DIY boat owner

1999-#3

the MARINE MAINTENANCE MAGAZINE

Features

MAINTENANCE

OFF-SEASON STORAGE TIPS

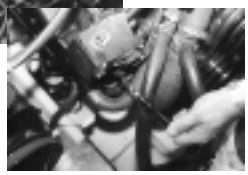
Things you should know about boat covers, ventilation, chafe protection, securing tie-downs and fuel additives when preparing your boat for extended storage.

DIY MECHANIC

STERN DRIVE LAY-UP & START-UP

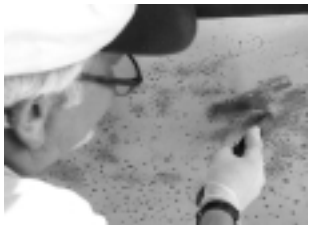
Storage is one of the greatest enemies of a marine engine. Follow these steps to properly lay-up and relaunch your stern drive.

By Jim Marotta



REFIT

STEP-BY-STEP BLISTER REPAIR



Here's everything you need to know to ensure a successful job, including a summary of material costs, daily scheduling, reasons for failure and prevention tips.

By Jim Shotwell

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By Wayne Reddit

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Charging Techniques: Here's what you need to know to keep your batteries in peak condition.

By Kevin Jeffrey

Sailboat Rigging

Custom Shearlegs: Lowering and raising a deck-stepped mast is easy with this custom-rigged frame.

Engine Troubleshooting

PART 2 - DRIVE TRAIN TUNE-UP: Stuffing Box Replacements: A look at dripless shaft seals, alternative devices to traditional stuffing boxes.

By Robert Hess

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Ship-Shape Storage; Bag Holder; A Secure Berth.

Good Boatkeeping

Keep It Simple Storage: Roll Preventer, Unroll Preventer, Curse Preventer.

By David & Zora Aiken

TALKBACK Q&A

Dry Start

Q: In the article "Wet Exhaust Systems" in DIY 1999-#1 issue, I understand the author's point about closing the engine thru-hull seacock when trying to start an inboard engine but won't that destroy the impeller?
Lynn Barnes, Huddleston, Virginia

A: The concern isn't damaging the impeller as some water (or antifreeze for cold-winter storage) is always contained in the cooling system, but flooding the engine. When an engine is turning over but not starting, the water pump continues to turn and pumps water into the engine. Until the engine starts, the water isn't expelled out the exhaust. Continually cranking the engine without it starting with the water intake valve open will eventually fill the entire engine with water. This is more of a precautionary measure, as it would take a lot of cranking to flood an engine resulting in a major engine rebuild. As soon as the engine starts, open the water intake.
— *Jan Mundy*

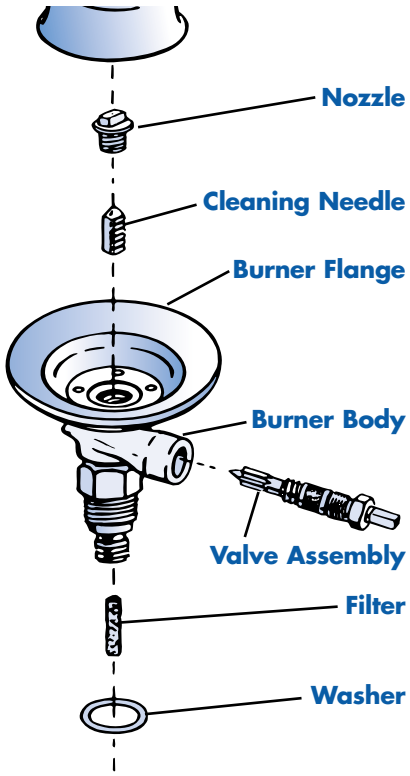
Hull Cleaning

The hull of my boat had a bad case of the "brown mustache." I had tried a few products which did not begin to attack the problem. I read the article in DIY 1997-#2 issue where three products were tested and of the three mentioned, I purchased the Mary Kate On-Off and it worked remarkably. It was as easy as the article suggested. I'm so thankful I came across your website.
A.S. Pierce, RiverRat, New River, Fla.

Fine Tuning Stove Burners

Q: Our Kenyon stove has one burner that flares up all the time. I believe it needs a good cleaning but the burners don't appear to be detachable. Have you any recommendations for proper cleaning procedures?
J.K. Holman, "Freebird," Toronto, Ont.

A: According to Kenyon customer care manager Gary Buttrey, the burner which is flaring up has either a loose or badly corroded burner flange. The burner flange is the brass bowl, or flange which the caps at the top of the burner snap into. On older units there is a disk under each cap which as it turns, opens and closes four holes which are in both the disk and the flange. The newer burners (mid-70s on) are adjusted by rotating the flange, while the disk remains stationary. If the holes are completely closed a lazy yellow flame is the result. Most burners perform their best with the holes completely open. If the flanges are badly corroded or loose on the burner body, the heat is not transferred properly and the burner body cools down, resulting in liquid alcohol burning (and flare-ups) rather than vapor. Remove any scale with an abrasive, such as a wire brush or buffing wheel. Badly corroded ones with holes in them require a new burner. If flanges turn easily, retighten with a slot screwdriver. They should be tight enough just so they are difficult to turn by hand. To do this, remove the inner and outer cap and look at the stake marks around the nozzle and inside the stationary disk. Place your screwdriver between the old stake marks and hit the driver with a hammer. This should "crush" the ridge of brass and tighten the flange. Repeat as many times as necessary until the flange is tight.
— *Jan Mundy*



Testing Stern Drive Coolant

Q: I would like to know how to winterize a 1982 Volvo stern drive. It has antifreeze in the cooling system, so what's left to do?
John Anderson, "Misty Slip," Hastings, Minn.

A: Engine coolant is typically a 50-50 mixture of antifreeze and water and must be checked twice annually to monitor any contamination. Assuming you checked the coolant mixture with an antifreeze tester in the spring and had a reading of -37°C (-35°F), the minimum requirement in your area, when you haul out

this fall, test the antifreeze again. If all is mechanically sound, the tester should still read -37°C (-35°F). If the value has decreased, say to -26°C (-15°F), you're getting seawater into the antifreeze. Start with a fixed number in the spring and add this to your maintenance records. The rest of the winterization process is outlined in "Stern Drive Lay-Up & Start-Up" starting on page 33.
— Jan Mundy

Monitoring Water Pressure

Q: Is there a water-pressure gauge adaptable to a 1980 MerCruiser 350?
Robert Younger, "SammiB,"
Walnut Grove, Calif.

A: A water-pressure gauge is typically an outboard addition, and one of the two most important outboard gauges (the other being a tach). Unless you monitor the gauge on a regular basis, the stern drive's overheat alarm will activate before losing water pressure. Because this gauge reads out the nominal water pressure, this gauge makes the ideal diagnostic aid for monitoring stern drives, says Steve Auger of Mercury Marine. At idle, a normal reading is 5lb or lower, raising to about 20lb at WOT. If one day you're underway and the gauge reads 25lb, you'll know you have a restriction in the water outlet; if it lowers to 15, then you need to service the water pump. Available from any Mercury dealer, it's listed as an outboard part. Easy to plumb into any MerCruiser, it plugs directly into the drain on the block. See DIY 1997-#1 for step-by-step installation in an outboard.
— Jan Mundy

To Rebuild or Replace

Q: In 1998 I had my three-year-old Gray Marine 327 AMC engine rebuilt. After about three hours of use this year the starboard side overheated and the result was a totally

fried engine. The engine rebuilder told me last year that it was very expensive to rebuild as many of the parts (pistons,etc.) were very difficult to obtain. I don't think I should consider this again. I am now faced with a decision of repowering, either new, or some more modern version of a rebuilt. I don't believe that you have covered this subject before. Please advise.
Bob Poirier, Brechin, Ont.

