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DIY boat owner
the MARINE MAINTENANCE MAGAZINE

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ANNUAL REFIT

FIBERGLASS Build A Swim Platform

ENGINES Home Balancing of • Marine Propellers • Filter Dirty Water

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ELECTRONICS Install A Closed-Circuit TV System • Automatic Anchor Lights • "Smart" Electrical Installations

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STARBOARD Easy-to-Make Swim Platform • Gluing StarBoard • 8 Things to Make of StarBoard

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CANVAS Sew a Companionway Hatch Cover

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Talkback Q+A

For more information on these or any other topics, go to www.diy-boat.com, at the home page click on "Search" and type in specific keywords (i.e. diesel, epoxy, gelcoat, MerCruiser,outboard, etc.).

Technical Helpline 1(888) 658-BOAT

Plug-in AC Overload

Q: My French-built Lagoon 37 catamaran has a 110-volt, 30-amp shorepower receptacle but a 220-volt breaker on the AC panel, one European-type shorepower plug in the galley and a 220-volt automatic battery charger connected to two battery banks. If I simply replace the 220-volt breaker on the AC panel with a 110-volt breaker, can I plug in 110-volt appliances to the shorepower plug in the galley? Will the water heater run on 110 power? I would also like to install a Heart 2000 inverter. Can I use the existing wiring? How do I connect the 220-volt battery charger so I can charge my batteries at the dock when I'm in the French West Indies, but otherwise have it out of the loop when I'm plugged into 110 power?
George Chester, "Wivus," Fernandina Beach, Fla.

A: It appears that your boat's interior has been wired completely for 220-volt AC. I'm not sure why there is a 110-volt shorepower inlet; there should be a 220-volt inlet somewhere. I don't like the idea of mixed voltages, so I'd choose 110-volt as your AC source. You must rewire the boat for 110-volt AC including all breakers, outlets, polarity indicators, water heater elements, etc. Install the inverter then use your existing 220-volt charger when in European cruising areas. (You'll need a 220-volt shorepower inlet if there isn't one installed already). Simply plug into the 220-volt outlet and let that charge your batteries, then use the inverter to produce the 110 power to run the AC system.
— *Kevin Jeffrey*

Balancing Power and Gravity

Q: I own an Osprey Eagle 5.6m (18') RIB, which I use for diving. The boat takes water over the transom in bad weather when moored and deck space is very limited when the outboards are fully tilted forward. I propose to fabricate another transom and bolt it to the existing transom; engines would mount on the false transom. To stop the ingress of water, I would raise the height of the original transom. If the engines are moved further back will the boat, especially the transom, be able to cope with the strain?
Olly Agbebi, "Jaffa," Muscat, Oman

A: A number of things happen when you move engines further aft, without increasing the length of the bottom of the boat. First, and most important, is the shift in the center of gravity (CG). This causes the boat to float lower at the stern when at rest, which will compound the water-over-the-transom problem. Secondly, it will cause the boat to behave differently when underway. A boat is designed with an optimum trim angle for the speeds it's expected to achieve. This trim angle determines the safety of the vessel when planing. Moving the engines further aft alters the CG and center of buoyancy (CB), and this may lead to uncontrollable porpoising (pitching) or a dangerously low trim angle. As for the strain on the transom, it's my experience with RIBs that they develop cracks in the area where the transom and bottom meet due to flex in the side tubes. If you undertake this modification perhaps you should install some beefy gussets from the top of the transom to the floor of the boat.
— *Wayne Redditt*

Fine Tuning Not Always the Remedy

Q: My 1989 9m (30') Tollycraft sedan sport cruiser, powered with twin 5.7L 260 hp MerCruisers, fails to reach maximum rpm at wide-open throttle (WOT). It develops 3,100 rpm to 3,500 rpm, depending on load, number of passengers and sea conditions. According to the original owner (I purchased it in '97), the boat has run at this rpm since new. Because I wanted to increase fuel economy — 32 gph to 35 gph at 2,000 rpm per my Floscan meters — and I thought the boat would run better, I changed the props from factory original 17x16 to 16x15 Dymalloy props. The rpm increased to 3,700, but there was no noticeable improvement in fuel economy. The engines have been recently tuned, both carbs rebuilt, fuel filters changed at normal intervals and the bottom gets professionally cleaned monthly. Any suggestions?
Mike Morelli, Kailua, Hawaii

A: When repropping a larger boat, it's normal for the rpm to change by approximately 100 to 150 rpm for each inch of pitch, say changing from a 19" pitch to a 17" pitch which raises the rpm by 200 to 300 at WOT. You reduced the props by 1" of pitch and the engine WOT rpm increased corresponding to this formula. Therefore, I would conclude that the boatbuilder did not equip the boat originally with correctly sized propellers. If the boat cannot reach its recommended maximum rpm at WOT, engine damage could occur, such as detonation. Other contributing factors to a low rpm condition could be a hook in the

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boat bottom, incorrect center of gravity, boat balance (i.e. overloaded bow area), too little gear ratio, poor fuel quality or the engines are compromised and do not perform to spec.
— *Jan Mundy*

When Tanks Peel

Q: I'm rebuilding a Pearson Triton sailboat. The water tank is between the berths in the forward cabin. The interior surface is peeling in thin white sheets. I plan to cut a large access hole in the top and resurface the entire interior with something safe for potable water. How best to proceed?
Dan Glick, "Jubilant II," Annapolis, Maryland

A: Until you remedy the condition, the tank will be impossible to keep clean with flaky particles trapping algae as well as the obvious problem of loose flakes clogging the water system. Before you proceed, you'll need to determine the tank material. If it's fiberglass, completely remove all of the degrading material, dry the tank surfaces completely and prep the interior surface of the tank with 80-grit and apply an appropriate epoxy barrier coat rated for use with potable water. The Devoe Coating division of Amercoat manufactures the Bar-Rust line of epoxy paint, one of which is a potable water tank liner. Various other epoxy coatings are also suitable but check with the paint manufacturer to ensure that they are safe for potable water.
— *Nick Bailey*

Restoring Canvas Decks

Q: The deck canvas on my 1966 Chris-Craft Cavalier is scuffed and dirty looking. No amount of scrubbing seems to get it clean. Can I paint old canvas? If so, what paint and procedure do I use?
Peter Brugmans, Merrickville, Ont.

A: Painting deck canvas is workable provided the material is still solid and not ripped or rotted. A good quality yacht enamel will be the easiest to apply and will be a good compromise between ease of application and quality of finish. If a non-skid finish is necessary, then either buy a pre-mixed paint or mix in abrasive particles suitable for the job. [Ed: for application details, see "Deck Coverings" on page 60.] After cleaning the surface, power sand lightly with an orbital sander and 240-grit (no coarser, no finer) abrasive. Avoid sanding through the old finish and exposing the canvas. This sanding gives the original coating "tooth" for satisfactory paint adhesion. Follow the paint manufacturer's recommendations on primer and topcoating. Pay attention to the climate. Avoid painting in direct sunlight, at dusk, if rain is forecast and so forth.
— *Wayne Redditt*

TECHNICAL HELPLINE

When you need help with a problem, or are unable to find information on products, or do-it-yourself projects consult the TECHNICAL HELPLINE.

Cost is FREE to DIY subscribers.

Send your questions via mail or e-mail. Include your name, subscriber ID number (if known), boat name and home port. Describe symptoms in detail and include manufacturer, brand, year built and other pertiment information.

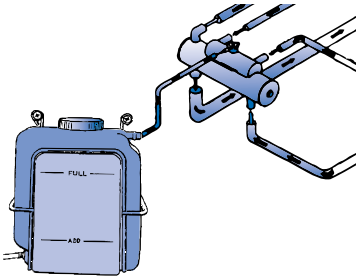
MAIL:
P.O. Box 22473
Alexandria, VA 22304

E-MAIL: info@diy-boat.com

Impaired Cooling

Q: The 7.4L MerCruiser in my 11.4m (38') Carver aft cabin has a large heat exchanger combined with a plastic expansion tank. This tank never seems to add coolant to the heat exchanger when the engine overheats, though it does appear to have filled. Carver mounted the tank 61cm (24") below fill cap on the heat exchanger and about 15cm (6") away from the outside edge of the engine, which based on what I read, is too low. The engine also appears to loose coolant. What can I do to pinpoint the leak before dismantling the risers?
Carlos Velategui, "Mystic Morning," Everett, Wash.

A: Your engine operates on a closed-loop system that uses antifreeze to cool the engine block and exhaust manifolds. According to Steve Auger of Mercury Marine, your assumption that the manufacturer originally mounted the coolant recovery tank too low is correct. When the engine gets too hot, coolant expands and



spills into the expansion tank. As the engine cools, the antifreeze empties back into the engine. This tank must be mounted level with the heat exchanger fill neck; it cannot be below this point for the engine has no means of pushing the coolant uphill. After relocating the tank, you'll need to determine why the engine is overheating and if damage to the engine has already taken place. Your engine should not be overheating. An overheated engine can damage head gaskets and other components. You'll need to determine if the coolant leak is in the exhaust manifold or engine block. To do this, pressure test the system to 15 psi. If pressure drops (loss), take exhaust manifolds out of the system and repressurize. If the pressure holds, you likely have an exhaust manifold or riser gasket leak. If pressure drops, the failure is likely inside the engine block. If it's a corrosion related failure, the fault is the heat exchanger.
— Jan Mundy

Tips for No Starts

Q: I just bought my first sailboat, a 1976 9.7m (32') Endeavor with a Westerbeke 30hp that fails to start by a fully charged (and tested) 850 cranking amp Stowaway battery. I pumped out the old diesel fuel, replaced both fuel filters, pumped in new diesel fuel and bled the system. Out of frustration, I bought a Nautilus 1,000 cranking amp battery, and, after several attempts, the engine finally started. Once warm, the engine easily restarted several times. I activate the glow plugs for 20 seconds, even in the summer, before trying to start each time, although I'm not sure if they are functioning, but I can hear a clicking sound when turning the key. Perhaps the engine is not getting enough compression to generate the heat required for ignition? The engine has about 900 hours.
Phil Primm, "Stank Boat," Charlotte, N.C.

A: An 850 cold-cranking amp battery is sufficient for your diesel engine. The clicking noise is likely a solenoid problem. While it's now working intermittently, it eventually will fail. It may also be loose wiring contacts. Make sure all wiring connections are tight, and clean and free of corrosion. Then check the solenoid. Glow plugs draw a lot of amperage, so you should see an initial power loss on an ammeter or voltmeter when the plugs are energized. Limit the activation to no longer than 20 seconds or you'll overheat the wires. The problem could also be caused by a lack of sufficient pressure to ignite the fuel. Have the compression checked for comparison with min-max specs for your engine. If all checks out, it may be ring wear, though 900 hours is not much for a diesel that's been properly used and maintained. Usually a good indication of ring wear is bluish smoke. Seeing that smoke depends, of course, on being able to start your engine.
— Jan Mundy

When Zincs Go Astray

Q: In July I had my Silverton 40 convertible hauled, bottom painted and two sacrificial zincs put on each shaft and the rudder zincs replaced. Three months later, a diver cleaned and inspected the bottom, and found both port engine zincs were almost wasted. All other zincs looked fine. Is this a bonding problem with the port or starboard engines and the rudders?
David Sanderson, "Cruzan," Newark, Delaware

A: Zincs that corrode in just three months are a good indication you have a problem. It sounds like a DC stray current situation originating in onboard equipment that's grounded to your boat's port engine and/or shaft. It might be in the engine starter, your converter, or other electrical equipment grounded to the port engine.

Discuss your observations with a qualified marine electrician who can help you pinpoint and correct the problem. When I need answers to troubling electrical problems I encounter in my surveys, I call Marine Electric Systems (410/647-5001) for help. Peter Kennedy Yacht Services, (410/280-2267) is another good source for assistance.
— Susan Canfield, AMS, Marine Associates

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Tech Tips ✓

HOSE ARMOR: To protect hoses from abrasion, kinking and puncture, you can make a hose shield by cutting a short piece of hose of the same or larger diameter along its length, and wrapping the split section over the primary.

DON'T POUR, LADLE: Instead of pouring paint from the can into a paint tray or other container, use a ladle to transfer the paint. That way you'll avoid spilling paint on the can label, and you'll still be able to read the application instructions.

ALISON HOOD

TASTES SPRING-LIKE: Chlorinated water from your dockside water supply stays fresh longer in the tank if you don't filter the water when filling. Instead, mount the water filter downstream on the supply line from the tank to remove chlorine just before you use the water.
Nick Bailey, DIY

GREASE'S THE ANSWER: When repacking a stuffing box, lightly coat each ring of packing with Molycoat 44 silicone grease. You'll be able to remove it easily next time you service it again.

REPAIREE'S CODE: When having a professional service your boat engine, the smart "repairee" asks that the original parts be returned to him/her when the job is completed. Asking the engine technician to explain, in writing, what was done, and why, is a good way to build a trusting working relationship with your mechanic, and it's a terrific record of the engine service history.

TANK CLEANER: Use MDR Sludge and Slime or Biobor to break down contaminants in gasoline tanks that can then be easily filtered by a water separator-fuel filter.
David Aiken, DIY

ANODE-DODES: The kind of water you boat in decides the type of anode you use. Magnesium anodes, for example, are okay in seawater (saltwater) but can be troublesome in brackish waters.
Peter Foster, "MME," Faversham, England

WIRE TWISTER: To twist (or untwist) stainless steel wire, place the end(s) in the chuck of a hand brace or a power drill run at low speed to unlay the wire strands.
Dean Yates, Springdale, Nfld.

BOARD-TIGHT: To secure noisy, loose-fitting floorboards or access hatches to berth lockers and other compartments, simply peel and stick self-adhesive Velcro, using the loop (fuzzy) section, around the outer edge. The board will snug up nicely and not rattle.

LEAK FINDER: When you have water entering the cabin from an unknown source and saturating the cushions, draw a horizontal line just below the sheer inside the cabin with a washable, non-toxic color marker. A stained line just below the point where the water entered marks the leak.

CLAMP TUBE: When gluing parts, line the inside of the clamp you're using to hold odd shapes with rubber tubing, bicycle inner tubes or surgical tubing to prevent marring the surfaces.

ANOTHER NO-START TIP: If you haven't run your outboard engine for a while, and it won't start when you want it to, you may suspect a fuel problem especially if you can't smell gasoline. Try having someone squeeze the primer bulb while you crank the engine a few times. If you smell fuel, and the engine still won't start, stop! Fuel is leaking somewhere. Find the leak before you go any further.
DIY thanks the gaffer at the dock for this tip.

SHOWER IN THE ROUGH: A quick fix for a shower-less boat is to adapt a garden sprayer by installing a threaded fitting to attach a shower hose and spray nozzle, and a fill connection that attaches to a freshwater source. To use your new shower, simply fill the tank, pump the handle to pressurize the tank and squeeze the hose nozzle. Enjoy!

DISCLAIMER: DIY boat owner is not accountable for any products or procedures that appear in this column.

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ShopTalk

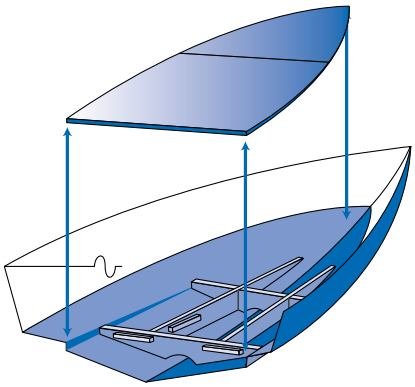
FLOOR SAVER

Many older runabouts have rotted or delaminated plywood floors and floor supports. Here's a solution that will likely outlast the original construction.

By Wayne Redditt

Most older fiberglass runabouts have a cockpit floor (a.k.a. deck or sole) made of plywood, and often exterior ply instead of the more expensive marine ply. The floor is supported on timber or plywood stiffeners, called longitudinals that run fore and aft, and thwarts (supports perpendicular to the floors). These structural members are fiberglassed to the hull interior. Over time, these floors become saturated with moisture, which inevitably rots and/or delaminates (the process of separating the thin wood layers that are laminated with glue to form a specified panel thickness). Beyond the telltale soft feeling underfoot and the visible rippling of the plywood, the boat hull may suffer flexing problems and gelcoat cracking since the floor and its support structure are vital to the hull's resistance to excessive flexing.

Preserving the structural integrity of the floor and its support system is vital to the boat's ability to withstand its expected service. These repairs are not technically difficult, but doing the job right is important. Replacement begins with a thorough survey of the floor and supporting structures. This requires removing all interior furniture like seats and engine boxes, lifting the carpet or vinyl floor covering. Many manufacturers used a contact cement-type adhesive to install the flooring. Removing it means ripping it out in pieces. Take care to note the location of cleats, sliders and other hardware that fastens components to the floor before you start tearing away.



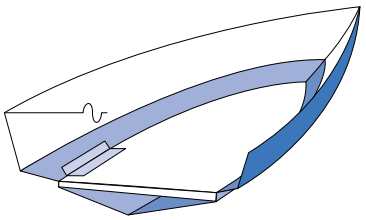
Structural interior of a typical fiberglass runabout.

Once you know the extent of the damage, you can determine the best repair method. The quick-and-dirty approach would be to cut some plywood to shape and install it directly over the top of the existing floor, provided there remained some solid original material to which you can fasten the new floor. Stainless-steel screws would be the first choice for fasteners, although galvanized deck screws (green ones) would fit a tight budget.

A better approach to safeguarding the boat's value is to carefully remove the existing plywood floor, preserving as much as possible, especially the edge profile. Original pieces will serve as patterns to produce the new floor. Fiberglass tabbing probably secures the floor to the hull at the outer edges. Floors often fit poorly against the hull and the tabs bridge the gap. Use a small angle grinder with a disk capable of cutting fiberglass to remove the floor. There is a simple way to conceal the gaps when installing the new floor, which will be discussed later.

With the floor removed, you need to assess the condition of the athwartship and longitudinal supports where you'll likely find rot or delamination. You should attempt to create patterns of these before removing them from the bilge. Use cardboard or stiff paper. Good patterns make for an easier final installation. They don't have to be perfect though, since the epoxy putty mixture used to bed these parts to the hull fills gaps up to 3mm (1/8"). Remove any soaked flotation foam, if included.

Grinding through the fiberglass tabs that clamp the floor supports to the hull is a messy and time-consuming job. Grind off the leftover tabbing after you remove the wood parts. Grind away all putties, fillers and gelcoat in the surrounding area. Be sure to wear appropriate dust protection when grinding any fiber-reinforced materials. Dry out the bilge thoroughly before grinding or cutting with power tools. The bilge and hull



A wide 45.7cm (18") strip of fiberglass cloth, roving or mat ("tabs") imbedded in resin is applied along the entire length of the seam to secure floor to hull.

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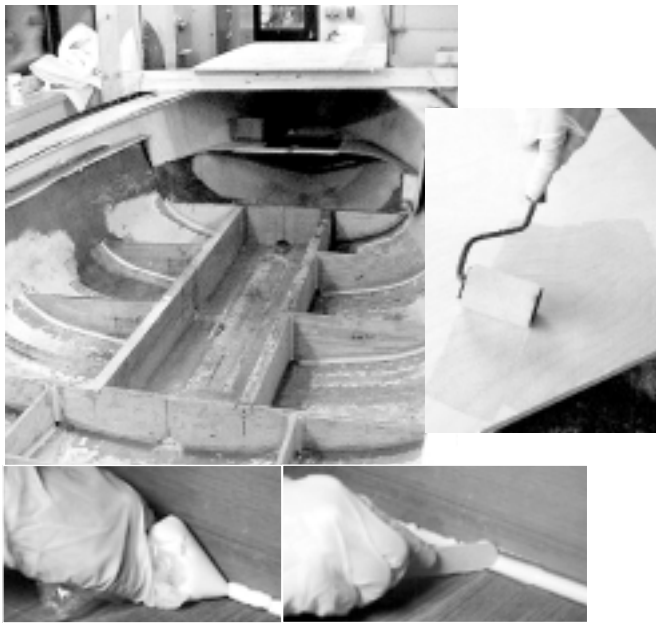
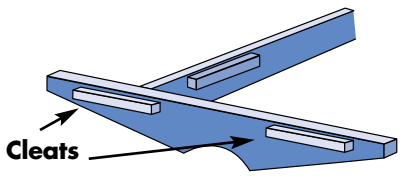


New longitudinal and athwartship floor supports coated with unthickened epoxy resin for moisture protection, then epoxy glued to hull, seams sealed with epoxy fillets and taped. Note limber holes cut for routing of bilge water. (left) Pre-cut rolls of 7.6cm- (3"-) wide fiberglass cloth tape simplify taping of floor supports.

interior must be bone dry before and during installation of new supports and floor.

