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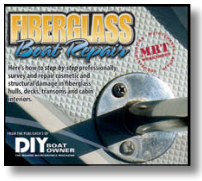

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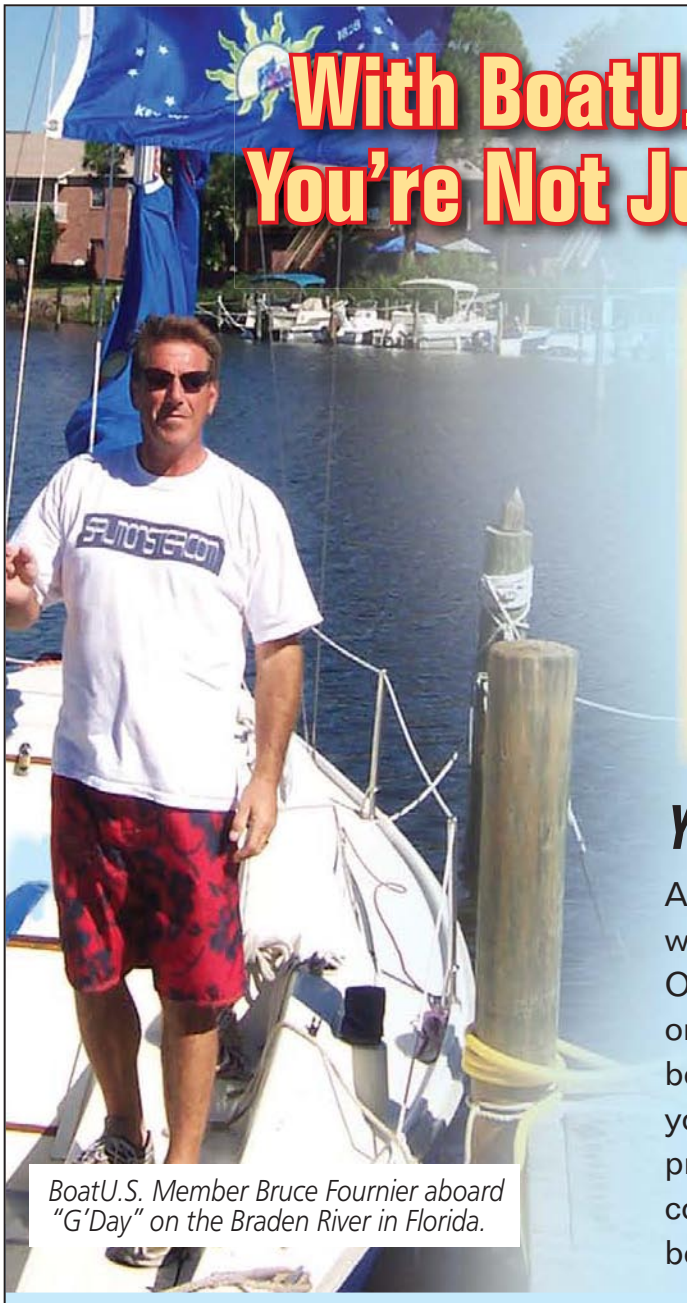

BoatU.S. Member Bruce Fournier aboard "G'Day" on the Braden River in Florida.

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—Bruce Fournier, Bradenton, FL

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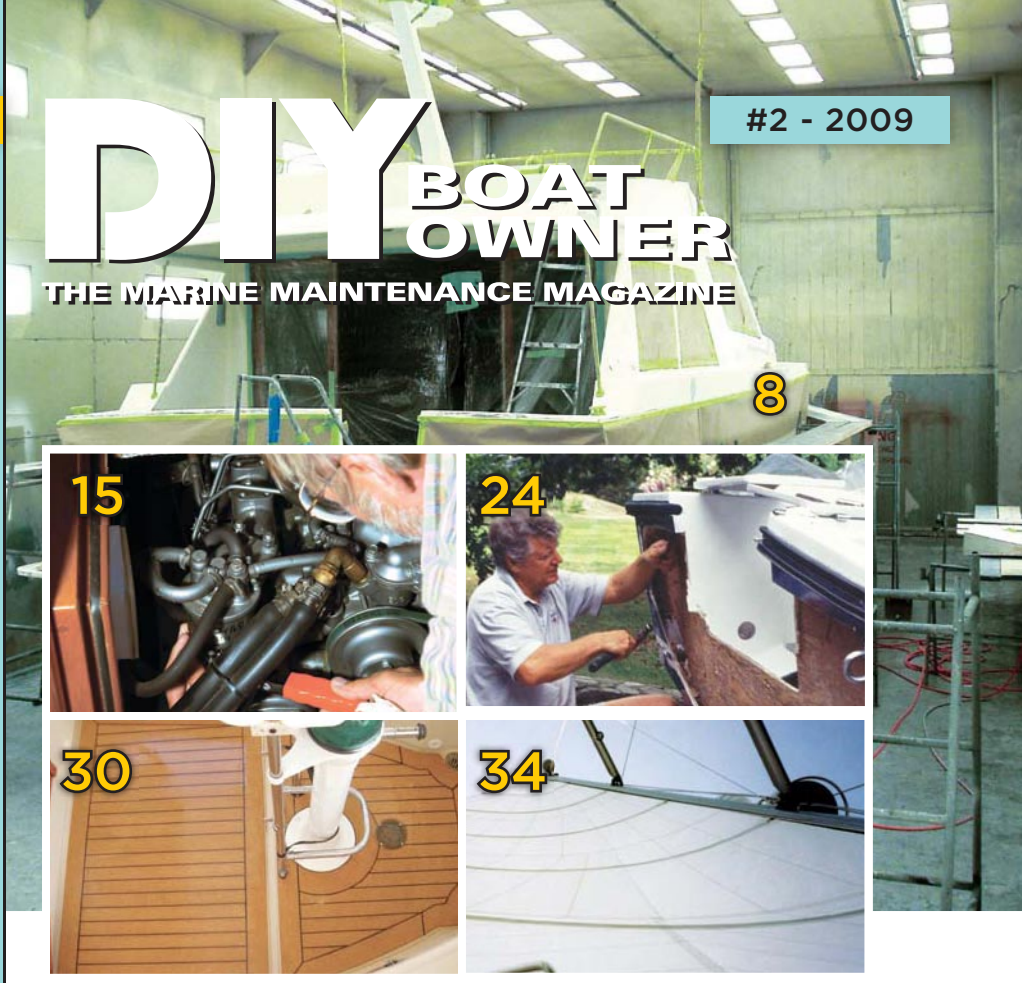


COLUMNS

DEPARTMENTS

On the Cover: *BearBoat*, a fully restored '89 Trojan International 12 Meter Express, at anchor off Catalina Island, California. See Jim Discher's story on page 26. Photo by Kim Discher.

Edited by Jan Mundy

Reader's Tool Sites

Further to the article on websites for do-it-yourselfers in the 2009-#1 issue, we heard from a number of readers who emailed us with their favorites. Here are four more to add to your list:

www.american-sailing.com
The American Sailing Association (ASA) certifies sailors at all skill levels, including the certification of sailing instructors. Individual memberships are available and the benefits are bountiful.

www.myboatsgear.com
This is a store where you can shop for information, the experiential kind, in 18 categories and 200 plus sub categories. The site presents reviews of the latest and greatest boating equipment, sailing accessories, safety gear, books and clothing.

www.uspowerboating.com
US Powerboating offers on-the-water training, along with classroom instruction through participating schools, community programs and clubs. An affiliate of ASA (see above), courses start at the entry level and progress into advanced boat handling, cruising and applied piloting and navigation.

www.sailrite.com
Sailrite is the one-stop shopping source for anything and everything that you need for fabric and other soft goods projects. The site includes material specs, accessories and the right kind of sewing machines for the DIYer who wants to make a dodger, cushions, curtains, covers and more. You can even see project videos of other DIYer's work. Sailrite is more than just a store; it's the total resource for sewing and stitching.

Green Boating Contest

As part of its mission to improve and protect marine habitat, West Marine, the nation's largest boating supplies retailer, will award a $10,000 prize for the "Green Product of the Year."

"One of West Marine's goals is to be an industry leader in sustainability and, through this initiative, we hope to encourage innovation and a steady stream of environmentally friendly products so our children and our children's children will have the opportunity to enjoy plentiful oceans and beautiful blue waters, as we have," said Geoff Eisenberg, CEO of West Marine.

The competition is open to individuals, manufacturers, distributors and/or inventors of boating products. The panel of judges includes Ruth Wood, President, BoatU.S. Foundation and Chuck Husick, former president of Chris-Craft Boats, DIY contributor and *BoatU.S. Magazine's* technical editor.

The judges will select the winner based on such factors as how effectively the product improves the marine environment, conserves natural resources, reduces the "carbon wake" of boating (i.e., fossil fuel consumption) and how it improves upon products currently on the market.

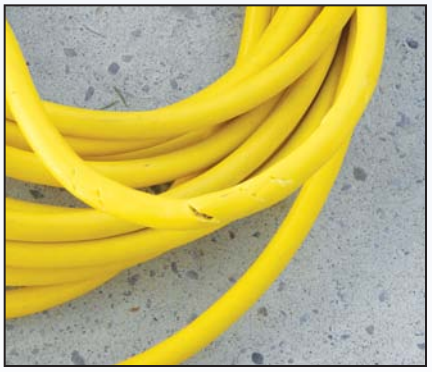
Complete rules and entry forms are found at www.westmarine.com/green. West Marine will announce the winner at the 2010 Miami International Boat Show.

Bilge Blowers Beware

If you operate the bilge blower while underway as a means to help cool the engine and remove noxious odors, think again. Some blowers are designed to withstand continuous operation and some aren't.

Read the label or owner's manual. If you're buying a new blower, the less expensive models say "intermittent;" the more expensive blowers are marked "continuous." If you're not sure what's on your boat, don't operate the blower continuously. Blower manufacturers recommend blowers not be left running for more than 15 to 30 minutes. If run continuously, the bearing in the motor may seize and the plastic fan can catch fire.

High Current Caution



Jan Mundy

Good quality shorepower cords are built to take a lot of use but not abuse. The cord shown in the photo above was pinched between the dock and the boat during a storm. Though it may appear to work, a pinched wire could cause a short and a fire. If you think a cord may be damaged, inspect it carefully. Any crushed areas or flat spots mean trouble. Don't use it. Most cords carry 30 to 50 amps and a fire can easily start before a breaker trips. Also, don't store flammables in a locker that's adjacent to your shorepower connection.

Band-Aid Fix for Painted Finishes

Q: Do you know of a product that will put a shine on scuffed Awlgrip? The company suggests using only its cleaner and buffing/wax product. Rather than repaint my hull for $6,000, there must be a way to take the edge off a few "dock scuffs."
Chip Lohman, Woodbridge, Virginia

Jan Mundy

3M Perfect-it system can extend the longevity of an oxidized urethane paint finish but as aging and fading continues, eventually, repainting is the only cure.

A: If your boat has an aged polyurethane finish and you have applied the Awlcare Protective Sealer and are unable to regain the gloss, the Perfect-it system will revive the paint and give you a few more years before the surface needs repainting. This should be considered as a last ditch approach and should never be applied to a finish in good condition. Using incorrect products or wrong technique can destroy a painted finish. This is the main reason why manufacturers of urethane coatings, such as Awlgrip, don't endorse sanding and buffing of their coatings.

3M Perfect-it is a four-step system: sand to remove any defects and then compound to remove sanding scratches and sander swirl marks, follow with a glaze to remove swirl marks from compounding and deliver a high gloss and then wax to protect the hull from UV damage. After washing the hull with boat soap, sand the hull with 1,500-grit wet paper or 1,200-grit dry paper. Dry sanding is faster; wet sanding is messy and there's the slurry to clean up.

Wipe off the sanding residue and apply the Perfect-it rubbing compound with a white foam or wool buff pad. (Foam is not as aggressive as wool.) Mount the pad on a soft foam pack-up pad and run the polisher/sander at 1,800 rpm. Begin buffing by applying a medium pressure on the surface, then light pressure. As paint is softer than gelcoat, there's a better chance of burning through it than gelcoat. Do a test spot first in an inconspicuous area to determine the amount of pressure required.

Next step is to apply the glaze. This is what gives the paint a mirror-like gloss. Apply glaze with a black foam waffle pad; never use a wool pad. (Waffle pads work fast and generate less heat.) Again, start with medium pressure and then lighten up. This helps to dry the glaze and buff the surface to a high gloss. When applying compound or glaze, be careful you don't scorch the paint. Work in the solution over a small area, say a 2' (609mm) square area. These products act as a lubricant and, once you see the solution work into the paint, stop. Aged, badly faded painted finishes may require additional compounding. Since glaze has no UV inhibitors, the last step is to apply a quality marine wax or polish to protect your glossy finish from sun damage.
— Jan Mundy

Cure for Power Loss

Q: My dinghy outboard, a 3.3 hp, two-cycle, 2006 Mercury, will start and idle in neutral but quits under a load. I removed the carburetor, cleaned and inspected it and filled with a fresh gas/oil mix. Now the engine does not get full power under a load. What's causing the problem?
Ed Pysa, Ridgefield, Connecticut

A: If you are certain that both the carburetor main jet and idle jet are clear, use a piece of thin wire and push it right through the jet. I suggest you install a new spark plug, if you have not done so already. If the problem continues, then most likely the exhaust ports are plugged with carbon and/or engine deposits. Refer to DIY 2008-#3 issue for details on how to decarbonize your engine. You'll need to purchase a can of Mercury Powertune Engine Cleaner to do this job.
— Steve Auger

Repairing Fiberglass Thru-Exhausts

Q: The exhaust thru-hull fittings on my '86 Cruisers are damaged possibly from past overheating of twin 260 hp Mercruiser inboard engines. These fittings are below the waterline and are constructed of 3" (76mm) diameter molded-in fiberglass pipe. The old fiberglass pipe requires cutting out and a replacement thru-hull fitting installed. As you can imagine, I am more than a little nervous about cutting a huge hole in my transom.
James Priest, Fredonia, New York

A: There are two ways to replace molded fiberglass exhaust ports. The first option is to cut off the glass pipes and fit an off-the-shelf metal exhaust thru-hull fitting. Assuming the existing glass exhaust pipe is joined perpendicular (90 degrees) to the transom it should not involve cutting a huge hole in your transom. If it connects at a significant angle the existing port and any transom cutout will be elliptical so in that case it requires an angled metal exhaust port. The other option involves replacement with new glass pipes. This requires skilled glasswork and since this is a below-the-waterline fitting carrying potentially lethal exhaust gases, I do not recommend you attempt it unless you are very experienced working with fiberglass. Your insurance company would be inclined to agree. Note that all materials used in marine engine exhaust systems should meet the requirements of ABYC standard P-1, Marine Engine Exhaust Systems, including hose, piping, fittings, etc.

Vetus

Vetus stainless-steel transom exhaust connection comes in sizes from 1-9/16" to 6" (39mm to 152mm).

It may be feasible to repair the existing glass pipes. As I don't have a clear description of the damage you refer to, it is difficult to give any prescribed detail for a repair. Are there leaks? Are you concerned by gelcoat cracks showing in and adjacent to the exhaust port on the exterior of the transom? If it is just gelcoat cracks that lead you to believe the ports are damaged you may want to get a second opinion. In many cases, the gelcoat cracks are due to normal thermal expansion and contraction and this may not

be a structural problem at all but rather a cosmetic issue. These cracks are very common on molded exhaust ports on various models including many Sea Rays from the '80s. It is certainly possible to do the gelcoat repairs to fix the problem but the cracks may eventually return.

To replace the glass exhaust port(s) with a metal thru-hull fitting, follow these steps. First check the inside dimension (ID) of the exhaust port from the outside of the transom and compare this to the 3" (76mm) hose barb outside dimension of the various 3" (76mm) nominal exhaust fittings commercially available. The ID port opening will be a bit undersized as it corresponds to the inside diameter of the glass tube, not the ID of the hose. As long as the difference is not more than 0.25" (6mm) this does not present a big problem.

Next, get your hands on an appropriate thru-hull to match the hose ID and then arrange haulout at your DIY yard for a weekend. To gain access to the exhaust port glass pipe stub, remove the rubber exhaust hose attached to the exhaust port. If it was overheated, you should replace the hose anyway. Shroud the engine room against dust and/or set up a dust removal ventilation or vacuum system. Put on a haz-mat suit (or hooded coveralls), gloves and a good respirator type dust mask. Remove the fiberglass pipe stub from the transom by cutting it off with a jigsaw so that it is nearly flush with the inside facing transom panel. Use a grinder with a 36-grit disc to remove and clean up the stub of the tube and also flatten the adjacent inner face of the transom. Recheck the exhaust port opening ID versus the thru-hull hose barb outside dimension.

Use a coarse-grit drum sander fitted to an electric drill to enlarge the hole as necessary. Dry fit the exhaust port thru-hull and drill the fastener holes where required. Install and caulk the thru-hull with generous amounts of a polyurethane sealant (3M 5200 or equivalent). After the sealant has fully cured, connect the new (and possibly longer) exhaust hose with new stainless steel, heavy-duty hose clamps, doubling the clamps as required by the ABYC standard. Launch the boat and check carefully for exhaust or water leaks.

Replacing the existing glass exhaust ports follows the same procedure as above but, instead of mechanically fastening a caulked metal thru-hull, a new fiberglass pipe (usually Vernatube made by Centek, www.centekindustries.com/product_descriptions.html) is glassed into the transom opening with new glass secondary bonds to the inside face of the transom. The outside will also need to be glassed, filled and faired and then, if any gelcoat is exposed above the waterline, a color-matched gelcoat repair is required to finish off the cosmetics.

— Nick Bailey

Not a Hot Solution

Q: I see that West Marine sells an on-demand hot water system for boats and wondered if you could give me any details on these? If this system works well, I could build a larger freshwater storage tank that would look after the needs of my "city-fied" wife who uses water as if we had a boat full of it.

Art Moseley, Shady Lady, Lake Simcoe, Ontario

A: Not really, not the way you (or the Mrs.) might expect. The demand heater carried by West Marine is the Eemax tankless water heater and the most powerful model West Marine sells draws 29 amps of 120-volts AC shorepower, which is close to the absolute maximum you can squeeze from a single 30-amp shorepower outlet.

Unfortunately, according to the sizing guide and performance formulae published on the Eemax website (www.eemaxinc.com/images/sizingguide.pdf) and, assuming a typical boat water pump maximum flow rate of 3 gallons per minute (gpm), this 3.5 kW water heater is only going to raise the water temperature about 8F (13C). To get lukewarm water at 90F (32C) from 70F (21C) tank water requires reducing the flow rate to a mere 1.2 gpm. Obviously, this is not enough for a good shower but okay for filling a washbasin. To get a nice hot shower at 110F (43C), at 3 gpm, from the same 70F (21C) tank water requires a household size 240-volt demand heater drawing a massive 17.6 kW. Eemax does make demand heaters big enough to handle this but you won't be able to power them off a normal shorepower service. This requires a 100-amp, 240-volt service or a 20 kW gen-set.

Many of the customer reviews on the West Marine website are quite disappointed with these demand heaters but the detailed information Eemax provides makes plain what the various size heaters will and will not do. Providing a nice hot shower from room temperature water at normal flow rates is not what the smaller models sold at West Marine (and sized for typical shorepower service) are capable of delivering.

— Nick Bailey

Plugging Holes

Q: I'm removing stainless steel bolts from the fiberglass and plywood transom on my 22' (6.7m) Bayliner Explorer. What is the best way to plug the holes so that moisture will not seep into the plywood?

Ian Waymark, Gabriola, British Columbia

Nick Bailey

A long-term hole patch involves restoring and reconnecting the glass laminate over the hole. This requires a little prep work and planning as well as some basic skills for working with fiberglass.

A: It may sound a little disingenuous but, by far, the simplest way to seal the bolt holes is to put bolts back in as plugs. Be sure to bed them with lots of polyurethane sealant (e.g. 3M 5200) and once the nuts on the inside facing transom panel are secure, they are not going anywhere. If you prefer a more permanent fix, the best solution is to do a proper fiberglass patch over the holes. This would be a small-scale version of the repair outlined in the article titled, "Patching Plumbing Holes" in DIY 2008-#3. Avoid the temptation to just fill the hole with sealant or a patching compound. Without glass fibers or a

solid mechanical fitting to reinforce the filler goop, it will crack and leak sooner or later.
— *Nick Bailey*

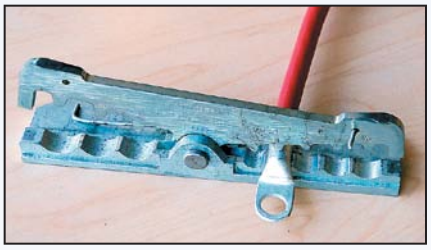
Cooling System Failure

Q: My boat has twin MIE 228 305 Mercruisers and the starboard engine seems to have a thirst for coolant, maybe a gallon every 25 hours. I cannot find any leaks but there is a milky discharge in the water from the exhaust on engine start up. Will adding a coolant leak stop work in a closed-cooling system?
Wade Jurke, Vanderhoof, British Columbia

A: Coolant loss from a closed-loop cooling system is usually caused by (in order of most likely to least likely): an exhaust manifold to riser gasket failure; cracked tube in the heat exchanger; cylinder head gasket leak; intake manifold gasket leak. Most of these failures are detectable with a pressure test. If the leak is small enough, however, you may not be able to make the system fail at room temperature so connect the pressure tester to a cold engine and run it up to temperature. The system should make and maintain 15 psi. Now, shut down the engine and see if the pressure remains at 15 psi for at least 10 minutes. You can add a small amount of cooling system sealer without any detrimental effects.
— *Steve Auger*

Wiring Cables

Q: I intend to enhance the lightning protection on my sailboat by joining each of the forestay, backstay, shrouds, mast and engine to the keel bolts using tinned 4 AWG battery cable. The pulpit, stanchions, winches, etc., will be linked by 6 AWG battery cable bonded to the keel bolts. This task includes preparing a number of lengths of battery cable with two tinned lugs per length. I need to know the best way to cut battery cable? Also, I would appreciate your suggestion on how to strip battery cable insulation without nicking the tinned strands within and what is the best way to crimp battery cable?
Bob Griffiths, Parry Sound, Ontario



Position the crimp tool in the middle of the lug barrel. Little or no wire should be visible outside the lug.

A: Battery cable is best cut with the Ancor lug crimper and the tool of choice for stripping cable that cuts the cover around the circumference of the cable and lessens the chance of nicking the wire strands is Ancor's 702065 (www.marinco.com/product/battery-cable-stripper). To prep the cable, cut approximately 16cm (5/8") of the vinyl cover off each cable end using the cable stripper tool. Peel off the cover and then check that the exposed wire bottoms out in the lug with

little bare wire visible. Using the crimping tool, select the correct size slot for your wire and align the lug so that it crimps at its midpoint. Strike the crimping tool with a hammer, using multiple blows if necessary, until the tool is fully compressed. Be sure to hold the tool and lug in place so that subsequent blows strike the lug in the same spot each time.