A: Assuming the engine is really damaged beyond repair (seized not just blown head gaskets and warped heads) and the condition and value of the boat justifies the cost, I suggest a similar sized remanufactured late model marine engine be purchased from, and installed by a reputable marine engine dealer. Get a written quote (with warranty terms) from at least three reputable dealers and talk to several references from each. Extensive modification of mounts, transmission adapter plates, drive shaft, wiring harness, controls, etc., will probably be necessary, which could be expensive, so I also suggest comparing the resale value of the boat with a new engine versus trading it in as is on another boat.
— *Robert Hess*

Three-way Battery Wiring

Q: My 7.8m (26') 1988 Cruisers with twin stern drives originally came with two batteries. I'm installing a third deep cycle to power the accessories and was told that I needed a three-battery isolator (the boat currently has a two-battery isolator) or battery combiner. Before I go through the cost of buying the new isolator can I just combine the two batteries on the port side by means of a jumper wire connecting both the positives and negatives?
Jeff Janda, "Sanctuary," Chicago, Illinois

A: On your boat you'll essentially have two starting batteries and one house battery dedicated for accessories. If your engine has separate starter feed and alternator output wires, I would lead the output from your charging sources (alternators and other sources) to the house battery, then charge the engine batteries through a device known as Echo Charger (US$100) from Heart Interface. They feed a small amount of current to a starting battery and you need one for each battery. Make certain that the starting batteries have no other loads than starting the engine and they should always stay topped up. If your engine uses the same wire for starter feed and alternator output, you'll have to use a battery link device — you would need one three-bank battery link — that links battery banks together under the influence of a charge. When the engine(s) is turned off, this device breaks the connection and all battery banks are electrically isolated.
— *Kevin Jeffrey*

Stick-On Dashboards

TALKBACK Q&A

Q: The glues and contact adhesives you've tried are leaching the plasticizers out of the vinyl when applied, causing the bond to fail. The adhesive experts at 3M Marine recommend 3M Super Trim Adhesive (part number 08090), a heat- and plasticizer-resistant aerosol contact adhesive commonly used to glue vinyl roofs on cars. Remove all old adhesive with 3M General Purpose Adhesive Cleaner (see product review in DIY 1997-#3 issue) or any good solvent, then spray on both surfaces. Do a test patch first to check for compatibility. Not a marine product, it's available from NAPA or other auto parts suppliers.
— Jan Mundy

Hot Running Stuffing Box

Q: In DIY 1999-#2 issue, page 37, the article states that after repacking, the stuffing box should not be hot. I have followed the article word for word and my packing nut is too hot to touch. I called Perko and they said this is normal. Am I doing something wrong?
Carl Dispoto, "Innamorata," Barnegat, N.J.

A: If you used traditional packing, normal drip is one drop of water per minute when the shaft is rotating. If it drips less, slacken off the nut. If it's too tight, the water can't lubricate the shaft and the nut will be very hot. If it still runs hot, the packing is either oversize or packed too tight. Stuffing boxes packed with synthetic packing (i.e. GFO, Teflon), disperse the heat so they not only run cooler, many don't drip.
— Jan Mundy

Waterlogged Foam Cuts Speed

Q: Last year, the top speed on my 7m (23.5') Bayliner was 29 knots. This year, with a clean bottom, top speed is only 22 knots and the bilge needs pumping out daily. I know three owners who removed the entire heavy, saturated foam from their hulls and their boats have never run better. After removing the foam it seems a waste to replace it, for in spite of manufacturer's claims to the contrary, the foam is not as "closed-cell" as they'd have you believe.
Stu Sveinson, "Halcyon Days," Powell River, B.C.

A: If you're pumping out the boat daily, there is a leak. That amount of water is coming in from the sea, not as rainwater, or condensation. Remove the foam. This is a very messy and time-consuming job. The difficulty depends on the methods used to fasten the floor to the stringers and such. After the foam is removed, the leak should be found and corrected. It's most likely the seal around the drive, but it could be a hole in the bottom. I wouldn't replace the foam. There is barely enough volume for adequate foam to make the boat unsinkable. The other potential benefits of having the foam in place are marginal. I tend to agree that in larger boats the foam causes as many problems as it solves. There are regulations manufacturers must follow regarding flotation, and that is why you see it in smaller boats (see "Weight Gain" on page 7). I doubt your cruiser was expected to float when swamped.
—Wayne Redditt

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TECH TIPS

SEAL FOR CHRONIC LEAKERS: After trying various sealants to plug a leaking foredeck hatch — it leaked between the Plexiglas and the metal frame — I found a permanent solution at an autoglass shop. For $35, the shop sealed the joint with the same hot glue used to seal car windshields and it hasn't leaked since.
Jan Burnham, St. Andrews, New Brunswick

QUICK TEAK FIX: When you don't have time to prepare new teak for application of a coating, and don't like the look of oxidized (gray) teak, sand lightly and apply an exterior oil-based stain. As the wood weathers, the stain can be used as a touch-up to keep the color fresh.

MANUAL ADVANTAGE: Next time you use a liquid cleaner, attach a spray nozzle. You'll use the soap more efficiently — *DIY* cleaned the deck of our 6.6m (22') test boat using less than a cup — and you can target high-soil areas. Incidentally, Dolphinite Boat Soap with Wax! is one of the best boat soaps *DIY* has tried. It contains a mildewcide, has a pleasing fragrance, cleans with little or no scrubbing and leaves behind a shiny, spot-free finish.

REMOVING BEDDING COMPOUND: To remove old sealant quickly without scraping or damaging the gelcoat, use a small diameter bronze wire wheel (don't use a steel one which leaves rust stains) with a cordless drill (or rotary drill) at a low speed setting. Wear safety goggles. Light pressure and slow speed are key to avoiding gouging the gelcoat. The wire-brushed, clean surface is ready for recaulking.
Bruce Colman, Orleans, Ont.

GRAPHICS STRIPPER: A safe product to remove vinyl boat names or graphics without damaging gelcoat is Amazon's Strip Away. Sold primarily as a paint stripper, don't use it on painted or varnished surfaces.

SCREW CLAMP: When you need to secure screws that continually back off, dab on some silicone sealant, which will hold most everything, or use Lock Tite. It's available in various grades but don't use the stud and bearing grade unless you want a permanent fix.
Ed Harrow, "Defiance," Hopkinton, Mass.

HOSE-AID: When you need to replace a ruptured hose but the only spare hose onboard is too large in diameter, cut a temporary replacement from the larger hose, then cut two short lengths. Split these short sections longitudinally and remove enough material from each, forming them to the required smaller diameter. Insert these "bushings" into each end of the temporary replacement, install the hose fittings and replace hose clamps.
Phil Friedman, Port Royal Marine, Pompano Beach, Fla.

SHROUD RIBBONS: Before you take down the mast, tie red ribbons on the port shrouds, green ribbons on the starboard ones, and other colors for running backs, baby- or jackstays. Ribbons simplify sorting of rigging when raising the mast and are especially helpful when the mast has multiple shrouds or backstays.
Kevin Dean, "Via Sophia," Point Roberts, Washington.

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ShopTalk

WEIGHT GAIN

Boat manufacturers add foam flotation for safety. When foam absorbs water it increases the boat's designed weight which affects performance, handling and flotation capacity. Replacing the foam is possible, but not easy.

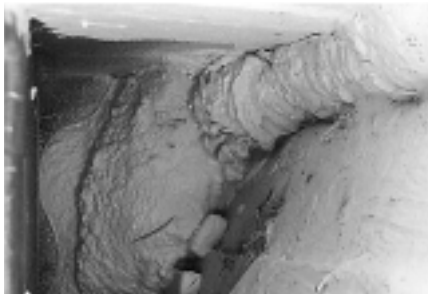
By Wayne Redditt

When most people think of flotation in small boats they immediately think "foam" and invariably have a story to tell about water saturation. So what can you do about flotation and foams in particular? Let us first examine the underlying reasons why foam is the most popular form of flotation material.

Federal regulations require flotation in boats under 6m (20'), except canoes, kayaks, sailboats and some other craft. American Boat and Yacht Council (ABYC) defines three types of flotation: basic prevents a swamped inboard, stern drive or sailboat from sinking when its passengers are in the water clinging to it; level flotation keeps a swamped outboard-powered boat over 2hp floating in a level position; and modified basic flotation delivers the same buoyancy as basic but also floats manually-propelled boats and outboard boats with less than 2hp in a level attitude. ABYC also specifies building practices that cover buoyancy in the event of swamping. In brief, the recommendations cover three types of installed flotation: non-integral air chambers; pre-shaped plastic foam; and liquid mix plastic foam poured or sprayed in place.

Non-integral air chambers are separate from the hull structure. These include air bladders which are commonly placed in canoes and kayaks. Testing procedures for manufactured boats require that integral air chambers be flooded. This eliminates any construction flaws. Few manufacturers use this type of flotation in small boats.