Transfer patterns for the floor supports and floor onto fir AC-grade exterior plywood (G1S), and cut with a jigsaw or bandsaw. Cut some mahogany cleats, 2.5cm (1") square, and epoxy glue to top edges of supports. Be sure to transfer the placement of all floor hardware onto the new floor. Coat sides and edges of all pieces with unthickened epoxy resin for moisture protection. Use epoxy resin thickened with wood fillers to bed and glue the new supports to the hull. After curing, sand off any sharp edges of protruding fillers. You may wish to apply epoxy fillets to all joints before taping. Cut tabs so they extend well onto the hull, at least several inches on both sides, from heavy fiberglass cloth or very light roving if using epoxy resin. Epoxy doesn't work with some types of chopped-strand mat. If affixing tabs with polyester resin, chopped strand mat will work. Before resin cures, give supports and tabs an extra dose, then let cure. [Ed: Refer to DIY 1998-#4 for the proper methods of mixing epoxy resin, coating wood, gluing and filleting.]



Rather than fastening into plywood end grain, solid wood cleats attach to floor supports allow screw fastening of floor.

When cured, you are ready to lay the floor. If flotation foam was present in the cavities replace it now with two-part liquid urethane foam (styrene-based foam is not recommended), allowing it to expand above the level of the supports. As this foam is a critical safety feature, make sure to use a flotation foam. The Coast Guard can provide the specifications for this special foam. After curing, use a long knife to remove excess foam so it's level with the supports. If there is a permanently installed metallic fuel tank under the floor, this is the time to check its condition, especially on its underside where bilge water might have caused corrosion. If the tank is questionable, now is the time to replace it.

Install the new plywood floor, fastening with stainless screws only to the cleats on the supports since plywood end grain doesn't hold screws firmly. Fill gaps between the hull and floor (here's the tip) with urethane foam. Let cure then cut the excess with a sharp knife. Lay fiberglass tape over the plywood and up the hull sides, lapping at least 30.4cm (12") onto the plywood and 15cm (6") up the hull sides. I suggest epoxy for this job, since polyester will have bonding problems with the coated plywood unless it's been very carefully prepped.

Once cured, install weatherproof carpet or a vinyl deck covering, followed by reattachment of seats, etc. When properly coated, glued, taped and screwed, this repair will last for many years, probably much longer than the original construction.

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Electrical

FINE TUNING DC POWER SYSTEMS

Heavy-duty wire connection and switching devices add a dimension of flexibility in DC (direct current) system planning and installation, as well as improved safety. Here's how to choose the best equipment for your next upgrade.

By Kevin Jeffrey

Beyond the glamour of high-output alternators, solar and wind-driven battery chargers, battery banks and system monitors are the hidden essentials of any respectable marine electrical system; namely, heavy-duty DC circuit components that provide safe, efficient wire termination points and switching ability. These devices, often not considered by boat owners, boatbuilders and electrical system suppliers, are fast becoming standard equipment in first-rate marine installations with high-energy demands.

I use the term "heavy duty" to describe this class of electrical devices, not to imply that they all have the same degree of robustness, but to focus on devices that are designed and built to perform well at their rated capacity in rugged marine environments.

Wire Connections

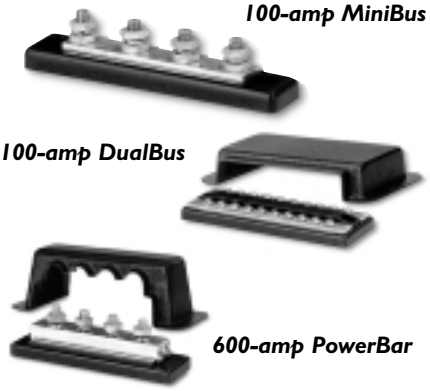
The first heavy-duty DC circuit components to plan for are wire termination devices, which include common electrical busbars, distribution posts and terminal blocks. Battery posts, battery switch terminals and other adhoc connection points have been used for attaching positive and negative wires in an electrical system. Now specially-made wire termination devices provide safe and convenient ways to connect wires and cables.

Electrical busbars are solid blocks of conductive material, such as tin-plated brass, with multiple wire connection points. These connection points can combine individual studs and/or screw terminals for attaching wires in a DC circuit. Since all termination points on a busbar are electrically connected, the busbar itself acts as a jumper from one connection point to another. These features make busbars the preferred method for connecting common groups of positive or negative wires. The conductive material on a busbar is fastened to a base block of non-conductive material such as plastic used for mounting the busbar to a bulkhead or other convenient surface. Ground wires can be connected on a grounding busbar, which is similar to a standard busbar, but lacks the thick metal heat sink and the non-conductive mounting surface.

Busbars are available in a range of styles and electrical ratings. Some models have only stud termination points (typically four). Others have two studs, one at each end, with smaller screw terminals in between. Some have only screw terminals. Dual common buses with screw terminals are also available for terminating both positive and negative wires on a single mounting block. Dual common buses have one common bus for terminating positive wires and a second common bus, electrically isolated from the first, for terminating negative wires.

Busbars are rated for their continuous current capacity and maximum DC voltage. Since busbars can also be used for AC systems, a rating for AC maximum voltage is also given. Be sure you select busbars with sufficient current and voltage ratings for your needs.

Busbars have advantages over single stud distribution posts. They can handle more wire terminations on a single device. ABYC (American Boat and Yacht Council) standards state, "No more than four conductors shall be secured to any one terminal." Busbars also allow wires of varying sizes to be connected on the same device, and wires can be arranged in an orderly pattern.



The connections on a busbar should always be protected with a non-conductive cover. Some busbars on the market have specially-made plastic covers for this purpose.

Distribution posts provide safe, secure connection points for up to four high-amperage cables on a sin-

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Blue Seas PowerPost

gle post. Distribution posts are not typically rated for amperage since current flows between the various conductors and their terminals, not through the post itself. They are, however, rated for maximum DC voltage. Distribution posts for the marine market are typically rated up to 48 volts DC.

Some distribution posts also provide low-amperage screw terminals for connecting conductors from controls, displays, monitor shunts and appliances with small electrical loads. In certain applications, this device can eliminate the need for an additional post or busbar.

As with busbars, distribution posts typically are made with mounting bases of non-conductive material, with recessed mounting screw holes to avoid contact with the conductors on the post. Some models come with a rubber or plastic insulating boot, color-coded for positive (red) or negative (black) wires. The boot is good for one or two wires only, so terminal protection for the other wires on the post is often left to the customer.

Dedicated terminal block for negative wires.

Terminal blocks provide a convenient common connection point for wires in multiple DC circuits. Individual circuits in a wire harness can be terminated on a terminal block, and rerouted to an appliance, a power source, or a monitoring or control device.

A typical terminal block has individual pairs of screws serving as circuit connection points for incoming and outgoing conductors. These screw pairs are isolated by the mounting base itself and by raised plastic separators between circuits, and they can be easily joined by a properly rated metal jumper to give the required number of connection points for each circuit.

Terminal blocks typically have a closed back design that completely insulates the electrical power at the screw terminals from the mounting surface.

Switch Controls

The ubiquitous 1-2-Both-Off battery switch used to be the only heavy duty switch on a boat. Boaters can now choose from several varieties of switches that perform a wide range of tasks.

1-2-Both-Off battery switches, supplied with most production boats, are primarily intended for electrical systems that have two battery banks. The switch directs which battery bank accepts the charging current, which

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Four-position switch.

battery bank supplies the load current, and it can disconnect the batteries completely from the rest of the electrical system.

Many four-position battery switches on the market are equipped with an alternator field disconnect (AFD) switch that protects the diodes in an engine-driven alternator if the position of the main switch is changed while the engine is running. An AFD is a secondary switch inside the main switch, connected to the field wire of the voltage regulator. When the position of the main switch is changed, the AFD opens, stopping the alternator output before the main switch contacts open, and the AFD closes again before the main switch contacts close.

On-Off switch

Battery switches can be directly mounted to a bulkhead or other flat surface, or they can be flush mounted in standard or custom electrical panels. The electrical contacts are on the back of the switch, protected from accidental human contact.

Many boaters set up their electrical systems with one large house bank and designated starting batteries for auxiliaries and generators. For these systems, a simple On-Off battery switch to isolate or disconnect the house bank and the individual starter batteries makes sense. Main battery switches for the house battery bank and engine starting battery(s) should be rated to handle the maximum current expected in the system. A house bank battery switch with a continuous rating of 300 amps and intermittent amperage rating of 40a0 amps is a good choice for most marine systems.

Mini battery switch with removable key.

Lighter duty On-Off switches, known as mini battery switches, can be used to disconnect small starting batteries, but they have other uses in an electrical

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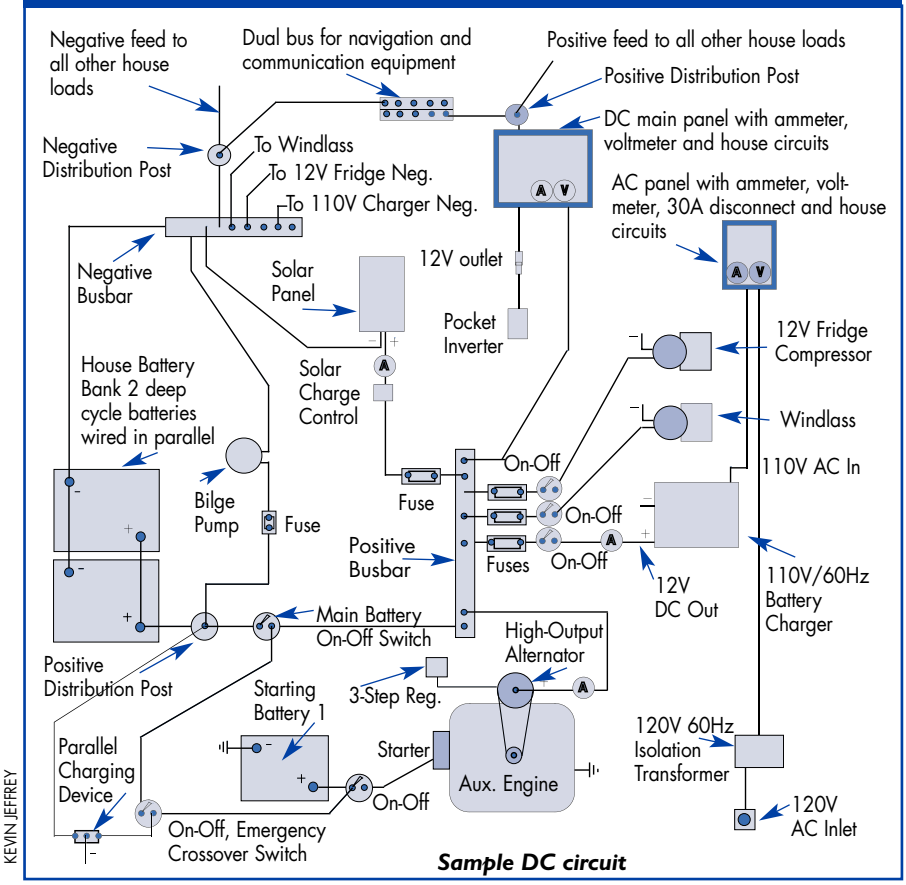
power system. They can serve as convenient circuit disconnects for larger branch DC circuits onboard, including circuits for high-amperage appliances and charging sources. Mini battery switches from Blue Sea Systems are rated at 250 amps continuous and 375 amps intermittent. Some models have a removable key to avoid accidental switching of critical loads or charging sources.

Another option for heavy duty switching in a DC circuit is to use a properly rated, high-amperage DC circuit breaker that combines switching and circuit protection in a single device. Heavy-duty magnetic DC circuit breakers are available in the 50- to 300-amp range for use with inverters, bow thrusters and windlasses. These devices are not designed to open a circuit when the load is drawing current under normal conditions. Interrupting the circuit at high current flow can cause pitting of the contacts that can lead to undesirable resistance. Use a relay to handle the high current arcing that occurs when large DC motors are turned on and off.

Figure 1



KEVIN JEFFREY

Fine Tuning

There are many reliable wire connection and switching devices to fine-tune simple and sophisticated electrical power systems. These devices improve flexibility in system planning and installation as well as improved safety, security and aesthetic appeal. If you're uncertain about the components or installation in a wiring upgrade you're planning, sketch it on paper, and consult a qualified marine electrician before you proceed. [Ed: For instructions on producing a proper electrical schematic, see DIY 2000-#2.]

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

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DIY DIESEL MECHANIC

GETTING TO KNOW YOUR DIESEL

When problems occur, a systematic approach to maintenance and troubleshooting can save you time and money and often get you underway again. Here's what you need to know to keep your diesel humming.

Story and photos by Jan Mundy

Your boat's diesel engine thrives on a relatively simple diet of air, fuel and combustion. A lack of any one of these three key ingredients can keep your boat at the dock. Your engine does give warnings of impending operational indigestion, and recognizing these warnings, and detecting the symptoms of a diesel ailment is what makes a good mechanic.

Bernard Jansen, service inspector of Vetus Diesel, headquartered in Schiedam, Holland, recommends boat owners become familiar with their engine and know what is "normal." Listen to it run, observe the vibration at various rpm with load and without, watch for changes in exhaust smoke, record the oil pressure at cruising speed and at idle. When your engine starts to run rough or shakes more than normal, or rpm decreases, stop and find the fault. Ignore the warning signs, and problems will inevitably spoil your day.

Vetus Diesel, a division of Vetus Den Ouden, one of the largest suppliers of marine equipment in Europe, has sold Mitsubishi and Peugeot marine diesels in Europe for more than 20 years, and more recently in North America. The company was established in 1964, publishes catalogs in seven languages and has a network of dealers and service shops in more than 30 countries. All design, marinization and research of its diesel engine line is handled by its in-house design and R&D group. Engines range in horsepower from 11 to 286, in two, three and four cylinder models. Smaller horsepower models meet the emission regulations of the Lake Constance Requirements (Bodensee), the strictest standard in the world.

Lack of maintenance is the root of most engine troubles. On the following pages, Jansen and the Vetus Diesel staff outline the routine maintenance procedures they recommend for long engine life, better performance and economical operation. A list of common problems, their possible causes and suggested remedies, appears in "Troubleshooting Checklist," on page 20, and of course, follow the manufacturer's recommendations in your engine service manual for maintenance and service intervals.

Check engine and transmission oil levels before every start. Do it when the engine is cold (not run for at least 6 hours) to prevent overfilling. By then, all the oil will have run back into the pan, and the dipstick level will be most accurate. An extra 12mm (1/2") above the upper mark on the dipstick won't likely harm your engine. Any higher and you should pump out (or drain) oil to the proper level. Constantly running an engine with too much oil can result in extensive (and costly) damage to the cylinders. Know the difference in oil capacity between the two level marks as specified in your service manual. Check the gearbox oil level with its dipstick. It

SHERYL SHARD

should be between the tip and the notch in the dipstick. Top up with the specified oil via the dipstick opening. *Tip: To facilitate reading the gearbox oil level, wipe the dipstick clean then dust a little chalk or talcum powder on the dipstick and dip it again.*

Check for dirt in the raw-water strainer daily or before every use. Close the seawater intake seacock and remove the strainer cover. To clean it, remove the basket insert, rinse it in clean water

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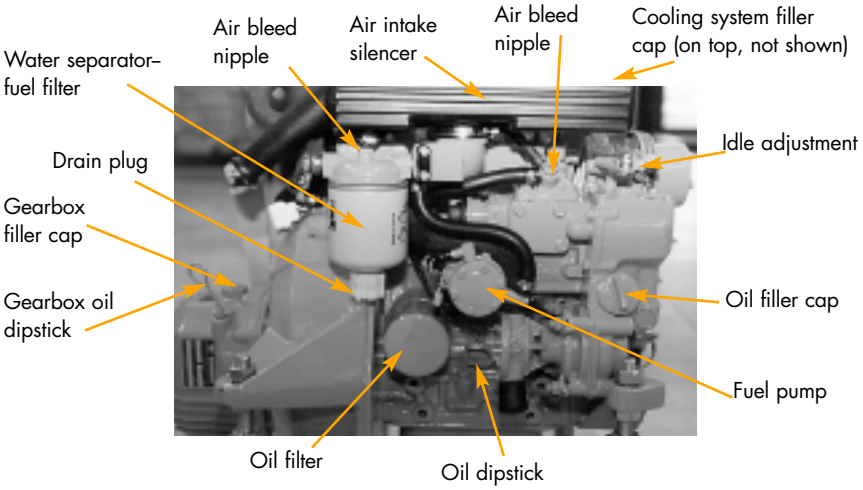
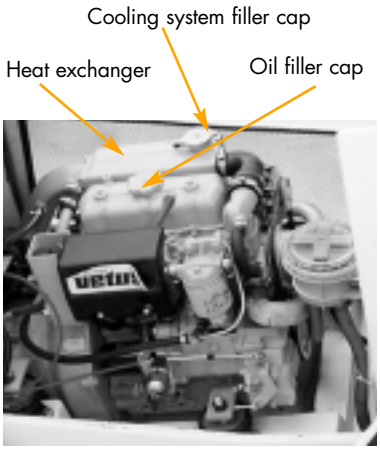
Serviceability is an important factor, whether you are doing the work or paying a professional mechanic. Mitsubishi engines are maintenance friendly with most components easily accessible, and many located on the same side.





and reassemble. Be sure the cover gasket is properly seated or the seawater pump will pull air into the system, causing insufficient cooling and overheating. Replace gasket if worn.

Check freshwater cooled engine coolant level every day or before using engine. Do it when the engine is cold. Remove the cap at the filler neck on the heat exchanger. The coolant level should be 9mm (3/8") below the lower edge of the reservoir neck. A loss of antifreeze indicates a leak in the system.

Check the fuel, cooling and exhaust systems for leakage before every use. Oil or fuel residues in the engine pan or at the

fuel filter mean leaks. Track the source immediately, cautions Jansen.

Don't neglect your battery. Check lead acid battery electrolyte and specific gravity levels. Fluid should be 12mm (1/2") above top of all plates. Top up with distilled water as needed, and charge the battery. Check the battery charge level with a hydrometer. Keep battery posts clean and dry. Always remove negative cable first when servicing a battery.

Check tightness of all fasteners at least monthly. This includes all engine bolts, nuts and screws, control cables, hose clamps, wiring harness connections, etc.

Monthly check hoses for chafing and cracking. For complete instructions on servicing hoses, see "What You Should Know About Hose" in DIY 2000-#2 issue.

Clean diesel fuel is important for top engine performance. Dirty fuel clogs fuel filters, plugs injectors and shortens engine life. Fluctuations in ambient air temperatures as well as fuel temperatures produce condensation that activates the microorganisms in the fuel and hatches microbial growth. Warm temperatures also heighten bacteria growth, so boaters in these areas should frequently add a biocide, such as Biobor, or install an Algae X to reduce germination.

Change oil and oil filter at least once a year regardless of engine hours or at service intervals specified in your owner's manual. Run the engine at idle speed for 10 minutes or until it reaches operating temperature to warm the oil. Stop the engine, then pump out the oil using a suction pump through the dipstick hole, or drain the oil, if you have sufficient space below the engine. Examine the oil for metal deposits and water contamination. Be careful. Hot oil can burn your skin.

Always change the oil filter when you change oil. After draining the oil, place a plastic bag around the filter and remove it by hand or use a strap wrench, turned counterclockwise (check direction in manual). Seal bag and dispose of the filter at an approved disposal facility. Insert a new filter, wipe contact surfaces with a clean rag, dab some clean engine oil (or petroleum jelly) on the gasket, then reinstall filter and tighten by hand. Collect and dispose of

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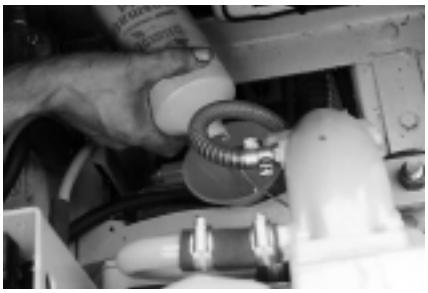
the oil and filter in an environmentally friendly manner.

Refill engine with the oil type and quantity specified for your engine. Start engine and run at idle speed for 30 seconds to circulate oil through the filter. Check for oil leaks. Let stand for 5 minutes to let oil drain into the sump and check oil levels with the dipstick.

Though it's not necessary to change the gearbox oil every year, it's usually done during off-season lay-up (see "Preparing Your Diesel For Storage" on page 21). Pump out the oil through the dipstick on the



gearbox housing (or remove drain plug). Smell the oil. A burnt odor may signal a drive cone problem. Refill with the specified oil type to the correct level. Refer to your service manual for recommended engine and gearbox oil grades and volumes.