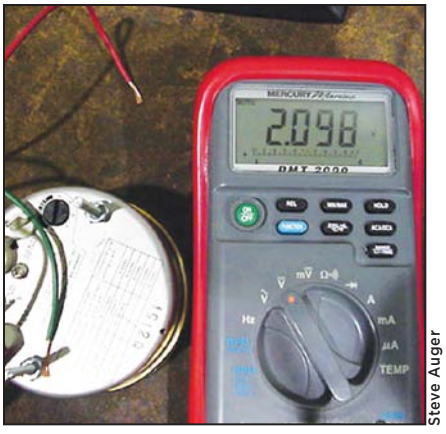
Next, cut a length of shrink tubing long enough to extend from the barrel of the lug to about 1" (25mm) over the vinyl cover. Shrink the tubing using a heat gun, butane torch or similar device. Be careful not to burn the wire cover. Use caution when using an open flame on a boat, especially in compartments that may contain explosive gases. Ventilate the work area well before starting the flame and always have a fire extinguisher at hand for instant use. Allow the lug to cool completely before disturbing the wire. Install the cable and then stand back and admire your work.

— Jan Mundy

Troubleshooting Tachs

Q: The tachometers on my '88 Carver Mariner with twin Mercruiser Bluewater 5.7L inboards with Thunderbolt 4 ignition intermittently read as much as 10 rpm higher than normal without any throttle adjustment. Both tachs were tested and they checked out okay.

Murray Abbott, Toronto, Ontario



Steve Auger

Use a multimeter to verify that the tachometer has the required operating voltage.

A: A tachometer is a gauge that displays engine speed based on the number of pulses from the negative side of the ignition. The pulses coincide with the firing of each spark plug. Most marine tachometers fit both outboard and inboard two- and four-cycle engines. Verify that your tachometer is on the correct setting for an eight-cylinder, four-cycle engine.

The tachometer requires a minimum 12 volts DC to operate correctly. Using a multimeter set on the 20-volt DC setting, check the voltage supply by connecting the red meter lead on the "I" terminal of the tachometer (should be a purple wire) and the black meter lead on the tachometer "G" terminal (should be a black wire) and then start the engine. Voltage supply needs to be 12 to 15 volts DC. If this checks out, then you need to verify that the tach signal lead is working. Set the multimeter to the ohms scale and check the continuity of the gray tach wire. Disconnect this wire from the tach and the negative side of the coil and hook up each end to a meter lead of the multimeter. There should be 0 ohms resistance. If there is resistance, replace the tach signal wire. If there is no resistance, then switch your port and starboard tachs in the dash and see if the problem follows the tach. If it does then the tach is faulty.

— Steve Auger

Smoke Signals

Q: My boat's 454 Crusader engine blows white steam out the exhaust at wide-open throttle, less at idle. My mechanic found water in the cylinders. The head gasket is okay and the block is not cracked. The boat has been winterized professionally every year. What causes water in cylinders?

Ottis Escoe Sr., Garden city, Michigan

A: Sources of water in the cylinders include: a cracked cylinder head near or at the valve seat, which can be found by pressure testing; rain or seawater entering the flame arrestor, which is usually a hatch cover or vent issue; improper engine or exhaust elbow height that allows less than 16" (406mm) difference between the top of the exhaust elbow and the waterline outside the boat; cracked cylinder block, exhaust manifold, riser or elbow or even a cracked intake manifold near the thermostat housing; or a blown head gasket. The correct way to test a cooling system is to pressure test the system prior to disassembling the engine. If the engine is already disassembled, each component will have to be checked separately.

— Steve Auger

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Tech Tips

Clean Connections: The best solution for removing the telltale bluish-green corrosion off cable end terminals of your boat's bonding system is to apply a spray of common white vinegar, which softens the corrosion, and then wipe with a wire brush.
Jim Discher, BearBoat, *Long Beach, California*

Slip fit: When your open-end wrench is too big, insert a washer to adjust the jaw for a snug fit.

Joe VanVeenen

Renewable Glue Brush: To make an always-ready-to-use glue brush, poke a length of line through a hand-size piece of 1/2" (12mm) ID hose and splay the end. After using, cut off the used part and pull more rope through the tube for the next job.

Joe VanVeenen

Throwaway Rim Liner: To keep a paint can rim clean, press a pipe cleaner in the recess and, when the job's completed, lift it out and replace the lid.

Jewel in the Rough: For a long lasting corrosion blocker, spray your engine exterior with Boeshield T-9, a heavy, waxy solution that's messy to apply, but don't wipe it off. It leaves an ugly looking residue that should only be removed when you decide to sell your boat, and at that time, you will have a nearly new looking engine.

Scratch-less Barnacle Scraper: To remove the "glue" rings left on the hull after removing barnacles, use a piece of 1" by 6" (25mm by 152mm) Plexiglas, of any thickness, and bevel cut the "working" end to give it the necessary bite to flick off the barnacle rings.

Jan Mundy

Cleat Secure: The proper way to secure a line to cleat is to take a single round turn around the base of the cleat, then engage the horns in a Figure 8. To leave unattended, make the last turn a half hitch for security.

Sticky Comfort: A yoga mat cut in half has a multitude of uses aboard. Use it to protect decks from crab traps, gear, tools and dirty beach shoes. Lay it in the engine room to cushion the mechanic. If you need to leave with the tide and you haven't stowed everything, just take it below and stack all gear on the mat and it won't go anywhere. Of course, you can take it on deck and practice Pranayama at sunrise.
Julia Johnson, Sea Swan, *Seattle, Washington*

Protect China: Separate your galley dishes by putting a coffee filter between each dish. You can buy packs of 1,000 filters at the Dollar Store for almost nothing.

Brush Ointment: If cleaning a quality China bristle brush leaves the bristles feeling "dried out" and not as supple as they were originally, after a thorough cleaning, rub some face or skin cream that contains lanolin into the bristles. Clean it in brush cleaner before reusing.

Roller Proof: Many roller covers are unidirectional. To verify this, hold the roller lightly and turn it, first in one direction and then in the opposite direction, to see if the nap stands up when turned against the "grain." Be sure to mount the roller on the handle so the paint is not applied in the "wrong" direction.
Mike Myers, Wendy Lynn, Baton Rouge, Louisiana

Super Bond: To repair small pinhole leaks in Hypalon inflatables, fully inflate the boat, put a few drops of Crazy Glue on a finger-tip-size Hypalon patch, smear the patch around in a circular motion, then press hard for 10 seconds. It works "in a pinch."
Derek Hewson, San Pedro, California

Whip Wrap: When a fiberglass VHF radio antenna splinters from UV damage, slip a Davis Instruments snap-on 3/8" by 6' (9mm by 1.8m) plastic shroud cable cover over the antenna for a $4 or less fix.

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EXTREME Deck Makeover

Next to repowering, professional deck refinishing is the single most expensive refit project. The key to success is in the approach strategy to this labor-intensive job. It's all in swapping "elbow grease" for dollar savings.

Story and photos by Nick Bailey

What can you do to bring back the boat show gleam when the best compounds and waxes have no effect? If budget allows, there is nothing to equal a professionally applied linear polyurethane (LPU) paint such as Awlgrip, Interspray 900 or Imron. If your budget has more time available than cash, many of the techniques below are also applicable to DIY deck refinishing using Interlux Protection or Brightside.

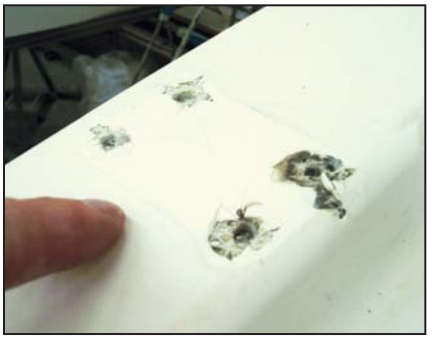
Professional deck refinishing that includes all the upper surfaces (deck, cabin trunk, cockpit, flying bridge) is expensive. It is, next to repowering, the single most expensive aspect of most major refit projects.

Like spar refinishing [Ed: For step-by-step details on spar refinishing refer to DIY 2009-#1 issue], the "devil is in the details" and that cliché translates to large amounts of labor. There are lots of fittings to remove and reinstall ("re-re") or to mask and work around; complex shapes with many inside corners that are time consuming to prep-sand; large surface areas that are folded up to make them appear deceptively small (cockpits, flying bridges) and, ultimately the smooth surface and non-skid paint applications.

Major core repairs are a good reason to refinish a deck.

All this plus the reality that most decks need repairs at stress cracks and/or core replacement prior to painting means that it's normal for a deck paint job to be two to four times the cost of a hull paint job. For example, if it takes 100 man-hours to refinish a 40' (12.1m) hull, the bare minimum labor expected for a relatively simple deck job is around 200 hours.

At that number, we're not factoring in repairs or a flying bridge and we are considering only a deck design with a simple cockpit and a customer willing to "re-re" the fittings. For a 40' (12.1m) motor yacht with a flying bridge, areas of the deck molding needing repair and lots of deck hardware to be considered, the labor estimate can approach the 400-hour mark. Multiply those hours by the yard's hourly labor rate and add 10% to 15% for materials (plus haulout, blocking, taxes, environmental surcharges, etc.) for an estimate total. Compare that dollar cost to the cost in personal time of a die-hard do-it-yourselfer putting in 20 hours every few weekends. Do the math based on 40 hours a month and you might be boating again in 10 months.



Underlying fiberglass problems, including minor gelcoat cracks, require repair prior to painting.

Some fittings are masked, others removed.

Repairs

There is not much point going to all the trouble of a top-notch paint job if there are underlying problems with the laminate or core. Often the strip mining involved in large-scale core repairs requires a paint job to restore the appearance of the deck after all the glass work is done but to do the opposite, refinish the deck while ignoring the underlying structural issues is really getting the cart before the horse. One famous yard manager refers to this error as "chroming a turd." I know of one DIY deck paint job where, after months of hard work, the boat owner discovered large areas of wet core under the new paint job. I believe he has since been talked down from the window ledge but, to avoid a similar nightmare, engage a qualified marine surveyor to perform a thorough inspection, with the usual and accepted percussion sounding and taking moisture meter readings, which can lead to recommending some invasive testing to confirm or deny observations formed in non-destructive testing. This survey is a prerequisite to any deck paint job.

Hairline stress cracks or crazing that may be inconspicuous on weathered gelcoat will print through the gleaming new paint and be painfully obvious. Paint alone cannot fill cracks so repairs here are mandatory. This usually involves "vee-ing out" the crack with a Dremel tool or, if there is a cluster of cracks or crazing over a wider area, using a mini-grinder to remove the cracked gelcoat until sound glass laminate substrate is all you see. The removals are followed by filling and fairing with epoxy or vinylester fairing compound to restore the contour. (Generally polyester fillers are only used to fill the smallest defects due to their high shrinkage during cure.) If the crack continues into the laminate it requires a glass patch prior to filling and fairing. No shortcuts here. The payback will be in deep regret.

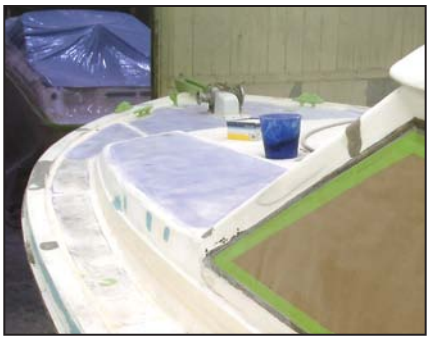
Not all the hardware removed is destined to be reinstalled. Any deck paint job is an opportunity to upgrade or change fittings that serve broken or obsolete equipment. The holes that remain from the previous installations rarely fit any new substitutes so before you fill them and forget them, repair them properly. Again, no shortcuts here. Filling the holes with putty is a Band-aid approach that will only lead to a future repair and refinishing headache.

Prep

As with any paint job, it's the quality of the prep work that predicts the success of the final finish and a clean, dry surface is essential. So before the paint goes on, all working surfaces are scrubbed with detergent, good brushes and/or 3M ScotchBrite pads, and followed by a thorough freshwater rinse. Next, adhesive-backed vinyl graphics or stripes are removed by applying heat with a hair dryer or heat gun and peeling them away manually or using a rotary rubber "eraser" striping wheel. Digital photos taken before the removals come in handy later as reference memory for restoring the name and registration markings.

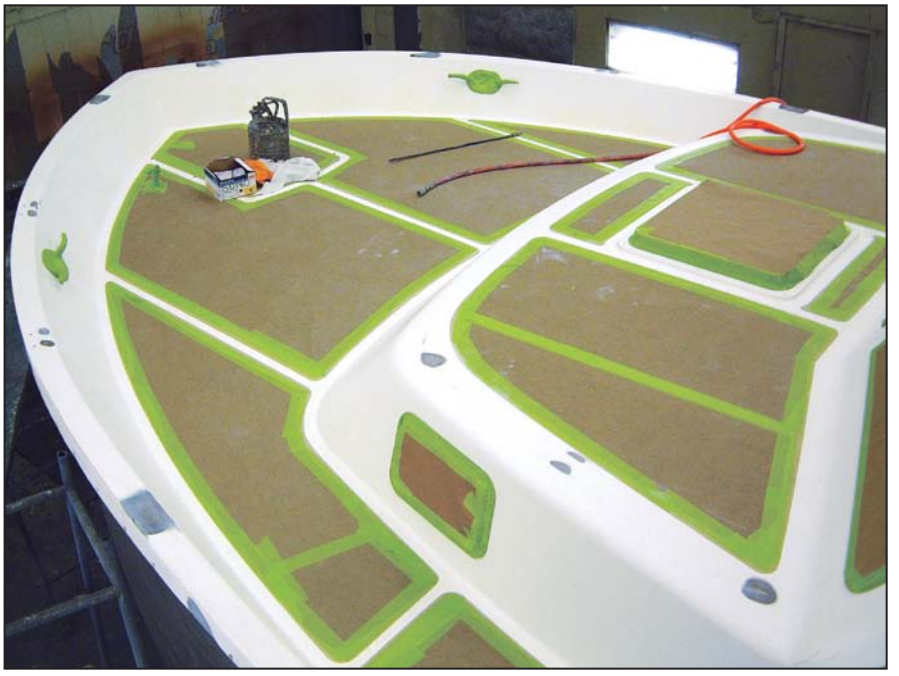
All fittings are now reviewed and designated for removal, masking or disposal. This usually involves a walkthrough with the boat owner to make the final decisions. Instructions marked on the deck adjacent to each fitting simplify the process. Use the digital camera again to capture a record of all hardware placements for reference when it's time to reinstall the fittings. After removing and/or masking all fittings and prior to sanding, any openings to the interior of the boat, including the engine spaces, are sealed with plastic sheet or heavy masking paper (not newspaper) to prevent the inevitable dust created in this process from entering the boat.

Most detail prep-sanding must still be done by hand. Tools like this Fein edge sander can help speed up the work.



Blue machinist's dye is useful as a sanding guide.

Removal of original non-skid pattern using a 1,500 rpm polisher fitted with a foam pad and 40-grit disc. Only use a sanding tool this aggressive to prep non-skid areas that will receive a textured finish. Note haz-mat gear worn by the technician — these are nasty materials!



It's not necessary to paint non-skid in good condition; just mask well to protect from paint overspray.

The area to be prepped and painted is delineated with 3M Fine Line #218 masking tape, backed by conventional masking tape. The remainder of the boat is shrouded or masked with a substantial apron. Residues of bedding compounds and sealant remaining from the hardware removals are scraped off the deck and needed repairs can now commence. A final cleaning and degreasing with solvent (acetone, or a commercial dewaxer such as Interlux Fiberglass Solvent Wash 202, US Paint Awl-Prep) is recommended to remove any remaining contaminants, including those from marking pens used in the prep process.

Prep Sanding

The amount of abrasion required depends on the hardness of the surface but 100 to 150-grit paper is typical for standard prep sanding of gelcoat. A dual action (DA) sander with hook and loop paper is the weapon of choice and sanding continues until every trace of the original gloss is gone. Careful hand sanding or the use of a special detail sanding tool is required in places where the DA sander can't reach or at corners and edges.

One optional technique that helps ensure complete sanding coverage and avoid repeating areas already done is to use a rag or brush to apply machinist's indicator dye, diluted with acetone, on the surface prior to sanding.

A previously painted surface that has proven to be well adhered and compatible, as evidenced by the scratch adhesion test [ED: Refer to page 14 in DIY 2009-#2 issue], is prep sanded in much the same way as gelcoat but with a slightly finer grit (120 to 180). Old paint that is incompatible or poorly adhered must be completely removed.

Non-skid surfaces involve different prep options. If the skid-resistant pattern is to be preserved, you must decide whether to mask it off and leave it untouched and original or to paint it. Unfortunately, preserving and painting non-skid requires compromises in the paint process. Obviously, any prep sanding will, at a minimum, flatten or blur the pattern. Reasonable paint adhesion can usually be achieved if the prep is limited to a thorough scratching with a ScotchBrite pad but this is only possible with a very flat and open non-skid pattern. After primer and topcoat is added, the pattern is still recognizable but it could hardly be called aggressively skid-resistant.

The best option is to sand the old non-skid completely off and reapply a new non-skid either with an aggregate impregnated or thickened stucco-like topcoat (discussed on page 14). Other reverse molding patterns can be fabricated but that is for another discussion.

Once the prep sanding is complete, the copious dust is blown off the boat with dry, oil-free compressed air and the surface wiped clear of residuals with clean dry rags followed by a two-cloth solvent wipe. The surface is now ready for priming.

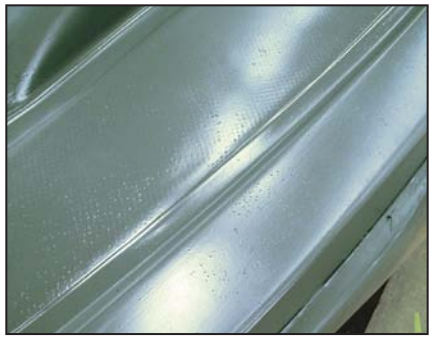
Primer application.

Priming

Why prime? The epoxy primers featured in every high-quality LPU paint system provide a hard coating that seals off the porous substrate. This provides the best adhesion for the topcoat and is essential to a consistent gloss finish. Also, until the primer is applied, it's impossible to determine what additional work is left to repair pinholes, scratch marks (usually from overzealous hand sanding) and such prior to topcoat application.

Primers come in different "build" classifications depending on their solids content, which, in turn, governs the film thickness of a single coat: low, medium, high and ultra. There are even thicker variations but those are classified as sprayable fairing compounds. The dif-

After priming comes slicking with epoxy sanding surfacer, a high-build primer with a consistency somewhere between ketchup and mayonnaise.



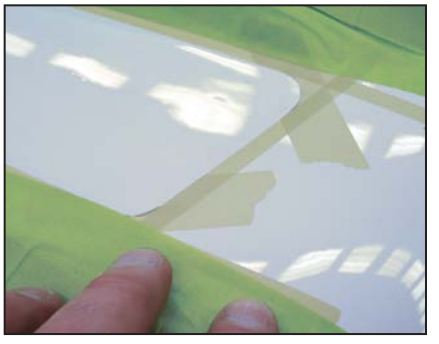
The primer reveals all surface defects including pinholes (top) and prep-sanding scratches, which are filled with sanding surfacer (bottom).

(top) Applying the surfacer with a putty knife allows it to be squeezed into a every tiny defect. (bottom) It is not unusual to require a lot of sanding surfacer.

Proper spray booth ventilation that removes paint overspray mist helps ensure a good gloss, what the pros call "definition of image."

Deck topcoat application often requires a team effort, even on a small boat like this Boston Whaler Outrage 21.

Masking for non-skid application on two classics: (top) Hatteras 53, (bottom) Boston Whaler Outrage 21.



Creating a curved corner for future non-skid with 3M Fine Line masking tape.

ferent applications for all these different primers is beyond the scope of this article but the most common primer usage for over-coating gelcoat is to spray apply two or three coats of a low-build primer followed the next day by trowel or squeegee application of a medium-build primer/sanding surfacer as required to fill any pinholes or scratch marks revealed by the low-build primer.

Once the primers have cured (usually overnight) the entire primed surface is carefully sanded with a medium fine paper (220 to 400 grit), compressed air blown to remove dust; solvent wiped and then wiped again with specialized tack rags to remove the last traces of dust. Any source of dust, such as on adjacent masked surfaces or on the paint booth interior are also blown clear of dust and cleaned.

Topcoating

The first phase of topcoat application in the smooth glossy areas (or semi-gloss as many prefer on decks) follows immediately once the dust cleanup is finished. The two-part paint and catalyst is mixed in the correct proportions and thinned with the appropriate reducer for the ambient temperature. A slow evaporating reducer is chosen in hot weather and a fast reducer for cooler temperatures. The correct viscosity is verified by timing how long the mix takes to flow out the drain hole in a calibration cup (a.k.a. Zhan cup).

Rolling on a polyurethane stucco non-skid.

At this point, the painters finish suiting up in their haz-mat suits, rubber gloves taped at the cuff and NIOSH/MSHA approved respirators (most LPU paints contain isocyanates). The booth air make-up machinery is started to provide a steady cross-flow of filtered air at a constant temperature throughout the spray operation. This massive floor-to-ceiling ventilation system constantly clears out the clouds of overspray mist and traps it in the booth exit filters, preventing the overspray from contaminating the environment or settling back down onto the curing high-gloss paint. This overspray redeposition can be a big problem and, if allowed to occur, it will inevitably and severely mar the gloss finish.

Professionals that are forced to spray paint in poorly ventilated sheds are driven crazy by this problem and will work around it by using the faster drying but softer acrylic urethanes. These can be buffed to improve the gloss. Some contractors resort to even more desperate measures to achieve an acceptable gloss such as wet sanding the cured topcoat with 1,000 grit and applying a final clear coat. That is a lot of extra labor. A proper spray booth is one very important and expensive piece of shop infrastructure that is rarely available to the DIY painter.

Applying topcoat to the upper works of a larger yacht may end up being done in two or three stages due to the sheer size

(above) Before: Most of the hardware on this Rhodes Reliant will be removed. (left) After: Teak refinished and all hardware reinstalled.

Tada! Roll-out to launch.

of the job. Additional colors for stripes or accents also require a separate "shoot."

Deck painting is further complicated (and the labor cost increased) by the need for at least a two-man team during spray painting. The assistant's job is to handle the spray-gun air hoses and keep them from dragging across the freshly painted surfaces.

The first coat is applied and allowed to "flash-off" (evaporate reducers) for about 30 minutes. Two more coats are usually required. The volatile organic compounds (VOCs) in the reducer and paint are unfortunately lost into the air, an unavoidable environmental consequence of almost any paint job. VOC emissions are becoming more tightly controlled in many jurisdictions prompting the paint manufacturers to work towards lower VOC content in all paints. Someday we may even see a water-based, high-gloss topcoat with comparable durability but so far there aren't any.

So far we have painted around the non-skid areas allowing a slight overlap. Once the fresh paint has cured enough to be masked and handled (usually the next day) it is covered where needed by protective paper and the masking and lay-out of the non-skid areas begin.