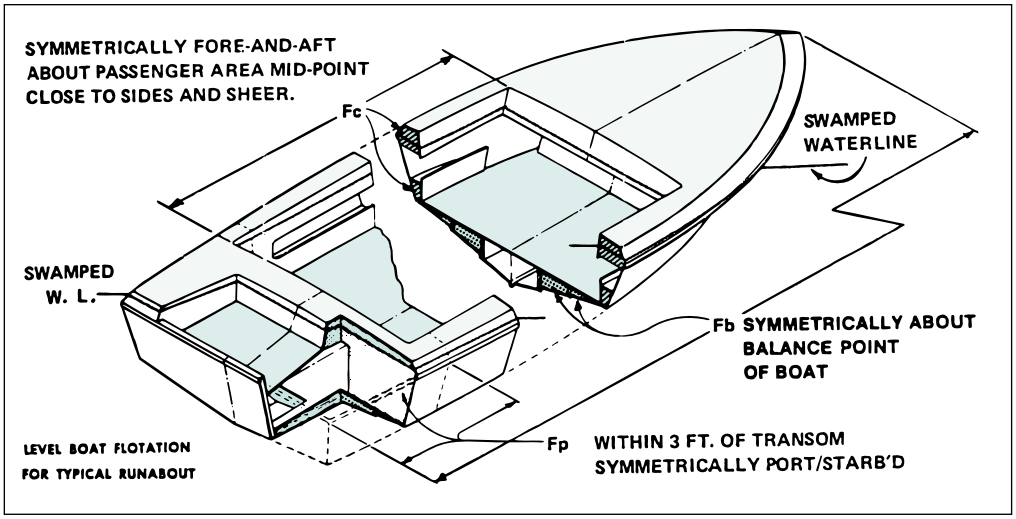
Rigid urethane foam blocks and other shapes are cut to size to fit hull cavities. Rigid foam is expensive and requires more time to install than the blow- or pour-in liquid foam, which partially explains the widespread use of the latter.



Level flotation foam keeps an outboard-powered runabout afloat when swamped.

Besides ease of use, there are a number of other reasons that manufacturers use the blown-in urethane foam. It expands to fill in cavities completely and bonds to surfaces. This creates a very rigid-feeling structure. The adhesive properties can also be utilized to secure structures and accessories, such as fuel, water and holding tanks. A boat that has plenty of blown-in foam seems solid and well built.

Over time, repetitive hull slamming, freeze-thaw cycles and water lying in the bilge causes an unpredictable deterioration in the water-saturated, closed-cell foam. This results in the boat becoming exces-



ABYC

Placement of Level Flotation Foam for Typical Runabout
Fb=flotation material needed to support the swamped boat.
Fp=flotation material needed to support the engine.
Fc=flotation material to support the live load.

sively heavy, which affects performance and handling, and creates a loss of flotation capacity. This loss of flotation may be sufficient to sink a boat when swamped. Fortunately, many manufacturers exceed the recommended standards for flotation and should the foam degrade, their boats still float.

What can you do if you suspect that the flotation foam in your boat is saturated? Simply weighing the boat will tell you whether or not the foam has become heavy with water. Alternatively, have a marine surveyor perform a moisture check with a meter to distinguish wet structures from dry ones. You may even have access into flotation compartments through inspection ports.

Once diagnosed, the decision to replace the foam may require careful consideration. Most manufacturers do not intend the foam to be removed and it's not an easy task. The stuff bonds strongly to the hull, stringers, deck structures and whatever else it contacts. In most cases, removing the foam requires removal of the floor and bulkheads. Removal is entirely mechanical and manual. Chisels, pry-bars, scrapers, grinders and the like are the tools needed for the job. There are no solvents that you can pour onto the cavities to simply dissolve the foam.

The time may come when you decide to refoam the hull to achieve the buoyancy necessary for safety. Over the years, every possible option for replacing flotation has been tried — Ping-Pong balls, white or blue Styrofoam, even Styrofoam peanuts. Because Styrofoam doesn't resist gasoline or styrene-carrying products like uncured polyester resin, you cannot use it in the bilge or as a "glassed-in" component. Some boaters may opt to wrap Styrofoam in polyethylene plastic and heat sealing the film or perhaps use zip-locking freezer bags to prevent fluids from contacting and degrading the foam. Personally, I would opt for closed-cell urethane foam blocks cut to fit into the hull cavities. One benefit of this approach is that you can insure the drain holes in the bilge remain open and free to transport water to the pumps.

Using pour-in-place urethane foam that expands to fill the compartments may be attempted by the do-it-yourselfer, but be careful. The foam has enormous capacity to distort structures as it expands. By not calculating the volume properly, I once bulged a cockpit sole about 2.5cm (1") in the center on a small cathedral hull runabout. It also makes keeping the bilge drain holes open extremely difficult. And you don't want to perpetuate the problem of water collecting and saturating the foam all over again.

The benefits of positive flotation have saved many lives. If you wish to calculate the flotation required for your boat, ABYC publishes a detailed formula in its manual. Interested readers should contact *DIY*'s editor for copies.

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

ELECTRONICS

CHARGING TECHNIQUES

Proper controls for 12-volt charging sources will protect and extend the life of your boat's battery banks. Here's what you need to know to keep your batteries in peak condition.

By Kevin Jeffrey

Each charging source you install on your boat must have some sort of charging control to limit or shut off the current once the batteries are full. Alternators and other charging sources are designed strictly to provide power, a given amount for the conditions they operate under. They provide the electrical "brawn;" if no electrical "brain" in the form of an automatic charge control is in the system, and the operator doesn't manually intervene, charging sources will happily supply power indefinitely (as operating conditions allow), destroying batteries in the process. Controllers vary in price, costing roughly US$175 for three-stage alternator controls and US$50 to US$250 for solar or wind controllers depending on maximum charging amps and features desired.

Before purchasing and installing a charging source, it's wise to investigate which types of controllers are available for that source and select the one best suited for the job.

Automatic Versus Manual

Charge control can be achieved automatically, manually or some combination of the two. Since automatic controls are generally reliable and modestly priced, boaters usually choose them over manual controls. Alternator controls are almost always automatic, although I can think of two devices for alternators where both automatic and manual control are available.

The first is an adjustable two- or three-stage control for a high-output alternator. An example is the two-stage external, adjustable controller for the Ferris Powermax alternator. The control functions automatically, but the user can tweak the voltage setpoint to allow for different motoring patterns — a higher setpoint for occasional motoring and a lower setpoint for more frequent motoring. The second device, marketed under the name Auto-Mac, allows the user to dial up the charging current even after the standard voltage regulator determines that it's time to limit the current. Originally intended to override the voltage regulator on a standard alternator, the Auto-Mac is less popular now that high-output alternators and fully automatic three-stage controls have come down in price.

This page: (left) Powerline Aqualine three-stage regulator has LED status, electronic reset field current protection, turn-on delay, battery over-temperature protection and amplified tach circuit; (top) Heart in-charge 12-volt regulator features LED status, adjustable voltage setpoints, short and open circuit protection; (bottom) Powersource flush-mounted solar control digital meter displays charging voltage and current, has low-voltage warning and is temperature compensated. Opposite page: (top) Trace 12/24-volt charge or load controls are available in 12- or 40-amp capacity, have adjustable voltage setpoints, equalize function, optional temperature sensor and digital display; (bottom) Ample Power Next Step alternator regulator for 12/24-volt systems, controls one or two alternators on same engine, has adjustable voltage setpoints, temperature compensated and overload detector.

Some liveaboard boaters choose to manually control the output from a renewable charger (see "Renewable Chargers" DIY 1999-#1 issue), at least initially, in an effort to save money or maintain simplicity in the system. Manually stopping the rotor of a wind or water generator or switching off the output of a solar panel is relatively easy and can be effective, but failure to do so when the batteries are full can be an expensive mistake. And without an automatic controller you won't be able to keep your batteries charged if you have to leave your boat for an extended period of time.

Charge Controls for Alternators

Charge controls for alternators are commonly known as voltage regulators, although I feel that name is a bit dated, especially for multi-stage controls designed to achieve high performance. An alternator control does indeed regulate output using some voltage setpoint — or multiple setpoints if a multi-stage control is used — as a reference, but it's the amount of current that is being regulated to prevent battery overcharge.

For a given rpm, the output of an alternator is regulated simply by reducing or increasing the level of what is known as the "field current," or the small amount of DC current needed to create electro-magnetism inside the alternator. The smaller the amount of current passing through the field current windings, the weaker the magnetic field and the less electricity produced by the alternator. Instead of handling the full output current, as do controls for wind and water generators, an alternator control handles only the field current, which varies from 0 to 6 amps for a standard alternator and 0 to 10 amps for a high-output alternator. This is why charge controls for alternators are typically not suitable to handle the output of renewable chargers, and why you need a separate charge control for each unit in a dual alternator installation.

There are three main battery charging cycles to

ELECTRONICS

consider when you have a relatively high-output charging source: bulk, absorption and float (for a review of these charging cycles refer to "The Most Charging Amps for the Least" in DIY 1998-#2 issue). Standard two-stage voltage regulators (included with all marine alternators) allow for the bulk cycle and essentially an indefinite absorption cycle (they don't drop to a lower float level).