Regularly drain the water from engine fuel filter and water separator-fuel filter unit when engine is in use. When the engine runs, fuel is pumped from the tank to the fuel-water separator, to the injection pump and injectors, through the engine where it's heated and then returns to the tank. After stopping the engine, the fuel cools and condenses. Water is heavier than diesel fuel, so it settles, along with microbes (bacteria, fungus, molds, yeast, etc.) and dirt particles to the tank bottom

or anywhere else in the system that allows it to collect. To drain the water, open the bottom drain plug on the fuel-water separator and drain into a container. When diesel fuel starts to flow out, close the plug. Repeat this procedure with the engine fuel filter. Check drained fuel for evidence of contamination. Metal particulate in the drained fuel may be a sign of a corroding fuel tank. A fuel-water separator with a clear bowl allows you to visually inspect the amount of water collected. Because no air is introduced, draining the filters doesn't usually require bleeding the fuel system.

Replace fuel filters at least once a year. Install a new engine fuel filter and water separator-fuel filter at the same time as the engine oil filter. Replacement is easier if you have a shutoff valve on the fuel feed line to the filter. (Install one if you don't!) Place a plastic bag or container underneath to contain spillage. To replace the filter element, close the shutoff valve to prevent fuel flow. Remove the band holding the top of the filter (or unscrew the top). Remove the used element, put it in a plastic bag and seal it for proper disposal later. Insert the new filter element. Be sure to use an element with the proper micron rating to prevent fuel flow restriction. Before reassembly,

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TROUBLESHOOTING CHECKLIST

Engine will not crank

Possible Fault	Remedy
1 Discharged battery.	1 Check and/or recharge battery, check alternator and battery charger.
2 Loose or corroded connections in starting circuit.	2 Clean and tighten connections.
3 Faulty starter switch or starter relay.	3 A clicking sound normally indicates a failure. Check and/or replace.
4 Faulty starter motor or pinion does not engage.	4 Measure voltage at starter with VOM per manufacturer's specs. Check or replace starter motor.
5 Starter relay is not engaged due to a voltage too low caused by a very long intermediate cable from engine to control panel.	5 Check manual for recommended cable length. Install an auxiliary starter relay.

Engine cranks but will not start, smoke from exhaust

Possible Fault	Remedy
1 Air in fuel system.	1 Check and bleed fuel system.
2 Faulty injector and/or injection pump.	2 Check, clean or replace, if required.
3 Setting of stop valve incorrect.	3 Check and/or adjust.
4 Faulty glow plugs.	4 Check and/or replace.
5 Incorrect valve clearance.	5 Adjust.
6 Incorrect injection timing after overhauling of engine.	6 Need to service. Normally done by qualified marine diesel mechanic.
7 Insufficient intake air.	7 Check suction at air intake. If necessary remove cover and check if clogged.
8 Wrong fuel quality or contaminated Incorrect lube oil SAE class or quality for ambient temperature.	8 Check fuel. Drain and flush fuel tank. Replace with new fuel.

Engine starts but idles rough or stalls at load

Possible Fault	Remedy
1 No fuel.	1 Fill tank.
2 Air in fuel system.	2 Bleed fuel system.
4 Fuel filter clogged with water and/or contamination.	3 Drain and replace.
4 Leaking fuel supply line or fuel injection line.	4 Check and replace.
5 Faulty injector/injection pump.	5 Remove and test by repair shop.
6 Vent line of fuel tank clogged.	6 Check vent for spider webs, clean.
7 Fuel supply line restricted.	7 Check. Inspect fuel pickup tube in fuel tank and remove screen if fitted.
8 Incorrect valve clearance.	8 Adjust.
9 Idle setting too low.	9 Check manual for idle rpm and adjust.
10 Exhaust restricted.	10 Check exhaust elbow and hose and clean.
11 Wrong fuel quality or contaminated fuel.	11 Replace with new, clean fuel.
12 Clogged filter of electric fuel lift pump.	12 Clean or replace.
13 Compression problem.	13 One or more cylinders are misfiring. Check.

Engine oil consumption excessive

Possible Fault	Remedy
1 Oil level too high.	1 Pump out oil.
2 Excessive inclination of engine.	2 Check and adjust.
3 Incorrect lube oil SAE class or quality for ambient temperature.	3 Replace with correct oil.
4 Excessive wear of cylinder or rings.	4 Check compression; overhaul engine.
5 Insufficient intake air.	5 Check suction; check filter.
6 Engine overloaded.	6 Check size of propeller

Engine has little or no oil pressure

Possible Fault	Remedy
1 Oil level too low.	1 Increase level.
2 Excessive inclination of engine.	2 Check and adjust.
3 Incorrect lube oil SAE class or quality for ambient temperature.	3 Replace.

Engine does not reach maximum rpm under load

Possible Fault	Remedy
1 Air in fuel system.	1 Check and bleed fuel system.
2 Fuel filter clogged with water and/or contamination.	2 Check or replace.
3 Leaking fuel supply line or fuel injection line.	3 Check and replace.
4 Faulty injector or injection pump.	4 Check, replace if required.
5 Setting of stop valve incorrect.	5 Check and adjust.
6 Oil level too high.	6 Lower level.
7 Incorrect valve clearance.	7 Adjust.
8 Exhaust restricted.	8 Clean exhaust mixing elbow and hose.
9 Insufficient intake air.	9 Check suction at air intake, remove and check filter.
10 Wrong fuel quality/contaminated	10 Replace with new, clean fuel.
11 Engine overloaded.	11 Check size of propeller.

Engine cranks but will not start, no smoke from exhaust

Possible Fault	Remedy
1 Fuel stop valve closed.	1 Open.
2 No fuel.	2 Refill tank and/or check fuel system.
3 Air in fuel system.	3 Check and bleed.
4 Fuel filter clogged.	4 Check or replace.
5 Fuel leak.	5 Check for visible leaks and replace.
6 Faulty injector or injection pump.	6 Remove and test by a repair shop.
7 Fuel tank vent line clogged.	7 Check vent for spider webs, clean.
8 Exhaust restricted.	8 Clean exhaust mixing elbow/hose.
9 Electric fuel lift pump doesn't operate.	9 Check and/or replace.
10 Electric fuel lift pump delivery and suction valves obstructed by dirt.	10 Disassemble, check and clean. Install a fuel pilot filter in fuel line from tank to engine.
11 Clogged electric fuel lift pump filter.	11 Check and clean.
12 Stuck decompression lever.	12 Check and service.
13 Clogged fuel tank pickup tube.	13 Remove tube from tank and remove screen, if fitted.

Engine not firing on all cylinders, vibration increase, rpm decreases

Possible Fault	Remedy
1 Air in fuel system.	1 Check and bleed fuel system.
2 Fuel filter clogged.	2 Check or replace.
3 Leaking fuel supply line or fuel injection line.	3 Check and replace, if required.
4 Faulty injector, injection pump.	4 Remove and test by qualified repair shop.
5 Fuel supply line restricted.	5 Check and replace.
6 Faulty glow plugs.	6 Check and replace.
7 Incorrect valve clearance.	7 Adjust.
8 Clogged filter,electric fuel lift pump.	8 Check and clean.
9 Faulty electric fuel lift pump.	9 Check and replace.

Engine overheats

Possible Fault	Remedy
1 Seacock closed.	1 Open.
2 Blocked raw-water intake.	2 Check and remove restriction.
3 Oil level too high.	3 Too much resistance. Lower level.
4 Oil level too low.	4 Add oil.
5 Faulty oil filter.	5 Incorrect size. Replace.
6 Coolant pump defective or faulty impeller.	6 Check and clean. Check impeller.
7 Heat exchanger dirty or clogged.	7 Clean tube stack. Replace impeller.
8 Coolant level too low.	8 Check level and top up.
9 Raw-water strainer clogged.	9 Clean strainer basket.
10 Leaking raw-water intake system.	10 Check seal on strainer,check intake hose.
11 Faulty injector, injection pump.	11 Remove and test by repair shop.
12 Faulty thermostat.	12 Check and replace, if required.
13 Faulty raw-water pump impeller.	13 Replace.
14 Insufficient intake air.	14 Check suction. Replace air filter.
15 Faulty temperature switch, sensor or meter.	15 Bypass switch and run engine. Replace only.

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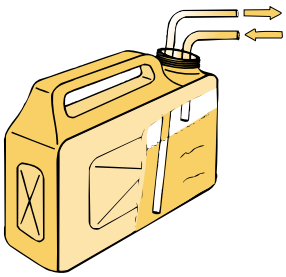
PREPARING YOUR DIESEL FOR STORAGE

Here are a few steps you can take to prolong the life of your diesel when storing it for winter or for extended periods. **Turn to page 39 for relaunching tips**.

• Add a diesel fuel stabilizer to the tank about two weeks before lay-up.

• Change the oil, service the fuel filters using the procedures outlined in this article. Service the seawater strainer and prepare it for winter by filling it with non-toxic antifreeze. Start engine and run until strainer is empty, turn off engine. Reinstall strainer lid. Close engine drains.

• To protect the fuel system, injection pump and injector nozzles from corrosion, Vetus Diesel recommends preparing a soup of 1 part thin motor oil (i.e. diesel 10W40) and 9 parts clean (water-free) diesel fuel in a jerry can. Connect a spare fuel hose to the fuel lift pump inlet, remove the fuel return line and place both into the jerry can. Run the engine at idle speed and no load for about 10 minutes. Remove hoses from jerry can and reconnect engine hoses.



VETUS

• Remove water pump cover and impeller, and inspect it for wear. Don't reinstall or it will take a permanent set. Rather, store it at room temperature. Replace water pump cover. Be sure to install impeller before launching.

• To prevent corrosion during storage, the freshwater cooling system requires an antifreeze-water mixture. Remove the filler cap on the heat exchanger and check the level of the coolant. Use an antifreeze tester to check the strength of the coolant. Change coolant as needed, depending on storage temperatures.

• Disconnect battery cables. If batteries are to remain onboard, make sure they are fully charged.

• Seal the air intake opening with vinyl tape and remove exhaust hose and plug engine exhaust with a rag, or seal both with plastic bags held with tape.

• Open seawater seacock to allow air circulation and reduce condensation caused by temperature changes.

• Loosen all drive belts.

• Spray engine with a corrosion inhibitor.

• Open petcock in waterlock muffler to drain water. Remember to close valve after draining.

• Update your engine maintenance log and make a list of parts to order.

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wipe the glass bowl clean, lightly grease the filter O-ring and reassemble, hand tightening only. The bowl should spin on easily. If it doesn't, don't force it. You may damage the threads.

If the engine fuel filter housing has a drain plug on the bottom, first drain off any water. Put a bag over the filter housing and unscrew, using a strap wrench, in the direction prescribed in the engine manual. You can also use a screwdriver tapped lightly with a hammer to turn a notched oil cap housing (Yanmar). Wipe the rim clean and lightly lubricate the rubber gasket with oil. Fill the new filter with clean diesel fuel and screw on until just finger tight. Don't overtighten. Jansen advises applying just another 1/2 to 3/4 turn after the gasket closes against the housing. You'll have to bleed the air from the fuel system after installing new filters. *Tip: OMC Triple Guard Grease is high-quality grease for lubricating rubber gaskets and O-rings.*

You must bleed all the air from the fuel system after servicing it, or if you have run out of fuel. You'll find bleed points on the engine fuel filter and injector pump. Locate the fuel lift pump. A manually operated pump has a priming lever. Larger engines have a self-bleeding electric pump. To prime the fuel system, turn the key switch to the "on" position. From the fuel-water separator, locate the first bleed point upstream of the fuel lift pump, usually located above the engine filter. Move the pump lever (or power the electric pump) four or five times, open the vent (nipple, bolt or nut), wait for fuel to exit and close vent. Repeat

-Tip- SPILL CATCHER

Place an absorbent pad under the engine to soak up oil and fuel drips and spills before they reach the bilge.

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again until fuel displaces all air bubbles. Locate the second bleed point on the injector pump and repeat the procedure. Continue until all air is purged from the system. Start engine and run for 15 minutes at idle in gear to ensure all air is removed. Mark the bleed points with a permanent marker for quick identification next time.

Periodically check the amount of suction at air intake. Insufficient intake air affects the engine operation, causing overheating and other problems. Jansen recommends that you carefully feel the amount of suction at the air intake. Make a mental note of the pressure so you have a comparison when doing troubleshooting.

Be sure you know the proper cold-start procedures. Diesel engines have no ignition system. Instead, air is compressed until the temperature of that air rises beyond the ignition point of the fuel, then fuel is sprayed into the cylinders and ignites, starting the engine. A fully charged, properly sized battery should start your engine easily. Never turn over the starter motor for longer than 20 seconds. If your engine doesn't start, stop cranking, and try again. Some diesel engines are equipped with glow plugs. In cooler temperatures, these devices pre-heat the air before it mixes with fuel to assist starting. Engine control panels may have "idiot" lights that burn when glow plugs are activated, usually 15 to 20 seconds before the engine starts. Another way to start a cold engine is to momentarily engage the decompression handle or lever while cranking the engine a few turns, then releasing it. Not all have this capability (my Yanmar 1980 1GM model does) as the lever can fail or stick and the engine won't start. Never use an engine starting fluid.

Adjust the idle speed. The correct engine idling speed is specified in your shop manual and serviced at intervals specified by the manufacturer. Jansen has an easy method to check idle speed. Place a small piece of reflective tape on the flywheel. Using a photo tachometer, point the light beam onto the tape and read the rate of revolutions in the

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DIY MECHANIC

display. Reset the idling speed by turning the adjustment screw on the fuel pump. Turn the screw clockwise to increase, counterclockwise to decrease, or as specified in your manual.

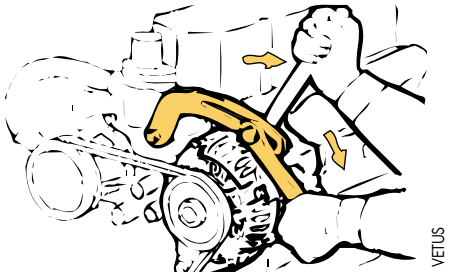
Smoke signals are key diagnostic tools. A well-tuned engine may smoke at startup and while idling, but never when under load. Whitish exhaust smoke on startup of a cold engine is normal. This also occurs when low temperatures cause vapors in exhaust gases to condense, a more common problem in southern regions where after a warm spell, the air temperature drops to 15°C (59°F) or lower. If the exhaust remains white at full load (or after a rise in temperature), it may mean other problems, such as water or air in the fuel, water in cylinders, misfiring cylinders, faulty injector or injection pump, or lack of compression.

The sooty, black exhaust that contains unburned fuel due to incomplete combustion is common when a diesel starts. It results from running for long periods at low speed with load, operating at low engine temperatures due to a faulty thermostat, a restricted exhaust, oversized propeller, clogged air filter or faulty injection system. (For instructions on servicing thermostats, refer to DIY 2000-#1). When black smoke doesn't clear at load, disconnect the exhaust hose and clean out clogs of carbon or salt deposits or replace it. Also, remove the exhaust mixing elbow and remove clogging deposits with a steel brush. Check air intake and air filter. Never wash a paper filter, replace it. Finally, have injectors and injection pump serviced, if needed.

Blue smoke indicates your engine is burning oil, and is normal on startup. If blue smoke continues at idle, the oil level may be too high, the engine angle may be excessive , or there is a problem with valve guides and stems, piston rings or worn turbo-supercharger oil seals. You'll likely smell oil as well.

Inspect V-belt(s) and tension. Turn belts inside out and replace if cracked, delaminated or frayed. To check tension, apply moderate thumb pressure, about 10kg (20lb), on the belt midway between pulleys. The belt should not deflect more than 12mm (1/2"). To adjust, loosen the

bolt on the adjustment bracket and alternator mounting bolts, and reposition alternator. Retighten the upper mounting bolt on the alternator first, then the mounting bracket bolt, and the lower mounting bolt. Never apply upward force with a screwdriver or stick propped under the alternator! You risk over tightening and overloading the bearings. Always carry a spare belt.



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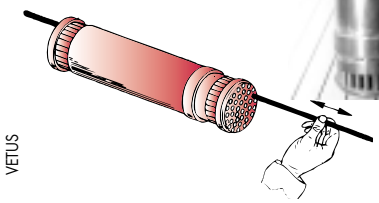
Inspect the engine Fuse. Every engine has a dedicated fuse. Annually inspect the connections, and the fuse and fuse holder for corrosion. Add this task to your spring commissioning list.

Service the seawater cooling system annually. The condition of the water pump impeller is vital to your engine's cooling system. Close the seacock and remove the pump cover. Etch a mark on the pump cover and impeller to ensure correct alignment if reused. Remove the impeller by pulling straight outwards with waterpump pliers, a dental pick or screwdriver. Be careful not to scratch the pump housing. Examine the surfaces of the pump housing and cover for scoring, and replace if warranted. Replace the impeller, lubricating it (or the old one) with silicone spray. Be sure all of the impeller blades bend in the proper direction. Replace the cover gasket with a new one and reinstall. Start the engine and check for seawater discharging out the exhaust.

Service a closed-cooling system as specified in your service manual. Inter-cooled engines have a two component cooling system. A mixture of ethylene glycol antifreeze and freshwater in the heat exchanger cools the engine, and seawater cooled in the heat exchanger is discharged into the exhaust mixing elbow. Even if you boat in southern climes, use an antifreeze-water mix or a corrosion inhibitor year-round to help prevent corrosion.

To drain the coolant, open the filler cap to vent the system, remove the drain plugs from the engine block and heat exchanger, and collect the solution in a container for proper disposal. After draining, replace the drain plugs. Before refilling, service the heat exchanger. First close the seawater seacock and detach the inlet water hose. Remove the end covers and O-rings then extract the tube stack. Use a heat exchanger bundle brush or pipe cleaner to remove fouling in the seawater pipes. Flush with clean water. Reassemble the tube stack, grease and insert new O-rings and fit the end covers in the housing. Be sure to properly align the locating pin. Tighten the bolts, reconnect the hose, and refill the cooling system through the filler cap, either with coolant or antifreeze mix to the correct level. Refer to your service manual for recommended engine coolant mixture



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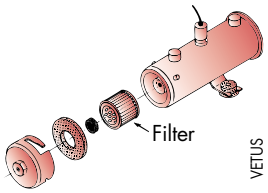
and capacity. Replace cap if corroded, and gasket if worn.

Annually check engine remote stop control. This device allows you to shut off the engine in an emergency or from below when servicing. It seldom fails, but often corrodes, especially engines fitted with a pull-push cable. Normally there is no need to adjust the stop control.

Clean fuel lift pump filter. Check your engine manual for servicing frequency. Many newer engines have an electronic fuel lift pump. Close the fuel shutoff valve. Disassemble the pump to clean the filter. Open the shutoff valve and check for leaks. After cleaning you'll have to bleed the engine.



Check the valve clearance at servicing intervals specified by the manufacturer. This is normally done on a cold engine, though some engines are adjusted hot, so follow the instructions in your service manual. Remove the bolts holding the rocker cover. Locate the timing marks (TDC) for cylinder one at the end of the compression stroke. Check valve clearance at cylinder one with a feeler gauge and turn screw adjustment, if necessary. Repeat this procedure for remaining cylinders, following manufacturer's directions. Apply a high-temperature liquid gasket to the inside edge of the rocker cover and reinstall. Jansen cautions that if you're unsure of this procedure, have the valves serviced by a qualified marine diesel mechanic.

Visually examine engine mounts. Check for breakage, loose nuts and condition of rubber pads. This is normally done annually.

Torque head bolts every two years. Use a good quality torque wrench (Gray) to torque head bolts. Follow the engine manufacturer's specifications and sequence as outlined in the service manual.

HANDS-ON DIESEL TRAINING

Do you want to learn more about your engine? Two firms that specialize in the sales and service of diesel engines are offering seminars for amateur mechanics in 2001.

Mack Boring & Parts Company, headquartered in Union, New Jersey, in conjunction with Engine City Technical Institute is conducting one and two-day classes for owners of Yanmar engines at Mack Boring locations in New Jersey, Massachusetts, North Carolina and Illinois. Thirty-one classes in total run from January through to June at the different facilities. The one-day Basic Diesel Seminar (US$150) covers the components and operation of all models of Yanmar engines and is a prerequisite for the two-day, hands-on Diesel Engine Course (US$400). For information call 800/305-3487, or log on to www.enginecitytech.com.

E&C Marine, Toronto, Ontario, offers a series of seminars for owners of Yanmar, Westerbeke, Universal, Volvo and Bukh diesels, as well as the gasoline Atomic 4 engine. The hands-on, one-day seminars (CDN$200) focus on the maintenance and troubleshooting of all engine systems and related components, drive train servicing, engine winterizing and more. For information, or to register, call 416/363-7770, or email to ec_marine@msn.com.

Class sizes are limited in all seminars, so register early to avoid disappointment.

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ANNUAL REFIT Projects

There is probably no better way to spend an off-season weekend than puttering around the workshop. Here are some ideas to tempt you.

Fiberglass

STERN LANDING

Easy-to-follow instructions for building a fiberglass swim platform with molded-in non-skid.