The perimeter is masked with 3M Fine Line and all the corner radii carefully constructed. Any topcoat overspray onto the non-skid areas is heavy scuffed with a brown ScotchBrite pad, wiped and tack ragged.

There are several ways to do non-skid but painted non-skid is usually either sprayed on as a mix of regular LPU topcoat combined with flattening paste and a specialized aggregate (e.g. Awlgrip Griptex) or rolled on as a pre-mixed ready-made paint (e.g. Interlux Interdeck). It also can be applied by roller as a mayonnaise consistency stucco created on the shop floor very similar to gelcoat stucco. I have never found this paint stucco method in any of the paint manufacturer's guidelines but at our shop we make it with Awlgrip topcoat and Awlcat #3 brushing catalyst combined with flattener and colloidal silica. (The details shall remain a trade secret). This stucco non-skid is easy to apply, has good grip and can be tailored to be more or less aggressive. It also ages well as it does not get spotty and lose grip over the years as the tiny aggregate bits wear off.

Regardless of application technique, the flattener additive is a key ingredient in all painted non-skid. If omitted, the non-skid is glossy and gets very slick when wet. Not good.

Non-skid application usually requires two coats for good coverage. It builds to a fairly thick coating so as soon as possible after it's rolled or sprayed it is wise to carefully remove the perimeter masking. We try not to drag the tape over the fresh surface. If this step is left till the non-skid has cured, it will be difficult to remove the tape from under the cured paint; or worse, the paint edge will tear off unevenly. Regardless, some edge trimming and tidying of the non-skid is usually required.

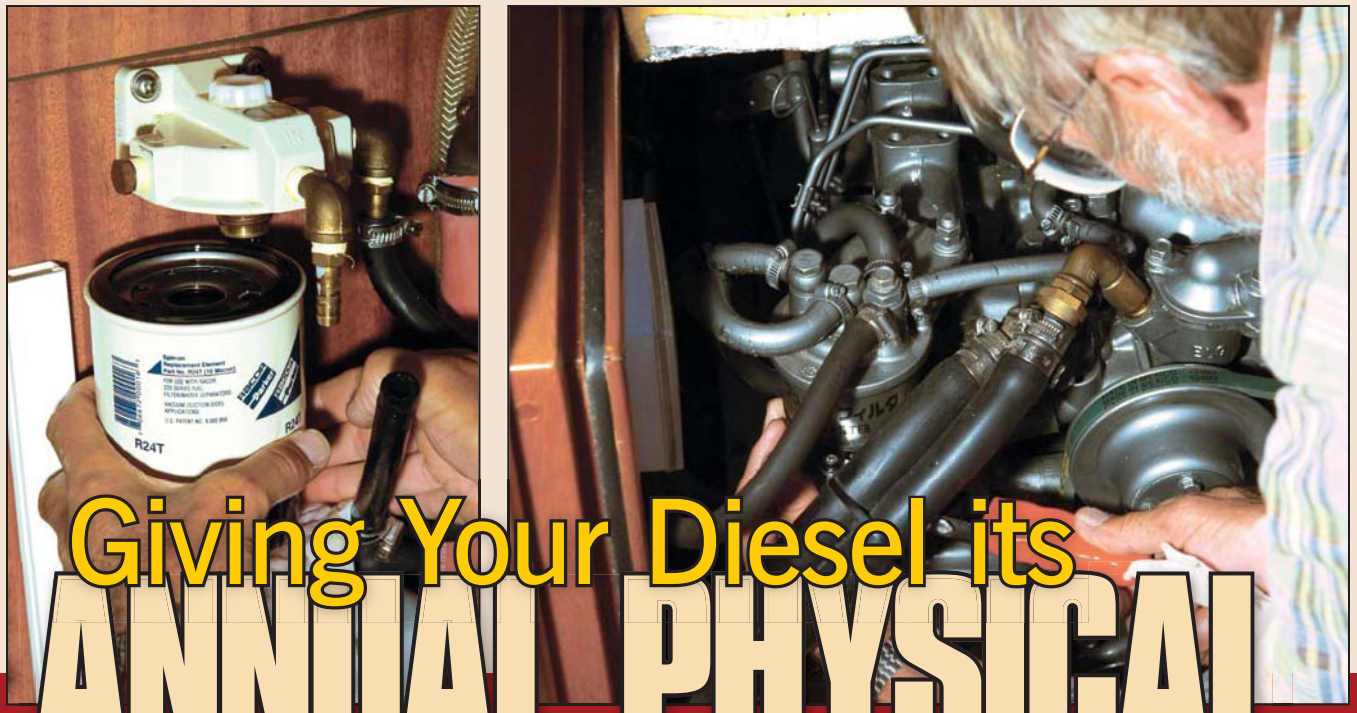
Reassembly

This phase seems to go on forever and is where many jobs go over budget. With any luck the customer has volunteered to do it. It is also where the installer gets the opportunity to put big scratches in the new paint job as a screwdriver or half-installed fitting slips and there's an audible expletive heard. Masking off the new paint with heavy paper or one of the new proprietary spray-on protective coatings can minimize shop damage and wear.

It may be several weeks, depending on the temperature, before the new coatings achieve their full mechanical properties, i.e. hardness.

At last, it is time to let the graphics guy onboard to do the vinyl and here comes the Travelift.

About the author: Nick Bailey is a frequent DIY contributor and past Pro Series topics include core repairs, filling and fairing, hull refinishing, non-skid repairs and patching holes. For a complete article index, go to www.diy-boat.com.



Check for dirt in primary and the secondary engine-mounted fuel filters.

Giving Your Diesel its ANNUAL PHYSICAL

The words of wisdom that follow are proof positive that taking take care of the simple stuff on a diesel engine is the smart investment strategy to big dividends in long, reliable service.

Story and photos by Nigel Calder

From time to time I am asked if there is a simple way to gauge the health of an older diesel engine. To some extent, there is. The following are some of the checks I like to make.

I begin with a visual inspection of the exterior of the engine and its ancillary components (exhaust system, controls, etc.). Engines that see little use (notably those in sailboats) tend to decay from the outside, rather than fail from the inside. I'm also looking to see if the owner has taken pride in the engine's appearance, because, as often as not, a clean engine has been well maintained. Cleanliness is not easily faked since it takes a good deal more than a superficial wash down with a degreaser to remove the ingrained pockets of dirt and corrosion that accumulate on a habitually dirty engine.

Cleanliness coupled to meticulous maintenance records is even better. These records should note, at the least, all oil and filter changes, all fuel filter changes and any other work, together with the engine hours at which the work was done. Note that, if an engine has no hour meter or the hours are not recorded, then there is a good probability that the maintenance has not been done on schedule.

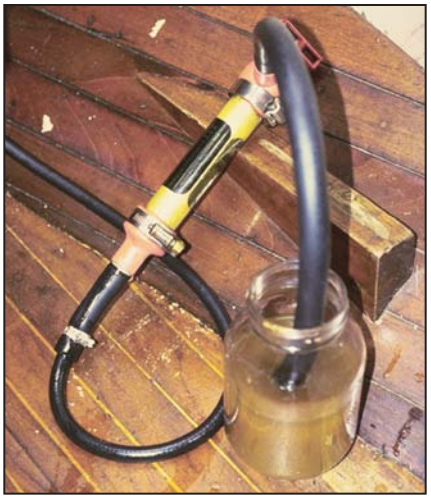
Records may be supplemented by verbal reports, which can be revealing. I might be told that the filters were changed more regularly than called for because they have been fouling. While I am supposed to be impressed with the operator's diligence, I will, in fact, be wondering if the boat has a fuel contamination problem.

Fuel System

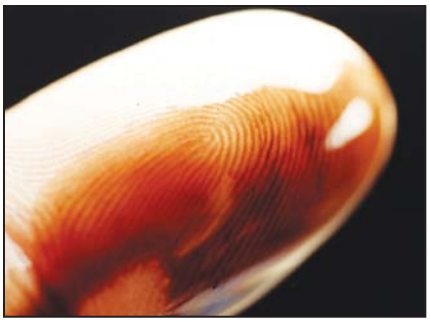
The fuel system is the single most expensive set of components on a diesel engine. Given that contaminated fuel is one of the principle causes of marine diesel breakdowns, I want to know that the fuel system has been kept scrupulously clean.

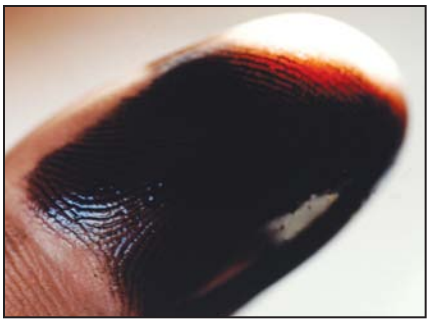
Clean fuel requires both a primary and a secondary filter. I may open the filters to see if they are dirty. The engine-mounted (secondary) filter needs close attention. If it is even moderately soiled, the engine has a potentially serious problem.

A really useful check of the general state of the fuel system can be made by examining a sample of fuel from the lowest point in the fuel tank. Unfortunately, on most tanks to gain access you need to take off an inspection plate. I insert a tube and use a small hand pump discharging into a jam jar. I allow the sample to settle for a few minutes, at which point any significant contamination (water, sediment, bacteria) is immediately appar-



Take a fuel sample from the tank using a hand pump to confirm fuel quality.





Regular oil analysis will forewarn of problems. In this finger test, one shows clean fuel (left), the other dirty fuel (right).

ent. If the tank is contaminated, especially with dirt or bacteria, the entire fuel system is suspect.

A dirty tank needs cleaning, regardless of how much trouble this may be (and it can be quite a bit of trouble). If it is not cleaned, the next time the boat is in rough water, the sediment or bacteria gets stirred up and sucked into the fuel system where, at best, it plugs the filters and may shut down the motor, and at worst it can lead to ruptured filters and a wrecked engine.

Oil Analysis

An excellent way to gauge the state of an engine is through regular oil analysis, but it's a rare owner who does this (I am guilty on this count, myself). If done, oil samples should always be sent to the same lab. The analysis tracks microscopic quantities of numerous metals and other substances. What the analyst is looking for are sudden changes, which can then be correlated with specific developing failures. A one-time sample does not provide the same history, although it picks up major problems and establishes a base line reference for future sampling.

In the absence of oil analysis, I like to take a couple of drops of oil from the dip stick and smear them around my fingers. Since soot is a normal byproduct of diesel engine operation, unless the oil has just been changed, it will be black, but with an element of translucency. However, if oil change procedures have been neglected or the engine is suffering from "blow by" (see discussion on page 19), the oil is likely to be intensely black and completely opaque.

I remove the oil filler cap and wipe my finger around the underside of the valve cover. A black sludge in here is also indicative of poor oil change procedures and/or an engine showing its age. Diesel engines, which are consistently under loaded and/or not run long enough to warm up, are particularly prone to problems. These operating conditions lead to fouling of the valves and piston rings, glazing of the cylinder walls, loss of compression and numerous other problems.

Next, I locate the water lift muffler, into which the exhaust from the engine discharges, and remove the inlet and exhaust hoses from it. I look inside the hoses and inside the muffler. There may well be a light greasy film of carbon and that's okay. If there is any kind of a crust, you can bet the valves and pistons are also fouled. The engine needs an expensive overhaul and a review of the manner in which it has been operated.

Water and Oil Don't Mix

Occasionally, when you take oil samples, or wipe your finger around the inside of the valve cover or the oil filler tube, you find oil with a creamy color and texture. This is symptomatic of water in the oil. This water can come from the raw-water cooling system, via the exhaust, or from the freshwater system. The former is more typical and relatively easy to fix, which is just as well because the latter generally indicates an expensive repair. One way to determine where the water has come from is to get an oil analysis; water from the freshwater cooling system has glycol (anti-freeze) in it, which shows up in the analysis.

The raw-water cooling system has a rubber impeller pump that draws water in via a through hull, circulates it through a heat exchanger, and discharges it into the exhaust. The exhaust gases carry this water overboard. If the engine is installed below the waterline

(top) Remove the water pump cover and (bottom) check the raw-water pump impeller for damage.

Emulsified (water contaminated) oil in the valve cover.

(as many are) and the vanes on the rubber impeller pump fail (not uncommon), when the engine is at rest, water can siphon into the cooling system, flow through the heat exchanger and fill the exhaust to the point at which it backs up into the engine. The water then flows past any exhaust valve that is open (at least one will be), filling that cylinder and, from there, it dribbles down the sides of the piston into the sump (and the oil).

There are two lines of defense against this siphoning: a regular check of the impeller in the raw-water pump and a siphon break somewhere between the raw-water inlet and the

exhaust. The latter is at the top of a loop of hose that goes above the waterline. Unfortunately, it is not something that comes with the engine and may get omitted by the boatbuilder doing the engine installation. If the water pump impeller fails, there is then no protection against siphoning. On any boat with a below the waterline engine, you should check for this siphon break. Cleaning its valve is a regular maintenance item.

Another way water can make it into an engine is from waves driving up the back of the boat when the engine is at rest, filling the exhaust system. This is prevented by looping the exhaust hose above the maximum waterline level (based on a fully loaded boat, heeled over and running in rough seas).

On the freshwater side of the cooling system, there are several potential sources for water in the oil. These include a corroded heat exchanger, a blown head gasket, a cracked cylinder head and a corroded cylinder liner. Unfortunately, once failed, all but the heat exchanger require a professional fix.

Inspecting Heat Exchangers

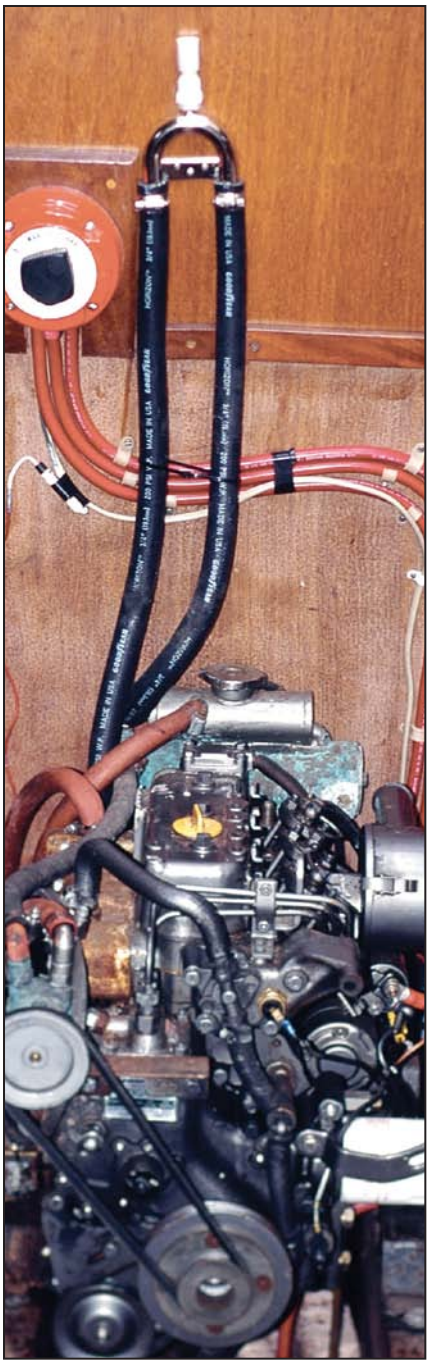
The heat exchanger has raw water on one side of it and freshwater, which circulates through the engine, on the other. The freshwater contains antifreeze, which is also a corrosion inhibitor, so this side rarely causes problems. The raw-water side is another matter. Here we have warm saltwater and dissimilar metals, an excellent brew for promoting galvanic corrosion.

Older heat exchangers, made of galvanically incompatible materials, require sacrificial zinc anodes to protect them. The effectiveness of a zinc is directly proportional to its surface area, which means a zinc needs to be replaced when it is half consumed and not when it is completely gone. On any heat exchanger that has a zinc, I pull it out to take a look. If it is gone, as it often is, there has to be a question mark over the integrity of the heat exchanger.

If the heat exchanger has removable end caps (some do; some don't), you can take these off to inspect the tube stack, although, as often as not, scale and other deposits mask any corrosion, making it difficult to ascertain how much, if any, damage has been done. A more telling indication of corrosion may be found by removing the raw-water hoses from the heat exchanger. For some reason, when zincs are neglected, the pipe stubs are often one of the first things to go. If these are pitted, the entire heat exchanger may be in trouble.

Exhaust Elbow Troubles

Another component that is particularly susceptible to corrosion is the exhaust elbow where raw water is injected. Here, we have very high temperatures, saltwater, and frequently dissimilar metals, an especially potent brew for spoiling your fun. Some of these elbows (generally one-piece cast iron kind), last for years while others (fabricated from various pieces welded together) fail in just a few years. You should regularly remove the hoses and



(top) Proper installation of a vented loop. (bottom) Vented loop not installed on engine.

Check the heat exchanger and any zincs. If not maintained, there may be expensive corrosion repairs.

take a close look inside the elbow. Note that if it's crusted with carbon, you have other problems.

While inspecting the heat exchanger and exhaust elbow, give the various hoses a squeeze, feeling for soft, bulging or cracked spots. Also, back off one or two hose clamps a turn or two to see if corrosion of the band has developed inside the clamp housing. Unfortunately, many "all stainless steel" hose clamps have screws made of an inferior grade of stainless steel that corrodes in a salt atmosphere. Replace these with all 316 stainless-steel hose clamps and make sure the screw is the same alloy; "316" is the key indicator of a good quality hose clamp.

Compression Ignition

You will notice that so far I haven't even turned the engine over. It's time to crank it and see what kind of a story it has to tell. The simple act of cranking can provide important information about the internal health of the engine. This is because a diesel engine has no ignition system. It compresses a given volume of air until the temperature of the air rises beyond the ignition point of diesel. The fuel is then sprayed in and spontaneously ignites.

As an engine ages, the normal wear of cylinder walls and piston rings slowly reduces the seal between these two components, causing a loss of compression. Loss of compression causes a loss of compression temperatures. Eventually the temperature of the compressed air is insufficient to ignite the injected diesel, particularly in cold weather when the air charge itself contains less heat. Over thousands of hours of run time, the engine develops a starting problem.

This is one mechanism of aging. Another is repeated operation for short periods of time and at low loads and temperatures. The many cold starts accelerate cylinder and ring wear, while the low loads and temperatures cause excess carbon and condensates to form in the combustion chamber. These, in turn, foul the valves and gum the piston rings into their grooves, resulting in "blow by" past the rings and valves. Once again, the engine loses compression and develops a starting problem but, this time, sometimes after just a few hundred hours of engine operation.

It follows that the number of hours of use on an engine is not a good indicator of its internal health. What is of far greater significance is whether or not it still retains effective compression levels and this we can roughly gauge from its willingness to fire when first cranked.

The Cold Start Test

Once the internal surfaces of a diesel engine are warm, the compression levels necessary for ignition purposes decline (heat retained by the engine substitutes for some of the heat of compression). To gauge compression levels without a compression tester, the engine must be cranked when cold. Unless there is some good reason for an engine to have been run before an inspection (such as the need to bring a boat to the dock for boarding). I am immediately suspicious if confronted with an already warm engine.

Given a cold engine, even if an engine has pre-heat devices, it is worth trying to start it without these devices. If it fires right up, the compression is excellent. If it does not fire, the cold start devices can be activated, after which

Most hose clamps are all stainless steel but the screws are often inferior grades. Hose clamps with rusted screws can fail and should be replaced with all 316 stainless-steel ones.

the motor should crank right away. If it does not, it probably has a compression problem. If the motor emits little puffs of white smoke smelling of diesel (put your hand over the exhaust outlet for a moment, and then sniff your hand) it almost certainly has a compression problem. If it fires up, but runs erratically until warm, it probably has a compression problem on just one or two cylinders.

If the compression is in doubt, it may be worthwhile to have a mechanic do a proper compression test but this will be moderately expensive.

Running Tests

Let's assume the engine fired up on the first attempt so the compression looks good. I immediately check the overboard raw-water discharge and the exhaust smoke and then note the oil pressure. Since the oil is initially cold and thick, this pressure should reflect the pressure setting on the oil pressure relief valve, which, in turn, should correspond with the normal oil pressure given in the operator's manual.

Whitish smoke during warm-up is probably nothing more than water vapor, but also may be unburned diesel, signaling a compression problem and, with a water-cooled exhaust, it's hard to tell the difference. Blue smoke comes from engine oil that has found its way into the combustion chamber. This is a little normal on startup until the pistons and rings warm and seat fully but, if it continues, there is probably a compression problem. Black smoke comes from unburned fuel. At high engine loadings, it may be the result of an obstruction in the air inlet (particularly the filter) or the exhaust but, at low loads, it is more likely caused by fuel injection problems requiring servicing of the injection pump or injectors, which is another expensive proposition.

Run the engine until warm, check the smoke again and then load it up and check the crankcase breather for blow by.

I accelerate and decelerate the motor, loaded and unloaded, watching for changes in the exhaust smoke, listening for unusual noises and feeling for vibration. I like to open the crankcase breather (typically a vent cap on the valve cover or a hose that runs to the air inlet manifold) and then tie off the boat, put the transmission in forward, and fully load the engine. (Make sure the cleats on the dock are strong enough to take the load.) Normal engine operation produces a slight gas discharge from the breather but, if there is a significant air flow, probably accompanied by smoky fumes, one or more pistons is blowing by.

Once the engine is hot, the oil pressure should again be noted both at higher rpm and at idle. At the higher speed it should be similar to the original pressure. At idle it may fall off some but, if it drops precipitously (say down to 15 to 20 psi/1-1.5 kg/cm2), there is probably a fair amount of generalized engine wear.

Did it Pass?

That's about as far as I like to go with a quick inspection. More extensive testing gets both intrusive and expensive. In most circumstances, in just an hour or so, the above tests give a pretty fair impression of the engine's overall mechanical health.

All that remains is to check the core DC systems: batteries, starting and alternator circuits and voltage regulator but that's a subject for another article.

About the author: Nigel Calder is best known for his best-selling *Boatowner's Mechanical and Electrical Manual* and *Marine Diesel Engines*, available from International Marine Publishing.

Sacha

BETTER, BRIGHTER BULBS

Replacing incandescent bulbs with LED ones in navigation light fixtures delivers a sizeable power savings but not all bulbs are created equal in terms of longevity or brightness.

Figure 1

Bulb base for AquaSignal 40 series showing double contacts and offset pins.

Story and photos by Harry Hungate

The tricolor masthead navigation light is found on most sailboats and is only legal for use when under sail power alone. That is also the time when electrical power is most precious. A standard 25-watt, incandescent lamp draws up to two amperes, not an inconsiderable load, especially when in use from dusk to dawn.

Light emitting diodes (LED) are continuously being improved and prices constantly decreasing. Most navigation light manufacturers offer LED models and these command a considerable premium compared to conventional incandescent light technology. There are a growing number of suppliers of LED replacements for incandescent lamps. As prices of these LED fixtures decrease, it is becoming increasingly attractive to upgrade to them. Also, their service lives are measured in tens of thousands of hours, making replacement a very long-term prospect.