Battery protection is achieved through a reduced voltage setpoint, which to some degree compromises the performance of the charging source. Two-stage controls work fine for most powerboat applications using a lower voltage setpoint, and for sailors who motor infrequently and use a higher voltage setpoint. However, three-stage controls from Ample Power, Balmar, Heart Interface and Powerline offer a higher level of performance and battery protection to sailors and even powerboaters who spend time at anchor and want to minimize engine-running time just for charging batteries.

Two-stage controls are typically installed inside the alternator, and thus the voltage setpoint is not adjustable. This type is the most common and least desirable. Externally mounted, adjustable two- and three-stage controls are preferable since the voltage setpoint can be adjusted to meet individual needs. Three-stage controls are best since they automatically provide a good balance between performance charging and battery protection.

Controls for Battery Chargers and Inverter-Chargers

Battery chargers, and inverter-chargers in the charging mode, usually have an internal charge control circuit; on some models the voltage setpoints are adjustable (i.e. Trace inverter-charger). High-performance models take the batteries through a three-stage charging cycle and automatically shut off when the batteries are full. Less sophisticated "trickle-charge" models reduce charging current to a low but constant trickle charge that can spell disaster for batteries when the charger is plugged into dockside power and left unattended. If there is no electrical load to moderate battery voltage, the voltage can rise to unacceptable limits and destroy the batteries.

If you are in the market for a battery charger, make sure you purchase one with three-stage operation and a model that automatically shuts off 100% when the batteries are full. An inverter-charger may make the most sense if you presently, or in the near future, wish to operate household appliances on board.

Controls for Renewables

The output from solar, wind- and water-powered generators is typically fed to individual charge controls for each source, although there are some multi-source controllers, such as Ample Power Solar/Wind Controller, that can handle charging current from any renewable power source up to the control's maximum current limit. If the idea of a single controller intrigues you, your aim should be to find one that has the capacity to handle your present as well as your future needs; units include ASC Controllers (4, 8, 12 and 16 amp models) and Trace C-12 and C-40. For instance, a multi-source control rated at 30 amps may be able to handle a 20-amp wind generator and two 60-watt solar panels, but if you decide to add more solar panels at a later date a second controller will be needed.

Three-stage charging is less of a concern for renewable chargers. Unlike high-output charging sources, their current output is usually low compared to the size of the battery bank. This means that almost all of the charging power is converted to stored power in the batteries, reducing the need for the absorption cycle. When the voltage setpoint of the bulk charging cycle is reached, the batteries will be nearly full. When the voltage setpoint is reached most renewable charger controls simply disconnect the circuit until the voltage falls to some preset level, then reconnect again. This on-off action continues until the batteries are completely filled.

Battery Type Selection

Most alternator and battery charger controls allow the operator to select which type of batteries they are

using, either gel or wet. Changing the battery type selector switch on the control changes the bulk voltage setpoint, which is usually 14.1 or 14.2 for gel batteries, and 14.4 for wet batteries. Solar, wind and water controls typically use the lower of these two values and are therefore suitable for use with either type of battery. The slight difference in voltage (and therefore charging performance) isn't a problem with renewable chargers, since by the time the voltage setpoint is reached the batteries are very nearly full, and there is no concern about how long an engine is running.

Temperature Compensation

An important optional feature found on many controls for a high-output charging source is temperature compensation. All charging controls base their operation on battery voltage and its relationship to state of charge. The relationship between battery voltage and state of charge, however, changes with battery temperature. In fact the difference can be rather dramatic when the batteries are very warm or very cold. A temperature compensation circuit in an alternator or battery charger control ensures that the various charging cycles begin and end when they are supposed to, and that the batteries aren't routinely under- or over-charged.

Controls with temperature compensation come with a temperature sensor that adheres to one battery in the bank. A low-voltage wire links the sensor to the charge control. Locating the sensor on a battery in the middle of the bank will give best accuracy.

As with multi-stage charging, temperature compensation is less of an issue with renewable charge controls since the current levels are usually low relative to battery capacity. Even so, if this option is available for a solar, wind or water controller (i.e. Pulse PM Series controllers or Powersource PSR-16 and PSR-24), I recommend you opt for it.

Equalization Cycle Feature

Some alternator and battery charger controls allow you to equalize wet batteries (equalization cycle). They do this by temporarily, under controlled conditions with low charging current, allowing battery voltage to rise until the batteries are gassing vigorously to remove sulfate deposits on the battery plates. The operator should always monitor conditions during an equalization cycle, and keep in mind that gassing means the release of hydrogen gas. Proper ventilation and the elimination of any possibility of sparks or open flames are essential. Under no circumstances should you attempt to equalize gel batteries — they don't need it and a potentially dangerous condition will result from applying high voltage to a gel battery.

ELECTRONICS

Monitoring Functions

Many charge controls incorporate monitoring functions so you can see what is happening as the batteries are charged. Some have basic LED lights that indicate if there is power to the control, if conditions are right for charging (on solar, wind and water controls), which charging cycle is in process (bulk, absorption, float), and basic battery state-of-charge information.

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

THE BALMAR MAX CHARGE

The new Balmar Max Charge has what you need in a high-performance alternator control. It has all the usual features, including three-stage operation, optional temperature compensation, a battery equalization feature, and monitoring functions, but it offers much more. This versatile control also has:

- An automatically adjusting absorption cycle that extends the time of the cycle if the batteries are coming from a discharged state and reduces the time of the cycle if the batteries were relatively full when charging began.
- A 45-second delay circuit that gives the engine a chance to develop oil pressure before the alternator load is applied.
- A Ramp Up feature that, after the initial four-second delay upon engine starting, provides a one-minute soft start to gently apply the alternator load. This helps seat the alternator belt and allows the engine to accept the load gradually.
- An Amp Manager feature allows the user to cut back on alternator output, and therefore loading on the engine, for times when full engine power is needed (like when running an inlet in rough conditions).
- LEDs that not only monitor conditions but also assist in troubleshooting.
- An Alarm Output connection for a warning LED, light, or audio alarm to alert the user to high-low battery voltage, a thrown belt, system malfunction, or temperature setting violations.
- Inverter Load Sensing provided by a circuit that recognizes when a heavy electrical load is applied and increases the available amperage, even in the float charging cycle.

OFF-SEASON STORAGE TIPS

Things you should know about boat covers, ventilation, chafe protection and tie-downs plus fuel additives when preparing your boat for extended storage.

By Jan Mundy

PUTTING ON THE WRAP

Is shrinkwrapping a good option for your boat? Here's what you need to know for a successful do-it-yourself shrinkwrap cover.

When it comes to protecting your boat in the off season, there is no better investment than a boat cover, preferably one that is properly fitted. Your options include a custom synthetic fabric cover (expensive and generally long-lasting), polyethylene tarp (most economical but short-lived) or shrinkwrap (moderately priced for one-time use). Although shrinkwrap costs about 25% more than a premium tarp, if installed correctly, it's a better option for many boats because it fits glove-tight, so it won't abrade or damage surfaces and its high-tension framework sheds snow and ice better. Unless well ventilated, it's not recommended to wrap boats with painted or acrylic (i.e. Vertglas) finishes.

Dr. Shrink (Tel: 800/968-5147, Email: drshrink@dr-shrink.com) offers a complete system for wrapping boats. It consists of three parts: shrinkwrap film; hardware kit with a video tape, propane-fired heat tool, 7.5m (25') hose, adjustable regulator, film knife, leather safety gloves and safety glasses; and installation kit containing strapping for supports, buckles, four vents, repair tape in case of tears or burn-through and attaching doors or vents, and recycling bag. All you need is a fuel source (i.e. 20lb propane tank) and you're ready to wrap.

A professionally installed shrinkwrap cover averages $8 per foot for a 7.2m (24') boat. You can cover the same boat for about $400, less if you can share the cost of the hardware kit (US$280), your biggest outlay, with a few friends. Even when purchased for single use, the do-it-yourself savings will likely be recovered in two or three years. Installation kits cost US$40 and precut film, either blue, clear or white in 6ml or 7ml, ranges from US$30 for a 7.5m (25') boat to US$120 for a 34-footer, or bigger rolls for groups at substantial savings. An optional zippered access door that you'll probably want is US$16.

Simple to install, providing you closely follow the instructions on the video and pick a dry, windless day, you should reserve about four hours to complete the job. The video clearly shows how to install the support structures, fit the cover, make cleats and darts, and the proper use of the heat tool to get a wrinkle-free cover. After the cover is shrunk completely, vents are installed. The kit comes with four Airlette vents (see "Vent Away Mildew" on page 19). For maximum airflow, Dr. Shrink's owner Mike Stenberg recommends locating vents just above the gunwales on a vertical surface so air flows in the cockpit and around the deck and cabin area, being careful not to install vents in front of bulkheads or other obstructions. More vents mean a drier boat, a drier boat means no mildew, so you'll probably want to install more at a cost of US$10 each.