By Michael Myers

It all started on a summer day in 1997 onboard our 1970 9.4m (31') Chris-Craft. My wife casually said, "We need a swim platform." My marina neighbor added, "You can't build a swim platform too big." This seemed like a good idea, but the platform could only be made of fiberglass so that the non-skid pattern would match the diamond-textured non-skid deck surfaces.

The key to the project was how to replicate the non-skid. A year later, while sitting in the dentist's chair and staring at the ceiling, the lens in the fluorescent light fixture above inspired the solution. The back side of the lens was probably the pattern I needed to do the job. I headed directly to a school supply place, bought some modeling clay (expensive stuff!), went on to Home Depot, pulled out a fluorescent light lens, and laid it down in the modeling clay. Sure enough, the pattern was close enough for me.

That night, still knowing nothing of fiberglass lay up, gelcoat or the particulars of female molds, my wife and I returned for the materials to build the mold and work table for the project.

Mold Making

We built a table to support the mold during the project. The table was 1.5m x 3.3m (5' x 11'), made of 2x6 fir pieces laid on end, with two intermediate pieces lengthwise, and covered with 19mm (3/4") particle board. This sat on two saw horses.

The female mold was constructed on top of the table. First, 3mm (1/8") tempered hardboard (like pegboard without the holes) was cut to the shape of the platform and four holes cut out for the non-skid. This pattern was then glued (with polyester resin) to the table top. Next, four light lenses were cut to match the shape of the holes in the mold. Initially this was a problem since the lens would shatter when touched with a jigsaw or skillsaw. To prevent breakage, I used a very thin cutting blade, one normally used for metal, chucked into a drill that was clamped in a vise so the blade touched the workbench, and then slowly fed the lens, cutting it to shape. Lenses were then glued to the table top. Resin applied with a syringe filled the small gaps between the lens and hardboard mold. The bottom of the mold now formed the top surface of the platform. Edges of the mold that formed the platform edges were made of

Author's party-size home-built fiberglass platform nicely blends with the styling of his older Chris-Craft.

3mm (1/8") hardboard cut into 10cm- (4"-) wide strips laid on edge, and jammed against the mold. These were held firmly in place with about 30, 5cm by 5cm by 15cm (2" by 2" by 6") wood blocks screwed to the table top.

Building the inboard edge was difficult. I wanted the platform to mount to the transom with a few contact areas, each about a foot long, with cutouts between the platform fastening points on the boat to drain water. A pattern of the transom's vertical and horizontal curves was made of wood blocks and some boards that I cut and clamped until I had a piece that fit (not an easy task on a floating boat). The mold was cut to match the pattern and cutouts were formed from 2x4s,

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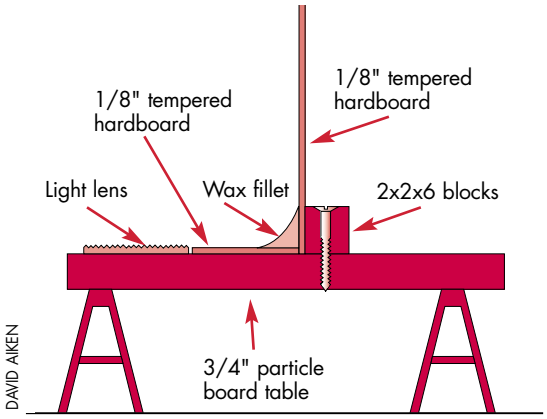


Plan of female mold and table frame.

radiused and screwed inside the mold.

I had no idea how to radius the inside 90° angle between the top and edges (sides) of the platform. FiberGlass Coatings (813/327-8117), a Florida-based supplier of repair materials, suggested using wax fillets, triangle-shaped pieces of wax about 19mm by 19mm (3/4" by 3/4") wide and 45cm or 61cm (18" or 24") long, placed on the edge, then heated with a stainless-steel ball until melted into a nice radius. It took practice to get the radiuses just right. If the ball was too cold, it pulled the wax; to hot and it plowed leaving ridges on each side. At the same time, we started to work on the lay-up schedule and the particulars of releases, gelcoat spraying pressures, etc. Since I wanted to order pre-mixed gelcoat, I purchased paint that matched the hull color, sprayed some swatches and sent them to Fiberglass Coatings to match the gelcoat.

Prep Test

I'm one of those guys that figures practice is for sissies, but in this case, I decided that I should assemble some test panels first. A mistake in the final platform might be irreparable, and I had invested too much money to fail. I built some sections about 45cm (18") long, complete with the edge, piece of lens, wax fillets, spray releases and gelcoat. I made every possible mistake. FiberGlass Coatings helped again by recommending a sprayable product that would ensure the release of the non-skid's complex shape. (I couldn't use a paste-wax release on the mold because of the textured non-skid.)

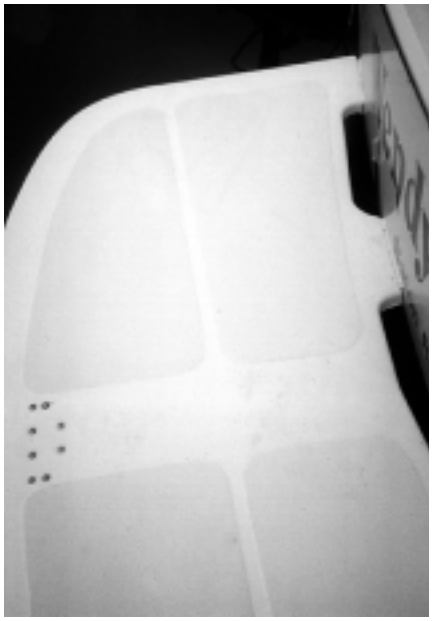
Lay-Up Procedures

Before starting, I cut all the cloth to fit, numbered the pieces and stacked them in order so first down was on top of stack. Also the foam core was precut at about 7.6cm (3") smaller overall than the platform. If cut full size, the core would not match up with the edge radius. What follows are the instructions I developed for glassing a platform. You'll find additional details in the how-book available from Fiberglass Coatings.

Day 1 Apply Release and Gelcoat

Spray three coats of PVA at 60 psi. Spray 5 light coats of TR 214 with an auto sprayer at +/- 20 psi. Let dry and wipe with a clean rag between each coat. When the last coat dries spray gelcoat with gun at 50 to 55 psi, at least 20-mils thick and let dry completely. In spite of what the pros recommend, I found that in my test panels you must apply the gelcoat thick, 1/16" to 3/32" is about right; too thin and the resin-mat layer "melts" the gelcoat. The mold was then covered so no dust could settle on it overnight.

Day 2 Lay-up Coat Klegecell (foam core) with resin on one side and edges. Apply 3/4oz mat using a gallon of resin. Use a mohair roller with phenolic (solvent-resistant) core and roll out mat with a ribbed roller. Let cure, then cut out any air bubbles and patch. Apply 1-1/2oz mat using about 1-3/4 gallon of resin. While wet, lay down



Diamond-textured non-skid pattern (darker areas) is made with fluorescent light fixture lenses. Cutouts in platform allow water drainage.

-Tip- FIX FOR GLASS VOIDS

Fiberglass cloth has a "springy" characteristic the can be a real problem when laminating a tight bend, especially where the bend is in a curved area of the molding, like the base of the hatch coaming, or, in my case, the keel of a wood strip kayak. This springiness can cause air bubbles and an unevenly cured surface that can result in hours of sanding and a weak joint. Here's a way to avoid the problem. Purchase some 3/4oz cloth from a hobby store that caters to the model aircraft crowd. It's as sheer as fine silk. Use a dowel or a broomstick that has the diameter of the cloth "bung" needed. Loosely roll about 10 turns of cloth around the dowel, and secure this with a little masking tape. To patch the bend, prep and heavily coat the area with epoxy resin, carefully slide the cloth off the dowel, then stick on the rolled-up bung. It conforms great and edges are easy to power-sand fair.
— Doug Barnard, "Fiesta Bimbo," Agoura, Calif.

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DIY MATERIALS LIST

I didn't shop price, though I'm sure some of the materials could be purchased cheaper. Instead, I purchased all goods from one supplier. Any price differences I considered as valued "consulting fees" since I couldn't have done the project without professional advice. All prices are in U.S. funds.

Mold and table frame	$70
19 wax fillets	$14
1 #4 wax fillet tool	$28
1/2 gal color-matched gelcoat	$120
4 yards 3/4 oz mat, 60" wide	$11
8 yards 1-1/2 oz mat, 60" wide	$35
8 yards XM1808, 60" wide	$66
1 piece 5/8" Klegecell	$107
2 quarts TR 214 mold release	$17
2 pints PVA mold release	$8
2 5-gal cans low-profile polyester resin	$179
1 pint MEKP	$7
2 12cc syringes	$3
1 1" by 6" aluminum ribbed roller	$15
1 1/2" by 3" aluminum ribbed roller	$10
1 G100 cup gun for spraying gelcoat	$149
3 2oz containers Marine-Tex epoxy	$24
Consumables (100 latex gloves, mixing pots, etc.)	$30
Total	**$893**

XM1808 mat (a double-bias mat stitched to a layer of mat), then wet back side of Klegecell with resin, lay in and weigh down until the resin kicks and holds it in place. Apply 1-1/2oz mat over Klegecell, then lay down XM1808 with mat side down. To build up the area where the platform mounts to the boat, apply 3 or 4 reinforcing strips of XM1808 mat on the transom edge, cut so it overlaps the core by a few inches.

Day 3 Let cure 4 days, at 15.5°C (60°F) minimum. Warmer is better.

Day 4 Trim the edges with a skillsaw, unscrew the edge blocks, pull the sides of the mold away. Now, just lift, and out it pops, if all goes according to plan. Since the mold release didn't leave a perfectly smooth surface, the platform required about an hour's worth of polishing and waxing to complete the job.

Mounting System

For the custom mounting brackets, I had a local machine shop cut 8, 3.8cm by 3.8cm (1-1/2" by 1-/12") stainless tabs, and 8, 2.3mm (3/32") thick,

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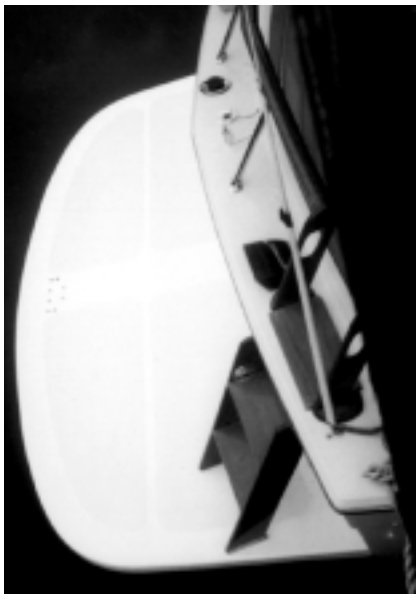

Finishing details: Mahogany ladders extend to the wooden stern rail. Screw heads in the center of the platform on the outer edge hold a retractable fold-down ladder.

10cm x 10cm (4" x 4") plates. The tabs were drilled with two holes each, then welded perpendicular and centered onto the plates. This made four brackets for the transom and four for the platform. Where these plates mounted to the bottom of the platform, I cleaned the surface with solvent and sanded, then glassed on two, 30cm (12") square pieces of XM1808 mat. When cured, I glued on (using Marine-Tex) the plates after sanding the mounting surfaces. Next, I cut out some smaller pieces of XM1808, about 25cm by 25cm (10" by 10"), slit a hole for the tabs to stick through, and glassed them over the plates.

We hauled the boat and dry-fit the platform. The four transom plates mounted below the waterline were bedded in 3M 5200 sealant and bolted with mahogany backing blocks on the inside and oversize washers. Tabs on the transom and platform plates connected with pieces of stainless-steel angle bolted with two 9mm (3/8") stainless bolts. These pieces formed a triangular shape that extended from the transom to about 20cm (8") from the platform edge. After bolting the platform to the transom, angled pieces were cut to their finished length, final bolt holes drilled, and everything bolted together.

To completed the job, a telescoping ladder mounted underneath the platform, and I built two short mahogany ladders, one for ingress from the platform to the transom, the other mounted on the stern deck, extending to the wooden handrail that was cut back for an entryway. Total cost with all materials, tools and haulout was US$1,300, much more than I planned, but considerably much less than a custom-built platform, and it was fun!

About the author: Michael Myers and his wife cruise "Wendy Lynn," a 1970 9.4m (31') Chris-Craft, from their home port of Baton Rouge, Louisiana.

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ENGINES

HOME BALANCING OF MARINE PROPELLERS

By Ben Owen

While running my restored 1965 8.5m (28') Owens cruiser, I noticed some vibration that I couldn't track. Suspecting the propeller, I had it pulled and a local marine dealer repaired the nicks and polished it. I was surprised that the dealer didn't balance the prop.

DIY jig for balancing props.

Since the shaking continued, I tried to eliminate all other usual sources of vibration. I replaced the shaft coupling, checked the engine mounts, aligned the engine and straightened the shaft. For the final effort, I hoped that balancing the propeller would help reduce the moderate shaking. The balancing jig I devised is not perfect, but it did the job.

I drilled holes in the workbench for four threaded rods to support two pieces of 2.5cm (1") angle iron. Positioning the angles with nuts top and bottom allowed me to level the angles across the bench. Using a small level and a long straight board, angles were leveled shaftwise along the bench. No attempt was made to trim the angles to knife edge tolerances, albeit this is usually done when building a similar apparatus for balancing aircraft propellers.

I was amazed at the amount of imbalance I found when I placed the prop-shaft coupling assembly on the supports. The shaft turned 1-1/2 to 2 revolutions, then halted with the heaviest blade downward. A piece of tape marked the culprit. Now, I had to determine how best to remove metal off the bronze prop.

Carefully, I removed metal from the hub area using a file and a wire brush to clean the file frequently. I eyeballed this process without any fancy jigs or protractors. I continued filing and balancing until the prop balanced well on my jig. Polishing the filed area with 60- then 120-grit paper and finishing with 220 grit, completed the job.

Installed back on the boat there was a noticeable reduction in vibration the next time I ran the boat. Though marine propeller supply and repair shops would have done a more professional job, my crude jig worked, and besides, I get great satisfaction from working on my boat.

About the author: Seward "Ben" Owen has spent more than 2,500 hours rebuilding and repairing the 1965 Owens cruiser he purchased in 1985, and berths in Oshkosh, Wisconsin.

IS IT AIR, FUEL OR COMPRESSION?

When either air, fuel or compression is amiss, your diesel engine will not run properly. The easiest component to check is the fuel system. Charles Gallimore of E&C Marine Toronto, Ont., recommends that you carry a gallon of clean diesel fuel in a jerry can rated for fuel along with a spare length of certified fuel hose. Bypass your onboard tank and clamp one end of the hose directly to your fuel filter while the other end sits in the can. Run your engine for a few minutes off this reserve fuel and if it runs perfectly, than you can presumably eliminate the fuel system and the source of the problem.

—Jan Mundy

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Projects

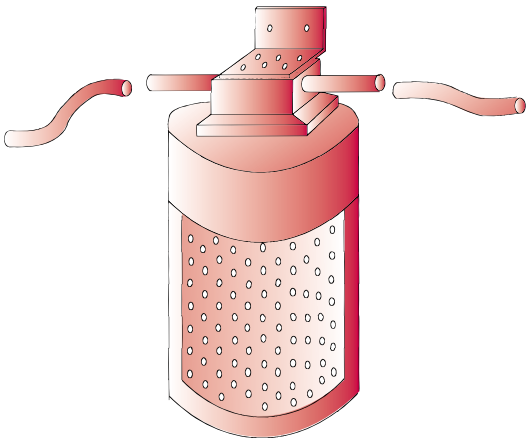
FILTER DIRTY WATER

By Don Boone

Any marine engine raw-water-cooling system should be filtered, regardless of where the boat is operated. Surprisingly, many inboard-powered boats are produced without seawater filters of any kind. I began researching seawater strainers after purchasing "Endless Summer," a Cascade 29, in the early 90s. At that time, all I could find were expensive marine filters in bronze housings that were much larger than my small four-cylinder inboard needed. There was also the problem of space in the engine compartment for a large filter. [Ed: Vetus offers myriad cooling water strainers made of thermoplastic resins with maximum capacities from 23L-min (14gpm) to a whopping 525L-min (140gpm).]

I found my solution for less than US$20 on a visit to a filter specialty store. I purchased a simple freshwater filtering strainer (for houses) without the filter normally sold for that unit as it was much to fine for seawater and would restrict water flow to the engine.

The filter housing is made of extremely durable plastic with a clear bowl for easy viewing. The bowl screws into the upper housing and seals with a rubber O-ring. To obtain a larger screen filter, I took a 7.6cm (3") diameter piece of black PVC pipe, cut to fit inside the clear strainer bowl. Then I drilled 3mm (1/8") holes through the pipe, about 12mm (1/2") apart, completely around the pipe from top to bottom. Start with smaller holes, run the engine, and if you need more water flow then drill slightly larger holes, though, I don't think you'll need to.



Seawater filter for inboard engines made of common household products.

On the top of the filter housing, I epoxy glued a 90°, L-shaped bracket. Five small holes drilled through the base allowed the epoxy to seep through for a stronger bond. This bracket had two holes for mounting to a vertical bulkhead in the engine compartment.

Before you epoxy the bracket to the filter, be certain the bracket length provides enough clearance between the chosen mounting surface and filter housing. If not, add a block spacer between the two surfaces.

An inlet and outlet on the housing accepts plastic pipe fittings. I recommend you purchase the more expensive bronze automotive hose fittings.

This custom filter effectively strains the larger dregs that you don't want inhabiting your engine block and provides adequate water flow for engine cooling. I used this device for eight years without any problems, it never leaked or came loose, and the boat's new owner still uses it.

[Ed: There is debate about the advisability of mating plastic and metal pipe fittings. Expansion coefficients are some concern, and thread compatibility is another. Consider the pros and cons before electing to mix the materials. One other concern is the effect that vibration can have on common household type plastics. Since, the manufacturer intended application is a static environment, the makers of these units do not build them to withstand the unique hazards of life in the marine environment. When it comes to marine grade fittings, you do get what you pay for. Using household-grade equipment could be a short sighted economy.]

About the author: West Coast sailor Don Boone writes for 12 magazines, many of which are boating related, and sails a Catalina 30.

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Rigging

HELP FOR TIRED PEDESTAL STEERERS

Edson pedestal refurbishing is an economical alternative to a costly pedestal paint job, plus labor and materials cost for repairing the steering gear.

Pedestal-mounted wheel steering systems become long-in-the-tooth with age. Bearings, chain, wire and other components degrade with wear, wheel brakes need relining and the once bright white, smooth pedestal finish is chipped and faded. The reliability of the steering system depends on the perfect harmony of its parts, regardless of age, and a meticulous owner will want the system's housing to look sharp, too. Edson, a Massachusetts based company, offers its pedestal refurbishing program for about the cost of an expensive folding propeller.

If your Edson steerer is in need of an overhaul, contact Edson Customer Service (508/995-9711) to get your return authorization number. Disassemble the system, remove the pedestal, clean and degrease all the parts, and box everything, including the quadrant, wire, chain and other components that you would like evaluated or restored, and ship it to Edson. It takes about 2 hours to disassemble a steerer with a screwdriver and wrench. The toughest part of job will be removing the stainless-steel bolts that hold the aluminum pedestal base. These can be effectively welded to their metal neighbors as a result of corrosion , and freeing them could require power grinding.

The base cost to refurbish the smaller model 335 steerer is US$275, plus US$80 to reline and renew the wheel brake; model 400 costs US$435 including the brake. Edson will inspect your steering system, replace the bearings, liners and other maintenance parts, give you an estimate for any parts or repairs not covered under the refurbishing plan, and pack everything in a new powder-coated pedestal complete with new mounting bolts. Just reinstall your like-new steerer, and go sailing. Pedestal-mounted engine controls can also be restored for under US$100; pedestal guard top plates for US$56 or less. Allow two to three weeks for delivery in the off-season — much longer if you wait till spring.

— *Jan Mundy*

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Projects

SAIL CHAFING GEAR

Compared to the cost of a new sail, baggy wrinkles are cheap insurance.

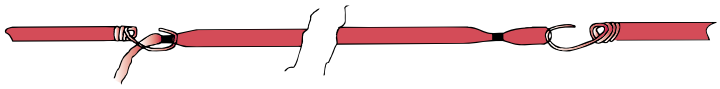
By Don Boone

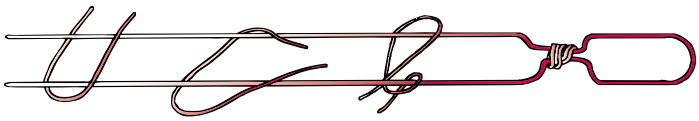
Are your sails showing the telltale skid marks? Those black marks from chafing sailcloth on shrouds during normal sailing activity. The sail luffing from being in "irons" or running downwind with the mainsail resting against a lower shroud will surely take a toll on a sail's longevity and appearance. Baggy wrinkles attached to the standing rigging could be an answer to deferring the inevitable wear by protecting the sail from direct contact with the shrouds, while adding a distinctly traditional look to your boat.