Assuming that your existing tricolor fixture is still serviceable and not embrittled from ultra-violet exposure, it's worth looking for the latest deals on LED replacement lamps. Shop around for the best specifications and prices, as these are constantly changing for the better. Look for LED replacements that meet U.S. Coast Guard visibility requirements. Be careful to order the exact replacement for your tricolor, as not all are the same. Many, like the AquaSignal 40 series, use the double contact offset pin bulb base, known as BAY 15d (**Figure 1**). (Note, red and green LED nav lights are colored, but must also be used with a colored lens; white LEDS should not be used with colored lenses.)

If you have the tricolor and anchor light combination, consider replacing the anchor lamp also for even greater savings in power consumption. Or, if you have a separate anchor light, consider replacing its bulb with the LED equivalent.

Whatever brand you purchase, be aware that some of them emit radio frequency interference (RFI), which can interfere with your VHF radio. Be sure that you can return the offending LED device for a refund if this proves to be a problem. I bought an Orca Green Marine tricolor last summer and discovered the RFI problem after it arrived. I attempted to eliminate the RFI with toroidal ferrites on the power lead but without success. The manufacturer was kind enough to refund my money, however, and stated that it was working on a solution to the problem.

Restoring Tricolors

Installing the LED replacement is as simple as changing the old incandescent light bulb. Take the time to carefully clean the lamp sockets and also to place a dab of silicone grease on the contacts at the bulb base to ward off corrosion. Should the LED replacement be a bit taller than the old incandescent bulb, just remove the two screws holding the upper bulb socket in place. Lift the socket just enough to provide clearance for the LED unit. Stow the old incandescent lamp for use as a spare, if needed. While all individual LEDs are

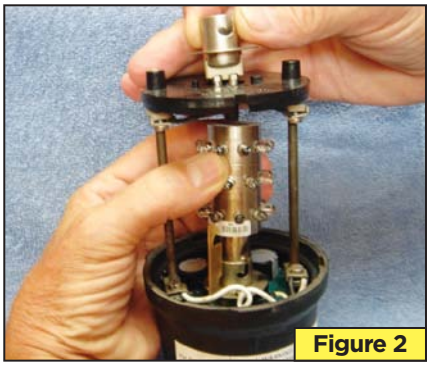


Figure 2

Installing the LED replacement lamps.

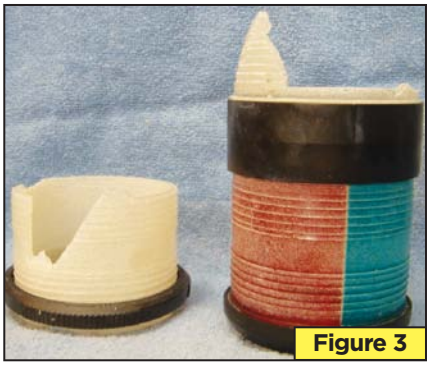


Figure 3

Fractured AquaSignal 40 Series tricolor lens, circa 1985.

polarity sensitive, most LED replacement fixtures have internal circuitry to correct reverse polarity (**Figure 2**). Carefully confirm this in the instructions accompanying the LED fixture.

If the years of exposure to the sun's rays have clouded the lens of your tricolor light,

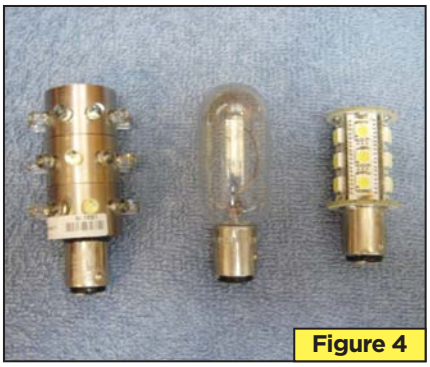


Figure 4

Actual measured current consumption at 12.6 volts DC supply is 240 milliamps for the LED lamp on the left, 270 milliamps for the LED lamp on the right, and 1,955 milliamps (1.95 amps) for the 25-watt incandescent bulb in the center.

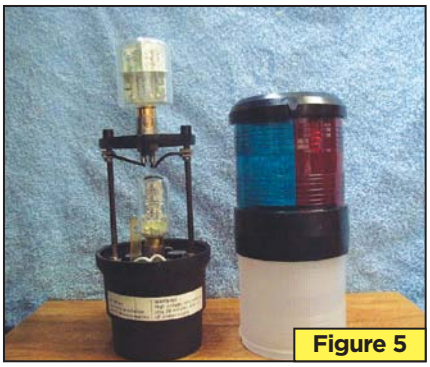


Figure 5

Dr. LED fixtures installed in tricolor assembly. The anchor light has a similar warm incandescent glow, not the harsh bluish white of most LEDs and the tricolor is quite bright.

or worse yet, embrittled it to the point of fracture, a replacement lens can add several more years of life to the old fixture (**Figure 3**). Try a Google search for "lens for AquaSignal tricolor" or whatever brand that you have. There's always hope!

On average, the values for the tricolor LED lamps approximate 13% of the current consumption of the incandescent 25-watt bulb installed originally in these lights (**Figure 4**). A 10-watt incandescent lamp for anchor light use actually measured 1,200 milliamps or 15.1 watts of power.

I considered replacing the incandescent lamps in the bow and stern navigation lights with LED fixtures and I may do so when I run out of spare incandescent lamps. These navigation lights are only used when under power (the engine running and the alternator supplying ample electricity) so the added cost of the LED fixtures cannot be justified on the basis of reduced electricity demand. Also, being at deck level, they are very easily changed, so the long service lives of the LED fixtures add very little to the economic justification.

Quality Counts

This article originally ended here, but a short time later, both LED fixtures shown in **Figure 4** failed, one completely and one with five of the several LEDs failed. I replaced them with bulbs from Dr. LED (**Figure 5**). The actual measured current consumption at 12.53 volts DC supply is 139 milliamps for the tricolor LED lamp (on the top), and 93 milliamps for the anchor LED lamp (on the bottom) that is almost exactly as advertised. These are the best that I have seen so far.

About the author: Harry Hungate and his wife Jane live aboard *Cormorant* their Corbin 39. After cruising the west coasts of Malaysia and Thailand they crossed the Indian Ocean and transited the Red Sea passage to the Mediterranean this past winter.

Emergency PREPAREDNESS

While having an engine spares kit onboard won't prevent a breakdown while underway, it does give you the tools to deal with minor failures on the spot.

Steve Auger

By Steve Auger

What if your engine should have a part failure that renders it non-operational just before a long-planned summer cruise or, even worse, while you are on vacation? Maybe a vee belt snaps, leaving you stranded miles from shore. Are you prepared for such an event?

You would never embark on a trip in your car without a spare tire so why would your boat be any different? When something goes awry with your car, you can usually just pull over and call for a tow truck. There are no shoulders in the road at sea. Cell phones and VHF radios will cut down your wait time to be rescued but, with a spares kit, you may be able to effect repairs that are good enough to get you home or to the next convenient port of call for professional assistance.

With a few basic tools, a service manual and the spare part, you could be up and running again in minutes. You'll be the hero who saved the day. No spare, no tools or manual and you'll wait to be towed and that can be very expensive in addition to spoiling your cruising plans.

A spares kit is a collection of parts and/or "supplies" that can remedy incidental breakdowns and get you underway again as soon as possible. Although this article is aimed more towards mid-size to large powerboats with gasoline engines, it applies to owners of all craft, large or small, who want to keep their boat's down time to a minimum. The parts and supplies listed in this article are just suggestions based on typical engine issues that occur with regular use. Obviously, you need to customize your own spares kit to meet the regional conditions and personal boating requirements.

Regardless of the boat size, the first component in every spares kit is a quality service manual for your boat's engine. Keep this onboard. It does you no good at home in the basement or shop if you have an emergency on the water. This manual guides you through troubleshooting and a basic repair without inflicting damage on you, your guests or the engine.

Sample Kits

Smaller boats on an inland lake might only need a small kit with spare spark plugs, a wrench or two and a manual pull start rope in a toolbox. Bigger vessels that operate in semi-protected or open water, with more exotic engines will likely want to expand their kits to include more difficult-to-find parts or those that are easily changed, such as fuel or oil filters, water-pump impeller kits and serpentine belts. Owners of offshore performance boats have been known to stow complete spare sterndrive units onboard in order to keep their down time to a minimum.

Some of the "cool" gadgets include plastic cable wraps (wire ties) and that good old reliable duct (not "duck") tape. My new favorite is shrinkwrap tape. This is strong stuff that sticks to anything and temporarily patches above waterline holes in the hull, deck, upholstery and canvas top tears long enough to get you home where you can arrange proper repairs. (Works great for beach ball repairs, too.) For repairing hoses, electrical cables or anything that needs to be wrapped, nothing beats a roll of self-amalgamating Rescue Tape.

Lubricants

Check your service or owner's manual for all oil and lube specifications and keep a supply of each product onboard. Always check your engine oil level prior to the first start up each day and add fluids as required. Oil costs way less than engine parts. If any oil level continues to drop, inspect the engine and surrounding area for leaks or splatter marks. Oil can also be lost through failed oil coolers and worn or damaged engine parts. Many Mercruiser power trim systems can be topped up with motor oil in a pinch. Check the manual first to make sure you don't make a bad situation worse.

Check the transmission fluid every day and top up as needed. If your engine specifies using Dexron III, this can also be used in emergencies to top up some power steering, power trim tab and power trim systems.

There are many types of sterndrive gear lube so again, you'll need to consult your owner's manual. Most modern sterndrives have an oil reservoir to supply oil to the sterndrive. Check this every day. Outboard owners should carry gearcase lubricant in their spares kit as well.

If your boat is equipped with hydraulic steering, add the specified hydraulic steering oil to your kit.

Carry a supply of gasoline engine fuel stabilizer and use it with every tank fill up. Modern fuel is designed for cars (not boats) and the fuel needs treating with stabilizer to try to maintain the best fuel quality and protect fuel system parts. Double up on the stabilizer amount if the boat sits more than it runs.

Water separating fuel filters are the big stoppage, especially on big gas engines. Carrying a spare filter can make the difference between getting back to port on your own engine and needing a tow. Exotic or non-domestic engines with hard-to-find filters dictate that you carry both oil and fuel filters in your kit. Keep some 1 gallon Ziploc bags for filter disposal.

Cooling Parts

It's very possible that sooner or later you'll pull an obstruction, which damag-

es the seawater pump impeller, into the engine's seawater intake. A spare water pump impeller or water pump repair kit allows you to make repairs to the cooling system seawater pump without having to wait for parts.

If your engine has a belt-driven seawater pump, carry a spare drive belt, as this can be damaged if the pump locks up because the impeller is damaged.

A thermostat and gasket kit is a wise choice for larger or exotic engines, as well as a thermostat housing, for this is where the broken pieces of the water pump impeller often migrate. You may also need to carry coolant if you replace a thermostat on a freshwater-cooled boat.

Driveline Spares

A spare propeller is the most obvious choice in this category. Verify the pitch and diameter before purchasing a spare prop. You'll also need a floating prop wrench. For some sterndrive and outboard applications, purchase an inexpensive "emergency" plastic prop designed to get you back to port.

You may also want to purchase a spare thrust washer, cotter pins and retaining nut kits from your dealer. These don't float and are usually fairly slippery, which is why it's good to have spares.

Many modern sterndrives and outboards have replacement hubs that are serviceable by the owner. If your engine is equipped with this feature, you should carry a spare prop hub and for older and non domestic small horsepower outboards a supply of shear pins as well.

Engine Electrical

Distributor caps and rotors, breaker points, spark plug wires, ignition coils and spark plugs all qualify for places in the spares kit.

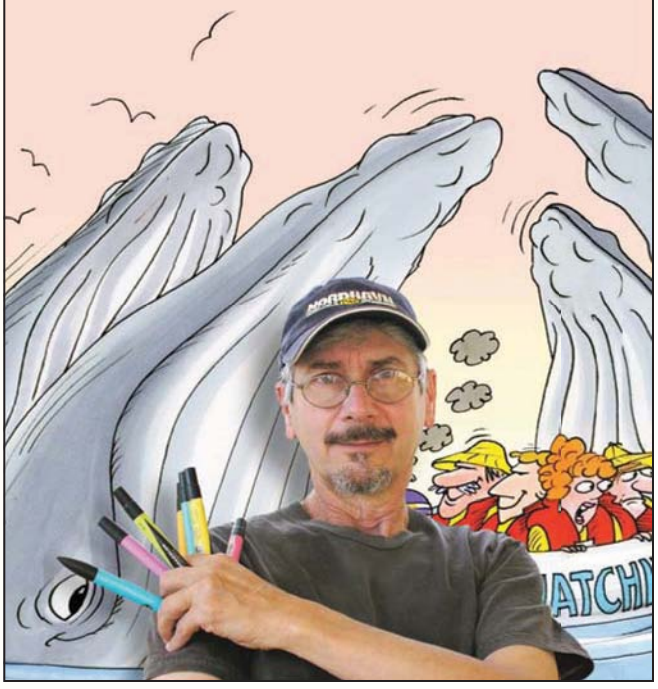
A set of battery booster cables or a self-contained 400-amp mobile power pack comes in handy when you run down the battery with the stereo or fridge. Go for the long cables and a heavy gauge cable rating, and make sure you periodically charge the power pack at home or you may find it dead just when you need it.

An electrical kit with a few of the common electrical connectors, marine grade wire and a set of terminal pliers often come in handy. Other useful items include bulbs, fuses, heatshrink tubing or electrical tape and an inexpensive multimeter to check voltage, amperage and continuity.

Odds and Ends

There are lots of other parts to be included in your spares kit. Consider adding: hose clamps; two-part epoxy, both the liquid for gluing most materials back together and the solid stuff to temporarily repair small hull punctures; industrial needle and thread for canvas repairs; small tool kit available from the big discount and club stores for very low prices; windshield wiper blades; spare nuts and bolts; stainless-steel fasteners; rivet and rivet gun. Consider this as your "start" kit and add to this list based on your own experiences.

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



TRANSOM TAKEDOWN

Bad news: Runabouts and some larger powerboats with transoms cored with layers of plywood are at risk of damage from water intrusion that eventually rots the wood. Good news: The repair job isn't difficult, it just takes a little knowledge and effort.

Story and photos by Roger Marshall

The first job in repairing a water-damaged transom is to decide how to open the transom to extract the rotten plywood. There are several ways to do this and the method you choose determines how the transom will be finished after completing the repair.

If the boat has an open transom and there is good access from the inside, your best option is to extract the rotted plywood by cutting away the inside facing layer of the fiberglass laminate sandwich. This prevents having to paint the hull exterior. [Ed: For details on replacing a transom from the hull interior refer to DIY 1998-#4 issue.] If not, you'll have to cut away the outside layer of laminate to uncover the plywood. Cutting the outside laminate at the hull sides requires repainting both sides and the transom, in other words, the entire boat. Cutting the laminate at the transom corners means you'll have to wrap new fiberglass around the corners, making repainting the entire topsides essential. If, however, you can limit the cut of the transom to the area slightly inside the corners, your new fiberglass work will be restricted to just the transom alone, so there is no need to repaint the rest of the topsides; you simply paint the transom.

This is the easiest method. We cut around the transom 3" (76mm) from the corners. Once the outer fiberglass skin was removed, we used a chisel to remove the rotted plywood inside the flange. This method of opening the repair area relieved us from having to paint the entire boat (the hull was previously painted).

Step 1 Making the Cut

Using a circular saw with the blade set 3/8" (9mm) deep, we cut through the old laminate. This depth cut through the laminate and the plywood as well but, since all the plywood had to come out anyway (what was left of it) this was not a problem. Initially, we assumed that the top portion of the transom was still sound so we only cut the lower section. When we started to remove the rotted plywood, however, our assumption bit us as we discovered that the entire transom was rotten, requiring us to open the upper section of the transom, too.

(across) The author removing the rotted plywood; a time consuming job.

Cut piece off transom. After replacing the plywood core, this will be rejoined to the transom using fiberglass tape.

Step 2 Cutting New Plywood

Because we opted for a fiberglass flange around the edges of the transom, we could not insert the new plywood in one piece.

First, we made a cardboard template of the new plywood. This entailed taping a large piece of cardboard to the transom and marking the required shape very carefully. By setting the cardboard inside the flange, we ensured that it fit properly. We then laid out the template on 3/4" (19mm) marine-grade plywood. This job required two pieces of plywood to fit the 1-1/2" (38mm) thick transom. In retrospect, high-density foam, specially engineered for use as a laminate core, is probably a better material to use for the core because marine grade plywood will eventually rot out again. However, with extra care taken to seal the plywood edges at openings in the transom where water can migrate into the core again, the plywood can be protected and remain durable for a long time.

After cutting the inner and outer plywood transom core pieces, we sliced them into three sections. We cut the inner piece horizontally across the bottom of the engine well. On the outer piece we cut downwards from the sides of the engine well. This created six pieces of new transom wood and by alternating the cut locations, every cut mated to a solid section. Each plywood piece, including

Fitting the cardboard template.

Marine-grade plywood is cut into sections to facilitate installation.

the edges, was then coated with two layers of clear, unthickened epoxy using a roller, to make them watertight.

Step 3 Grinding Fiberglass

The next task was to grind back the edges of the old fiberglass and prepare the flange for adding new laminate. This is a miserable job. If you don't want to itch for a week, wear a Tyvek suit with hood, a full-face mask or respirator, rubber bootees and heavy-duty rubber gloves. Apply a barrier cream under the rubber gloves for additional protection.

Step 4 Installing Plywood

To install the plywood, we first made a mixture of thickened Epiglass epoxy using a slow hardener and thickened with glue powder to a peanut butter consistency. We had this epoxy left over from another job but you can use any brand just be sure to use a slow hardener to maximize the working time before it cures.

We troweled the mixture into the flange all the way round the transom to serve as a bed to hold the edges of the plywood in place and then we coated the first of the inner pieces of plywood with thickened epoxy and laid it in the transom. The two inner sidepieces followed. The three pieces were back-screwed through the interior laminate to hold them tightly while the glue cured.

Pieces were dry fitted and then glued on and screw fastened. Note the beveled edges on the fiberglass laminate on the transom as well as the cut off piece.

Next, we followed the same procedure with the outer pieces of transom plywood. The first two were coated with thickened epoxy and pushed into place on either side of the transom. Finally, the last piece was pushed down into the remaining space. We screwed through both layers of plywood with 1-1/4" (31mm) stainless-steel screws to hold them tightly together.

The last step was to epoxy coat the inner face of the fiberglass laminate pieces and screw them back into place against the newly installed plywood.

The entire installation to this point took about two hours using a three-man crew. Epoxy gets on everything and everyone, so make sure to wear old clothes and protective suits and rubber gloves.

Step 5 Filling and Fairing

After removing the screws from the inside laminate, we discovered some voids between the inside laminate and

Fiberglass tape is laid over the sections where the fiberglass laminates butt together, saturated with epoxy, and then rolled to remove air bubbles.

the newly installed plywood. Where we had removed a screw, we injected unthickened epoxy into the holes until it ran out of the neighboring holes and then we taped over those holes and injected more epoxy until we felt we had filled all the voids.

On the outside fiberglass, we masked over all seams in the laminate using increasing widths of tape until we had built up a solid laminate and then sanded to a fair surface. We thickened epoxy with microballons to fill hollows. We then pulled a long straightedge over the transom, checking for low and high areas, and left everything to set up, after which we sanded again. In this way, we were able to get the transom flat and fair.

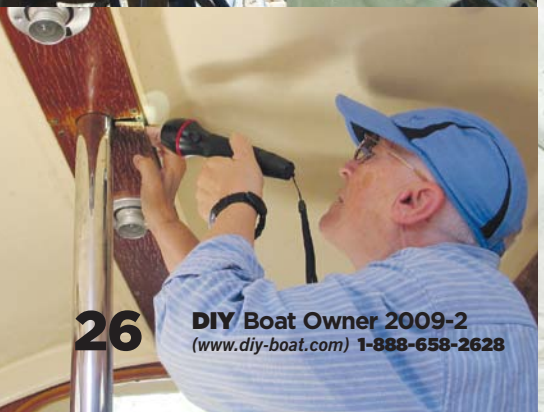
Step 6 Finishing

The final job was to coat the new transom with Interlux Epoxy PrimeKote, sand it smooth and repaint the transom to match the topsides. We painted over the transom topcoat with Clear Coat to preserve the shine and match the look of the rest of the boat. Now, all that was required was to add the boat's name and hailing port and remount the Suzuki 115-hp engine, only this time the mounting holes were drilled oversized, sealed with epoxy resin and the bolts well sealed with a a generous bead of polyurethane sealant. Hopefully, this prevents the new plywood from future rot.

The total out-of-pocket cost of this job was $300 for the plywood, epoxy and paint. Everything else was labor. It took two weekends to complete: one weekend working alone stripping the rotted plywood and another weekend doing the installation with a crew of three.

About the author: Roger Marshall is the author of 13 books and this article excerpted from his latest book, *Fiberglass Repair Illustrated*.

refit reflections



Sage advice from 10 years of boat refits for anyone who is considering a major boat overhaul or for those who are contemplating the pros and cons of buying an older vessel.

By Jim Discher

Since this is an article about refitting, I thought it was appropriate to understand what the word means. After a fairly deep dive on the word "refit," I learned the word is both as specific and elusive as the process itself. Its most basic meaning assumes something is unfit and it's made fit again or as yourdictionary.com states, "to make (a vessel) ready for use again by repairing or re-equipping." Other verbs to describe refit include: annual, complete, extensive, external, internal, major, restoration, transformation. Why is this important? Because like any plan for a major project, you need to begin with the final goal in mind.

I further split the word into "re" and "fit." Under the word "fit," dictionary.com defines the idiom, "fit to be tied" as "extremely annoyed or angry." When you couple that with the prefix of "re," meaning to do over, it would define the process one is likely to experience doing a refit on just about any size vessel; namely, "extremely annoyed or angry over and over again." If you've done any amount of work on your boat, you can relate. If you haven't, trust me.

(Opposite page) Some of the DIY team working on project boats (clockwise, top left): the author's '89 Trojan 12 Meter Express and the author; Jan Mundy; Nick Bailey; Pat Kearns; David Aiken; Steve Auger.

I am rounding the last corner to refitting my second boat in almost 10 years. My best estimate is I've invested more than 3,000 hours of my time and in excess of $50,000 in the two boats. This is a journey that is as rewarding as it is frustrating. I can't minimize the surprises you are likely to encounter but I would like to prepare you mentally and financially for your journey.

My personal mission with both boats was the same: to restore each to close to original condition, where everything is in good working order, and to make aesthetic and mechanical improvements where I felt I could achieve worth-the-effort gains. Neither of these boats were train wrecks. By most standards both were in good condition, received decent marks by the surveyors and were both coincidentally 15 years old when I purchased them. The first one, a 1985 Sea Ray 340 Express, was always a freshwater boat. The present *BearBoat* is an '89 Trojan International 12 Meter Express.

Resource Management

In the words of Dirty Harry, "A man's got to know his limitations," I'd like to offer three limitations that most of us need to contend with: time, money, talent or "TMT." (Not to be confused with TNT, the stuff you might be looking for by the time you're done with this process.)