Last step is the hole patrol. Any cover, unless you're very lucky, will have a tear where the film was dragged over a cleat or windshield corner, or a burn hole. Small holes are easily covered with repair tape; larger holes require attaching a scrap piece of shrinkwrap, then heating the patch until it shrinks.

When spring arrives, you remove the cover, stuff it in the recycling bag and ship it via UPS (service available in the U.S. and Ontario only) to Dr. Shrink. Next time you lay-up your boat, all you need is to purchase film and another installation kit.

FIX-IT TARP REPAIR

Shop Tested

Boat covers come in myriad fabrics, some lasting longer than others. As covers age, one thing you can plan on is replacing tie-down attachment points, such as grommets or webbing tabs. You could haul your tarp to a canvas shop for repair or purchase cheaper, more convenient options.

Last winter *DIY* tested the Tarp

OFF-SEASON STORAGE TIPS

Klip, a grommet replacement, and two cover anchoring devices: the Kwik Tek STD-6C and M&K's Cov-R-Clips (see review in Dockside, DIY 1998-#4 issue). The garter belt-like Tarp Klip slides over most fabrics of various thicknesses and the downward pull of the rope locks the clip in place — the more load applied the tighter the grip. Kwik Tek's non-marring 8cm (3-1/4") suction cups stick to most finishes and can be used with its standard shock-cord toggle or by attaching to a longer line. Holding strength depends on the direction of pull; a heavily loaded sideways pull may lift the base. Cov-R-Clips offer a positive snap-on anchor point for trailers, such as tandem ones, with limited attachment points. Made of strong nylon composite, a line will likely break before this clip does. All three devices were connected to polypropylene tarps. Tarp Klips were tied securely to trailer frames or to water jugs that when frozen, hold boat covers taut.

The garter belt-like Tarp Klip works great for a grommet replacement.

M&K's Cov-R-Clips snap securely to trailer frames for added tie-down attachments.

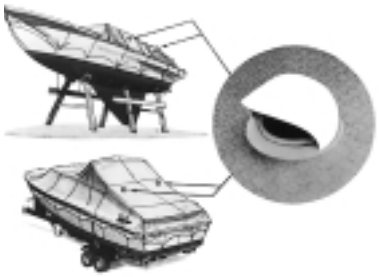
Kwik Tek's Suction Cup Tie Down holds well in above freezing temps and with moderate loads.

Both the Tarp Klip and Cov-R-Clip were not affected by temperature extremes; Kwik Tek's suction cups lifted when the temp dropped below freezing. The ultimate test was when the supports under one of our tarps failed and the oversize cockpit filled with ice, about 66cm (26") thick. Our best calculations estimate the ice weighed roughly 450kg (1,000lb). Cov-R-Clips and Tarp Klips held, as did the cover, a Taylor Made Products' Hot Shot, which by the way, is a premium cover. A few days after the ice was removed, the cover sprang back to its original shape and looked nearly new, except the addition of a few pinholes from ice picks.

TIPS NOODLE GUARD

Chafe is the biggest cause of cover wear and tear. There are various methods to protect high-chafe areas but the best we've found is the all-purpose pool noodle. These high-density closed-cell foam strips are easily sliced to fit over windshields, seat backs, transoms, cabin coamings, stanchions, pulpits, bow rollers, almost any exposed surface on your boat.

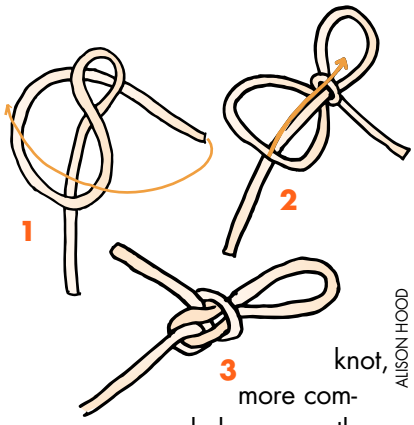
Shop Tested VENT AWAY MILDEW



Condensation is a serious problem with covered boats. Air under a tightly sealed tarp (or cabin if not covered) warms up during the daytime, then cools at night, forming water droplets on all surfaces. Some water will evaporate, but over time, excess moisture builds up, eventually forming mildew, particularly on vertical surfaces, carpets, fabrics. etc. Ventilating exteriors and interiors is the only way to combat mildew. If your tarp or cover doesn't have any vents or you need to add more, you can easily remedy the situation by adding an Airlette. Made of durable plastic, these inexpensive vents install in minutes without special tools or adhesives in all types of materials, such as shrinkwrap, acrylics and other synthetic canvas, poly-tarps and plastic or mesh screens. Available in three styles, they either snap-in, stick-on or push into the material. Designed for vertical mounting, the one-piece louvered Stealth Push-in vent (inset) automatically cuts with its serrated edge then seals the hole. For horizontal or vertical surfaces, Stick-on units bond to wood, plastic, metal and plastic surfaces, and the Snap-in vent (top) with its rotating hood provides a watertight 7.6cm (3") diameter opening. Tip: Tape the hoods so they don't blow away in strong winds. Prices range from US$2.10 to US$5.95 each. Available at most major marine stores and all shrinkwrap suppliers.

PERFECT SHOCK CORD LATCH

Shock cord or polypropylene line tie-downs are common on many tarps. Knots won't hold in such tie-downs, especially shock cord ones which require special clips or staples for securing. The perfection



ALISON HOOD

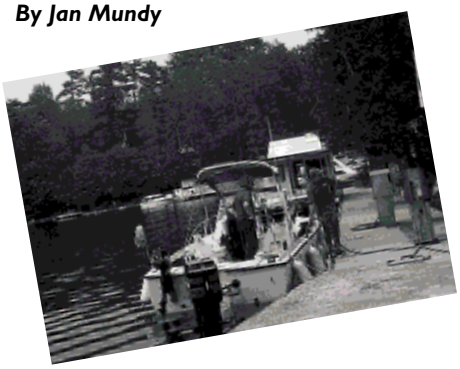
knot, more commonly known as the angler's loop, is widely used by fishing types to attach leaders to lines, etc. It's easy to tie, doesn't slide and is the only knot we're aware of that holds shock cord or synthetic line without slipping.

To tie, form a loop, so the end lies under the standing part of the line. Holding the base of the loop in your left hand, wrap the end of the line around the base, then wrap it around the base again. Continue holding the base with your left hand and with your right hand thread the first wrap through the original loop. This forms a new loop and, keeping hold of this loop, pull the standing part tight with your left hand.

WARNING: PROTECT ENGINES FROM DAMAGING FUELS

Modern fuels are causing serious problems with four-cycle fuel systems. Engine operation and lay-up now demands a new approach.

By Jan Mundy



Nowadays, the fuel you're burning is a blend of petroleum, 10% methanol alcohol (a combustion enhancer), detergent and other complex additives. Such reformulated fuel doesn't have a specific makeup; additives are supplied regionally which makes fuel quality suspect depending on where it's purchased.

If you lay-up your outboard or stern drive engine this year the way it's been done for decades — draining the gearcase oil, draining the water, fogging, adding stabilizer to a full fuel tank — you risk serious problems to your engine's fuel system. During extended storage, some of the alcohol evaporates, but the additives remain. These additives can gum up check valves, hold open the carburetor inlet valve or pressure relief valve on the electric fuel pump (if equipped). Engine manufacturers warn of other damage: seizing of check valves and increase in occurrences of preignition and detonation.

When preparing your engine for extended storage, Mercury Marine now advocates running two-cycle oil through both outboard and stern drive engines. To do this, disconnect the boat's fuel supply. To a portable fuel tank add a 1- gal mixture of fuel, stabilizer and oil (see "Stern Drive Lay-up," Step 2 on page 34) and run this through the idling engine. Detergents and additives will be suspended in the oil and then exhausted when starting the engine after lay-up.

Some engine manufacturers also now recommend draining the fuel tank. Run the engine until the tank is nearly empty. To the fuel remaining in the inboard tank, add an equal amount of fuel stabilizer containing methyl hydrate to absorb the moisture accumulated through condensation. Before relaunching, top up the tanks with fresh fuel and add more stabilizer.