Spreader boots help to protect sails from tearing at the spreader tips, but not against sailcloth chafing. Baggy wrinkles are not new, in fact, they have been on traditional sailing boats for centuries, yet you seldom see such nautical attire on modern cruisers.

The main talent you need for making baggy wrinkles is patience. You'll also need hemp line, sisal twine and some space to work with a couple of posts (stanchions will do) about 2.4m to 3m (8' to 10') apart. I prefer manila hemp rope. Almost anything else will crumble, rot or just plain droop in a relatively short time, though some boaters opt for synthetic line as it doesn't retain moisture that could corrode aluminum spreaders. In any case, a 2.5cm (1") diameter piece of stranded line generally has four twisted strands.

To get started, cut a 4.2m (14') piece of sisal twine. Tie the loose ends together in a knot about 15cm (6") from the ends. Also tie a knot, 15cm (6") from the loop end (**top illustration**). This becomes the top. It's easier if you hitch these ends to posts, or other convenient vertical (the mast), with bungee cords. This keeps the twine line taunt while you attach the hemp "brushes."





Cut the 2.5cm (1") manila line into 15cm (6") pieces. You'll need 18 of these to produce a baggy wrinkle about 30.4cm to 38cm (12" to 15") long, depending on your boat's shroud diameter and how tightly you wrap them. Now separate one hemp section into individual fibers, and attach these to the twine. To do this, loop each fiber strand around the outside of the twine, beginning at the loop end, tuck the ends down between the two strands of twine (**bottom illustration**), and pull. Push each strand tightly against one another to lock them in place. Continue this process until you can't stuff any more strands onto the twine.

Rig a bosun's chair and go up the mast to the spreaders, upper shrouds, aft lowers or the area where you want to install your new baggy wrinkles. If you're mounting them at the spreaders, start about 17cm (7") above the spreader tip. This places the baggy wrinkle about the same distance below and above the spreader tip. If you don't trust your knots, use a wire tie to secure the loop end (top) of the sisal twine. You then spiral wrap your twine-hemp "fender" around the shroud, working from top to bottom. Secure it tightly to the shroud when you reach the end.

Weathering may turn your new baggy wrinkles a darker color and they may not be quite as feathery, but they will provide the intended protection. If you're the first one in your marina to use baggy wrinkles, you'll likely have many visitors asking what those "brushes" are doing in the rigging.

About the author: Since the mid-sixties, freelance writer and author Don Boone has sailed the waters around the West Coasts of the U.S. and Canada, including nine years living aboard. He currently sails "Itchy Feet," a Catalina 30 out of Sequim, Wash.

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Electronics

A REAR VIEW

Shopping for an inexpensive, 12-volt closed-circuit TV system to view events from the stern end is just a click away.

By Charles Husick

Navigating in a narrow channel can present problems when you're unexpectedly overtaken by another boat. Since few boaters bother to use horn signals, seeing what is behind you can be as important as seeing ahead. What's lurking behind you is a special concern on powerboats that are operated from a lower helm station or the flybridge where structural obstructions can block a clear view aft. Sailboats steered from a pilothouse present similar limitations.

Some boaters have solved the problem by installing closed-circuit television systems with a camera fixed to look aft and a TV monitor at the helm. These systems work well, but are costly to buy and require considerable installation work to route the coaxial cable from the camera to the monitor. Now, there is an effective, low-cost alternative that is available via Internet e-shopping at www.x10.com.

You can gain visibility aft with an easy to install, indoor-outdoor TV camera system from the X10 Company. You won't need to run coax cable, and the only wiring required is a 12-volt DC power supply for each camera and TV monitor.

The X10 Anywhere Wireless Camera Kit consists of four elements: a color TV camera with built-in microphone connected via a 3.6m (12') cable to a 2.4 GHz radio transmitter; a 120-volt AC to 12-volt plug-in power supply and address control for the camera; a 2.4 GHz receiver-converter whose output connects to a TV to display what the camera sees; and a 120-volt AC to 12-volt DC power supply for the receiver.

The total cost of the system is US$98 with a certificate for an additional US$40 worth of home electrical system products. The same system, but with the camera and transmitter in one unit, sells for US$10 less.

As boats typically have an adequate supply of 12-volt power, the AC power supplies won't be needed, but don't toss these as you can use them with the system at home when it's not in use on the boat. The camera consumes very little power, less than 80 milliamps (0.08 amps), making it practical to power it from a small battery.

Although by no means a high resolution camera, the system provides a quite usable 310 TV line image, even in relatively low-lighting conditions. It's more than adequate to view the boat about to overtake you at 40 knots. It has a fixed focus, fixed aperture lens and built-in microphone. The microphone is of little use when the system is employed as an electronic rear-view mirror, but it comes in handy if you want to monitor the kids in the cabin when the hook is down and you're enjoying a brew on deck.

The camera transmits video and audio via the 2.4 GHz radio link to the receiver-converter placed near the TV monitor. The output of the converter is in the standard NTSC format used throughout the U.S. and Canada. (The joke is that "NTSC" stands for Never The Same Color, but that is another story.) The signal is received on either TV channel 3 or 4, or sent directly to the TV's video-audio input jacks. The transmission range from the TV camera to the receiver-converter is about 30m (100'), adequate for most pleasure boats. Since the signal from the camera is sent on the radio link the system needs no coax cable connections. All the camera needs is a source of 12-volt power. The receiver-converter and TV, usually placed adjacent to the helm, also need a 12-volt supply.

Antennas on the camera and receiver-converter are easily adjusted to provide a clear picture on the monitor. The use of 2.4 GHz for transmission allows for very small antennas. The one on the camera is only 5cm sq. (2" sq.). The camera is available in a white, UV-resistant housing, however with an overall size of only 10.7cm by 6.3cm by

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Projects

The X10 Anywhere Wireless Camera Kit costs less than US$100 (less than a TV alone) and consists of a compact, color TV camera with built-in microphone and integral antenna, a wireless video receiver that connects to a TV to display what the camera sees and all necessary cable.

7.6cm (4-1/4" by 2-1/2" by 3") high it will be easy to devise a housing to protect the unit from rain and spray.

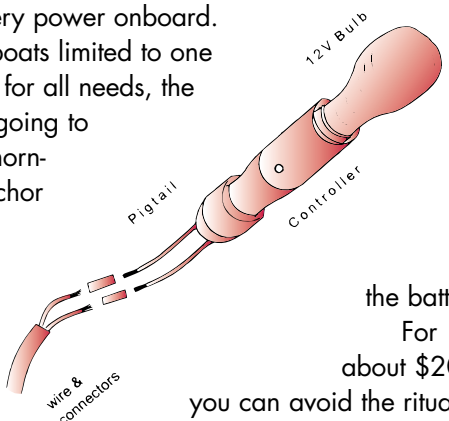
You'll probably find other onboard uses for this remote viewing-listening system. It can double as a babysitter for small children (equally useful at home), used to monitor the engine room or perform as a conversation piece at parties.

Beware! The X10 web site may cause a toy addiction. It's a fun place to visit, with many interesting offerings.

About the author: Charles Husick is a marine consultant and freelance contributor to numerous boating publications, and a former president of Chris-Craft.

AUTOMATIC ANCHOR LIGHTS

I'm always concerned about draining battery amps when using an anchor light. Owners of bigger boats probably don't share this concern because they have plenty of reserve battery power onboard. For smaller boats limited to one battery used for all needs, the engine isn't going to start in the morning if the anchor light has drained the battery. For about $20, you can avoid the ritual of trying to minimize the power drain by counting the amps you'll save by staying up late to turn on the anchor light at the last minute, and waking in the early morning to turn it off.



Consider assembling a simple photoelectric-controlled light system that turns the anchor light on when it gets dark and off when it's light. (There are more sophisticated, off the shelf automatic anchor lights on the market at about twice the price of one you can make yourself.) You probably won't need instructions to assemble this light as the parts speak for themselves.

You'll need to buy a pigtail and a simple light bulb socket (US$4) with two wires exiting the bottom of the base. As these wires won't be long enough to reach from the anchor light location to the battery supply, purchase more wire plus properly sized butt connectors to splice the wires. (Ed: All wires should be stranded and meet the wire type and size requirements specified in ABYC E-9's wire sizing chart, or refer to "Wiring Handbook," in DIY 1998-#4 issue.) You'll also need an auto light controller (available at Radio Shack, PN 61-2776, for US$8). This is simply a photoelectric eye gadget that senses light and darkness and is the brains of the automatic light. From your local chandlery or mail-order catalog store, purchase a supply of 12-volt, 15-watt, DC light bulbs (US$4 each) that screw into a standard light-bulb socket. Total cost is about US$20, depending on length of additional wire needed. Power draw is slightly more than 1 amp per hour.

To assemble, crimp the butt connectors to the pigtail and to the wires leading to your boat's positive and negative distribution loads. Use heat-shrink connectors to eliminate moisture. Except for the crimping, it's a simple screw-it-together project.

About the author: West Coast cruiser Don Boone has used novel devices onboard "Itchy Feet," a Catalina 30.

-Tip-

SCRATCH PROTECTION

Avoid cleaning and repairing floors, carpets, countertops, decks or upholstery when doing renovations onboard by applying self-adhesive polyethylene film from Protective Products (800/769-6633, www.protectiveproducts.com) before you start. A better alternative to heavy-duty paper or newsprint, both which tear easily, it's available in various roll lengths and finishes that stick to wood, carpet, porous and non-porous surfaces and peels off when the job is done.

— Jan Mundy

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CENTRAL INTELLIGENCE

If you're planning a repowering job, major instrument upgrade or extensive wiring rehab, this high-tech, time-saving "smart" system is the now-generation of electrical installations.

Story and photos by Jan Mundy

Imagine adding a voltmeter or chart plotter and after the dash installation it takes just 15 seconds or less to wire it. No crimping, no heat-shrink terminals. Just plug and play. Imagine having one screen that displays everything you need to know about your engine and boat: water depth, engine coolant temperature, boat speed, fuel consumption, battery voltage, wind speed, compass heading, rudder angle and more.

This is now possible with Teleflex's MagicBus, and it's coming to a dealer near you. Using the latest in computer and marine technology, MagicBus is a control area network (canbus) that serves as a digital backbone to connect intelligent instrumentation, remote displays and control devices. It consists of multiple mainframes, namely electronic control units (ECU), each col-

Teleflex MagicBus components: (1) Serial gauges connect to datastream for uninterrupted diagnosis; (2) LCD display provides selectable engine status and boat monitoring; (3) Smart main switch panel delivers multi-function control of electrical components; (4) Rocker-style switches function independently or via the network; (5) Fully-integrated chart plotter, fish finder and GPS; (6) Electronic shift and throttle offers adjustable detents for shift and throttle, self-calibration for individual driving styles, synchronization, multiple idle options, shift delays and safety features; (7) computer-controlled autopilot connects to existing hydraulic steering and interfaces with a GPS.

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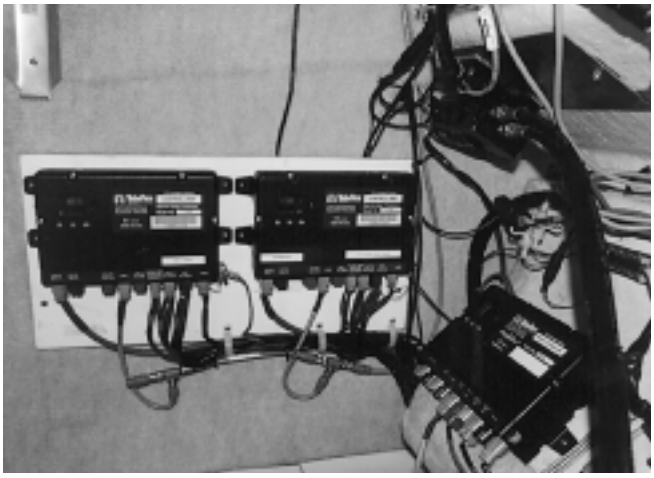
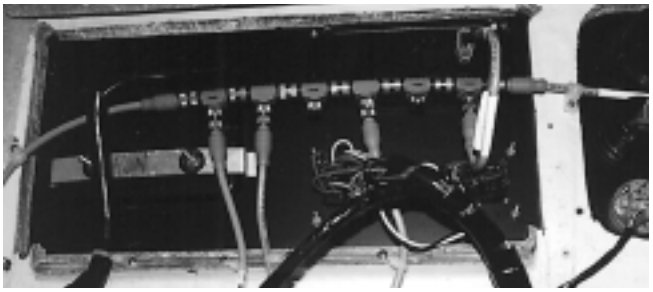
Projects



Two "brains" collect data via the bus from the shift-throttle control then each one transmits to only one engine and a pair of shift and throttle actuators. Pilot computer (shown on the right) manages instructions from the dash-mounted remote hand-held control to the autopilot.



Installation of components is fast and simple with daisy-chain wiring and snap-together connections.

lecting and sending packets of information via the bus. Separate ECUs are required for each engine, one for high-power devices and one for electronic accessories, depending on the amperage draw.

"Since the canbus can only carry up to 9 amps, partner pieces plug into different control units," explains Joan Neill, marketing coordinator for MagicBus. "This means you can't directly connect bilge pumps larger than 9 amp-draw, for example, so these link instead to separate control units that then transmit the signal onto the bus."

Available Teleflex Intelligent Systems (TIS) components that read into the MagicBus include: engine actuators, one for both throttle and shift, one pair per engine; analog gauges; autopilot; shift-throttle control; combination chart plotter, fish finder and GPS; main switch panel to control lights, power supply, stereo, etc;

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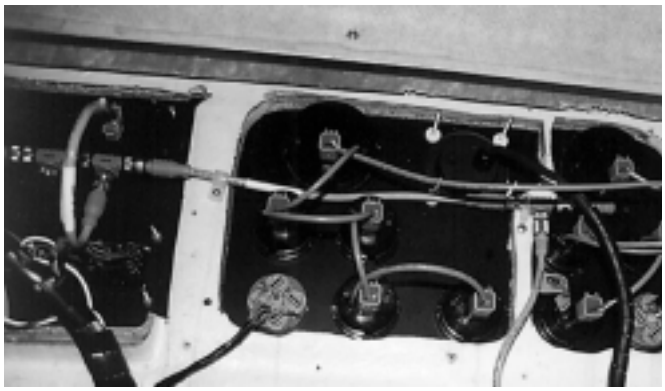

Maze of wires forms standard gauge installation. Adding gauges to network is simple with plug and play connections.

and remote LCD that monitors all engine and boat systems. Any TIS components can be used in a stand-alone system, in the network or easily added at a later date. Since TIS are designed to the NMEA 2000 standard you can connect any NMEA 2000 compatible marine electronics, (i.e. different brand autopilot or depth finder), not just TIS equipment.

Plug and play installation lets you repair, upgrade or add components easily. Daisy-chain wiring and snap-together male-to-female watertight connections mean you don't have to construct individual point-to-point wiring. Pre-assembled cables, available in different lengths, are complete with T-fittings, straight fittings and waterproof terminator caps on ends. Cable and ECU connections are all color coded and of different shapes, which makes assembly idiot-proof (i.e. actuator cable can only plug into actuator port on ECU). Functional, user-friendly and completely modular, this system excels in a repowering installation.

"Where normally all electrical wiring instrumentation components are ripped out and replaced point-to-point, MagicBus eliminates a ton of wiring," says Neill. "The savings in time and labor using this technology is unparalleled. Once equipment and control boxes are mounted, all that remains is how best to tag the cable."

For now, Teleflex MagicBus and TIS components are only available to boatbuilders, with systems for consumer purchase planned for market by summer of 2001. Suggested list prices start at US$2,000 for a single station, single engine installation, which consists of a ECU, actuator and shift-throttle control plus options: programmable throttle (US$100), trim switch (US$40), synchronizing function (US$300) and all TIS components.

— Jan Mundy

-Tip- THE PERFECT TOUCH-UP TOOL

Minimize your rag inventory with 3M Marine's reusable ScotchBrite High Performance Cleaning Cloth (US$8/CDN$13.50 each). This patented cleaning tool cleans and polishes without scratching, streaking or smudging surfaces, and often without the need for liquid cleaners. Use it dry, and tiny microfibers trap dirt, dust and grease. Use it with a solvent and it absorbs the dirt. When it becomes soiled, machine wash it up to 300 times (but don't use a fabric softener). Available in five colors in single or multiple packs. FYI: This product won the 2000 Boating Innovation Award in the soft goods category.

— Jan Mundy

DIESEL RELAUNCH GUIDE

- Clean engine and touch-up rust spots with paint.
- Manually tension all V-belts.
- Inspect anti-corrosion zinc(s) and replace as needed. Examine hoses and hose clamps for cracks or chafe.
- Check wiring for corroded or loose connections.
- Inspect engine fuse and fuse holder.
- Check coolant level.
- Check engine oil level.
- Check gearbox oil level.
- Check engine mounts.
- Check engine pan for coolant, fuel or oil leakage.
- Reconnect battery cables, check electrolyte levels and refill as needed.
- Install new impeller.
- Open seawater intake seacock.
- Tape a bag over exhaust outlet to collect antifreeze.
- Start engine and run at idle for 5 minutes while carefully observing engine and exhaust. Check operation of instruments, shift-throttle cables and the remote stop control. Stop engine.
- Pump out (or drain) oil in gearbox and refill with oil specified in owner's manual.
- Drain water from fuel filters.
- Replace water separator-fuel filter and engine fuel filter.

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Woodworking

COCKPIT QUARTERS

Custom hardtop enclosure provides shelter and additional living and storage space.

By David and Zora Aiken

"My boat would be just perfect if it was only 3' longer." This is a classic dream for a lot of boaters who suffer from bigger-boat syndrome. At least one boat owner we know acted on that wish and lengthened his boat. Not one to worry about naval architecture, he simply cut the steel hull in half, made a new center section, and welded the pieces together. Obviously, no such add-on was a feasible project for our fiberglass, center-cockpit sailboat but we did find a way to gain extra usable space by enclosing the cockpit.

Since the maximum beam of our boat is in the center-cockpit area, a roof-over, coupled with the option of side enclosures (weather being the optional directive), gave us a new room without the need for any drastic hull modifications. This addition may not transfer exactly to other boat designs, but the planning and procedures can be applied to similar projects.

Renovations weren't a one-time change, but rather evolved over many years. Originally, our boat had a windshield with a very long, attached canvas bimini that covered the cockpit. We planned to remove this strange looking combination until a trip south changed our minds. The enclosure kept us dry, warm, and sunburn-free. We could travel on the worst of days, as we liked.

For years we patched or replaced canvas, until we finally realized that there was very little reason to have a removable top. A permanent hardtop would be easier (and cheaper) to maintain, so we built one.

In our first modification, we added side panels connected to the windshield to create a partial wheelhouse. A new hardtop extended from the windshield to just over the wheel. Except when wind drove rain inside, the helmsperson was covered and stayed dry. We traveled north and south with the seasons, so we didn't need any extra protection.

Starboard side of finished hardtop with enclosure shows vinyl "portlight," and zippered canvas entrance aft on the port side.

It took another 12 years, with one winter spent dockside in a latitude that saw snow occasionally, to convince us that it was time to entirely enclose the cockpit. We could keep the boat warmer in winter, cooler in summer, dry all year, and the shelter gave us the added bonus of a three-cabin boat.

Planning

So far, trading the canvas for a hardtop hadn't much changed the original look of the boat. But this extension would require added supports aft and on the sides. Since we didn't want to affect the overall look or character of the boat, and it's impossible to picture the end result from overview plans, we photocopied a profile drawing from an original spec sheet, enlarged it and began sketching alternatives. A profile photo also provides a start for a basic drawing. Just copy it to a size that allows you to make easy alterations to a convenient scale. For example, a 44cm (17-1/2") copy of our 35-footer gave us a scale of 12mm to 30.4cm (1/2" to 1'). Computer buffs can also do some rough three-dimensional views. It's a good idea to transfer your design to cardboard templates or artist's mat boards, and construct a full-size model.

In the planning process, decide if or what ports or hatches you want, both for visibility and ventilation. Do you want doors or canvas, and/or screen enclosures on the sides?

Construction Details

After cutting a rough template of the aft bulkhead from 16mm (5/8") tongue-and-groove look closely resembled the paneling on some of the boat's interior bulkheads. A hole for the port was cut, then the final shape, cutting the top to match the curves of the existing hardtop, the bottom to match the aft cabin deck. Cardboard templates and a compass used as a scribe made it easy to transfer lines and duplicate arcs. When marking the dimensions for the aft bulkhead, be sure to allow sufficient height to accommodate the curves of both the aft cabintop and the new overhead.