Time: Boat projects can consume massive amounts of time and most often way more than we anticipate. You probably have a day job and in addition, you need time for family, a home that needs attention, friends, just the business of managing your life and not to mention other hobbies. Keeping all those plates spinning can be a big challenge. So consider how much of the boating season you'll miss with a fixer upper and the impact your absence will have on the other parts of your life.

Money: I always resent when nonboaters feel compelled to give you the "it's just a hole-in-the-water" or the "second happiest day" speeches. They all paste on the same smirk and it always starts with, "you know what they say ...." If you've owned any kind of boat you know that there are cheaper hobbies. Truth be told, the refit process is crazy, sneaky expensive. You don't want to run out of money before you run out of projects. So including cost estimates in your refit plan is critical. Keep in mind you also need to have funds set aside for ongoing maintenance like oil changes and bottom jobs.

To keep a handle on my financial exposure, I keep a running list of projects planned and completed in an Excel spreadsheet (see "Documentation" on the next page). All projects have high and low estimates. The totals on those columns serve as a forecast of future expenses. Total of the completed projects indicates the extent of my investment to date.

Never supplement products intended for automotive or household use for marine-grade components to save money. Marinized parts are manufactured to a higher standard to operate safely and reliably in the punishing environment in which they live. Stainless-steel components or tinned wires are designed to fight the ravages of saltwater, exposure to the sun and the pounding they must endure in rough seas. Spend money on quality components and you increase longevity, durability, reliability and, ultimately, safety.

Talent: Ambition and enthusiasm proceed undaunted. As a novice at this stuff 10 years ago, I made a deal with myself. I figured if I successfully fixed two out of three jobs and had to hire the mechanic to rectify the third botched attempt I would be money ahead. That philosophy continues to provide me the courage to jump into unfamiliar projects to this day. Turns out, I'm happy to report, I have rarely had to make that call.

Before you jump in with both feet, do a quick self-assessment. Consider: mechanical skills, knowledge of how things work, ability to research and dig for information, desire to learn, physical condition and patience. What I lack in skill I make up for in patience and tenacity by doing things over and over until I achieve a professional grade result. If you aren't a natural at this stuff, you need to enjoy the rigorous detective work of assessing problems and the deep research sometimes necessary to find the obscure information needed to solve problems.

Know your limits but challenge yourself. A refit can be a very rewarding endeavor. The pride of ownership and sense of accomplishment are worth the effort in my view. That random compliment at the public dock can really fuel your enthusiasm and ego. Most people guess my Trojan to be half its 20 years. In fact, the guy I bought it from five years ago saw us on the water not long ago. He got into an argument with his wife who just would not agree it was their old boat. Nice.

The Two Ps

Planning and prioritizing are essential to the refit process. Organize your priorities into three categories, in order of importance: safety, maintenance and repairs, and aesthetics. Finally, scheduling based on the time and financial resources you have available.

If it's a new old boat for you, assuming your vessel is safe and seaworthy, get out on the water a few times before you start mapping out your plan. If it's a cruiser, spend a few weekends on it. More often than not, repairs that weren't even planned become your most urgent priority.

Efficient management of downtime maximizes your uptime. Don't run aground on "Someday Isle," that place where you get snared into always thinking, "Someday I'll take a whole week on the boat." Or "Someday, when everything is perfect, I'll have my family and friends out for a day cruise." The boat is breaking whether you use it or not, so you might as well get some fun out of it. Gaskets dry out, engines rust, electrical systems are always corroding. Machines and mechanicals are built to run. They are happiest at running temperature, turning and burning and pumping. Use it or lose it.

Aesthetics are least important and should be left for last. Avoid the temptation to make it look pretty. There are other debilitating items that demand your time and money. A beautiful, broken down boat that's dead in the water doesn't do favors for anyone and can spell disaster in minutes, maybe seconds. Make safe and mechanically sound your first priority.

Consider having your local Coast Guard Auxiliary do a safety check. It's free and a great way to verify the boat's safe and seaworthy. If you need some inspiration, do yourself a favor when you sign up for your annual BoatU.S. membership and pay the extra $10 for its quarterly *Seaworthy* publication (www.BoatUS.com/Seaworthy). It provides details on sometimes pretty simple failures that have turned new and old boats into sunken treasures.

Even with the best planning, beware of scope creep. Every planned project mys-

teriously spawns additional unplanned projects. "As long as I have this baby opened up, I might as well …." It's the smart thing to do, no question. You have taken the time to carefully dismantle some part of your boat. You discover something that's not right, maybe even unsafe. The only thing to do is plow ahead and complete the repair.

We wander deeper into the abyss. Sometimes we have quick, inexpensive fixes. Many times, we increased the financial scope and time commitment substantially. If I had a dime for every time I've told my wife I was going to finish a project before lunch, only to find myself in some contorted, upside down position with a flashlight and backache, I'd be paying somebody else to do the dirty work. I persist and she forgives (or probably didn't believe me in the first place).

Documentation

Keeping detailed records can pay huge dividends. I created repair and maintenance spreadsheets in Microsoft Excel that allow me to sort the data to find the last time I changed pencil anodes, replace impellers or had an oil change. I plug in formulas to total cost columns and enter as much detail as I wish about how and what I did. Because it's electronic, I email a copy to my Blackberry. My plan and target projects are always shifting around. Being able to reorder, add detail and revise cost estimates is invaluable.

My Excel workbook includes 14 tabs. Primary tabs are listed below.

1. Comprehensive listing of all repairs performed. Who did the work, date, cost and detailed work description. The first section of this tab has all future projects grouped by A, B, C priority, with high and low cost estimates. Completed projects have a "D" in the priority column so I can sort those into one section and each section is color-coded.

2. Another tab that more succinctly has my short-term target list. It breaks down projects into more detailed chronological steps so I can go about the repair in the most efficient way. Also included is my "need to buy" list. Detailed planning and preparation can really boost productivity by sequencing steps and avoiding multiple runs to your local chandlery for parts and supplies.

3. This is where I record valuable information about the boat that I want to preserve but that doesn't fit anywhere else. Information such as: specifications; information on places I acquired parts and what was purchased; good website sources, etc.

4. I keep all maintenance, specs, everything about the dinghy and outboard components under this tab.

5. I'm rigorous about recording part numbers and serial numbers. At last count, I have 55 parts listed, including such details as: item description, make, model, part number, serial number and purchasing comments.

6. I have dedicated tabs for major projects. Items such as major electrical, canvas and vinyl "glass" replacement, haulout procedures, TracVision install, audio/visual refit, etc. I use these pages to build detailed specs that I use to bid these projects out to multiple suppliers, if necessary. These specs are usually built over time and usage of the boat. The result is a very comprehensive and inclusive list of everything I want to accomplish when that project floats to the top of the list.

Having a complete set of documentation on major components can save your bacon. Repair and maintenance manuals for engines, transmissions, electronics and sanitary system should all be kept onboard. Many of these are available as printable PDF files on manufacturer's websites. I keep all these in an accordion file onboard at all times. The specification, model numbers or instructions for every new item I install is filed.

Organizing this information as you go provides a wonderful resource and reference over time. Going through the effort and expense of a refit implies you are most likely planning to keep the boat for a while. Your documentation and record keeping pays dividends throughout your ownership and provide an enormous value add when it comes time to sell. Few boats that I have looked at have detailed repair and maintenance records. It's one way you can make your boat stand out from the crowd when it's time to sell.

Research and Reference

Before you lift a wrench, be sure you have updated your *DIY Boat Owner* subscription and you have the most current version of the DIY *Hands-On Boater* CD ROM of all past issues. I am completely serious. This is my first "go to" reference in diagnosing and planning a project.

If you have diesel engines, fork out the $25 and take an online subscription to www.boatdiesel.com. This is a great forum on diagnosing and fixing problems with most brands of engines and transmissions. It has a decent search function that allows posting questions and, at a bare minimum, provides great directional information to get you started on a good repair.

As a pretty tenacious DIYer, sometimes I cry "uncle." It's an expensive cry. Nonetheless, sometimes the best tool in your tool box is your checkbook. Assemble your personal "A" team of professionals. You need a trusted team of pros to include a mechanic, boatyard for haulouts and bottom work, marine electrician and a marine plumber. Also handy to know are people who do quality canvas and upholstery work, and gelcoat work. Finding the good guys can be a project in and of itself so I'll share some ways I have found success.

Establish rapport with an engineer, customer service rep or, even better, the technical service representative at the company that manufactured your boat. These folks are an incredible resource. With my '85 Sea Ray 340, I was fortunate to get to know one of the Sea Ray technical service reps. He pulled up a microfiche of the original plans, gave me repair advice and saved my bacon on many occasions. For this reason, there is a significant benefit to owning a boat made by a company that has been in business for a long time (and still is).

Likewise, I have talked to countless manufacturers of boat equipment. I've even called chemists to talk about the best use and application of chemicals and paints. The most obscure finds were the deck pulls molded into the gelcoat that had to be an exact match. After two years, I tracked them down to a company in Sweden via the Internet. The only acceptable payment form was a bank wire transfer. Boatbuilders seem always happy to help answer questions and help solve your problems. I have never been disappointed.

Other great help sources are found in local marine directories, marine publications like "The Log" in Southern California, referrals from your local chandlery and fellow boaters, yacht clubs, Internet searches, online user's groups, other professionals you have hired, boat dealers and boat yards.

Spend some time at the boat show around the services and components booths. When shopping for electronics, I drove 100 miles to the San Diego boat show. In three hours, talking to different dealers, installers and manufacturer's reps, I was armed with everything I needed to start shopping and put together my system.

Keeping an organized spares inventory can be a real productivity booster throughout your refit. I have a fairly extensive collection of nuts, bolts, washers, O-rings, old parts that would do in a pinch, etc. Whenever I remove a broken part, I disassemble and take off all of the stainless steel and other usable parts for spares. I get a real kick every time I can recycle an old spare that didn't cost me a nickel. How often can you say that? The best part is I can complete my repair without spending time or money. If you don't have an inventory of parts I suggest you buy a $50 starter kit from West Marine. Then buy some plastic storage cases with dividers to start building your arsenal.

What Really Counts

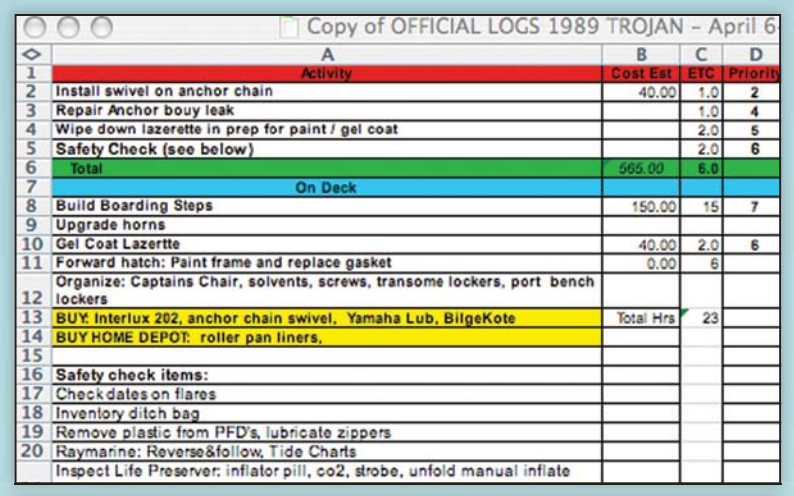
In the final analysis, unless you have barrels and buckets of money to hire everything out, the life of a DIYer is a ton of work. You need to carefully weigh the effort against the payoff to determine if it is your cup of tea.

I just finished a cross-country flight from the East Coast and am excited to get back to Southern California. After spending the last four weekends working on *BearBoat*, I'll drop the lines early tomorrow morning and head 26 miles (42km) across the channel to Catalina Island for a much needed respite from the madness. A weekend of relaxation and some time to rock back with a cold beer and admire my handiwork.

About the author: Jim Discher is a graduate of the College of Hard Knocks and many of his trials, tribulations and refits on both *BearBoats* have been documented in past DIY issues. His invigorating, do-it-yourself enthusiasm is best described by Jim: "I wake on Saturday morning, throw on my work clothes and go to my other job."

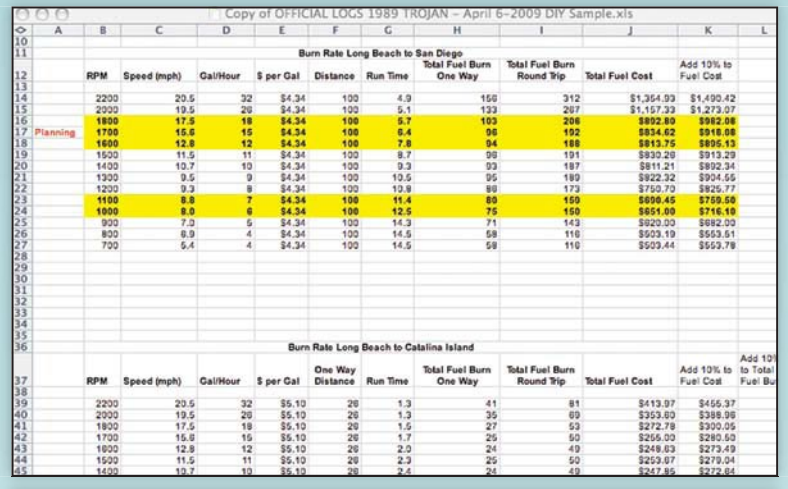
Fourteen of Jim's original Excel spreadsheets (three are sampled below) that include details of boat and engine service, installations and projects lists, replacement part numbers, calculations of fuel burn and power requirements, and worksheets of sundry systems are available for download at:

http://www.diy-boat.net/diyweb/edit/OFFICIALLOGS1989TROJAN.xls



Copy of OFFICIAL LOGS 1989 TROJAN – April 6

	A	B	C	D
1	Activity	Cost Est	ETC	Priority
2	Install swivel on anchor chain	40.00	1.0	2
3	Repair Anchor bouy leak		1.0	4
4	Wipe down lazerette in prep for paint / gel coat		2.0	5
5	Safety Check (see below)		2.0	6
6	Total	565.00	6.0	
7	On Deck			
8	Build Boarding Steps	150.00	15	7
9	Upgrade horns			
10	Gel Coat Lazertte	40.00	2.0	6
11	Forward hatch: Paint frame and replace gasket	0.00	6	
12	Organize: Captains Chair, solvents, screws, transome lockers, port bench lockers			
13	BUY: Interlux 202, anchor chain swivel, Yamaha Lub, BilgeKote	Total Hrs	23	
14	BUY HOME DEPOT: roller pan liners,			
15				
16	Safety check items:			
17	Check dates on flares			
18	Inventory ditch bag			
19	Remove plastic from PFD's, lubricate zippers			
20	Raymarine: Reverse&follow, Tide Charts			
	Inspect Life Preserver: inflator pill, co2, strobe, unfold manual inflate			



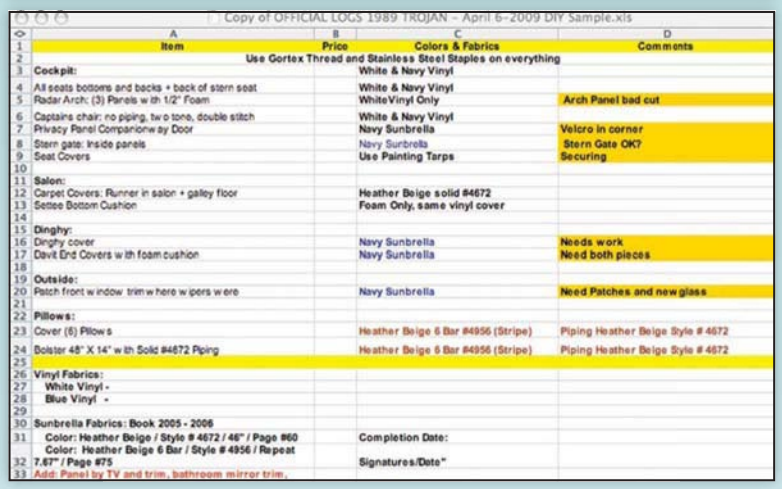
Copy of OFFICIAL LOGS 1989 TROJAN – April 6–2009 DIY Sample.xls

Burn Rate Long Beach to San Diego

RPM	Speed (mph)	Gal/Hour	$ per Gal	Distance	Run Time	Total Fuel Burn One Way	Total Fuel Burn Round Trip	Total Fuel Cost	Add 10% to Fuel Cost
2200	20.5	32	$4.34	100	4.9	158	312	$1,354.93	$1,490.42
2000	19.5	28	$4.34	100	5.1	133	267	$1,157.33	$1,273.07
1800	17.5	18	$4.34	100	5.7	103	206	$892.80	$982.08
Planning 1700	15.6	15	$4.34	100	6.4	96	192	$834.62	$918.08
1600	12.8	12	$4.34	100	7.8	94	188	$813.75	$895.13
1500	11.5	11	$4.34	100	8.7	99	191	$830.28	$913.29
1400	10.7	10	$4.34	100	9.3	93	187	$811.21	$892.34
1300	9.5	9	$4.34	100	10.5	95	189	$822.32	$904.55
1200	9.3	9	$4.34	100	10.8	89	173	$750.79	$825.77
1100	8.8	7	$4.34	100	11.4	80	150	$650.45	$715.50
1000	8.0	6	$4.34	100	12.5	75	150	$651.00	$716.10
900	7.0	5	$4.34	100	14.3	71	143	$620.00	$682.00
800	6.9	4	$4.34	100	14.5	58	116	$503.19	$553.51
700	6.4	4	$4.34	100	14.5	58	116	$503.44	$553.78

Burn Rate Long Beach to Catalina Island

RPM	Speed (mph)	Gal/Hour	$ per Gal	One Way Distance	Run Time	Total Fuel Burn One Way	Total Fuel Burn Round Trip	Total Fuel Cost	Add 10% to Fuel Cost	Add 10% to Total Fuel Bu
2200	20.5	32	$5.10	26	1.3	41	81	$413.97	$455.37	
2000	19.5	28	$5.10	26	1.3	35	69	$353.60	$388.96	
1800	17.5	19	$5.10	26	1.5	27	53	$272.78	$300.05	
1700	15.6	15	$5.10	26	1.7	25	50	$255.00	$280.50	
1600	12.8	12	$5.10	26	2.0	24	49	$248.03	$273.49	
1500	11.5	11	$5.10	26	2.3	25	50	$253.07	$279.04	
1400	10.7	10	$5.10	26	2.4	24	49	$247.85	$272.84	



Copy of OFFICIAL LOGS 1989 TROJAN – April 6–2009 DIY Sample.xls

Item	Price	Colors & Fabrics	Comments
Use Gortex Thread and Stainless Steel Staples on everything			
Cockpit:		White & Navy Vinyl	
All seats bottoms and backs + back of stern seat		White & Navy Vinyl	
Radar Arch: (3) Panels w ith 1/2" Foam		WhiteVinyl Only	Arch Panel bad cut
Captains chair: no piping, tw o tone, double stitch		White & Navy Vinyl	
Privacy Panel Companionw ay Door		Navy Sunbrella	Velcro in corner
Stern gate: Inside panels		Navy Sunbrella	Stern Gate OK?
Seat Covers		Use Painting Tarps	Securing
Salon:			
Carpet Covers: Runner in salon + galley floor		Heather Beige solid #4672	
Settee Bottom Cushion		Foam Only, same vinyl cover	
Dinghy:			
Dinghy cover		Navy Sunbrella	Needs work
Davit End Covers w ith foam cushion		Navy Sunbrella	Need both pieces
Outside:			
Patch front w indow trim w here w ipers w ere		Navy Sunbrella	Need Patches and new glass
Pillows:			
Cover (6) Pillow s		Heather Beige 6 Bar #4956 (Stripe)	Piping Heather Beige Style # 4672
Bolster 48" X 14" w ith Solid #4672 Piping		Heather Beige 6 Bar #4956 (Stripe)	Piping Heather Beige Style # 4672
Vinyl Fabrics:			
White Vinyl -			
Blue Vinyl -			
Sunbrella Fabrics: Book 2005 - 2006			
Color: Heather Beige / Style # 4672 / 46" / Page #60		Completion Date:	
Color: Heather Beige 6 Bar / Style # 4956 / Repeat 7.67" / Page #75		Signatures/Date"	
Add: Panel by TV and trim, bathroom mirror trim,			

UPGRADE

Whether you call it a "floor" or a "sole," this cork composite treading surface improves the comfort and security underfoot with an added benefit of a new and pleasing appearance.

renew your cockpit floor

Story and photos by Harry Hungate and Jane Lothrop

"The cork floor is extremely comfortable on bare feet and, when wet, the traction is even better."

Our Corbin 39 cutter, *Cormorant*, has sailed around the world one and a half times since it was launched in 1986 and the cockpit floor was showing some wear. The molded-in non-skid was deteriorating and we had tired of sliding on and sticking to the plastic floor mat so we finally decided to splurge on a new cockpit floor.

A few years ago, we replaced the ceramic tiles on the floor of the head compartment with a solid sheet of interior cork. It was a great success. Also, we had previously admired a few boats decked with a nice looking cork composition material laid in planks and caulked like a traditional teak deck. Both materials are manufactured by STAZO in The Netherlands and distributed in the U.S. by STAZO Marine Equipment NA in Thomaston, Maine. The deck material is marketed as Marinedeck2000 Exterior. The company's website (www.stazo.nl) has excellent instructions and both the site and the local dealer insisted that even moderately handy people could install it themselves.

The planks are available in 3/8" (9mm) thickness and in 2" (50mm), 3" (76mm), 5" (127mm) and 16" (406mm) widths by 74" (1.8m) in length. All but the two largest widths are smooth on one edge and milled with a 5/32" (4mm) rabbet on the opposite edge to facilitate spacing and to provide a channel for the caulking compound. Double thickness (3/4"/19mm) planks are available in 3" (76mm) and 5" (127mm) widths but we did not require these for our installation.

This project kept us busy for the better parts of six days and the total cost for the materials was around $1,033. As with most first-time jobs, it took longer than expected because we spent extra time rethinking and redesigning. We followed the instructions on the website closely and, with our DIY Hints, indicated by the bulleted paragraphs in italics, you should be able to do it more quickly than we did.

Prep and Patterns

The first step was to clean the cockpit floor and then sand it lightly with a power sander in preparation for the bedding compound. It is not necessary to sand the molded non-skid, so all we had to do was to sand flat the raised edges of the molded panels. We wanted the cork to go to the outer edge of the floor panels so we would have a nice even surface for our feet.

While I sanded the floor, Jane designed the layout of the perimeter planking and began cutting paper patterns. This actually was the most difficult and the most critical part of the project. Our cockpit floor is divided into two sections: forward, there is a removable section for access to the engine; and the steering pedestal is aft. Four cockpit drains and curved sides of the cockpit molding complicated the installation of the perimeter planks.

To visualize the pattern, Jane taped an overall paper pattern and also made full-scale 2" (50mm) and 3" (76mm) patterns of planks out of cardstock. She even used a black marker to simulate the caulked seams.

