by 4") device operates for up to 30 days on two D-size alkaline batteries. It distributes a more even temperature throughout the box, preventing milk and other liquids from freezing. The result is a more efficient fridge and easily regulated thermostat. Originally designed to circulate air in ice boxes, cube fans are available from many marine and outdoor stores.

For boats with top-loading units, consider making a "reefer slicker" to block warm outside air from leaking into the fridge through the lid gasket. We made ours of windshield reflective materials, faced with thin foam rubber then covered with white vinyl and sewn around the edges. For front-loading fridges, cut strips of clear flexible vinyl and fasten to the inside door so they hang vertically. It's a similar idea used at factory loading docks, only in miniature, and according to reports from other boaters, works well. [Ed: For more details on how to install and troubleshoot refrigeration systems, see articles in DIY 1996 #1 and 1999-#4.]

About the author: Harvey Berman and his wife are halfway through a two-year voyage to the Caribbean, Mexico, Central America and beyond aboard "Soulstice."

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Good Boatkeeping

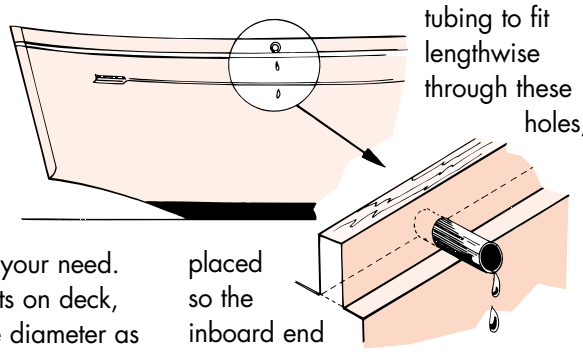
By David and Zora Aiken

LIKE WATER OFF A BOAT'S DECK

Here's a way to add or enlarge deck drains (a.k.a. scuppers) and at the same time prevent the unsightly vertical stripes that appear when dirty or rust-stained water drains down the topsides.

From the plumbing department of the local hardware or building supply store buy some copper tubing or PVC pipe, 12mm (1/2") ID or larger depending on your need.

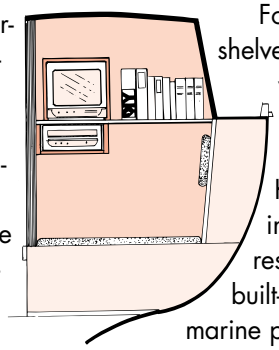
Where water collects on deck, cut some holes the same diameter as the tubing OD through the toerail as close to deck level as possible. Cut holes so that tubing sits at a slight downward angle at the outboard end. Most decks are angled for faster draining of water.



Now cut some short lengths of tubing to fit lengthwise through these holes, placed so the inboard end is flush with the toerail; the outboard end extends beyond the toerail, past the topsides at least 6mm (1/4"). Use caulking (i.e. 3M 4200) to hold tubes in place and seal the hole. Water flowing out the tube falls straight down into the water, not down the topsides.

MEDIA BULKHEAD

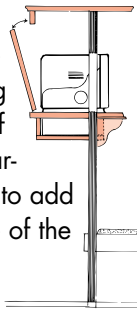
Though the concept of an entertainment center may seem misplaced on some boats, a TV (with or without VCR) is standard equipment on many modern cruisers. The components look less obtrusive and will ride more safely when given a permanent place for viewing and storage.



On our boat, the most convenient area for viewing is the bulkhead that separates main cabin from head compartment. Installing the TV on a permanent shelf in the main cabin was too ugly. After careful planning and cutting, the TV and VCR now fit on shelves that are mounted through the bulkhead — the screen and tape-slot face the cabin's U-shaped seating area, the TV and VCR units are built into a locker in the head.

This is very much a do-it-yourself project, as each installation will have different specifications, but certain general guidelines may prove helpful.

Make a cardboard dummy of the whole arrangement, to be sure you'll be pleased with the way it looks. Allow adequate space for wires, plugs, antenna, charging unit and also cooling space for each unit. For the TV, allow an extra 19mm (3/4") on either side, so the set can be turned a bit for a better viewing angle. Before cutting the hole, be very sure you know where all wiring or plumbing is, or is not. If cutting through a load-bearing bulkhead, you'll need to add a support to replace some of the strength you're removing.



For the shelves, choose a nice hardwood that matches or blends with your boat's interior wood. Keep the overall look in character with the rest of the boat. For the built-in backside, use marine ply, especially when water spray might be a concern (i.e. head shower). Establish a way to hold the TV securely using TV Grips [Ed: See review in DIY 1999-#1], shock cord, fids, whatever, when underway.

About the authors: David and Zora Aiken are the authors of "Good Boatkeeping" and "Good Cruising" published by International Marine.

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