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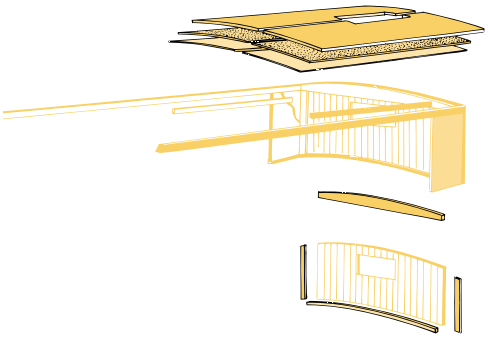
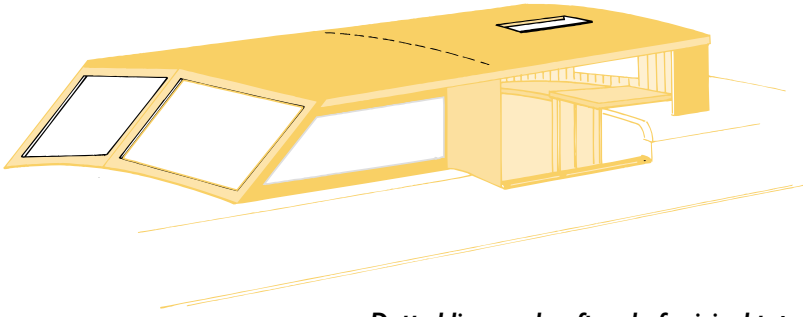
Construction Plan



DAVID AIKEN

Schematic of Finished Addition



Dotted line marks aft end of original top.

mahogany plywood, vertical grooves were router-cut into the ply at 5cm (2") intervals. This faux tongue-and-groove look closely resembled the paneling on some of the boat's interior bulkheads. A hole for the port was cut, then the final shape, cutting the top to match the curves of the existing hardtop, the bottom to match the aft cabin deck. Cardboard templates and a compass used as a scribe made it easy to transfer lines and duplicate arcs. When marking the dimensions for the aft bulkhead, be sure to allow sufficient height to accommodate the curves of both the aft cabintop and the new overhead.

Cleat stock, 2.5cm (1") square, was epoxy glued and screwed to the aft cabintop, and the aft bulkhead was glued and screwed to the cleat, making sure the wood remained perfectly vertical (use a level). Next, mahogany trim, 19mm (3/4") thick, was fastened to the inner edges of the bulkhead at the sides and top for added strength and to provide a larger mounting surface for the adjoining panels. Side trim measures 7.6cm (3") wide; the top trim varies in width from 7.6cm (3") at the sides to 15cm (6") in the center to match the curve of the existing top.

Framing to connect the aft bulkhead to the forward sections was lengths of 19mm by 7.6cm (3/4" by 3") mahogany, fastened with epoxy glue and screws. On our boat, this framing curves inward slightly, matching the curve of the cockpit coaming. This gives the sides graceful lines, helping to prevent what might have been a boxy look.

Now the 12mm (1/2") plywood hardtop was cut to shape, allowing a slight overlap to be trimmed after installation. Because of the span we were covering, we did it in two sections. Other boats may be able to use one sheet of ply. Using epoxy glue and screws, the top was fastened to the frames. Where the new top met the old, a trim piece was added to cover the seam.

We fiberglassed the hardtop next by laminating a layer of cloth, saturated in epoxy resin. If your installation requires that you be able to stand on the top, add wood beams on 30.4cm (12") centers to the underside for support. If using polyester resin, you can also laminate a layer of mat followed by a layer of cloth for extra strength.) Fill any voids with thickened epoxy, sand fair, and then apply four coats of clear epoxy resin. A primer and two coats of white single-part polyurethane paint finished the exterior.

If your plan calls for an overhead port or hatch, cut the hole and fasten fore-and-aft stringers along the sides of the cutout. On the underside of the new top, we posi-

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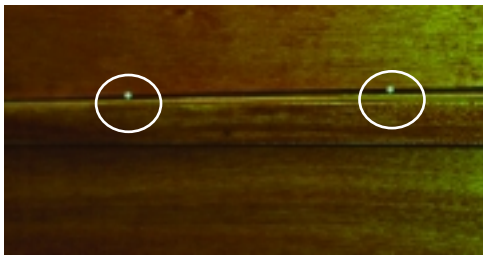

Small brass tacks hammered in at an angle temporarily fasten the ceiling panels, allowing easy removal for servicing of wires, etc.

(right) An inside view through entryway; (below) bolt rope sewn to canvas slides in a channel mounted on the hardtop.

tioned 6mm (1/4") thick, closed-cell foam insulation, and covered it with 3mm (1/8") mahogany-veneer plywood, held in place by small brass tacks spaced about every foot. This allows easy removal for access to wires, or whatever. To finish the sides of our new "quarters," we added narrow plywood panels in the corners joining the aft bulkhead, then varnished all inside panels.

Canvas "doors" closed in the space remaining between the side panels and the vertical end supports on the original hardtop. Each canvas side panel attaches to the hardtop by a bolt rope while turnbuttons at the sides and bottom hold the canvas in place. A vinyl starboard side window lets in light, and two zippers provide doorway access on the portside. We also ordered alternate screen panels for warm weather use. These attach to the overhead, so they roll up and out of the way when not in use. Lastly, we cut channels for the mainsheet and other control lines, and installed a 12-volt light.

Our enclosure continues to evolve. After taking great pains to natural finish the mahogany ply ceiling and aft bulkhead, we've now decided to paint the interior white to gain more light and perceived spaciousness. We plan to mount handrails on the roof, and eventually, install solar panels atop as well. While we are temporarily dockside, the cutout for the port in the aft bulkhead is used to hold a small, window-type air conditioner in the summer. Eventually, it will frame a window with sliding Plexiglas panels. [Ed: For a different design and procedure to build an all-fiberglass hardtop, see "Building a Hard Dodger," in DIY 1996-#4 issue.]

About the authors: David and Zora Aiken have written and illustrated numerous books on boating, camping and for children. They live aboard "Atelier," a 10.6m (35') Chris-Craft sailboat in Grasonville, Maryland.

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DIY BILL

All prices are estimated and in US funds.

1 sheet 16mm (5/8") Lauan* marine mahogany plywood	$70
2 sheets 12mm (1/2") Lauan* marine mahogany plywood	$100
Mahogany trim (old flooring)	$100
Fiberglass cloth	$20
1/2 gallon epoxy resin	$60
Rollers, gloves, squeegee, brushes	$40
Lexan port	$30
Cabin light and wiring	$25
Opening port (not yet installed)	$200
Total	**$645**

(*Meranti marine mahogany plywood is more commonly sold nowadays.)

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StarBoard

NEED A SWIM PLATFORM?

When the time comes to replace your wooden swim platform (or your boat is without one), this maintenance-free design is built of a do-it-yourself boat improvement material that's easy to fabricate and install.

By Dwight Powell

Our Chris-Craft Cavalier is typical of many cruisers of its generation. It didn't originally have a swim platform. In the late '60s, lots of things were free, but not the swim platform on this boat. It wasn't even available as an option.

Years later an owner added a swim platform. It consisted of cast aluminum supports with teak strips fastened on edge between the supports. There were numerous problems with this design. Teak strips made for an unstable walking surface and often cracked. Strip planking made it difficult to securely fasten the boarding ladder and davit brackets. The teak required periodic cleaning and refinishing, made worse by the narrow gaps between the strips. Paint flaked off the aluminum castings, leaving a blotchy appearance, much to my dismay. To fix the problem, I decided to use more modern methods by building a new platform of maintenance-free King StarBoard.

Original teak strip-planked swim platform supported by custom aluminum castings (top).

I dismantled the entire platform, including the support brackets mounted to the transom. These were cast aluminum and a few were broken. But after a professional stripping and cleaning, corrosion pinholes filled and white powder-coated by a company specializing in this process, they looked new (cost US$166/CDN$250). A local shop fabricated four new support arms made of stainless-steel tubing and new transom mounting brackets (US$133/CDN$200).

Reconstruction began with rebolting the castings to the transom, then fitting the support arms to the aluminum supports and mounting brackets to the transom. All hardware was bedded with a good dose of polyurethane sealant.

For the body of the platform, a 4x8 sheet of 2.5cm (1") King Starboard (US$500/CDN$750) was cut into strips on a table saw, then planed to size. Strips were laid over the castings, assembled edgewise, one strip at a time, and screwed together using galvanized steel deck screws, the green-colored ones available at hardware stores. Household deck screws are a good alternative for freshwater use, but boats in saltwater must use bronze wood screws, preferably Everdur a high-quality alloy. Also, deck screws have a long, smooth shank before the threads start, making them appropriate for StarBoard fastening. Drill screw holes oversize to allow for expansion of the StarBoard. I used a tapered drill bit, so the entry was wider to accommodate movement of the StarBoard. Twelve strips formed a solid platform with a few cutouts for drainage.

Modern looking platform made of StarBoard makes a nice addition for this classic cruiser.

It took 25 hours from the dismantling of the old platform to finishing the new one, which cost US$815/CDN$1,222 to build. This design provides an exceptionally strong base for attaching other equipment, and gives the platform a pleasing, modern look.

About the author: Since purchasing "Largo Lady," in 1991, Dwight Powell has rebuilt, replaced or reconstructed most of the boat's superstructure and systems. Deck resurfacing and adding new cabin windows, a bow seat and hardtop extension appeared in "Facelift for a Classic Chris," DIY 1999-#2 issue.

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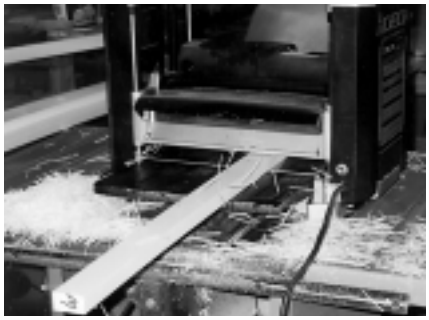

Author uses a table saw and thickness planer to mill StarBoard. "It cuts and planes like wood — even better," says the author.

Refinished white powder-coated aluminum castings mount to transom before laying in StarBoard decking.

Edge-laid strips of 2.5cm (1") StarBoard, screwed on one strip at a time. Stainless braces fasten to castings and mount to brackets on the transom.

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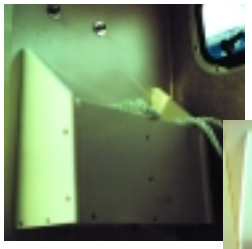
MORE STARBOARD

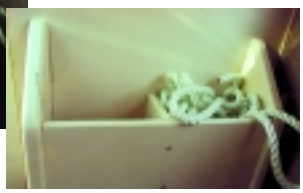
There aren't many items onboard, made of fiberglass or wood, that can't be fabricated of StarBoard. It cuts and shapes just like wood and is wholly maintenance-free. Since there isn't space in this issue to profile all the items we built this year of StarBoard, here are some of our favorites.

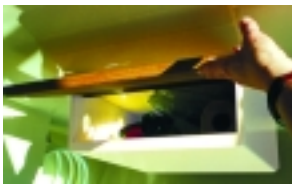
Lid for cockpit bar sink made of 12mm (1/2") material. Note cleats that position and hold top in sink opening.

Lid for the head and a comfortable perch for a shower.



Easy-to-make storage bin for binos, flashlight, lines, and whatever.





Overhead bin for odds and ends just needs a 3M Dual Lock to secure front cover.

Before: Following 10 years of cleaning, sanding, and recoating teak, it was time for a change.

After: New classy-looking, bright-white, no-painting-required StarBoard hatch board.

STARBOARD MADE EASY NOW ON *CD-ROM*

If you've been a long-time reader of DIY, you know I have a great fondness for StarBoard, (or other polymer-type material such as Vetus Poly-Wood which is available in Europe), likely because I built and maintain a wooden boat. Since first profiling this material in our 1996 Boat Refit issue (DIY 1996-#4), we have covered myriad projects in the five (including this issue) subsequent Annual Refit issues. Past articles provide complete step-by-step details on cutting, milling, shaping, drilling, gluing, fastening and finishing StarBoard, along with building plans for various gear. Because some of these back issues are sold out, DIY has just released a CD-ROM of the entire StarBoard Collection. The cost is just US$19.95. To order, call us toll-free at 1-888-658-BOAT.

— *Jan Mundy*

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Projects

Maintenance

-Tip- THE GLUE IS THE SECRET

The biggest problem with StarBoard is fastening it. Gluing requires complex preparation and the special glue sold by the manufacturer isn't readily obtainable. Some builders join StarBoard using mechanical fasteners coupled with 3M 5200 sealant, but this doesn't provide the same high-tensile structural bond only achieved by gluing. Now, there is another option. Scotch-Weld Structural Plastic Adhesive DP-8005 from 3M, previously only available for industrial use in bulk quantities, will be available next year in retail packaging. A two-part acrylic-based adhesive, it fastens hard-to-bond plastics (i.e. StarBoard) without mechanical fasteners or complex preparation. Just wipe off dust or oil. No plastic "welding" required. It's available in white or black, and Scotch-Weld is easy to apply using the 3M EPX Plus Applicator, 10:1 plunger and 10:1 mixing nozzle. Cost for the applicator is under $100; 35ml (1.18fl.oz) glue cartridges sell for $40 or less. The glue only has a three-minute working time, so you need to have all pieces ready for assembly before loading the applicator.

— Jan Mundy

COCONUTTIEST TEAK CLEANER

By Vicki de Kleer

Maintenance work on boats is universal in scope and on a tall ship, with miles of rigging and masts, some higher than 40m (131'), the work is endless. Scrape, sand and paint, scrub and polish, replace worn gear and splice, even if the line is as thick as your arm.

One of the ships berthed in Halifax, N.S, had a unique method for cleaning teak decks. "Akogare," a three-masted topsail schooner built in 1993 for sail training, had a Japanese crew that kept the ship beautifully maintained — clean white hull, neatly furled sails, spotless decks.

Work onboard the Tall Ship "Akogare" includes a new approach to deck cleaning.

When escorted on deck, I was shown a bin of sand and another containing coconuts, sawed in half, which the ship obtains in Hawaii. To clean the decks, the crew sprinkled a little sand, then scrubbed using the cut surface of the coconut. The area is then sluiced down with seawater and rubbed with a fine stone, known as a "holy" stone. Deck cleaning was done on a regular basis, though I don't know how frequently, but I'm sure this abrasive, grain-raising technique is rough on the decking.

When you're in southern climes you may want to give this a try if you have a teak deck. There's plenty of seawater and sand. All that you need is a few coconuts and a saw!

About the author: A frequent contributor to DIY, Vicki de Kleer sailed onboard the tall ship "Lord Nelson," a 55m (180') three-masted barque, in the transatlantic leg from Halifax, Nova Scotia to Amsterdam, in The Netherlands.

HOW TO PLUMB BENDS

Plumbing a bilge pump, cockpit drains, sink or thru-hulls often necessitates bending hose at acute angles. Most rubber water hose collapses when tightly bent, and the cheap multi-flex corrugated stuff that does bend punctures easily and should never be used in critical installations. Vetus exhaust hose is the perfect solution. Form this hose into a tight coil and it retains its inside diameter without crushing or kinking. Unlike other exhaust hose, it can be used in pressure applications. The 50mm (2") hose, for example, is rated for 174 psi (or 12 bar). It's available in various diameters starting at 30mm (1-3/16") ID. Vetus black exhaust hose (look for the yellow stripe) is expensive at US$8 per foot for the 50mm (2") size, but a better option than using inferior hose or PVC tubing and adding elbows.

— Jan Mundy

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Canvas

HAPPINESS IS A BUG SCREEN!

With a Sailrite Ultrafeed machine and a few evenings work, you can sew this easy-to-make companionway hatch cover with built-in bug screen.

By Arlie Anderson

Many beautiful anchorages and dockside settings are made unpleasant by the presence of swarming flies and biting bugs. Sometimes, the only way to escape is to go below decks, close the companionway hatch and deck hatches (don't forget the vents) and sit in a stuffy, uncomfortably hot cabin. Long term survival depends on having good ventilation, preferably a cross draft. Opening and screened portholes help somewhat, but a better solution is to open the deck hatches. Our previous boat, a Catalina 28, had custom hatch covers made by a local canvas shop. With my new Sailrite Ultrafeed sewing machine, and some direction from the helpful canvas people, I constructed a companionway cover with built-in bug screen for our newly purchased Catalina 42.

This cover snaps over the outside of the companionway and fills in the area normally covered by drop-in hatch boards. You'll need to adapt the size to fit your hatch, but the basic assembly instructions will be the same.

Materials to make one hatch cover are: acrylic Sunbrella cloth, 1.4m (4.5'); V-69 or V-92 thread; fabric screening, .91m (3'); heavy-duty plastic zipper; 19mm (3/4") nylon webbing, 1.4m (4.5'); 15 stainless-steel snap fasteners; and staples and/or basting tape. Total cost is about US$40/CDN$60. Materials were purchased mail-order from Sailrite (800/348-2769 or www.sailrite.com) and some from the canvas shop. Besides a commercial heavy-duty sewing machine, tools needed include scissors, hot knife or wood burning tool, stapler, drill and bits, snap fastener cutter, punch and die, and screwdrivers.

Measuring

The cover attaches to the front top edge of the companionway hatch, both sides of the companionway and to the sill at the bottom. It should overlap the companionway opening by at least 4cm (1-1/2"). Measure each of the four sides and the total height of the companionway at the center point. Be sure to include allowance for the overlap.

Transfer your measurements onto Kraft paper, newsprint or cardboard using pencil and ruler. Cut out the pattern, tape it to the companionway and make adjustments as needed.

Now transfer the pattern onto the fabric, using a chalk pencil and ruler. Before you cut the fabric, double-check the size against the pattern. Cut the fabric using a hot knife or wood-burning tool to eliminate frayed edges. Cut the cloth screen-

CANVAS MADE SIMPLE

Sailrite (800/348-2769, www.sailrite.com) now offers seven how-to videos (US$15.95) and CD-ROMs (US$9.95) on making boat covers, cushions, spinnakers and socks, sail maintenance and more. The step-by-step format makes these must viewing before starting a canvas project or repair.
— Jan Mundy

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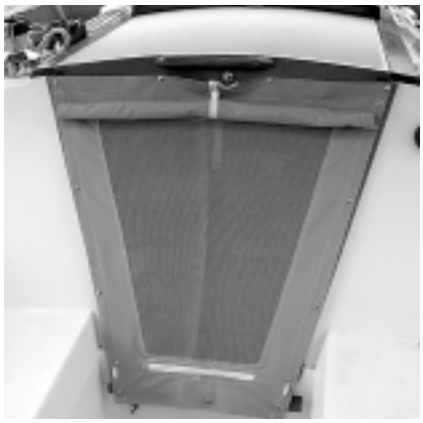
Companionway hatchcover with screen cover closed.



Screen cover rolled up and secured with webbing tab. Note placement of screen, zipper and snap fasteners.

ing smaller than the cover, so the screen edges run parallel to the cover and allow a fabric border of at least 12.7cm (5") on the top and both sides, and 15cm (6") at the bottom.

Putting Together

To sew the hatch cover, first mark a pencil line 5cm (2") in from the outside edge. Fold the fabric to the inside (wrong side) along this line, and crease it using scissors handles or some similar blunt instrument. Don't iron Sunbrella. Ironing it will destroy the UV protection. Cut a V-shape in the corners using a hot knife to reduce the fabric thickness to one layer when folded (**Figure 1**). Stitch the hem to the inside of the fabric, sewing one row of zigzag stitching or a double row of straight stitches.

Next, center the screen on the fabric, and trace around the edges. Temporarily fasten the screening in place with staples or basting tape. Sew the screening to the inside of the fabric using a zigzag stitch. Mark a pencil line on the outside of the fabric 5cm (2") inside the edge of the screening. Snip and cut the fabric along this pencil line, removing the center portion of the cover. The screening is now exposed on both sides.

There should be approximately 3.8cm (1-1/2") of fabric border around the screen on the front of the cover. This is then folded towards the screening to cover the raw edge. To do this, snip 12mm (1/2") slits at the corners (this gives a miter corner), then turn under the fabric and score it with scissors. Sew a row of zigzag stitching around the perimeter of the screening, 3mm (1/8") inside the folded edge.

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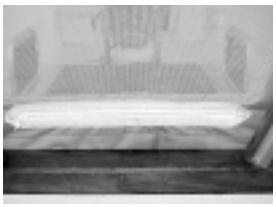
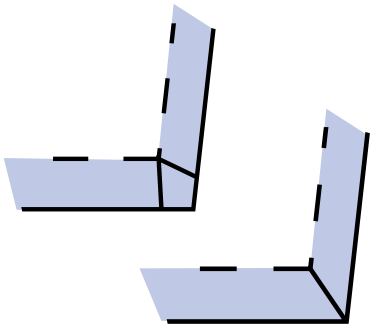


A view inside looking out. Note webbing sewn to sides. (top) Details of zippered opening with webbing reinforcement.