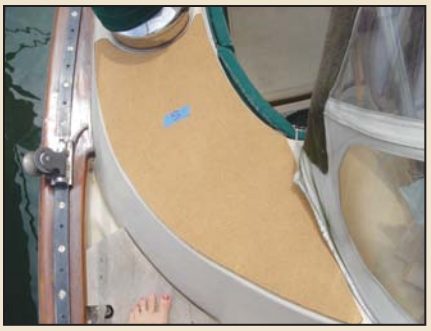
We decided that, for the small space of the cockpit sole, the 3" (76mm) planks would look best to frame the perimeter, with the internal boards cut from the 2" (50mm) planks.

Materials

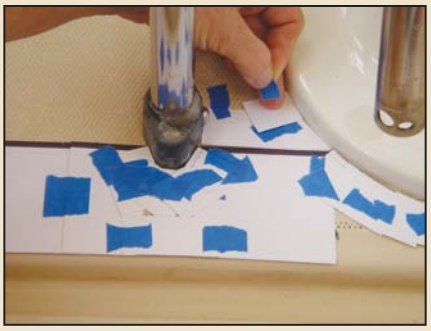
Patterns completed, Jane calculated the required number of the various plank widths required. We also purchased one 16" (406mm) wide sheet to cut into boarding pads for the port and starboard cockpit coamings. This extra project was small enough to be a good practice lesson for the main project.

A trim ring for the steering pedestal was also cut from this wide sheet. The result is a much neater layout than using several very small planks.

Sanding the fiberglass cockpit floor.



Starboard side cockpit coaming pad became the authors' practice piece.

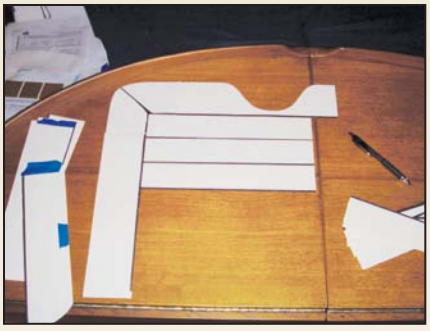


Making curved patterns using small pieces of paper and tape.

Designing layout with paper patterns on cockpit floor.

Trial fitting of perimeter planks and around the steering pedestal trim ring.

Blue tape indicates areas of needed adjustment.



Finalizing paper patterns.

Cutting the Planks

Once the paper patterns were cut to our mutual satisfaction, Jane laid the patterns over the planks and marked them with a felt-tip pen. I cut the planks with a fine-toothed hacksaw.

• Make accurate patterns for the curved pieces around the pedestal and the drains, using small squares of paper taped in place to make a smooth curve.

• Although the manufacturer's directions say the planks can be curved, a sharp curve or one in a short length is very difficult to hold in place while the bedding compound cures. We ended up cutting the port and starboard side planks of the forward section out of the 5" (127mm) board. That way we had a straight edge for the first inner plank and the cutout for the drain was easy to do. The resulting perimeter piece is actually larger than 3" (76mm) just aft of the drain but it looks good in place. The piece we cut and tried to curve to fit had to be thrown away. We also cut the small curved frame pieces from the larger width material to fit around the complex curves of the aft section drains.

• Before beginning a cut, both of us would review the plank to be absolutely certain about which part was to be used and which part was scrap. After cutting each piece it was dry fitted immediately and any adjustments made before fitting the adjoining piece.

• Be sure to mount the saw blade with the teeth facing you so the cut is on the pull rather than the push; this aids greatly in not bending or breaking the blade.

Cutting planks with a small hacksaw.

After planks were cut to match the patterns, we rounded the outer edges with a sanding block. A router with a bullnose bit would have been ideal for this job but with patience and a critical eye the sanding block did a neat job.

Assembly

We agreed to tackle the cockpit's aft section first. If we did a less-than-perfect job, at least our goofs would not be in full view. We placed the completed perimeter planks on the cockpit floor, properly spaced by the 5/32" (4mm) plastic caulking strips.

The supplier calculated how many tubes of bedding compound, caulking compound and primer we needed for the job. We also purchased cheap paintbrushes for applying the caulking primer and a spreader to apply the bedding compound.

• Purchase a length of 5/32" (4mm) interior caulking strip for use as spacers. These are hard plastic strips used with the interior version. You will see them in some of the photos above that illustrate the installation of the perimeter and interior planks.

We purchased extra planks and tubes of bedding and caulk in the event that we had underestimated the job (or worse, ruined some) on the understanding that the supplier would take back the leftovers and give us a refund later. This was a great help to us since a visit to the supplier was a daylong affair.

Applying white bedding compound.

Removing masking tape after spreading bedding compound within borders.

Bedded perimeter planks weighted down for an overnight cure.

Final fitting of interior planks. Note the channels for the caulking compound and the white spacers.

Rolling planks into position over the bedding compound.

• Outline the planks on the cockpit floor in pencil to define the areas to be primed prior to spreading the bedding compound. The fiberglass cockpit floor was primed with Simson Primer M, applied sparingly with a cloth in accordance with the instructions. The area was masked with tape to aid in cleanup. Bedding compound was spread over the primed areas and the masking tape removed to reveal the pencil outlines for positioning the perimeter planks.

• We first tried leaving the tape down but it was impossible to see where to place the plank. Removing the tape after spreading the bedding but before placing the plank made it easy, and the cleanup was easy, too.

• Don't skimp on the bedding compound, especially along the outside edges, as you really want a watertight seal. Any excess bedding compound cleans up easily after it cures.

The perimeter planks were weighted down with almost everything that we could find onboard to insure a good bond to the fiberglass cockpit floor. We suggest that you borrow enough bricks to cover the perimeter planks. Our collection of tool bags, juice jugs, etc., failed to apply a uniform weight on the perimeter planks and we had to do a bit of remedial bedding work the next day. It was easy and successful, but it was extra work that could have been avoided if we had had lots of bricks or some other uniform flat weights.

The following day we began cutting and fitting the 2" (50mm) planks to fill in between the perimeter planks.

• Measure and cut the planks to exact length as the width of the caulked seam will reveal any error.

Following the instructions, we cut and numbered the planks starting with the outermost ones and working towards the center of the floor. A king plank was cut from a 3" (76mm) plank to fit the centers, as the one for the aft section was almost 3" (76mm) wide and the forward one was just a bit wider than 2" (50mm).

Satisfied with the layout and trial fitting, we primed the fiberglass floor with Simson Primer M, again applying it sparingly with a cloth. Then the bedding compound was spread and the planks were laid down.

• Start with one end pushed up against the perimeter plank to get a bit of bedding compound on the end of the plank, and then smoothly "roll" the plank down into the bedding.

We worked to amazing precision, as the king plank fitted exactly. The process was repeated on the other section of the cockpit floor, again with excellent results. We measured, cut and installed all the interior planks in both sections in only one day.

Seaming

The next day we switched from the white bedding compound to the black seam caulking compound. The caulking channels were primed with Simson Primer P, and after a wait of a one-hour minimum, the caulking process began.

• Apply masking tape to the outer corners of the perimeter planks to contain the caulking compound until it sets up.

• Use plenty of caulking compound. Move the caulking gun toward you and carefully watch the caulk fill the channel ahead of the nozzle, and also build up a surplus behind the nozzle, perhaps 1/8" (3mm) high. This insures that there are no concave areas in the caulked seam after the compound cures.

• Don't reuse the nozzle when changing to a new caulking cartridge, as you are most likely to get an air bubble, which forms a void in the caulked seam. This is repairable but it's avoidable extra work.

• Carefully inspect your work, especially on the outer corners and where the plank ends meet the perimeter. Make any needed repairs by adding more caulking compound before it sets up.

• Resist the temptation to disturb the caulking compound until it has cured overnight.

From start to finish we had both sections of the cockpit floor caulked in one hour and fifteen minutes.

After it cured, the excess caulking compound is easily trimmed level with the planks by using a sharp, flat blade (utility knife, box cutter, razor blade, putty knife, etc.). If it smudges or doesn't cut cleanly, let it cure for a few more hours. The instructions do not give any time guide, so the cure time depends on ambient temperature. We were working in the heat of the Malaysian summer at the 90F (32C) level and 16 hours provided a complete cure. Cooler temperatures probably require a longer cure time.

Applying black seam caulking compound.

Hand sanding excess cured caulking compound. Note before and after sanding!

Final Sanding

The instructions called for sanding the surface smooth with a belt sander and 80-grit paper. We had only an orbital sander, which was a dismal failure. The sandpaper became clogged with caulk and cork dust very rapidly. We finally resorted to a hand-sanding block with 60-grit paper. The sanding job was long and hot, but the results were stunning. Just keep sanding until the clean outlines of the caulked seams are revealed. The results are very satisfying.

• *Be sure to sand in the direction of the planks and not across them. The caulked seams stand a tiny bit proud of the cork planks, so don't try to get them absolutely level. All you will do is wear away the cork planks.*

• *We strongly recommend the use of a belt sander. Rent, buy or borrow one!*

• *Put on a dust mask and wear old clothes when sanding as the dust permanently stains them.*

A dust brush and a vacuum cleaner kept the work surface clear. A final sanding with 120-grit paper completed the project. A good scrubbing with soap and water revealed our beautiful new cockpit floor.

Foot Test

The underfoot feel is excellent and the appearance could not be better. This is not an inexpensive project but it should last the lifetime of the boat. If we had teak decks, we would seriously consider replacing them with this product. It is cool to the feet, naturally non-skid, needs no mechanical fasteners, will not erode into raised grain like teak and is extremely UV stable.

The instructions claim that a scrubbing with a soft abrasive cleaner, such as Softscrub, and freshwater cleans and restores the appearance if it gets extremely dirty. Otherwise, just soap and water will do the job.

Since installing the cork floor two years ago we have sailed some 3,800 miles and it still looks like new. It's one of the best upgrades that we have done on *Cormorant* in 12 years of living aboard.

About the authors: Frequent contributors to DIY, Jane Lothrop and her husband, Harry Hungate, live aboard *Cormorant*, a Corbin 39.

TAME YOUR MAIN

Quantum Sails

A full-batten mainsail system is an inexpensive upgrade that brings new life to a tired sail and lets you hoist, lower and reef with ease.

By Jan Mundy

How do you increase mainsail performance without replacing your existing sail? Upgrading a sail that is in good condition by adding one or more full-length battens is a popular and worthwhile conversion for both cruising and racing sailors.

A full-batten mainsail offers several advantages. Battens, extending from the luff to the leech, act as a semi-rigid framework to improve sail shape and better support the roach (the extra sail area beyond the straight line drawn from the head to clew). The added stiffness dampens sail luffing and makes the sail less prone to flogging during hoisting, reefing and dropping the sail.

Battens also act as "shock absorbers" to prolong sail life. "When tacking or reefing, a full-batten mainsail doesn't flog like a standard mainsail but gently inverts and flips to the other side," says Greg Bratkiw, president of Quantum Sails Design Group Canada, (800/505-5359; www.quantumsails.com). "The reality is that full-batten sails are lasting 20% to 40% longer because they don't get the flogging abuse."

Full battens provide a noticeably more efficient sail shape. They pull out some of the smaller wrinkles that occur in the fabric as it stretches with age. Their structure maintains a more aerodynamic cross-sectional shape and, as the wind increases, keeps the sail from becoming fuller and helps prevent the draft from shifting aft so the boat heels less and weather helm is reduced.

"When the mainsail is fully set, full-length battens stabilize the sail shape, holding the draft at 45% to 48%, creating more forward drive and reducing heeling in strong winds," Bratkiw says. "The biggest payback for upgrading is that the battens improve performance on all points of sail and preserve the mainsail's shape for the remaining life of the sail."

Cutting Not Necessary

An existing mainsail in good condition is a suitable candidate for a conversion. Full-batten sail conversions are priced per batten with a factor added for boat length. For cruising boats that take four full battens, prices range from $400 for a 27' (8.2m) boat to $600 for a 38' (11.5m). Considering that a replacement mainsail averages $2,000 to $3,500 for the same size boats, this is an affordable upgrade alternative.

A full-batten conversion is done without modifying the basic shape of the sail. Your sailmaker inspects the sail, checking the integrity of the fabric and stitching. Obviously, if the sail is blown out or damaged from UV, then it's not worth the cost of the conversion and you should consider replacing it.

Assuming the sail receives a passing grade, the work commences. The original batten pockets are removed and the luff tape is opened at the new pocket location. Quantum now glues a base patch, which slips under the luff tape and extends back to the leech, to help reinforce the compression loading that the batten induces on the sail and reduce chafe. This is a single layer of fabric, 2" to 4" (50mm to 101mm) wide, depending on the boat size; the larger the boat, the wider the patch. A short piece of Teflon reinforcing tape is sewn over the existing luff tape over the base pocket that then is covered by a second layer, the pocket itself, double stitched and extending from luff to leech, ending about 3" (76mm) from the luff to allow for mounting the batten end "cap" with machine screws and bolts.

Compression loading concentrated at the luff creates strain on existing grommets that attach the slides. This force causes chafe at the inboard end where battens press against the mast, eventually wearing holes in the pocket ends. Quantum resolves this problem by securing the batten ends in a protective plastic receptacle that replaces the grommets and protects the luff from chafe. "Batten caps are very important," says Bratkiw. "Without them, the compression loads against the luff make it difficult to raise, lower or reef the mainsail."

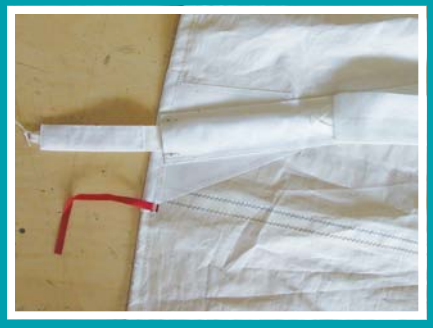
A Velcro closure secures the leech end of the batten pocket. The actual fastening design differs depending on whether the sail is intended for cruising or racing. On a cruising sail, Quantum uses a "flip-flop" pocket. This consists of a compression flap secured with Velcro that wraps over the pocket to pull the batten towards the luff, which is then covered by a finishing pocket sewn over the top and extending 1" (25mm) in from the leech. It folds back to the leech and is secured with Velcro. This double closure design prevents the pocket from peeling open should it hit a backstay or topping lift. A racing mainsail receives a "stuff" pocket with drawstring. The sailmaker supplies a short batten, about 12" (304mm) long, which inserts into an internal Velcro closure that goes inside a finished sewn pocket. Once inserted, the short batten breaks the Velcro contact and

Initial inspection by a sailmaker qualifies the sail for a full-batten conversion.

Greg Bratkiw

All-slip slides, shown on the top row, are nearly twice the length of conventional slides (bottom row), which they replace to reduce friction and ease sail handling on full-batten mainsails.

(top) Double fabric construction at the luff consists of the batten pocket sewn over a glued-on triangular protective patch. (bottom) Finished luff with batten end cap that solves chafe and compression loading troubles at the luff.



"Flip-flop" pocket for cruising sails compresses the batten and "seals" the batten end so it cannot open should it strike a backstay or topping lift.

allows you to easily pull the drawstring to remove the batten. "Both are good systems but, for racers, the stuff pocket keeps the leech cleaner, presenting a more visually aerodynamic appearance, especially on a Kevlar sail, but it's more troublesome to remove the extra batten," says Bratkiw.

Batten Types

Full-length battens are made of fiberglass and are tapered to place the draft between 45% and 48% back from the luff for optimum sail shape. These compression style battens are more expensive than the untapered battens used on standard mainsails and are available with various stiffness ratings. Your sailmaker selects the batten taper according to the aspect ratio and the square footage of your sail.

"Typically, with a high-aspect mainsail [one with a tall mast and short boom], the draft is a little flatter, otherwise the sail goes tubular quickly, so we tend to use a stiffer leech end batten," explains Bratkiw. "If the sail is low aspect, like a Nonsuch, where the sail is wide relative to its height, the battens require a different stiffness." Because of mainsail design specifics, Quantum stocks battens in as many as 50 different stiffness ratings.

Lessening Loading

When full battens transfer compression to the luff, the slides that attach the sail to the mast track are loaded. To overcome loading problems, Quantum replaces the original slides with All-slip slides at no extra charge. These nylon/plastic alloy slides reduce friction and prevent binding in the mast track when raising or lowering the sail.

All-slip slides fit on 90% of the mainsail tracks in service. For the rest and for larger boats, racers or those having trouble with slides binding, upgrading to a low-friction track and slide system offers the best solution. Luff track systems from Antal, Dutchman/MVB, Facnor, Harken, Schaefer and Tides vary in complexity and price. At $27.50 per foot of luff length, the Tides Marine Track and Slide System is the most affordable for boats smaller than 35' (10.6m). Sold as a do-it-yourself kit, it's also the easiest to install, as it rides in the existing mast track with few or no holes to drill. Larger boats require a tougher, more expensive system with an externally mounted aluminum track to handle the higher loads.

Few Drawbacks

On some mainsails, the batten pockets chafe where they contact the shrouds and spreaders. "Chafe is more an issue on boats with swept-back spreaders, like the newer Hunters," says Bratkiw. "When the mainsail comes in for inspection, any chafe marks receive a sewn-on clear vinyl protector."

A standard batten mainsail with a large roach that catches on the topping lift or backstay when hoisting or lowering may be more difficult to tack once converted to full battens. Though rarely an issue for cruising mains, which usually have a smaller roach than racing sails, it might require reducing the roach so discuss this with your sailmaker.

Lastly, some track and slide setups make it more difficult to lower while the sail is drawing.

Despite the drawbacks, upgrading to a full-batten mainsail is a relatively inexpensive way to achieve easier sail handling, especially when combined with lazyjacks. For not yet retired mainsails, full battens provide a longer lasting, efficient sail shape and increased performance.

About the author: Jan Mundy is DIY's co-founder and editor.

Current Thinking on Galvanic Corrosion

When it comes to boats, dissimilar metals and water do mix and therein lies the rub. Know your anodes and methods of isolation to protect metal fittings.

By Bob Adriance

Pitting on the sterndrive's lower unit was first noticed by the boat's owner in the spring of 2002. The following year, "some degree of corrosion was evident" on the same sterndrive, so the owner applied a fresh coat of paint and hoped for the best. He was making a big mistake.

By the next spring, the price of ignoring an obvious warning sign became painfully evident. The sterndrive was so badly corroded it would no longer go into gear. The reason was simple: the lack of an anode, which would have been sacrificed to protect the aluminum sterndrive from galvanic corrosion. The last anode, it seems, had been placed on the sterndrive in 2001, which is an eternity when two dissimilar metals are immersed in water.

Connecting dissimilar metals in an electrolyte creates a direct current (DC) "battery" and the scientific explanation as to why galvanic corrosion occurs has to do with things like migrating electrons and electrical potential. As a practical matter, a boat owner need only be aware that dissimilar metals, especially dissimilar metals left unprotected below the waterline, can cause horrendous corrosion problems to the least "anodic" or noble metal. As a general rule, the more dissimilar the metals (**Figure 1**), the more current created and the more likely galvanic corrosion occurs.

Saltwater is a more effective electrolyte than freshwater, which means that galvanic corrosion takes place more quickly in saltwater. Galvanic corrosion can even occur when dissimilar metals are joined above the waterline, since spray and moist salt air act as an electrolyte.

When mounting fittings above the waterline, avoid conjoining dissimilar metals, especially two metals that are far apart on the galvanic scale. When dissimilar metals must be used together, one can usually be insulated from the other. A stainless-steel halyard winch, for example, can be insulated from an aluminum mast with zinc chromate or polysulfide compound, a wood pad, Tef-gel or an inert insulating material like nylon or Tufnol.

Below the waterline, when you have a stainless-steel shaft and a bronze prop, which can't be isolated from each other, you'll need an anode, made of either zinc, magnesium or aluminum, that is sacrificed to save the more noble metal (and more expensive) fitting. Zinc is used in saltwater; magnesium in freshwater (never in salt or brackish water) but the most widely effective anodes these days are made of aluminum, which lasts up to 50% longer, and remains active anywhere in freshwater, saltwater and brackish.

How, you may ask, does an aluminum anode protect an aluminum sterndrive? The answer is that the anode is made with an aluminum alloy that is significantly different (more anodic) than the alloy used on a sterndrive.

A word of warning: Don't mix anodes! If you decide to use aluminum anodes, then use only aluminum anodes throughout the boat. When two different anodes are used, one (the least noble) will protect the other, which then won't do its job.

Likely candidates for an anode (anodic protection) include engines, sterndrives, rudders, shafts and trim tabs. Replacing anodes is typically done annually, sometimes semi-annually, especially on sterndrives. Anodes that are more than half dissolved should be replaced.

You may be able to get longer lasting protection by using two anodes, for example, on a shaft, but they should be inspected midway though the season. Conversely, an anode that doesn't appear to be worn at the end of the season is suspect and may contain impurities that kept it from doing its job. On the other hand, intact anodes may be the simple result of the boat's metals all being of the same or so close in position on the galvanic scale as to be quite compatible with each other. Before changing suppliers, make sure the anode is snug against the metal it was supposed to protect; an anode that is even slightly loose won't be doing its job. Never paint an anode.

Corrosion and Isolators

Let's say you dutifully put anodes on your sterndrive in early spring, which, in years past, has always been sufficient to protect the sterndrive from galvanic corrosion for an entire season. This year, midway through the season, the anodes are mys-

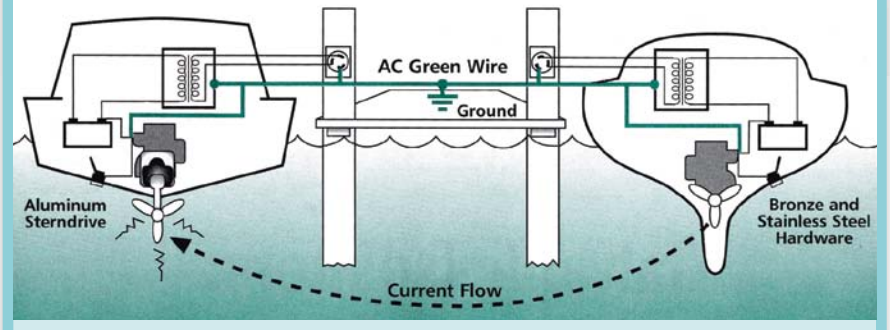
Figure 1
Galvanic Series

Fittings are damaged more quickly in saltwater than in freshwater but it is also possible for galvanic corrosion to take place when dissimilar metals are out of the water, e.g., metals on a sailboat mast or at a windlass or a davit installation on any boat. In general, the farther apart the two metals are on the scale, the more damage is likely to the anodic metal. The further those same metals are from each other as installed will also affect their ability to survive galvanic activity.

Cathodic	Graphite
	Monel
	Stainless steel
	Bronze
	Brass
	Copper
	Tin
	Mild steel
	Aluminum
	Zinc
Anodic	Magnesium

Note: Frequently published charts of the galvanic series may disagree slightly. For example, some brasses may be listed ahead of bronze or vice versa. This has to do with variations of the alloys as well as the electrolyte.