Draining fuel tanks totally contradicts our article "To Empty or Not?" in DIY 1998-#3 issue. To the best of our knowledge, based on discussions with representatives from the American Petroleum Institute and major refinery additive suppliers, there are potential damaging affects from storing fuel tanks empty. All tanks oxidize in the presence of oxygen, whether they're made of metal or plastic, which can leave minute particles floating in the fuel. Besides collecting water through condensation in the bottom of the tank, the internal tank seals will eventually dry out when not immersed in fuel, creating a fuel leak.

According to our sources, water requires equal amounts of methyl chloride to disperse it. An empty 200-gal tank, for example, can potentially collect through condensation 2gal or more of water, thus requiring at least 2gal of stabilizer. But such a high concentration, say the experts, may not dissipate through the fuel system. The result: your engine stalls, fuel-water separating filter fills with water, and you'll probably need to drain the tank.

Conversely, filling fuel tanks full for extended storage also causes fuel problems. The main concern is loss of octane. After a six-month or longer storage period, the octane level apparently decreases to about 85. Low-octane fuels can cause damage to pistons in older engines. Should you opt to store tanks full, Mercury recommends filling tanks with the highest-grade fuel available, preferably 94 octane, and adding a fuel stabilizer. At launch time, add an octane booster, then run the engine until you can top up the tanks with a substantial quantity of high-octane fuel.

Detergents and other additives were added to make engines run more economically and more environment-friendly. Now, some states (i.e. California) are banning reformulated gasoline because exhaust emissions from a tuned engine are considered more hazardous than non-reformulated fuels, but replacement additives may be just as damaging to marine engines. I suspect engine manufacturers will continue to amend engine design and maintenance techniques. We'll keep you posted in upcoming issues but in the meantime, contact the engine manufacturer or your local dealer for maintenance updates.

SAILBOAT RIGGING

CUSTOM SHEARLEGS

Lowering and raising a deck-stepped mast is easy with this custom-rigged frame.

By Jan Mundy

Made of readily available hardware, the frame consists of two fixed "legs" spread at the base and joined at the top.

MATERIALS

35' 3/8" to 7/8" braided line (G)
2 10' stainless-steel tubing (A)
4 eye ends (B)
2 deck fittings (C)
4" to 6" stainless steel tang (D)
2 shackles (E)
3 1/4" bolts, washers, locknuts
Spare halyard (I)

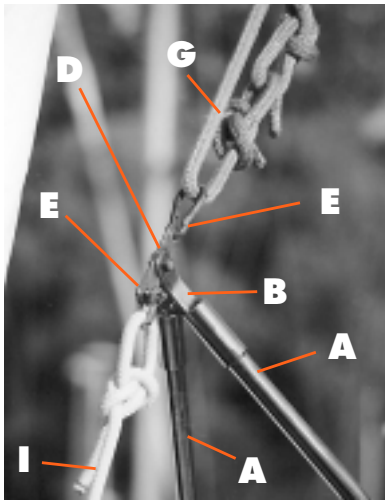
Lowering and raising a mast stepped on deck or in a tabernacle is straightforward on smaller boats, just lead a jib halyard through a block on the stemhead fitting and lower away. But doing this on larger boats without relying on a crane, bridge or other aid requires some mechanical assistance.

On long spars, the problem is the angle between the mast and halyard gets to zero before you can grab hold of the mast and it comes crashing down on deck. This is easily remedied by using spinnaker or whisker poles, or shearlegs to elevate the forward attachment point, thus widening the angle. If you plan to do a lot of mast raising and lowering, constructing a proper frame is a good investment.

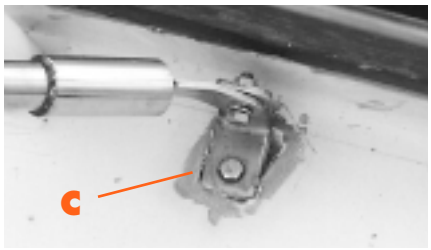
Building the Frame

There are many different ways you can build a mast-lowering device. The one described here was made for a 7.8m (26') Contessa with a 9m (30') mast. It's made of two sections **(A)** of stainless-steel tubing, welded to custom end caps **(B)**, but you can easily fabricate a frame of 2.5cm (1") minimum stainless-steel tube and common bolt-on canvas eye cap fittings. The length of the "legs" should position the frame at a 45° angle in front of the mast; on this boat they are 3m (10') long. You'll also need a tang **(D)**, 10cm (4") or longer, with three drilled holes equally spaced. Hole diameters will depend on the bolt and shackle sizes you're using. Attach a shackle **(E)** to the top and bottom holes. Deck fittings **(C)**, either custom tangs as shown in photo above, or sturdy eye bolts, mount on the port and starboard side opposite the centerline of the mast and in line with the foremost chain plate. Fittings must be thru-bolted and caulked with a marine sealant (3M 5200 or 4200).

To assemble, bolt the two legs together at the apex **(F)**, through the center hole in the tang **(D)**. Temporarily attach the base of each leg to a deck fitting **(C)**. Don't tighten so the legs can pivot freely.



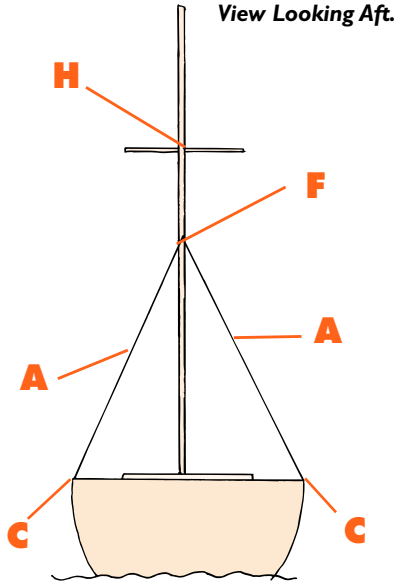
Shearlegs bolt together at the apex to the pre-drilled tang, control lines attach to shackles.



Leg ends bolt to deck tangs mounted opposite the centerline of the mast and in line with the foremost chain plate on port and starboard sides.

How It Works

Wrap a line **(G)** around the spreader bases **(H)** — over port spreader, aft around the mast, over starboard spreader — and tie a bowline



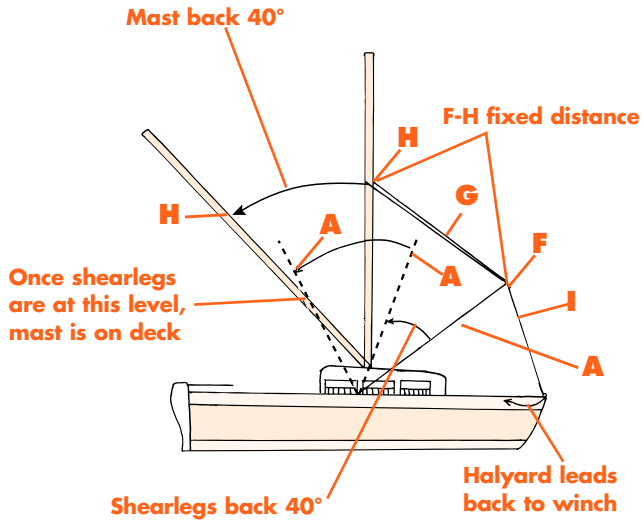
View Looking Aft.

ALISON HOOD

securely to the top shackle on the tang **(D)**. On this boat, a line length of 10.5m (35') positions the legs at the required 45° angle. Tie a spare jib halyard **(I)** to the lower shackle on the tang (use a bowline), passing through the bow anchor roller or a block on the stem fitting back to a primary winch, or lead forward to crew ashore. Once shearlegs are properly set up and lines secured, release the forestay, slacken the upper (forward) and lower (if rigged) shrouds and pull the retaining bolt in the deck step or tabernacle. Don't remove the pivot bolt.

To lower the mast, slowly play out the halyard as the shearlegs and mast pivot aft. Ideally, the lower (or intermediate) shrouds should remain tight to prevent lateral movement of the mast. If they are too slack, any sideways movement puts excessive strain on the deck step or tabernacle. This often happens on boats where the mast step or tabernacle pivot point is much higher than where upper shrouds attach to the chain plates. In this case, you'll need to extend the shroud length with a wire strap to maintain tension on the mast.

Follow the same procedures to raise the mast, only start with the shearlegs in their aft position. Raising a heavy mast definitely requires a two-speed winch, a strong wincher and some manual help lifting the mast to overcome inertia.



ALISON HOOD

Shearlegs control mast as it drops aft from vertical to 90°.