Mark the placement for the zipper above the companionway sill and at least 19mm (3/4") below the bottom outside sewing line on the screen. Cut the zipper the same length as the bottom width of the screen. Staple the zipper in place on the back of the cover, then staple the webbing around all four edges of the zipper. Sew a zigzag stitch around the outside perimeter of the webbing. Using the same technique as for the screening, cut a slit on the outside of the cover along the teeth of the zipper, leaving approximately 19mm (3/4") at both ends. Cut diagonal slits at the corners. Turn the fabric under (towards the zipper) and crease with scissors. Zigzag stitch along this creased edge.

The screen cover conceals both the screen and the zipper. To make one, cut a pattern the same shape as the hatch pattern. Hold this against the cover and mark the top and bottom hemlines. Now mark 2.5cm (1") above (or below) into the top and bottom hem allowance and draw cutting lines parallel to the pattern edges. Cut the fabric to match your pattern, turn under hems on sides and bottom, miter the corners (see above) and sew, using the same technique as for the cover. Cut a 30cm (12") piece of webbing, sealing the ends with a hot knife. Turn the top edge of the screen cover under 2.5cm (1") and score the folded edge. Fold under one end of the webbing and place at the center of the top of the screen so it lies between the hatch cover and the screen cover. Staple the screen cover and webbing to the cover, just below the bottom edge of the top hem. Sew with a double row of zigzag stitching. The sewing is now complete. All that remains is to install the hardware.

Figure 1



Forming Corners (Top) V-shaped corner; (Bottom) mitered corner.

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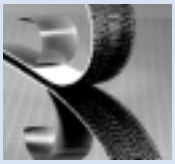
Projects

-Tip- READY "SNAP" FASTENER



Where you would normally use a bolt, buckle, hook, rivet, screw, snap or zipper to secure an item, consider fastening with 3M Dual Lock Reclosable Fasteners. These snap-lock closures feature mushroom-shaped stems that snap together forming a high-tensile attachment. Ideal for holding cushions to cabin sides or cockpit coamings, curtains to the overhead, lock a drawer or door closed (or open), attach a drop ceiling or removable panels in bulkheads or cabin sides to access wiring and plumbing, mount electronics, fasten flashlight or binoculars by the companionway, tack removable carpet, secure the boat hook or anchor, hang gear in lockers, secure appliances, floorboards, bunk tops and whatever else moves, rattles, shakes or slides. Available in clear or black, fasteners can be sewn, stapled or bonded to most substrates and are resistant to just about everything. Developed for industrial use and widely used by boatbuilders, Dual Lock is now available to boaters in mini-packs of different widths.
— *Jan Mundy*

Tensile strength of 3M Dual Lock is high enough to replace mechanical fasteners in many applications.

Attachments

Install turnbuttons at the bottom right and left corners of the screen. These allow the screen cover to be fastened over the companionway cover to provide privacy or rain protection. Cut another 30cm (12") piece of webbing and hot knife the ends. Attach this to the center of the top edge with a stud (male) snap fastener. Fold under the ends of both pieces of webbing and check the lengths: each should hold the hatch-screen cover securely in the rolled up position. Install socket (female) snap fasteners about 2.5cm (1") from the end.

Install snap closures on the front edge of the companionway hatch, side companionway frame and sill. Carefully mark the locations for these, then drill pilot holes and insert screw-in stud snap fasteners bedded in sealant. Mark the corresponding snap locations on the cover and using a snap setting tool, install the socket portion.

Escape Below

Fasten the top snap fasteners to the companionway hatch, then duck and enter the cabin. To secure the remaining cover fasteners, open the zipper (now you know what's it for!), reach out and fasten the snaps. Close the zipper and you are now happily bug free in the cabin. Do these maneuvers in reverse to remove the hatch cover. Your companionway cover will keep the bugs out and make accommodations below refreshing and enjoyable.

About the author: Freelance writer Arlie Anderson and her husband David have logged some 10,000 miles sailing the Great Lakes, Caribbean, and Atlantic and Pacific Oceans. Most recently they sailed "Stand Sure," a modified Catalina 42, on a circle tour from Toronto, Ont., out the St. Lawrence River to the East Coast and returned via the Hudson River and Erie Canal.

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Upgrade

A BOATERS GUIDE TO PROPANE

Here's all the information you need to survey your boat's LPG system and appliance installations, including warning label details and quick-reference checklists for ABYC standards' compliance.

By Susan Canfield

For many boat owners, petroleum gas (LPG) is the favored fuel for galley stoves, cabin and water heaters and refrigerators. LPG's high calorific value and worldwide availability make it the popular choice.

LPG is composed of propane, propylene and butane gasses. It's a gas at normal room temperature and atmospheric pressure, but it liquefies when pressurized, and vaporizes again when the pressure is released. This two-phase characteristic is what allows LPG to be stored in its convenient, concentrated form.

Aromatic Code

LPG is non-toxic and invisible, but it can displace the air necessary to sustain life. The law requires commercially available LPG to contain an odorant that lets you know there's a gas leak. Even if you can't smell that distinct odor, you should know that leaking gas could still be present since the odorant can dissipate even though the gas itself remains.

Released from its liquid state, LPG is heavier than air and will tend to sink to the bottom of an enclosed compartment. If mixed with air in certain proportions and confined, it will explode if ignited. (The lower explosive limit is between approximately 2% and 10% gas by weight in the air mixture.)

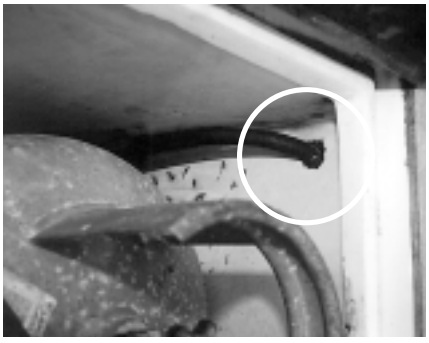
Any fuel that burns with a flame consumes oxygen and gives off both carbon dioxide (CO_2) and water vapor. In a tightly sealed boat cabin, the available oxygen can be rapidly depleted. This sets up a potentially deadly reaction since insufficient oxygen results in incomplete combustion and, instead of producing CO_2, you get carbon monoxide (CO). This combination of oxygen depletion and carbon monoxide buildup can be fatal. [Ed: A discussion on gas detection systems and the dangers of carbon monoxide appears in DIY 2001-#1 issue.]

Fine Tuning

As a marine surveyor, I find LPG systems in many of the boats I inspect don't meet American Boat and Yacht Council (ABYC) safety standards. While most boat owners recognize the hazards involved — explosion, fire, oxygen depletion and carbon monoxide — they are often unaware of the standards that apply to LPG installations and appliances. Below are ABYC recommendations for LPG systems, appliances and installations. Quick reference checklists appear on page 58.

Cylinders LPG cylinders must comply with Department of Transportation (DOT) or American Society of Mechanical Engineers (ASME) requirements. Look for the DOT or ASME stamp near the valve. Install all LPG cylinders on the boat's exterior or in a dedicated locker where escaping gases will flow directly overboard. Secure each cylinder for sea conditions, and provide protection from weather and mechanical damage. With an exterior installation, it's better to mount cylinders aft than forward where seawater or spray can cause corrosion.

WRONG: This multiple cylinder system with manifold shut-off valve, regulator, and copper piping, does not comply with ABYC standards. Holes at the bottom of the gutter allow water to drain into the locker. Both cylinders and the copper piping show evidence of corrosion. The steel bracket supporting the regulator is heavily corroded and has broken loose from the side of the locker. If a LPG hose pigtail were used to connect each cylinder to the manifold, it would be far easier to remove and replace cylinders. There is no pressure gauge. A solenoid shut-off valve, controlled from the vicinity of the galley stove, was installed inside the boat under the galley sink. It should have been installed in the propane locker.



SUE CANFIELD

WRONG: Flexible hose from the regulator to the galley stove is not labeled. Note the unsealed exit hole with its rough edges between the LPG locker and the adjacent cockpit locker. This installation requires a close-fitting grommet, sleeve or sealant to protect fuel line from damage and prevent any escaping gas from migrating into the interior. The hose support is not supported as required.

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WRONG: The unsupported black hose runs from the molded fiberglass locker (at left) through the port cockpit locker and inboard of the manual bilge pump. This hose is susceptible to damage by equipment stowed in this locker or by someone servicing the engine, water heater and other systems accessed via the locker.

Aluminum cylinders resist corrosion better than steel cylinders, but are twice the cost. In the harsh marine environment, they are well worth the extra expense.

Be sure you can access cylinders quickly without the use of tools. You may need to close the valves manually in an emergency, and you don't want to be hunting for a screwdriver or a key to the locker. Also, you must post a legible, waterproof warning sign (**Figure 1**) in the immediate vicinity of the cylinders. If your boat has a gasoline engine, you must also post the gasoline vapor warning sign (**Figure 2**).

Lockers In ABYC-speak, a "dedicated locker" is used for storing LPG cylinders, regulators, valves and piping, and absolutely nothing else. It should be made of corrosion-resistant material, with a top that opens directly to the atmosphere so any escaping gas will flow overboard, and mounted above the boat's static waterline. Recently, ABYC revised its A-1 standard, Marine LPG Systems, to recognize the LPG lockers that can be installed within a larger cockpit locker. These are popular aftermarket lockers often used to create LPG cylinder storage on boats that did not incorporate the provision originally. If you have one of these, locate it as close to the top of cockpit locker as possible so that you cannot open the LPG locker without opening the larger one. To keep out seawater and rain, and to prevent loss or accidental opening of the cover, the LPG locker's cover should be gasketed and latched securely. The locker itself must be vapor tight to the boat's interior. Locate piping exits near the top of the locker and seal them with flexible grommets or other sealant.

Fiberglass locker for one 10lb LPG cylinder from Trident Marine meets ABYC standards.

Locker Vent System The locker's vapor drain must be in the bottom of the locker, and must be installed to prevent any escaping gas from entering the boat's exterior. The vent system cannot be connected to a cockpit drain or bilge-pump discharge line. It must run directly from the locker drain to the overboard outlet.

All components of the vent system require at least 12mm (1/2") inside diameter to minimize clogging. The vent outlet must be above the static waterline and at least 50.8cm (20") from any opening to the interior to keep escaping gas from entering the boat. The hose run must be straight with no low spots or pockets (or loops) that could trap water and block the flow of escaping gas.

Multiple Cylinder Systems Systems with multiple, connected cylinders need a manual shut-off valve or automatic check valve at the manifold so each cylinder can be isolated from pressure feedback from the other. This is in addition to the valve on the cylinder itself.

SUE CANFIELD

WRONG: The LPG locker is secured to the molding by two fasteners, and its bottom is unsupported. The locker has been distorted by the weight of the filled cylinders, and the gasketed cover cannot be fitted. The white plastic vent hose running from the bottom of the locker to a deck fitting is useless for its intended purpose. The owner of this boat started with a perfectly good LPG locker and created a very hazardous installation.

Pressure Gauge Each system requires a LPG pressure gauge on the cylinder side of the regulator to provide a quick and easy way to test for leakage. The face of the gauge must be fully visible with the cylinder in place. Perform the three-minute leak test described in **Figure 1** page 56 every time you open the system.

Pressure Regulator Each LPG system must have a pressure regulator designed for use with LPG. If your LPG cylinder is stored on the exterior of your boat, make sure you locate the regulator's relief valve discharge, like the locker vent discharge discussed above, at least 50.8cm (20") from any opening to the boat's interior.

Shut-Off Valve There must be a "readily accessible" manual or electrically operated (solenoid) shut-off valve (remember, no tools allowed) that is operable within reach of the appliance in the event of an emergency. If the cylinder shut-off valve is accessible to the appliance, a separate shut-off valve on the supply line is not required. In either case, you should be able to operate the valve or its control without reaching across or through any flame and without risk

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Upgrade

JAN MUNDY

WRONG: The same requirements apply to small stoves as to larger LPG cook stoves. This rusted "camp" stove onboard a charter boat was fully portable and not fastened securedly. Not surprisingly, there was no oxygen-depletion warning

of being injured in the process.

Fuel Lines LPG fuel lines are either copper tubing or flexible hose. If your boat uses tubing, check for long nut flare fittings; short nut fittings, commonly used in refrigeration systems, are more susceptible to failure from vibration. Don't even consider using copper tubing unless it's specified for LPG use. Also, a copper line should never double as an electrical ground.

If your system uses hose, it must be marked to indicate its compliance with Underwriters Laboratory's UL21 LP Gas Hose. No hose clamps here, only permanently attached end fittings, such as a swaged sleeve or sleeve and threaded insert.

Support piping using corrosion-resistant (and galvanically compatible if copper tubing is used) clips, straps or other means. Where piping passes through bulkheads, decks or lockers inside the boat, drill oversized holes and insert close-fitting grommets, PVC tubing or other protective material.

Ignition Protection Electrical sources of ignition must be ignition protected to prevent sparks from escaping when activated in an area where LPG or other ignitable gas concentration is present. It's a critical safety feature for all electrical equipment located in closed compartments. Electrical equipment located in accommodation spaces and compartments open to the outside

Barbecues with integral cylinders are designed to be used only on deck. Always stow spare cylinders in a well-ventilated exterior compartment.

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Warning Signs

Obtain required warning signs from equipment manufacturers, or copy and laminate those illustrated below, and mount in locations as specified in this article.

Figure 1

Warning sign to be posted where plainly visible in the immediate vicinity of the propane cylinder.

WARNING

Liquefied petroleum gas (LPG) is flammable and explosive. Follow these instructions to avoid injury or death from fire or explosion.
• This system is designed for use with liquefied petroleum gas (LPG/propane /butane) only. Do not connect compressed natural gas (CNG) to this system.
• Keep cylinder and/or solenoid valve(s) closed when boat is unattended and when appliances are not in use.
• Close cylinder valves immediately in any emergency.
• Keep empty cylinders tightly closed.
• Close all appliance valves before opening cylinder valve.
• Apply ignition source to burner before opening appliance valve.
• Test for system leakage each time the cylinder supply valve is opened for appliance use. Close all appliance valves. Open solenoid shut-off valve, if installed. Open, then close cylinder supply valve. Observe pressure gauge at the regulating device, and see that it remains constant for not less than three minutes before any appliance is used. If any leakage is evidenced by a pressure drop, check system with a leak detection fluid or detergent solution that does not contain ammonia. Repair before operating system. Never use flame to check for leaks!

Figure 2

Additional warning sign to be posted at connected LPG appliances and in the immediate vicinity of the propane cylinder on boats with gasoline engines.

WARNING

Gasoline vapors are explosive. Open flame appliances can ignite gasoline vapor causing death or injuries from fire or explosion. Turn off all open flame appliances when fueling.

Figure 4

Additional warning sign to be posted where plainly visible in the immediate vicinity of the LPG galley stove.

WARNING

Open flame cooking appliances consume oxygen and produce carbon monoxide. To avoid asphyxiation, injury, or death from exposure to carbon monoxide, maintain open ventilation when using these appliances.
Do not use this appliance for comfort heating.

Figure 3

Warning sign to be posted where plainly visible in the immediate vicinity of the LPG galley stove.

WARNING

Liquefied petroleum gas (LPG) is flammable and explosive. Follow these instructions to avoid injury or death from fire or explosion.
• This system is designed for use with liquefied petroleum gas (LPG/propane/butane) only. Do not connect compressed natural gas (CNG) to this system.
• Keep cylinder and/or solenoid valve(s) closed when boat is unattended and when appliances are not in use.
• Close cylinder valves immediately in any emergency. Keep empty cylinders tightly closed.
• Close all appliance valves before opening cylinder valve.
• Apply ignition source to burner before opening appliance valve.
• Test the system for leakage in accordance with the instructions required to be posted in the vicinity of the cylinder each time the supply valve is opened for appliance use. Never use flame to check for leaks!

atmosphere that contain an LPG appliance, cylinder, fitting, valve or regulator are not required to be ignition protected. "Open to the outside atmosphere" is a space with at least 38 sq.cm (15 sq.in) of open area per cubic foot of net compartment volume. The solenoid valve installed in the LPG locker and any other electrical equipment that occupies closed compartments with LPG equipment must be labeled "Ignition protected." If you don't see a label, check the owner's manual or contact the manufacturer for verification. If you can't prove that protection exists, replace the device. It's cheap insurance.

Appliances For Cooking And Comfort

Where systems fueled by volatile gas are concerned, there is no room for cost-cutting. Adapting appliances intended for household, recreational vehicle or camping use to a boat is a recipe for disaster. The LPG appliances used on your boat must be designed for safe operation and built with materials that can withstand the rigors of the marine environment.

No LPG appliance should be installed in compartments containing internal combustion engines (gasoline or diesel), their fuel tanks or fuel system fittings. Onboard cooking stoves, heaters and other LPG appliances, all

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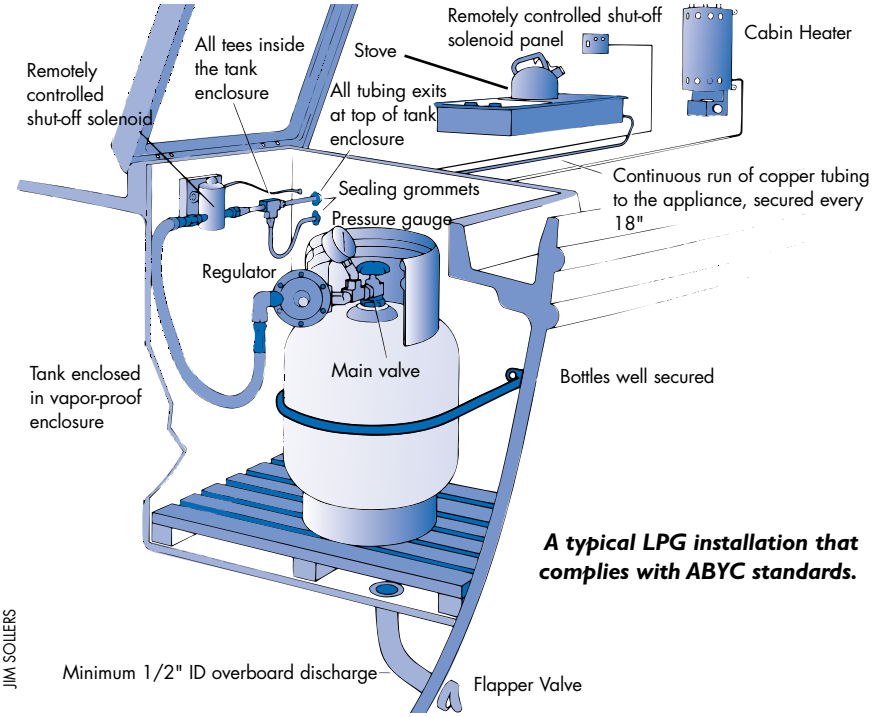

JIM SOLLERS

A typical LPG installation that complies with ABYC standards.

system accessories and fuel supply must be installed to prevent upset, displacement or any strain.

Post operating instructions at each LPG appliance. The warning sign in **Figure 3** must be plainly visible from the vicinity of galley stoves, as applicable. Gasoline vapor (**Figure 2**) and oxygen depletion (**Figure 3**) warnings must be posted at each appliance as well.

Burner controls must be the push-turn or other two-step operation type when going from the off to on position to minimize the chance of accidental operation. You should also be able to operate burner controls without reaching over an open flame.

LPG appliances that function without frequent attention by an operator pose special concerns. Thermostatically-controlled equipment like refrigerators, cabin heaters and water heaters operate unattended. Any malfunction resulting in incomplete combustion can be fatal if it goes unnoticed. These appliances are required to have a sealed combustion chamber. In a sealed combustion system, the air needed for combustion is drawn from the outside of the boat and the byproducts of combustion are exhausted to the outside. Air inside the boat is not consumed, so oxygen levels remain constant,

(Continued on page 52)

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LPG APPLIANCES ✓

The information below includes requirements applicable to galley stoves or cabin heaters fueled by LPG. Other fueled appliances may have additional requirements.

Installation

❏ Not in space containing internal combustion engines, their fuel tanks or fuel system fittings.
❏ Secured to prevent upset, displacement or strain on system and connections.
❏ Operating instructions posted at appliance.
❏ LPG warning sign at galley.
❏ Oxygen-depletion warning sign.
❏ Gasoline vapor warning sign (if applicable).

Controls

❏ Two phase, e.g., push-turn.
❏ Operable without reaching over open flame.

Burners

❏ Operate safely at pitch, roll and heel angles up to 30° from horizontal.
❏ Sealed combustion system if unattended.
❏ No pilot lights or automatic ignition devices if non-sealed combustion system.
❏ Exception: Pilot light that operates only when oven is operating.
❏ Oxygen-depletion sensor if non-sealed combustion system.
❏ Flame failure devices on all burners and pilot lights.