Figure 2



When two or more boats are connected to shorepower, one side of the necessary circuit required to form a galvanic couple is provided by the AC green grounding wire, which also connects to the boat's ground system, engine and underwater hardware. The seawater electrolyte provides the other side of the circuit. Galvanic current flowing around the circuit corrodes the least noble metal between the two (or more) boats, in this case an aluminum sterndrive.

teriously gone; dangling screws are the only indication they were ever there. The sterndrive is no longer being protected. What happened?

The likely answer has to do with shorepower. Keep in mind that I am not referring to alternating current as the stray current source passing through the electrolyte. As discussed above, galvanic corrosion occurs whenever two dissimilar metals are immersed in an electrolyte and the metals are connected by direct contact or by an external wire.

In the case above, the external wire was the shorepower cord: stray direct current passed from one boat's underwater fittings through the bonding wire inside the boat, onto the common ground point and then onto the AC green wire that passes out to the shorepower cord, to the dock pedestal, onto another boat's dock pedestal power cord, then to the other boat, to that boat's common ground, bonding wire, fitting and then back through the water to complete the circuit (**Figure 2**). It isn't unusual for all of the boats on a dock to be tied together via their shorepower cords and, therefore, be affected by stray current from a single boat with an electrical fault.

The rules governing galvanic corrosion are exactly the same regardless of whether they're in direct contact or connected by the shorepower ground wire. There won't be corrosion if all of the underwater fittings on all of the boats are made with the same metal, such as bronze, for example. If, however, there is an imbalance of metals among the boats, which is likely, then galvanic corrosion starts dissolving the least noble metal.

For example, several large cruisers are plugged into shorepower on the same pier as a center console boat with an inboard engine and an aluminum sterndrive. The cruisers all have bronze and stainless-steel fittings under the water (rudder, shafts, props) and no anodes. If there is an anode on the center console's sterndrive, the anode begins to quickly waste away in its valiant attempt to protect other metals in the aggregate of boats connected via the common grounds. As the anode is dissolved, the least noble metal on any of the connected boats, in this case, the center console's sterndrive, begins corroding.

Another possible situation: Several boats with aluminum sterndrives are plugged into AC power on the same pier. Some are protected with anodes and some aren't. Initially, the other boats' anodes will protect sterndrives that aren't protected. Conversely, the protected boats find their anodes are dissolving quicker. All it takes is one boat that isn't protected to affect other boats that have less noble underwater fittings. As the anodes sacrificially wear away, all of the boats' sterndrives are vulnerable to galvanic corrosion.

The source of the corrosion isn't always apparent and there is no instant fix, short of constantly replacing your boat's anodes. If you unplug the shorepower cord, you (and the boat) won't have the benefit of AC appliances like battery chargers and refrigeration.

Never cut the green grounding wire on your boat since the AC electrical system is now no longer grounded at all and anyone in the water near your boat runs the considerable risk of being electrocuted by stray alternating current resulting from a fault in that electrical system or equipment connected to it. Even a few milliamps of AC electricity in the water can sufficiently paralyze a swimmer's muscles, including the heart itself, causing cardiac arrest before eventually drowning. The current passes through the human body on its relentless way to seeking an earth ground and the heart stops by the electrocution in progress.

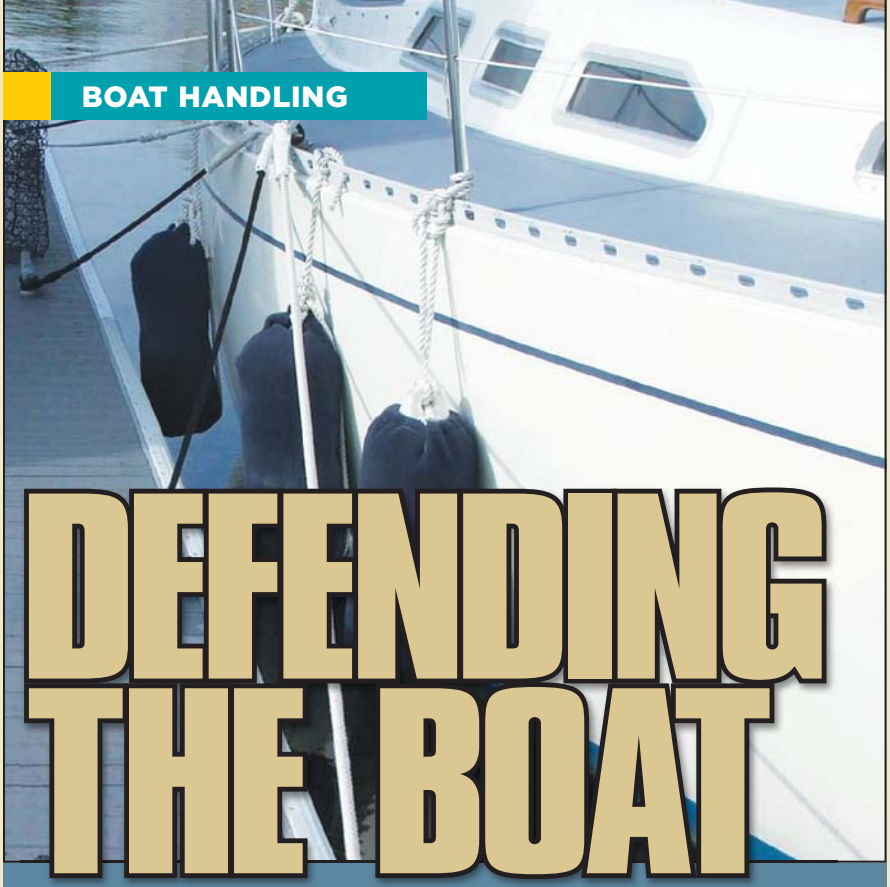
The most common way to reliably and safely interrupt the circuit is to install a galvanic isolator. It attaches to the green grounding wire to limit galvanic DC current flow (up to about 1.2 volts) between neighboring boats, while also allowing dangerous AC current to safely pass through to the ground on shore. The most efficient galvanic isolators have a capacitor that allows the isolator to continue to block galvanic DC current flow even if there is small AC leakage on the ground wire.

Protection can also be provided, typically on larger boats and aluminum boats, with an isolation transformer. The latter is much more expensive but it also protects the boat's AC system from shoreside power fluctuations.

Isolators are rated in two amperage sizes: 30-amp and 50-amp. A boat with a 30-amp cable needs a 30-amp isolator; a boat with a 50-amp cable needs a 50-amp isolator. If a boat has two shorepower inputs, it needs separate isolators for each input.

Just when all of this galvanic corrosion business starts to make sense, there may be instances involving corrosion that defy logic, such as when a more noble metal becomes severely corroded, leaving a less noble metal unharmed. This is likely the effect of stray current corrosion, which can drive normally cathodic metals to become anodic.

About the author: Bob Adriance is the editor of *Seaworthy*, the loss-prevention news journal of BoatU.S. Marine Insurance. Visit BoatUS.com/Seaworthy or call 800-262-8082, Ext. 3276 to subscribe.



DEFENDING THE BOAT

When a boat gets between a dock and a hard spot, you need to know how to protect it from damage. Fenders, strategically placed and properly secured, can do that job.

(left) A floating dock is the ideal tie-up and this boat owner does everything right: fenders hang from stanchion bases, toerail or track and they're covered to stay clean and prevent annoying squeaks.

(above) A fender board hangs outside the fenders to ride against a dock piling. Rubber bumpers protect the hull against an accidental touch and strips of metal on the outside of the board keep the wood from shredding on a barnacle-encrusted piling. Properly led and secured spring lines prevent the boat from shifting too far forward or aft of the piling. Note the fender hanger. Securing fenderlines to lifelines is a chancy practice.

Story and photos by David and Zora Aiken

Some readers may remember the days when old car tires or hay-stuffed burlap bags were used as boat fenders. Both provided good cushioning for the hull and they were especially useful in such places as commercial locks, where the lock walls were so scarred and marred that they laughed at the standard small-boat fenders of inflated vinyl. Today's boat fender design and manufacturing technology produce a variety of fenders to meet the most demanding cushioning needs so there's no need to look further than your favorite chandlery for substitute hull protection.

The choice of fender type depends partly on the intended application. Whether your boat is tied sideways to a pier or seawall, rafted alongside other boats, transiting a lock, tied in a slip or is subject to piling contact or things that go bump, there is a fender and a lashing method system to protect the hull from the expected effects of close encounters with fixed objects.

The classic, cylinder-shaped fenders are made in a range of sizes to suit boat size and to soothe the boat owner's paranoia about prevailing threats to hull from contact with damaging structures.The surface of the fender may be smooth or molded with ridges to minimize the tendency to roll. Most fenders can be hung horizontally or vertically and some fenders permit a line to be fed through their axis tube, which allows securing the fender with a single line. The options allow for almost any docking situation.

In cases where maximum fender diameter is desired (in selecting fenders, size matters and bigger is better) round fenders can be used. Tough to stow, these are deflated for storage and then inflated for use when needed. At the opposite extreme are flat fenders; thick modular, puncture resistant foam or vinyl covered foam forms, shaped as squares or rectangles, some of which snap together to cover more hull area. Another generally square-shaped type has radiused corners to produce a roll-resistant fender that is highly recommended for raftups.

In addition to these basic shapes, there are a number of specialty fenders made for unique applications. One such example is the clever design that fits around the edge of the swim platform. Another serves dual purpose as both fender and step and then there are other multi-purpose designs that do double duty as seating cushions. Specialty fenders are available for pontoon boats, PWCs and bass boats.

For homeport use, better protection is achieved with permanently attached pier and piling guards that are usually formed vinyl or rubber and available in multiple configurations, which can be fastened to dock and posts. An old reliable standby, fire hose, is still sold in many chandleries but it captures dirt, abrasives and oily residues, which limit its attractiveness. As permanent attachments to a dock or piling, these are not included in extensive discussion here, with one exception. A "portable" post bumper that is a vertical section of fabric-covered, closed-cell foam that is carried on the boat when traveling and can be strapped to a piling of any material at any dock (straps and buckles supplied).

Most fenders inflate easily through a needle valve using a hand pump. At least one type includes a built-in pump so the fender can be inflated without searching for the pump.

Fending Off

Choosing appropriate fenders is only one aspect of defending a boat from damaging structures or other boats. How they attach may be the most critical feature. This seemingly simple task is more than

These fenders eliminate concern about rolling and they are a good choice for rafted boats but attaching to lifelines puts them at risk of sliding fore or aft.

Even stainless-steel rails bend when under fender loading.

Specialty fender fits around the edge of the swim platform.

This Nordhaven has a T-track attached to the underside of its rubrail with slides on the track to which fenders are tied.

Fenders may not stay where they are initially placed, especially through all the changes in wind or tide that occur from one weekend to the next.

a source of frustration; it can be the cause of damage as well. No simple rules cover all the variables.

Generally, if the boat rests against vertical pilings, rig a fender board. At a floating dock, most boats use fenders hanging vertically. On a seawall, horizontal or vertical placement may work, partly depending on the height of the wall and the availability of fastening points. In an area with substantial tidal range, stagger fender placement with some high, some low. Ideally, when docking in a new place, it's a good idea to stay onboard through a couple of tide changes to adjust lines and fenders as necessary.

Many tie-on assists are found in the form of pre-spliced lines, a variety of clips, straps, hook-and-loop fasteners and brackets. While these items may help with the problem of fenders lost to slipped knots, there is still the question of where is the best fastening place?

Most boat owners choose lifelines or rails, for the obvious reason that fenders are easily positioned anywhere around the boat. For a short time, in calm weather, that's reasonable but when you leave the boat for a week or two, the fenders probably won't remain exactly where you hang them. Fender lines attached to either a lifeline or handrail can slide forward or aft, shifting the fender away from the place it is meant to protect.

Changing wind direction affects the boat's attitude in the slip, altering the position of the hull section that needs protection or subjecting unprotected areas of hull to point loads. An especially low tide might create another bad scene, as the boat rises with an incoming tide, a fender may get caught under the dock, putting a lot of strain on whatever the fender line's point of attachment, straining lifelines and stanchions and the attaching line itself. While lifelines and rails are the most common places to tie fender lines, they are not universally the best solution.

What are the alternatives? Stanchion bases are strong and generally well positioned. Use the space between two bases to hang a fender horizontally or to position a fender board. Sailboats have the added option of turnbuckle bases or the cars on genoa tracks, however, neither of these installations is intended for extended shear loading and turnbuckles have threaded studs that will chafe line. Standard cleats are an obvious possibility for any boat and these can be added as needed.

Why a Fenderboard?

A fender board has long demonstrated its value for docking when the boat is expected to put a constant load on a piling or pier structure. Depending on the size of the boat, the board is a piece of a 2-by-4 or a 2-by-6, roughly 4' to 6' (1.2m to 1.8m) long, with holes drilled through each end to attach lines for hanging the board. On a long dock, the boat is tied so the widest point of the beam is positioned at a dock piling. Two or three fenders are hung vertically and the fender board is placed outboard of the fenders to rest against the piling. If springlines are properly tied and positioned, the boat will ride on the piling, with the board taking the bumps and scrapes and the fenders absorbing the loads. A fender board is sometimes used in a slip too, perhaps positioned closer to the bow so the boat is convenient to a finger pier. One large horizontal fender might do the job, but only while people are on board to adjust lines if it slips away from the piling.

Specially shaped rubber bumpers slide over the ends of a 2-by-4 board to provide a cushion if the board is pushed askew and touches the hull. On a 2-by-6, attach small sections of rubber dock bumper to the inside surface of the board for the same hull protection.

Fender Accessories

Fending problems are minimal for boats at floating docks. With neat rows of fenders placed low between hull and dock, everything stays in the same relative place, moving up and down together with every tidal shift.

As with most key boat gear, there are accessories to enhance the basic function. Fender covers made of complementary colored acrylic, terrycloth or fleece fabric keep fenders clean and mitigate the occasional vinyl fender squealing. (Some folks apply dish soap to naked fenders to discourage noise.) A cleaner is available for fenders that are not covered and become soiled and, if even that fails, an appropriate paint will cover the damage. Storage racks are sold to keep fenders confined but accessible, much preferred to a lost-in-the-seat-locker or lazarette tangle.

About the authors: Frequent contributors to DIY, David and Zora Aiken have been liveaboards for more than 20 years and are authors of *Good Boatkeeping* and *Cruising: The Basics*.

BREATHE EASY

Regularly cleaning your engine's air filter offers the optimum in engine protection and this inexpensive kit does the job well.

Story and photos by Garrett Lambert

A diesel engine requires three things to run well: clean air, clean lubrication and clean fuel. Racor, a division of Parker Hannifin, has long been a market leader in the business of ensuring clean fuel but they also have a couple of neat products to deal with the latter two essentials.

The Cleanable Air Filter Service Kit (AF M82006) is simple, easy to use and inexpensive ($21.75). A small box contains two sealed plastic bags, one of which protects a bottle of cleaning fluid and the other a bottle of air filter oil. Also in each bag is a spray attachment.

The four-step instruction is printed on the back of the box as well as on the bottles. Spray on the cleaner generously, rinse, dry (see below), re-oil. Just in case that was too terse, there is also an expanded version on the sheet in the kit.

1 Spray the cleaner on the entire filter element liberally and let it soak for 10 minutes.

2 Rinse off the element with low-pressure water. Tap water is okay. Always flush from the clean side to the dirty side. This removes the dirt and does not drive it into the filter.

3 Shake off excess water after rinsing and let the element dry naturally. Do not use heat or compressed air!

4 After the filter has dried thoroughly, spray the air filter oil down into each pleat with one pass per pleat. Wait 10 minutes and re-oil any white spots still showing.

It sounds straightforward, but does it work?

Hands-on Testing

I removed the air filter from my boat's turbocharged Cummins 220-hp, 6 Diamond Series engine. Three springs clamp it between a pie plate cap and the air intake housing, so it's easy to remove and replace. The springs are under extreme tension so be careful you don't let them fly! The third spring is noticeably absent in **Figure 1**, as it fell into the bilge.

Since my engine room is quite clean, I was concerned there wouldn't be enough grime on the filter to make this test credible. It certainly looked and felt dry.

Per the instructions, I spritzed liberally with the cleaning solution, ensuring the filter was wet all over (**Figure 2**). After letting it sit for about 15 minutes, I rinsed it thoroughly with a hose set to spray rather than stream (**Figure 3**). I needn't have worried about the test. I was truly surprised to see just how much grime it had accumulated. After the rinse, the water color was black (**Figure 4**). I spritzed again, this time with the lubricant, and re-installed it on the engine (**Figure 5**).

I was happy with the result but one cleaning is hardly statistically valid, so I visited a couple of garages that service trucks and asked if they had any dirty filters about to be thrown away. The answer was negative in all cases, although one owner offered to let me clean the one on his pickup truck. Because these filters are so expensive (I learned that mine costs about $100), garages use the same cleaning and reinstall procedure I had followed on my Cummins filter. Since both garages confirmed that the solutions do a good and useful job, I turned down the generous offer of the pickup's filter cleaning.

The Cleanable Air Filter Service Kit is a convenient and easy way to keep an air filter clean and having clean air flow to your engine will save you money in the long run.

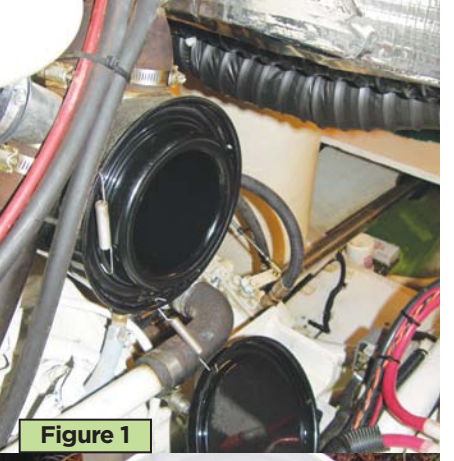


Figure 1


Figure 2


Figure 3


Figure 4

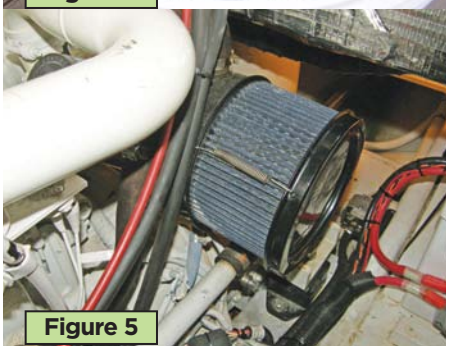


Figure 5

About the author: After three decades cruising the world as a diplomat, Garrett Lambert now cruises the Pacific Northwest where navigation and weather challenges play nicely into his interest in technological innovations.

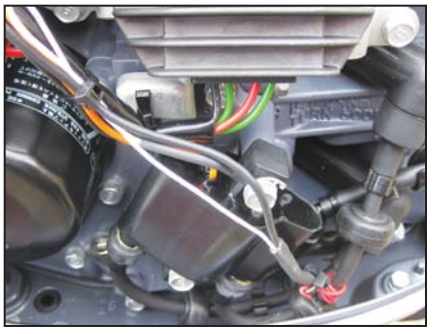
A Tach for Outboards

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

3

To find the perfect propeller you need to know your engine's maximum rpm at wide-open throttle but small horsepower, outboard engines are not equipped with inline tachometers. This simple device gives you the data and more.

When the engine is not running, the display reads the engine hours, as shown by the "5" in this photo, and can be reset to zero. Clear plastic flap (not shown) keeps off heavy rain. Since it has served its original purpose, it now rarely gets noticed.



Gray coax houses a red and white wire: the red pulse lead is twisted three to four turns around one of the plug leads, the white wire has a ring terminal grounded under the upper mounting screw of the ignition coil and that's basically the whole install.

By Dick Rogers

Wanting a tachometer on a small outboard began as a non-requirement and soon became a project. After purchasing a 20-hp Yamaha outboard for my 14' (4.2m) skiff, the dealer agreed to an in-water test to check the propeller match. After a couple of reminders and a suggestion that the engine felt "over-propped," the dealer finally arrived with a factory fitted suitcase full of test instruments and adapter harnesses. Impressive but no combination of test tachometer and service harness worked. He then tried running the boat while leaning out over the engine with a portable tach and, although wearing a Mustang auto-inflatable PFD, he declared that that was probably not a clever idea. The dealer left, did not return and I still believed that I had the wrong propeller.

If the perfect propeller is one that allows the engine to rev to its maximum rated rpm as specified in the engine service manual, how do you determine the rpm with a small, portable outboard engine? Remembering a new product item that I'd seen years ago in an industrial publication, I decided that it's Google time and there it was. Tiny-tach is a digital, inductive pickup tachometer, about a third the size of a deck of cards and designed for permanent installation.

Installation takes but a few minutes. Just wrap the center core of the integral coax cable around a spark plug lead and attach the ring terminal (outer shield) to a good ground. I used one of the coil mounting screws. With the screws supplied (or double-sided tape or Velcro), mount the readout somewhere visible. I mounted it on a piece of wood with a small angled block to put the unit at my eye line of vision. The block is held in place by the motor's transom screw clamps (the motor is bolted through the transom).

The coax is small diameter and the rubber seal on the engine cover of a typical outboard is sufficiently compliant to bring out the lead through the seal. Standard lead length is 6' (1.8m). I wished I'd taken the time to noodle the install first as I would have ordered the optional, longer lead ($10) to mount the readout display in a slightly more convenient place. Power is an internal battery that is apparently good for about 5 years but it's not replaceable.

The Tiny-Tach Standard version ($36.95) works with most any engine up to 9,990 rpm. With the engine off, the readout shows engine hours, which is handy for four-stroke owners tracking oil change intervals. Other versions offer multiple hour readings for total or service, interval or reset or non-reset hours. There's even a diesel version.

Product information and support is excellent from the manufacturer, Design Technology Inc., (www.tinytach.com/tinytach/index.php), not that much could possibly be needed. It works great on the Yamaha outboard but I haven't yet decided where to mount the readout for the second unit on the Honda generator. (I saved some freight buying two units.)

About the author: For nearly 50 years, 26 with his own company, Dick Rogers (alias "the electrical guru") has worked with electrically related automotive, industrial and marine products. He now resides in Indian Point, Nova Scotia.

Interior Facelift

8

Modern materials used to conceal years of water damage to teak plywood from leaking portlights adds panache to this early '80s cruiser.

Before: Teak plywood damaged by 28 years of the inevitable water leaks around the portlights.

After: A lighter and brighter saloon interior.

By Chuck Husick

We prefer sailing our boat to polishing it and, while we unstintingly devote time to mechanical and electrical maintenance chores, we are much less likely to spend time cleaning and waxing fiberglass or worrying about a few drops of water that gain entry through the gaps around portlights (created by the different thermal coefficients of expansion of the plastic and the surrounding fiberglass). Damage to the interior teak plywood from the water leaks eventually got to us. It was past time to repair the accumulated damage.

The decision to repair the obvious damage presented the usual initial choices: hire a professional to do the work or do it myself; the latter won. In part, the decision was based on the fact that, although sailing on the Gulf of Mexico off St. Petersburg is almost always very pleasant, from early July through mid-September, the trip to and from the dock can be too hot and humid to be at all enjoyable. Working in the air-conditioned interior would be a way to spend time onboard in relative comfort. We decided to do everything within our skill limits ourselves.