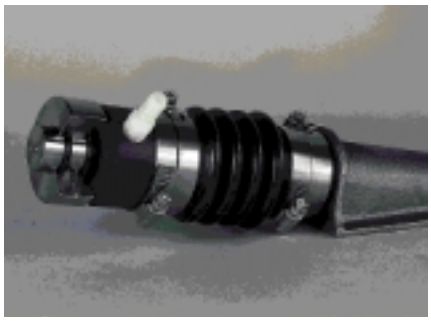
ENGINE TROUBLESHOOTING

STUFFING BOX REPLACEMENTS

Part 2 in our Drive Train Tune-up Series looks at dripless shaft seals, alternative devices to traditional stuffing boxes.

By Robert Hess

Because bilges usually contain trace lubricants and chemicals, and frequently more than a trace, produced by engines, storage tanks and cargo, the pumping of contaminated bilge water is increasingly becoming a serious environmental and moral issue, as well as being illegal in many regions. At the very least, bilge water should be filtered to remove petroleum compounds; the real solution is to eliminate the need to pump bilges at all by plugging all leaks. One source is the traditional stuffing box, which allows water to pass through the seal to keep the packing cool enough to prevent it from overheating, wearing too quickly or scoring the shaft. This water collects in the bilge to be pumped overboard by the bilge pump. Installing a "dripless" alternative to the stuffing box solves one source of water seepage.



The PSS (Packless Sealing System) installed on a stern tube. Carbon-graphite flange is double-clamped to a nitrile bellows.

In the past decade, several manufacturers have developed dripless shaft seals to replace the stuffing box. Such seals are often optional equipment on many new production boats and common upgrades in a professional engine refit.

Seals come in two styles, mechanical face-type seals or lip-type seals, to fit a broad range of shaft sizes from 3/4" to 3-3/4" plus metric sizes and most stern tube diameters. As well, there are shaft seals for boats with hull speeds of 12 knots or less, or high-speed boats with top speeds over 10 knots.

Regardless of the design, and no two models are alike, shaft seals cannot solve engine alignment or shaft problems. They will, however, tolerate minor engine misalignment or shaft problems — incorrect engine-to-driveshaft alignment, bent shaft bearing components (i.e. bent rear strut, engine mount or shaft flange), shaft movement (wobble) due to a bent or "whipping" shaft, cutlass bearing side play or engine mount movement under load — more than a stuffing box, and still remain dripless.

Mechanical Seals

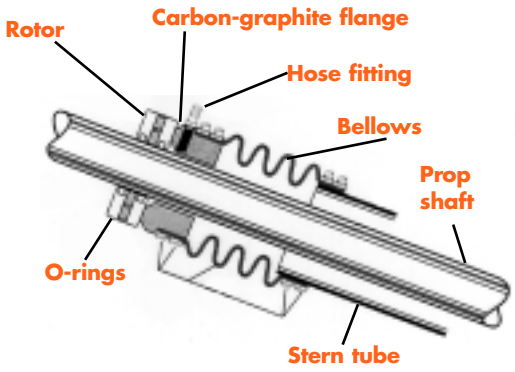
Mechanical face-type seals consist of two components: bellows and sealing

APPROXIMATE U.S. LIST PRICES

MANUFACTURER	BRAND	TYPE	LUBRICATION	BELLOWS	SEAL	SHAFT SIZE	PRICE	WARRANTY
Ibsen Company	Norscot	Lip	Oil	none	Oil-impregnated nylon	3/4"-3"	$190-$494	1 year
Johnson Duramax	Duramax	Face	Water	Rigid plastic [1]	Oil-impregnated nylon	3/4"-6" [2]	$191-$3,237 [3]	1 year
Nautical Specialties	Lasdrop Dry-Seal	Lip	Water	Flexible hose	Spring	3/4"-5"	$95-$995	3 year
	Lasdrop Gen II	Face	Water	Flexible hose	Carbon-graphite	3/4"-4"	$245-1,850	3 year
PYI	PSS Standard	Face	None	Nitrile w/Kevlar	Carbon-graphite	3/4"-2"	$170-$425	3 year
	PSS High speed	Face	Water	Nitrile w/Kevlar	Carbon-graphite	3/4"-3-3/4"	$195-$1,320	3 year
Tides Marine	Strong	Lip	Water [4]	none	Nitrile	3/4"-6" [2]	$103-$4,155	2 year/2,500 hrs

Note 1: Various mounting adapters available for flanged, hose connection, stern tube and thru-hull installations.
Note 2: Metric sizes also available.
Note 3: Price does not include mounting adapters.
Note 4: Water pick-up kits are optional.

ring. Bellows are made of hypalon, nitrile, neoprene or other rubber compound. The sealing action of mechanical face-type seals is between two precision machined sealing rings (faces). One sealing ring attaches to the shaft and rotates with it, the other ring is fixed and part of the bellows. Both surround the propeller shaft rather than pressing on it, thus eliminating the use of the shaft as one of the sealing surfaces. Depending on the manufacturer, sealing pressure is created by the bellows, a spring-loaded hose or a rigid, spring-loaded body that is compressed between the sealing ring and friction ring.



Components of PSS High-speed face-type seal for boats with hull speed of faster than 12 knots.

PYI's PSS seal has a fixed carbon-graphite flange held against a one-piece stainless-steel rotor that's fastened to the shaft so it turns with it. During the initial min-

TIPS — EASY SHAFT REMOVAL

Your most difficult task when installing a shaft seal is extracting the shaft from the shaft coupling. Never hammer the propeller or the shaft which may bend; instead, use a shaft puller. If you are without a puller, have a marine mechanic remove the shaft for you. If you're without a puller-equipped mechanic, PYI, supplier of the PSS Shaft Seal, offers this simple approach. Loosen the bolts holding the shaft and transmission couplings. Separate the couplings just enough to insert a wooden spacer (use hardwood) of a diameter slightly smaller than the shaft. Now, tighten the coupling bolts (this may require longer bolts). Provided the shaft isn't "bonded" to the coupling, the spacer will drive the shaft out of the coupling as the bolts are tightened.

ENGINE TROUBLESHOOTING

Vent line combination water-injection hose barb on the Lasdrop Gen II prevents air locks in slower-moving hulls or provides cooling water for planing hulls.

utes of operation, the carbon polishes the rotor face, which ensures a watertight seal. These are actually water-lubricated, but because their sealing surfaces are very accurately machined, the amount of water that passes through the seal is negligible.

Lasdrop's Gen II is a hybrid face-type seal. A hose replaces the bellows and attaches to a fixed carbon sealing face. A stainless-steel spring keeps pressure on the two sealing faces, while dual lip seals rotate with the shaft providing a watertight seal. It houses a built-in cutlass bearing, similar to other lip seal designs.

Lip Seals

Lip-type seals attach with flexible marine hose to the stern tube, use the propeller shaft as a sealing surface and require lubrication, either oil or water, to reduce frictional heat and maintain the proper seal face temperature.

Strong shaft seals from Tides Marine consist of a one-piece housing made of ultra-high-molecular-weight (UHMW) plastic, instead of metal, with a replaceable water-lubricated nitrile lip seal. A built-in cutlass bearing, normally installed in the outboard end of the shaft log, aligns the shaft and seal and reduces shaft vibration. A water-injection fitting connects to a pressurized water source, namely the engine's raw-water cooling system. Water enters the stern tube and flows through the cutlass bearing, reducing friction and cooling the shaft. Self-adjusting inner lip seal remains in contact with the shaft to prevent water leaking into the bilge. Tides offers water pick-up kits (US$25 for a 1" I.D. kit) for tapping into either engine cooling hoses, or drains and plugs.

Lasdrop Dry-Seal features a cutlass bearing built into the lip seal design. A two-piece plate allows for quick-and-easy seal changing. To replace, simply unbolt the split-face plate, remove the inner seal and slide the new one into position and tighten the bolts.

The Norscot multi-seal system consists of three lip-type seals pressed into a bronze housing. A remote gravity-fed tank supplies the seals with transmission oil (Dexron) for lubrication. An oil drain plug, located in the bottom of the housing, allows bleeding of air from the system and simplifies routine oil changes or

Cutaway of Strong Seal shows the inboard end of the UHMW plastic with the recess that holds the lip seal. Water pick-up connects to engine's raw-water cooling system.

draining when servicing the shaft or replacing seals, which must be done with the boat out of the water.

You can expect 1,000-plus hours of operation before lip seals show signs of wear. Should a lip seal fail, the amount of water seeping into the bilge is apparently negligible. Strong and Lasdrop allow easy replacement without uncoupling the shaft from the transmission (see "Installation Guidelines" on page 28) and while the boat is in the water.

Lasdrop Dry-Seal's split-face plate design allows quick in-water replacement of the inner lip seal.

Troubleshooting

Few devices are foolproof and shaft seals are no different. Improper installation, shaft misalignment and type of engine mounts are reasons for failure. Another problem is shaft crevice corrosion under the rubber lip seal against the shaft and under O-rings on face-type seals on boats that are rarely used. Where you boat may also cause problems. Boats fitted with shaft seals and operated in silty water, like in river deltas, may experience rapid seal contact area wear and subsequent leaks.