Cooking Appliances with Integral LPG Cylinders

❏ DOT approved 2P/2Q cylinders with rim vent release.
❏ No more than 8oz fuel capacity if used or stored inside boat.
❏ If cylinder attached, stored in ventilated location protected from weather and mechanical damage.
❏ Unattached cylinders stored on boat's exterior, where escaping gas will flow directly overboard.
❏ Warning sign for externally mounted grills/galley stoves with fuel cylinders of more than 8oz (if applicable).
❏ Oxygen-depletion warning sign (fuel burning stoves other than externally mounted grills).

LPG SYSTEM ✓

Use this checklist to determine if your boat's LPG system complies with current ABYC standards.

Cylinder(s)

❏ Located on boat's exterior, where escaping gases flow directly overboard or in a dedicated locker.
❏ DOT/ASME compliant.
❏ Secured for sea conditions.
❏ Protected from weather and mechanical damage.
❏ Accessible without tools.
❏ LPG warning sign.
❏ Gasoline vapor warning sign (if applicable).

Locker

❏ Not used for storage of other equipment.
❏ Top opening directly to outside atmosphere.
❏ Corrosion-resistant material.
❏ Located above static waterline.
❏ Gasketed cover; tightly latched.
❏ Vaportight to boat's interior.
❏ Vented at bottom.

Vent system

❏ Minimum 12mm (1/2") inside diameter (all components).
❏ Dedicated; not connected to other piping.
❏ Led outboard through hull to point below locker bottom and above static waterline.
❏ Outlet at least 50.8cm (20") from any opening to boat's interior.
❏ No low spots or loops that could trap water.

Pressure Regulator

❏ Designed for use with LPG.
❏ Relief valve discharge at least 50.8cm (20") from any opening to boat's interior.

Shut-Off Valve

❏ Manually or electrically operated.
❏ Operable from vicinity of appliance in event of fire.
❏ Operable without reaching over open flame.

Fuel Lines

❏ Continuous from regulator or solenoid valve to appliance or flex section if appliance is gimbaled.
❏ Annealed copper with long nut flare fittings or LP Gas Hose with permanently attached end fittings.
❏ Metallic fuel lines (if installed) not used for electrical ground.
❏ Flexible LPG hose section (if gimbaled stove).
❏ Supported by corrosion-resistant clips, straps or other devices designed to prevent damage to lines.
❏ Installed so bulkheads will not cut, abrade or damage lines.
❏ Protected by non-abrasive grommets, sleeve or sealant where run through decks or bulkheads.

Multiple Cylinder Systems

❏ Manual shut-off valve or automatic check valve at manifold.

Pressure Gauge

❏ On cylinder pressure side of regulator.
❏ Dial fully visible.
❏ System passes leak test.

Ignition Protection

❏ Electrical devices in closed compartments containing LPG appliances, cylinders, fittings, valves or regulators are ignition protected.
❏ Exceptions: (1) Accommodation spaces and (2) compartments having at least 38 sq.cm (15 sq.in) of open area per cubic foot of net compartment volume exposed to the atmosphere outside the boat.

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-Tip- SAFETY GUIDELINES

Don't mess with LPG systems. If ever you're unsure about a specific procedure or installation, consult a certified propane installer. Read and follow all safety procedures outlined on the warning labels on page 56. Post these warning labels on your boat in the locations as specified in ABYC standards. One item not mentioned but highly recommended is to install a marine-quality (i.e. Xintex MS-2) fume detector that monitors the buildup of gas in the bilge and sounds an alarm if it reaches an unsafe level.
— Jan Mundy

and there is no contamination of interior air by exhaust gasses. Only sealed systems may incorporate pilot lights or other automatic ignition devices.

An LPG cooking stove is an example of an attended appliance. During normal operation (cooking) a stove is frequently attended by the cook. Stoves are not required to have sealed combustion chambers, and could not do their work if they did because the flame produced by the fuel is used as the heating element. These appliances can have pilot lights or other automatic ignition devices. Non-sealed combustion system appliances require an oxygen-depletion sensor that cuts off the fuel supply to the appliance if the oxygen level in the space falls below 95% of normal. Check the owner's manual to determine if your attended LPG appliance is equipped with this sensor.

Flame failure devices are required on all burners and pilot lights on both unattended and attended appliances to prevent gas from flowing when a flame is not present.

Camping Gear

Cooking appliances with integral cylinders, such as camp stoves and externally mounted grills, are common onboard boats. These stoves are convenient and good alternatives to alcohol cookers, but don't confuse them with "camp" stoves that use a 14-ounce fuel cylinder. Stoves approved for marine use must be fueled by DOT-approved 2P/2Q 8-ounce cylinders with rim vent release. Don't stow or use any LPG cylinders with more than 8oz of fuel capacity. Use the stove in a ventilated location, out of the weather and the risk of damage. Stow unattached reserve cylinders on the boat's exterior where escaping gas will flow directly overboard. [Ed: For instructions to build a holder for LPG canisters, see DIY Projects, 2000-#3 issue.] Externally mounted grills and camp stoves with 8oz or larger LPG cylinders must be labeled as follows: "Do not use this appliance inside the boat or in any enclosed space." Also, post the oxygen-depletion warning sign (**Figure 4**) adjacent to all fuel-burning stoves with integral cylinders.

If your boat's LPG system and appliances do not meet current ABYC standards, make the necessary repairs or upgrades for your own safety. Consult the references listed below for additional information. Knowledgeable marinas, boatyards and marine chandleries typically maintain a copy of the ABYC standards for staff and customer reference. You can direct specific questions concerning LPG safety standards to ABYC's technical staff at www.abycinc.com or call 410/956-1050.

About the author: Susan Canfield is an accredited marine surveyor with Marine Associates, Inc. of Annapolis, Maryland. She is a member of the Society of Accredited Marine Surveyors and the American Boat and Yacht Council.

References

"Standards and Recommended Practices for Small Craft," published by the American Boat and Yacht Council: A-1, Marine LPG Systems; A-3, Galley Stoves; A-26, LPG and CNG Fueled Appliances; A-30, Cooking Appliances With Integral LPG Cylinders.

"Boatowner's Mechanical and Electrical Manual (Second Edition)," by Nigel Calder, published by International Marine.

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Maintenance

DECK COVERINGS

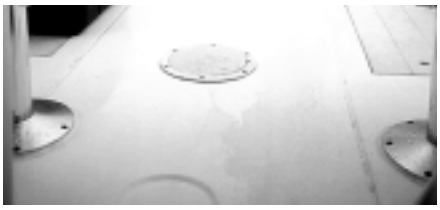
Dull, faded and worn deck surfaces crying out for a renewed finish that looks good, gives protection to the fiberglass beneath, and one that provides a secure footing for the crew, can be a do-it-yourself project. A professional tells you how to apply non-skid over new or existing decks using Interlux paint finishes.

By Bob Wright

The short recipe to maintaining a fiberglass hull is regular cleaning, waxing and compounding when needed. Textured, non-skid deck surfaces are a more challenging matter, and a worn, slippery deck is an accident waiting to happen. One way to spruce up a tired deck, other than having an expensive commercial non-slip finish professionally applied, is to paint it.

There is no single, universally proven deck surface that will prevent people from slipping on a boat deck. There are an almost infinite number of variables that affect "non-skid" performance, no matter how high-tech or famous the footwear, no matter the ingenious technology of the boatbuilder's deck molding. There's no such thing as "non-skid." A low-cost, slip-resistant, alias non-skid or non-slip, finish can be created (or recreated) by first priming the surface with an epoxy barrier coat, then applying paint, either mixed with a non-skid additive or the additive sprinkled over the wet paint.

A deck demands a tough coating to protect it from the damaging effects of foot traffic, anchors and other gear that descend upon it. Two-part urethane paint is your best choice for the job. It provides the most durable, abrasion-resistant, longest-lasting finish. Contrary to popular opinion, two-part paints are not beyond a novice's skills to apply. Working times are manageable (6- to 8-hour pot life), and you can attain a highly satisfactory finish



with a brush. Interlux Interthane Plus is especially well suited for deck refinishing. It's a two-part linear urethane developed for brush application using the roll-and-tip method. After rolling, the roller stipple and roller marks are leveled out with a high quality natural bristle brush. It's easy to apply on decks where the non-skid pattern is already present or one is created with the addition of a non-skid additive, and patterns help to hide any imperfections.

Preparation

Interthane is applied to gelcoat or to a properly prepared epoxy substrate primed with Interlux 404/414 Epoxy Barrier-Kote. As a general rule, two-part paints are not applied over single-part coatings. Such paints may not provide a stable substrate for the very durable Interthane Plus and more importantly, strong solvents in the two-part product may lift the single-part paint. One-part paints should be removed, or if impractical, primed with Interlux 2100 Multithane Primer. This provides a barrier between the Interthane and the old paint. For best results, remove any questionable coating down to a sound substrate.

Surface preparation is 75% of the job so take extra care to properly ready the deck for the process.

Read and follow all application instructions carefully. Mix only what you will use in a 4-hour period. About 946L (1 qt) of non-skid additive covers 80 square feet if shaken on (not pre-mixed); 946L (1 qt) of Interthane covers roughly 200 square feet per coat. Add a flattening agent (Interlux 2317) to reduce gloss if desired. Thin the paint during application as needed to maintain a working viscosity. It's best to mask all deck hardware, brightwork, etc. before coating with 3M Fine Line, 3M Long Mask or 3M 233 tape. You can also coat hardware with petroleum jelly to facilitate removal of paint drips or splatters.

Start painting mid-morning as soon as the dew has completely dried from the surface. If the deck was prepped the day before, wipe down only the bare gelcoat with 2333N solvent. Optimum working

-Tip- CLEAN UP

If water is allowed to stand in deck spillways, any above-water coating system may fail or blister. Be sure to mop up standing water, especially when the coating system is new.

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temperatures for deck coatings are from 10°C to 29°C (50°F to 85°F). Avoid applying any coatings when nighttime temperatures might fall below 10°C (50°F). When working outdoors, cover coated areas at night to keep horizontal surfaces from flattening from any dew that forms on the coating before it's fully cured. This is especially true of two-part urethanes, which are 25% moisture cured and flatten more easily. Keep nighttime dew off the surface for at least two days, longer if nighttime temperatures fall below 10°C (50°F). Allow 7 to 10 days for the paint to fully cure and reach its maximum abrasion resistance.

There are two different refinishing methods depending on your deck type: those with a molded, non-skid pattern, those with a non-skid pattern that needs to be created or the pattern is worn away.

Application: Gelcoat Non-skid

Step 1 Clean the deck area to be coated with medium to coarse bronze wool, and wipe down with Interlux 202 Solvent Wash. Work a

INTERLUX YACHT FINISHES

small area at a time, scrubbing in different directions, and wiping up the solvent residue before it evaporates. Repeat the solvent scrub to remove all old wax and contamination. This also creates an anchor pattern for proper adhesion of the Interthane to the gelcoat. An aggressive anchor pattern is important, as the paint doesn't use a primer because of its tendency to fill in the existing non-skid pattern. Don't use steel wool. Its fibers are ferrous metal, and, when they break away, you'll likely have rust specks on the finished deck.

Step 2 Apply one very thin coat of Interthane Plus, thinned 15% to 25% with 2333N solvent, using a low-nap foam roller with a solvent-resistant core (i.e. Interlux R7) and tipped off with a good quality natural bristle brush.

Step 3 Allow to dry at least 2 hours, no more than 8 hours at 17°C (70°F), or until the paint is no longer sticky to the touch. If the maximum overcoat time is exceeded, sand again with fine bronze wool.

Step 4 Carefully apply a second thin coat, thinned 15% to 25% with 2333N solvent, to the tack-free surface. Don't overwork the paint or the solvents may resolvate (soften) the first coat. Take care to tip this coat without over brushing.

Application: Shake 'N Bake

Step 1 Remove surface contaminants and wax from the deck area to be coated with Interlux 202 Solvent Wash using the two-wipe method. Wipe on the solvent with one lint-free rag, then quickly wipe it off with a clean rag before the solvent dries. Sand with 80- to 120-grit paper to a mat finish. Repair any damaged areas with 417/418 fairing compound, and evenly feather the edges to the existing surface, carefully following the manufacturer's application instructions. Vacuum the area and wipe with Interlux 2333N solvent to remove all remaining dust.

If the spillways (shiny deck areas with no non-skid pattern) are in poor shape, after vacuuming and wiping with solvent, apply a coat of 404/414 Epoxy Barrier-Kote, thinned 20% with 2333N. When fully cured, sand with 220-grit paper, changing paper frequently to create a good anchor pattern. Epoxy is a very hard coating that quickly dulls sandpaper. For the best results use 3M Gold paper or an equivalent. The barrier coat fills small imperfections and any porosity typical in weathered gelcoat. Fill any age cracks with 417/418 and sand fair prior to applying the primer. Note: Damage caused by fracture cracking or flexing of the laminate must be fixed by reinforcing the deck, either from above, or below with several layers of cloth and resin before a coating system is applied, or the crazing will return. [Ed: For how to repair structural cracks in fiberglass, see DIY 2000-#3 issue.]

Step 2 Apply one coat of Interlux 404/414 Epoxy Barrier-Kote, thinned 20% with 2333N solvent using a low-nap foam roller with a solvent-resistant core (i.e. Interlux

-Tip- SAFEKEEPING

Urethanes and epoxies contain strong solvents. A good quality respirator designed for use with these products is a must. We recommend a 3M 6000 series respirator with 6001 cartridges, 5n11 filters and 501 retainer (about $30 for the set). Paper masks are useless against solvents. Two-part linear urethanes also contain isocyanates, which are dangerous if inhaled or left in contact with the skin or eyes. Be sure you have adequate ventilation and a full body suit (disposable overalls are best) and rubber gloves are a must. Carefully read and follow the health and safety guidelines for all products. Be sure to read the MSDS (material safety data sheet) provided with each Interlux product. This information is also available on the Interlux website, www.Interlux.com. Interlux also maintains a product telephone helpline at 1-800-468-7589 to help with your questions about Interlux products and application procedures.

— Jan Mundy

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R7), and tip off with a good quality natural bristle brush. Apply an even film, coating all indentations, but not filling them. The thickness of the paint will load the non-skid.

Step 3 When cured, sand with 220-grit paper to a mat finish, changing paper frequently to prevent clogging the grit, which can prevent a sufficient anchor pattern for good paint adhesion. Vacuum the area, and wipe down with 2333N solvent using the two-wipe method.

Step 4 If the deck has both non-skid areas and spillways, mask non-skid areas with 3M Fine Line, 3M Long Mask or 3M 233 tape. Round the taped corners using a quarter as a pattern, and cut with a sharp single-edged razor blade, or Exacto knife to create a factory-like finish.

Step 5 Roll on one very thin coat of Interthane Plus, thinned 15% to 25% with 2333N solvent, applied with a low nap foam roller with a solvent-resistant core, (i.e.Interlux R7). Work in small areas, and tip off with a natural bristle brush. Using a salt shaker or fine sieve (or punch holes in a plastic bag or tin can), shake on a heavy layer of non-skid additive such as Interlux 2398, a product containing round, hollow spheres that soak up the coating and expand to form a non-skid pattern.

INTERLUX YACHT FINISHES

Often the non-skid is added directly into the paint, a procedure outlined on the label instructions. This is an acceptable application method, especially in small areas, but the paint must be applied in thin coats, rolling in one direction. Over rolling causes an uneven or blotchy finish due to the different densities of the non-skid.

Step 6 Allow to dry no less than 2 hours, no more than 8, at 17°C (70°F) or until the paint is no longer sticky to the touch (tack-free). Then you can carefully move around the boat to apply the second coat.

Step 7 Carefully vacuum up all non-skid additive that did not adhere to the first coat.

Step 8 Remove tape if both non-skid and glossy, smooth areas are to be the same color. Always pull masking tape at a 45° angle to the wet paint to leave a clean edge. Leaving the tape on gives a sharp, raised edge that will attract dirt later.

Many boats have two-tone decks with white or off-white spillways and off-white, beige, light blue or light gray non-skid areas. If this is the look you want, paint the non-skid areas first, remove the tape, allow the Interthane to dry, then carefully paint the spillways. If you paint the spillways first, you'll have to remove the tape, and when the Interthane dries, retape over the spillways, and then coat the non-skid areas. Either way, the Interthane must be fully cured, about 3 to 5 hours at 17°C (70°F). Lacking a full cure or if there is marginal adhesion to the primer or bare gelcoat, the paint may delaminate when the tape is removed and require touch up.

Step 9 Apply a second thin coat of Interthane Plus, thinned 15% to 25% with 2333N solvent, to the entire deck. Don't over roll or brush out the paint or the solvents may resolvate. If this occurs, a longer dry time is needed, or you're overworking the paint. [Ed: See DIY 1998-#2 issue, "The Art of Topside Painting" for more application techniques and painting tips.]

About the author: Bob Wright resides in Cape Cod, Mass., and is a sales and technical service rep for Interlux Yacht Finishes.

-Tip- PAINTING HINTS

- Don't paint in the same clothes you wear for sanding.
- Wear a properly fitted respirator.
- Work in small areas.
- Don't use paint directly from the can. Pour an amount you expect to use in 30 minutes into a paint tray.
- Roll and tip in different directions. Roll on the paint in one direction and then tip off with brushing crossways.
- Add thinner during application as needed to maintain good paint flow.
- Stir the paint frequently during application to prevent separation.
- Change brushes every 20 minutes to avoid overloading with paint.
- Always keep the lid tightly sealed on the paint can to prevent solvent evaporation, which causes the paint to thicken.
- If painting indoors in a heated shop, be aware that kerosene or propane heaters create moisture, which can affect the cure. Any carbon-fueled heater is also a source of carbon monoxide, a toxic vapor that is odorless, colorless and deadly. Also, open flame heating appliances can be sources of ignition, which can cause fire and/or explosion.
- Don't shrinkwrap a painted boat as the paint may blister.

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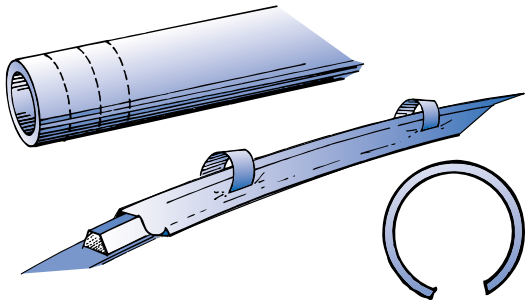
Good Boatkeeping

CLIP-ON CANVAS ANCHORS

By David and Zora Aiken

For some time, boatowners have been protecting exterior brightwork with custom-made fabric covers of various sizes and shapes. This prevents damaging UV rays from reaching varnished surfaces, but often requires drilling holes to fasten snaps or turnbuttons that hold the covers in place.

Here's a simple, noninvasive solution for narrow toe rails or handrails. Buy thin walled PVC pipe of the appropriate diameter. Slice it into 3.8cm or 5cm (1-1/2" or 2") segments. Cut through each slice to create an expandable ring. You will need to cut away a portion of each



ring, making the opening slightly smaller than the top of the rails. Fit the canvas covers over the rails, then pop the rings (now inverted U-shaped "clamps") in place every 60cm (24") or so.

WIRE CAMOUFLAGE

Whether you've done some remodeling, added a new gadget or it's just time to rewire your boat, here are some tips to contain or hide the wiring for a neater, safer installation. As with any such project, be careful not to nail, screw or staple into the wire itself. Also, watch places where wire leads around a corner or through a hole in the bulkhead; there should be no abrupt bends or sharp edges that could cause chafing of the wire's protective coating.

• In the engine room, group wires inside a flexible conduit, then run the conduit along stringers or beams, holding it in place with screw-on cable ties.

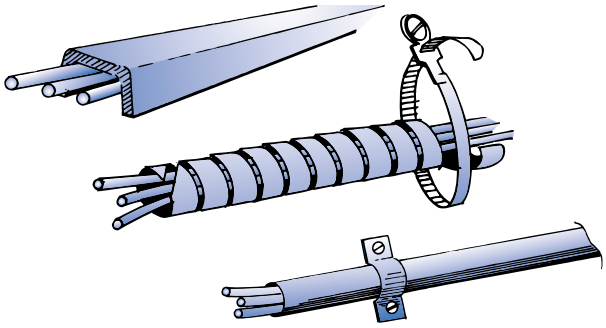
• Use a solid conduit to contain and protect wires. Paint it to match the color of the background bulkhead so it's least noticeable.

• Use U-shaped wood trim to cover wiring that runs along an interior bulkhead or across a section of the overhead.

• Where possible, use a router to gouge a channel deep enough for the wire. Triple-check the depth before cutting, then cover the routed area with an appropriate trim piece.

• If a wood trim piece is already in place, remove it and router the wire-enclosing channel into the inside surface.

• A junction box should be accessible. Cut an access hole to place it



where it's most convenient then cover the cutout with a decorative wood cap.

About the authors: David and Zora Aiken are the authors and illustrators of numerous boating, camping and children's books, including "Good Boatkeeping" and "Good Cruising" published by International Marine. They live aboard "Atelier," in Grasonville, Maryland.

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