The first step in the program was to eliminate leaks, especially around the large, fixed portlight, aft on the port side of the saloon. We made a new portlight and after two attempts, succeeded in eliminating (at least temporarily) the leaks.

We next had to decide how to deal with the very seriously deteriorated teak veneered plywood that surrounded the portlights, covering the upper side of the saloon bulkhead. New teak was an obvious choice, however like many production boats built in the early '80s almost all of the interior is finished with dark teak veneers. The traditional off-white finish used when boat ceilings were finished with paint appealed to us and led to the idea of using Grade 20 Vertical Postforming Grade Formica laminate with a nominal thickness of .028" (.7mm) to cover the teak, with matching stained wood trim moldings at the upper and lower edges.

Materials and Tools

We ordered two, 8' (2.43m) long, 30' (9.1m) wide pieces of laminate and they arrived rolled in a spiral, in a heavy cardboard carton that protected the fragile edges from damage. I quickly learned that the edges of this thin laminate are sharp and capable of piercing the skin, a snag avoided once we learned to respect the sharp edges of the material. As usual, with all of my boat projects, some blood would be donated to the effort.

The original teak-faced plywood bulkhead facings were made in sections, with vertical joints at the midpoints of the two fixed portlights. We would follow suit with the new coverings, using three pieces to cover the 11' (3.3m) fore and aft span. A sheet of dimensionally stable Mylar drafting film was used to create a template for the laminate that would cover the forward end of the new side panel coverings.

Three critical decisions had to be made regarding the use of the Formica laminate: how to cut the sheets to the required overall dimensions; how to accurately cut the openings for the portlights and how to attach the laminate to the existing plywood surface. The first decision was easy to make, as the most suitable tool was a laminate trimmer (**Figure 1**), a specialized router like tool. The laminate trimming cutter used with this versatile tool has a small ball bearing at its outboard end that guides the cutter as it is moved along the aluminum trim that surrounds the portlights. The ease and accuracy with which the cuts were made was a pleasant surprise.

A standard router bit was used freehand to cut the overall shape of the sections of laminate. It takes a bit of learning to do the freehand cuts and we found it best to do the work on a sacrificial surface (the hardboard covering of our workbench) allowing a depth of cut deep enough to ensure that the laminate was cut completely through. Since it can be difficult to directly view the path of the cutter, it's best to make the cutting layout on the reverse surface of the laminate, allowing for both the distance from the edge of the plastic router base to the center of the cutter,

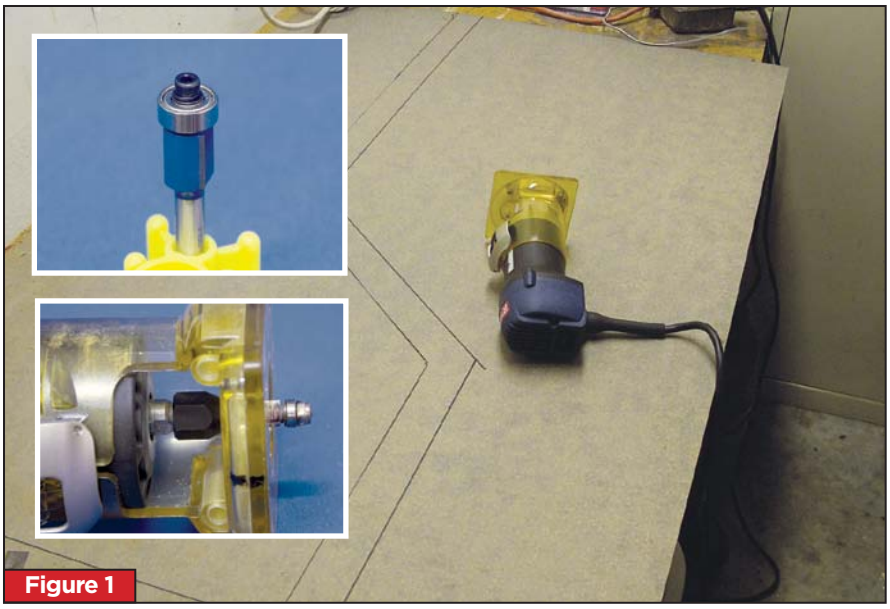


Figure 1

plus half the diameter of the cutter. The cutting process creates impressive quantities of fine laminate dust. Keep a shop vacuum handy and wear a high quality dust mask.

Our initial intent was to bond the laminate to the wood with a high-strength adhesive such as Liquid Nails. On further reflection, we decided to use the same method used to fasten the side panels of some over-the-road cargo trailers to the frames; namely 3M VHB (very high bond) double-sided polyester foam tape. We have used this fastening method with great success both on the boat and in commercial products we have designed. In fact, the two lamp fixtures mounted on the bulkheads between the fixed portlights were mounted using an early version of this tape more than 20 years ago and were still very firmly in place when we worked to remove them.

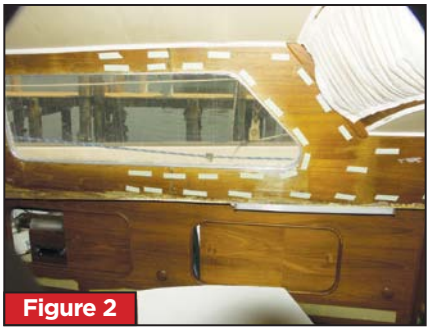


Figure 2

Assembly

As shown in **Figure 2**, the tape was applied in short lengths, spaced to provide adequate adhesion for the laminate while allowing the new material to be accurately positioned before being fixed in place. The tape, with its top covering in place, was firmly forced into contact with the wood surface by rubbing it with a cloth. The protective covering was removed, the laminate positioned (**Figure 3**) and then adhered to the tape by progressively


Figure 3


Figure 4

applying pressure over the entire surface, pounding on it using an old towel to cushion the blows.

With the laminate firmly attached (the strength of the bond improves during the first 72 hours), we addressed the task of cutting the openings for the portlights. We fixed the base of the router at a position that would ensure that the cutter would trim the laminate as the ball bearing rode on the aluminum trim around the portlight.

The actual cutting process turned out to be a non-event (**Figure 4**), except for the copious amount of laminate dust that resulted.

The restoration job was completed with the addition of wood trim, stained to closely match the teak trim color. We used clear pine, applying a pre-stain treatment to promote even color when applying the stain. The laminate was cut to match the lower edge of the bulkhead using the laminate trimmer (by now a favorite tool). The 90-degree wood molding for the lower edge was prepared by cutting a series of thin saw kerfs into the bottom, horizontal surface, allowing it to flex to conform to the curved contour of the bulkhead. A continuous length of VHB tape was applied to the vertical surface of the trim and it was pressed in place. The wood trim at the top of the bulkhead was similarly fastened in place using VHB tape, with a couple of small stainless-steel flat head wood screws for good measure.

New Venetian blinds were ordered, custom made to the required length and width. (We had modified blinds in the past and decided it was worth the additional cost of having new ones made to fit from the outset). The slats are made of a plastic, faux-wood that we believe will stand up to the marine environment better than real wood.

From our standpoint the result of the restoration effort has been entirely satisfactory. The interior of the saloon is lighter than when all the vertical surfaces were teak wood covered. The new blinds are better than the old ones. The home-made, high-efficiency fluorescent lamps, installed on the bulkheads, had been in use for more than 20 years. We disassembled them, power buffed their brass bases to restore the original brilliance and then reassembled and put them back in place.

This job required about 30 hours. The cost of the material, including the purchase of the laminate trimming router and cutting bits, was less than $350 plus $280 for the new Venetian blinds. We now have a refreshed interior in the saloon and the satisfying feeling that comes from working on your boat.

About the author: An electrical engineer, pilot and former president of Chris-Craft Boats, Chuck Husick has sailed the U.S. coastal waters and Great Lakes since the early '70s.

Not a Cushy Job

7

Replacing old cushions with new foam and vinyl won't cost a million dollars, but your boat will look like it.

By David Ladewig

After 10 years, the upholstery in our '96 Bayliner 2855 Sunbridge Cruiser was beginning to crack. The stains were difficult to remove and mildew had become a problem. I decided to have the cockpit upholstered with new vinyl. Quotes from several companies ranged from $3,000 to $4,800 for the job but didn't include new foam, just the covers. It seemed excessive so I looked into turning this into a DIY project.

The job required that I find someone to make the covers and then I would put them on. It didn't seem that difficult. I contacted Canvas Plus (tel: 360/435-0932), an authorized Bayliner canvas supplier based in Arlington, Washington. This company could make complete covers in the exact color and pattern as the original seats and ones that didn't need fitting. We agreed on a price and I gave them the boat's hull number to make sure we received the correct seat covers.

The next part of this project was to obtain an air-driven upholstery staple gun. You can find a stapler anywhere but most are not the proper unit for this type of work. Home improvement stores don't carry them, as a rule, but you'll likely find one on an Internet search. I used a

DIY tools needed for an upholstery refit.

Unicatch fine wire model USC71/16 and 22-gauge stainless-steel wire staplers with a 3/8" (9mm) crown. Its compact size makes it easy to hold and operate. Air output is set at 40 psi and adjusted as needed. My air compressor is a small unit purchased at Home Depot and works well with a stapler and small nail gun. Only stainless-steel staples are acceptable for this type of work and they were shipped with the stapler.

Dismantling

Now for the fun part; removing seats from the boat. If you have never looked, the screws and bolts that hold down the seats are not put in obvious places. I'm sure that

Mildewed foam is treated with a bleach solution followed by denatured alcohol.

most seats must be put in boats before the hull and deck are joined because they surely are not easily removed. In addition to the screws I could see, ceiling panels in the back bunk cabin were removed to gain access to the screws and bolts. After unbolting the lounge, the back of the lounge and unscrewing the jump seat, it all came out, sort of.

There was a lot of silicone sealer around the screw and bolt attachment points. Just keep tugging gently and they will break loose. It took half a day to remove all the pieces and then I spent the rest of the day cleaning up 10 years of grime and junk behind the seats. Yuk! That was the worst part of this job.

I decided to load up as many pieces as I could in my car and take them home and do the job in my garage. Everything would fit except the lounge back. It would have to be done at the boat.

Tools that really helped me get the old stuff off the plywood frames included a set of Craftsman probes and needle nose pliers to remove the 2,000 or so staples and a heavy duty paint scraper to remove the excess glue and foam from the plywood. All staples must be removed as does all the old foam and glue. When using these probes, be extra careful that you don't stab yourself.

Seat Conditioning

After 10 years, the vinyl was very brittle. It had cracked in several places and, after using the probe to remove several staples, I used my gloved hand to grab and pull. Most of it ripped right off. What remained was easy to remove. After all staples were removed, the task of cleaning or checking the foam began. A lot of the foam was covered with plastic to keep water out. Some of this was okay, but most had leaked through to the foam, which had become mildewed. Even with the boat stored under shrinkwrap in the early years and a cockpit cover the last three years, there was a lot of mildew. I sprayed it with bleach and then denatured alcohol. Some of it went away and some didn't. After three tries, it was time to rip the foam off and get some new pieces.

After removing the plastic and noting which pieces were covered, I very carefully removed all the foam. Each seat had two pieces of foam. These covers all have a hold-down strip of material stapled between the foam pieces to make the seats stronger. They hold their shape for years when they are built this way. I then took the foam pieces to a nearby foam company to have replacements made. When buying new foam, always purchase foam that is the same as the original in texture or firmness; otherwise, the seats may not fit back together. Your supplier will know what to supply for a perfect match.

Back Repairs

While waiting for the new foam and the arrival of the new covers, I worked on removing the remaining glue and staples. This was a tough job. Some of the glue was still flexible and sticky and removal demands lots of elbow grease with a paint scraper. The probe and pliers got the rest of the staples out of the wood.

Next, all plywood was checked for any rot. As it was still all good, it was repainted with marine deck paint and put aside to dry. Once dry, wood filler was applied to fill any staple holes the paint didn't fill. At that time, we decided to eliminate the transom-facing, pull-out jump seat. It wasn't used much and we have chairs for the aft cockpit anyway. By tossing out this small seat, there was now space under the settee for docklines and the flare kit.

The Main Challenge

So far, I've only described cleaning up the large lounge seat, side panel and jump seat. The captain's chair is a hard plastic shell with a side/back cover, four center cushions and a decorative piece. This was the next task. It was much easier than the larger settee but each of the four cushions was screwed into the plastic.

The most difficult part of this job was finding the screws. There are small holes in the vinyl where the screws go through to the wood and then into the plastic seat shell. Holes in the vinyl let the air out and in when one uses it. This seems to work

Attaching new precut foam to plywood.

Completed settee back.

Vinyl on settee bottom is held with temporary staples. Note finished covered side panel behind.

Captain's chair assembly: (top) Numerous staples hold the cover to the shell and it's ready for the four-piece cushion back; (middle) Cushions installed. (bottom) Finished seat.

well and cutting the four new foam pieces seemed like an easy job compared to the larger pieces.

Reassembly

With the painting, removal and clean-up completed, I was ready to start reassembly. I started with the flat panel that mounts against the cockpit side, next to the captain's seat. Being flat, the panel would give me an opportunity to master my skills before tackling the rounded seats. In addition to the cut foam, I purchased two sheets of 1/8" (3mm) and 1/4" (6mm) foam, which I used to pad the side panel and captain's seat back before putting on the covers.

The foam attaches to the plywood using Masco 200 Bond Heavy Duty Adhesive Spray. This is a heavy solids spray with a spray pattern that gives virtually no overspray to mess up your work space. I used this product to tack and hold or to spray both the foam and plywood and assemble for an almost dry bond. I also stapled the foam along the edges too.

After the foam comes the plastic film. It comes on rolls and the minimum order was a 100 yards by 4' wide (91.4m by 1.2m). It's made in heavier grades but I used the same grade that was originally used.

Next, I attached the cover. All the new seat covers arrived from Canvas Plus with foam sewn into the cover. By using the sheet foam first, the padding was thicker and much more elegant looking. On the panel there is a dark blue line of piping. That part attaches first and then the vinyl is pulled tight. I first pulled it tight and then attached just enough staples to hold it for about an hour and then I removed those staples and pulled the vinyl all the way down tight and stapled around the perimeter. Once every wrinkle was gone, I ran a second line of staples behind the first row offsetting each one to keep even pressure on the vinyl.

When the original side panel was made, the manufacturer used blind fasteners to attach it to the boat. I decided to eliminate this access problem and attach the panel using #12 screws with finishing washers and a flat washer. Next, the mounting holes for the engine controller were cut and stapled to make the reinstallation on the boat easy and smooth.

The side panel assembly went smoothly so I tackled the captain's seat next. New foam was glued to the back and sides of the plastic shell and then trimmed and stapled. Additionally, the sealing plastic film was attached and glued to the plastic shell. There are holes at the base of this seat for water to drain. The cover fit like a glove but was difficult to pull tight the first time so I let it sit until the next day and then pulled it tight again. Keep your stapler near by when pulling the cover over this seat. Just one quick staple and then the tightening becomes easier.

DIY BILL OF MATERIALS

Computer cut vinyl seat covers, sewn with backing and shipping from Canvas Plus, Arlington, Washington.....$500

Foam, plastic sheeting, 3 yards each of 1/8" (3mm) and 1/4" (6mm) thick Trimfoam sheets, 1 roll stuffer film, 2 cans #200 Bond Heavy Duty Adhesive Spray from Masco, Birmingham, Alabama $491

Staple Gun and stainless-steel staples from Fasco, Bakersfield, California.....$98

Miscellaneous: 2 quarts (1.8L) marine deck paint, acetone, disposable paint brushes, stainless-steel fasteners.....$50

The plastic shell is covered completely on its back, side and arms by this cover and stapled to the shell. Next, the foam attaches to the four pieces of plywood and then is covered with the new vinyl. The blue decorative piece fills in the gap between cushions on the seat back. Instead of punching a hole in this part, I first attached it using two #10 screws with a finishing and flat washer. The easiest way to punch the screw holes is to use the probe and work from the backside of the cushion through the hole in the plywood. Make the hole as small as possible for the screw. I also glued the bottom seat and used a silicon sealer to keep water off the plywood.

In addition to the new paint, this should resist water for many years. The next attachment was the four cushions and then attaching the bottom plate that goes on the pedestal. While the bottom plate was off, it was cleaned and greased for a smoother operation when you adjust the seat fore or aft.

The last piece I could do at home was the settee bottom. This is a large seat and is actually easier to cover than the smaller parts. The only degree of difficulty was stretching the vinyl tight and that was only due to size. Once again, I glued the back piece of foam on first. Next, it was covered with plastic film and then stapled and glued. I stapled the blind panel to the wood, making sure to get it even around the outside of the foam. Pulling the cover toward the back, a temporary staple held it in place. After wrapping the front foam in plastic, it was tucked under the cover on the front section and the cover pulled over it and attached with a temporary staple. Temporary staples were now removed and the cover pulled tight and held with staples. Once tight, I let it sit before retightening and removing staples and then I restapled it as needed. The same thing was done for the front side of the cushion.

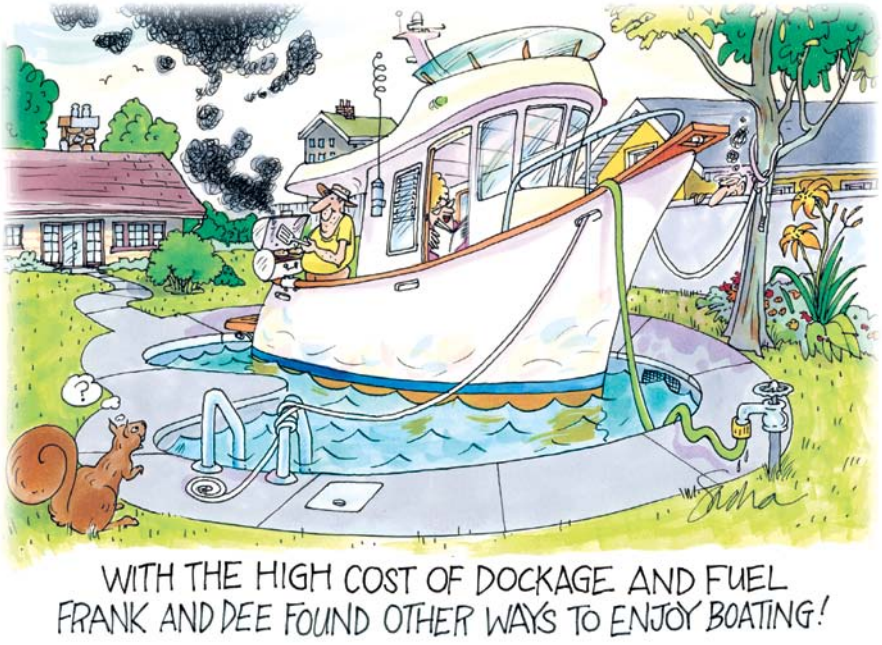
With these pieces completed, it was time to load all the tools and return to the boat to do the settee back. After completing the back using the same method as described above, I reinstalled the new seats. The side panel went on first and it required reinstalling the engine controller. The settee back was next, followed by the settee bottom and then the captain's chair. The cockpit looked like it did the day the boat was made 10 years ago.

Total cost was $500 for the covers and $491 for the foam, plastic sheeting and adhesive. The stapler was less than $100 with a box of 10,000 staples. My guess is that it takes about 2,000 staples to do this job. I already had the rest of the tools and the small air compressor. The entire job took two weekends and a few evenings to complete, about 32 hours. The cost savings by making this a DIY project was several thousand dollars.

About the author: David Ladewig has been an avid boater since his youth and has owned sail and powerboats from 12' to 32' (3.6m to 9.7m) in length. Home port for *Four Pyrates II*, which replaced his boat lost in Hurricane Ivan, is Dauphin Island, Alabama.

Add Some Water, Have Some Fun

Tough times for the recreational marine industry don't have to dictate your joy of boating. Fuel prices are half that of last season and there are other opportunities to stretch your boating dollars.



Sacha

By Roger Marshall

They say it's going to be a tough year for boating. With the economic downturn, rising fuel prices (even though oil companies have made record profits) and everybody working longer hours or for less money (or not at all) in an effort to keep themselves afloat (figuratively and literally), marine leisure time is taking a big hit. While the National Marine Manufacturers Association is reporting that boat registrations are up, new boat sales are spiraling downward, boat builders are furloughing employees and cutting production. Even actual boat usage appears to be decreasing with more boats sitting idle dockside. The spring launch is being deferred by some to postpone pre-launch expenses and others are looking at boats being offered for sale at very tempting prices. Some owners are opting to refit and refurbish an older, already owned boat in lieu of buying the floating temptress issuing a siren's call at a winter boat show.

What are you doing with your boat? If it's too expensive to buy a new one with the latest gizmos and gadgets, or too costly to launch and use, why not use this downtime to do a few upgrades. Summer is the prime time for refits and, when the economy comes back, your boat will be in tip-top shape, ready for fun on the water. Competition for work is keen among the good yacht yards so there's the potential for negotiating an excellent project value.

If you, like me, have many projects, it's sometimes hard to decide where to start. My own back yard is a typical example. There's a J/24 owned by my son that has had the hull faired and painted and is being upgraded with a new deck and new Ronstan deck gear. The goal is to have it ready to launch this summer.

My own 22-footer is getting an interior upgrade, replacing a rotted bulkhead, new cushions and laying on new varnish. My boys and I painted both boats with Interlux Perfection topside paint but saved the final topcoat for application by the professionals at Jamestown Boatyard, Jamestown, RI. By doing the hull prep work ourselves, we saved thousands of dollars and turned a sad sight into a very attractive boat, as well as taking a big step toward improving the boat's value.

Our RIB acquired new electronics. We've installed a Lowrance speedometer and depthsounder and a VHF radio. We put Aqualuma underwater lights in the transom [Ed: For steps on installing these lights, refer to DIY 2009-#1 issue] and new Hella area lights on the metal towing framework to raise fish at night, which are also great when backing up to a dock or boarding from astern. We've put new, very comfortable Todd bucket seats on it, too. These seats contain the driver better when cornering at high speeds and offer greater back support when sitting.

We also found a couple of really high quality marine speakers at a bargain price. So our next projects are to install an MP3 player/radio on both the RIB and J/24, so that we can play suitably loud and obnoxious tunes going to the start line of the sailboat races.

Almost all these upgrades were done by my teenage sons and I. The boats are more useable and more comfortable and we customized them to suit what we wanted and how we use the boats.

If you are planning on delaying launching this year, or maybe not launching at all, there are some great bargains around that may allow you to upgrade and make your boat more suitable for your on-water fun, be it fishing, sailing or just plain being afloat. But, I should add, don't delay your launch to make an upgrade. Use your boat as much as possible, have fun with it and, if you find a great bargain on equipment or a new or new-to-you boat, treat yourself and enjoy your next outing.

About the author: The author of 12 books, Roger Marshall's latest book, *Fiberglass Repair Illustrated*, is soon to be released.

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