Rather than a rubber bellows or spring-loaded hose, the Duramax shaft seal has a rigid, spring-loaded body that attaches to the appropriate adapter ring.

Water-lubricated seals must be installed to ensure that water reaches the seal when the boat is launched. After haulout, air is trapped in the shaft log, thus preventing cooling and lubricating water to reach the seal. Some seals include a valve to bleed the trapped air. To vent air pockets on PSS standard units, compress the bellows and hold until water spurts out the seal face. To remove any air locks with a Norscot seal, it's necessary to loosen the hose clamps on the housing until water seepage is visible, then retighten.

Traveling at 10 knots or faster, especially in planing hulls, also causes a loss of lubrication. Depending on the manufacturer, seals used in high-speed applications offer an optional hose barb fitting (standard on Duramax and PSS high-speed models) connected to either a hull water scoop or engine raw-water pump to inject water to the seal faces.

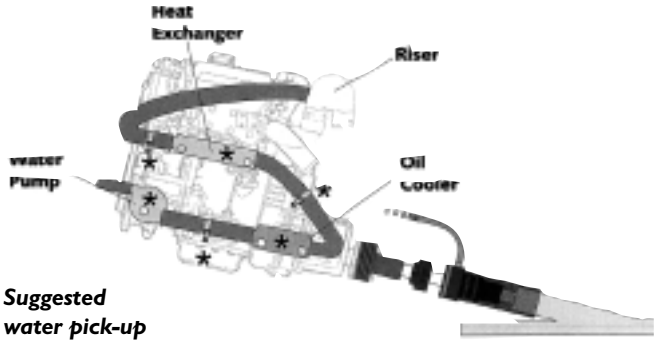
TIPS MATCHING COUPLINGS

When it's necessary to separate the shaft and transmission couplings, place a mark on the joining flanges with nail polish or liquid paper. This ensures that they align exactly the same way they came apart.

Installation Guidelines

To determine what configuration is best suited for your boat and whether you have sufficient space to install a shaft seal, you'll need to measure the shaft diameter, distance from the shaft coupling to the stern tube and the O.D. of the stern tube, which decides the I.D. of the bellows or flexible hose.

The number one reason for seal failures is improper installation: seals installed crooked will leak; misaligned bellows or seal faces joined unevenly cause uneven wear



Suggested water pick-up points (marked with an asterisk) for supplying pressure water to lubricate Strong seal.

and poor lubrication; lip seal installed over a nicked and blemished shaft wears unevenly and leaks; or a loose sealing ring slides up the shaft.

Installation involves hauling the boat and removing the propeller shaft flange and sometimes shaft as well. The most difficult task will be extracting the shaft from the shaft coupling. On some boats, it may be necessary to move the engine so that sufficient room can be obtained to gain access to the shaft flange and shaft. Never hammer the propeller or the shaft which may bend; instead, use a shaft puller. If you are without a puller, have a technician remove the shaft for you; the rest of the job you can easily complete with a few basic tools. Installation is simple, provided you carefully follow the procedures outlined in the manufacturer's installation manual.

Procedures vary depending on the model you're installing and the original stuffing box configuration. A basic run-through involves first separating the shaft coupling from the shaft (see "Easy Shaft Removal" on page 25) and removing the stuffing box and stern tube hose. Before attempting to separate the shaft and transmission couplings, coat the flanges with a penetrating oil, let sit for at least 24 hours, and use a gear puller. Clean the shaft to remove corrosion, saltwater residue and any sharp edges, nicks or burrs, especially the portion under the old hose, stuffing box and the coupling keyway. Once you've determined positioning, inspect the shaft area carefully. It must be free of burrs, nicks, pitting, scratches or surface imperfections that could cause leaking.

PSS face seals require that the shaft be deburred. Norscot requires the coupling end of the shaft be

tapered. Lip-type seals must have a polished and perfectly flawless shaft. If necessary to avoid a worn area, shift the seal forward by adjusting the position of the hose on the stern tube. Tides Marine recommends installing its seals only on stainless-steel Aquamet shafting, a highly crevice corrosion-resistant alloy that meets American Boat & Yacht Council standards. Install the shaft seal according to the instructions, then reconnect the shaft to the coupling, and tighten the coupling bolts. The last step is to plumb the seal for water- or oil-cooling as necessary. Most seals have a break-in period; check your manual for guidelines.

If you're installing a Strong or Lasdrop Dry-seal, it's recommended affixing a replacement lip seal (about US$95 for a 1" shaft) at the same time as the seal. Tides offers an optional carrier (US$44) to store the spare lip seal and facilitate installation. Boats with a Norscot unit must schedule a haulout to replace lip seals. Replacing face-type seal components involves removing the shaft flange and/or shaft, which may also require moving the engine and scheduling a haulout.

Maintenance

A properly installed shaft seal eliminates contaminated water leakage and bilge pumping and is virtually maintenance-free.

Mechanical face seals require no maintenance or adjustment, aside from frequent inspection of hose clamps, hose and sealing faces and a freshwater rinse in saltwater areas when preparing the boat for extended storage.

Seal surfaces of lip-type seals should be inspected periodically to insure they are smooth and free of any dirt, grease, etc. With water-lubricated seals, once or twice a season inspect the flow. To do this on a Strong seal, disconnect the injection hose from the seal's barb fitting. Elevate the hose end 30cm (12") or higher above the injection point on the engine. With the engine idling, you should get 3.1cm to 3.8cm (1-1/4" to 1-1/2") of water exiting the tube. In installations where the tube can't be elevated, place the end into a container and measure the flow. About 1gal per minute with the engine idling is good. In twin-engine installations, check the crossover tubes, connecting the water injection fittings on both seals.

Norscot seals require monitoring fluid level in the oil reservoir periodically during use and adding lubricant as necessary.

For lay-up afloat or ashore, shaft seals require no other special care.

About the author: Robert Hess operates Atomic Four Engine Service and is an authorized dealer for Universal and Beta engines.

DIY PROJECTS

SHIP-SHAPE STORAGE

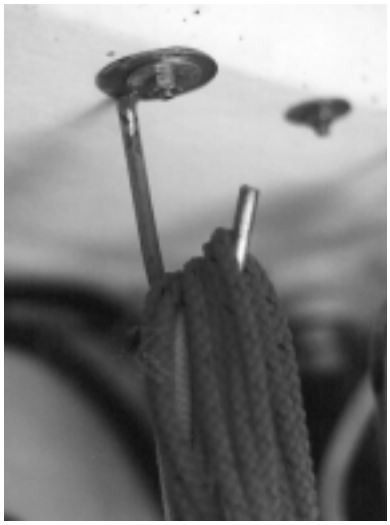
It seems the more items you stow onboard, the fewer you can actually find. Taking a look inside the average storage locker, you may see some fenders, lines and perhaps a lifejacket or two. Other items are beneath these but only the top of the pile is visible. Yet somewhere in this pile is a 30-amp adapter plug that you need right now. The refrigerator is running off the inverter and the batteries are getting weaker by the minute. Soon you must make a decision — dead batteries or warm beer. Where is that plug?

Safety items are the most important part of our keep-it-simple storage system onboard our 30-footer. I keep the flares, handheld VHF, flashlight and binoculars in individual holders by the companionway. They are always in the same place and anyone on board can reach them in an instant. Other items like boat hooks and a second anchor are stored where we can quickly retrieve them.

Many older boats have exposed wiring and steering mechanisms. Plastic containers are ideal housings for wiring connections, fuel filters and the like. [Ed: For construction details, see DIY Projects, 1999-#1 issue.] Be wary of the mop handle wiggling its way to the steering quadrant. I once, involuntarily, reversed my boat a quarter of a mile in a marina and smartly backed into a dock. A neighboring boater noticed my unique approach. He politely solved my problem, "Check the back of the shifter in the locker," he offered. Sure enough, there was the mop, firmly wedged into the shifter.

One solution to store items such as diving gear, safety harnesses, extra mooring lines and other sundry stuff is to hang these from hooks attached to the sides of lockers. There are many ways to do this: make leather wraps as described in DIY 1995-#3 issue; buy small plastic hooks and to each attach a loop of 15cm (6") bungee cord through the hole; or make custom hooks. I take small pieces of stainless-steel rod, bent into a hook shape and welded to large stainless washers. To fasten hooks against the inside of fiberglass hulls, you'll need a cleat made of marine plywood (or hardwood) and glued to the hull. Then screw the hooks, bedded in sealant, into the wood.

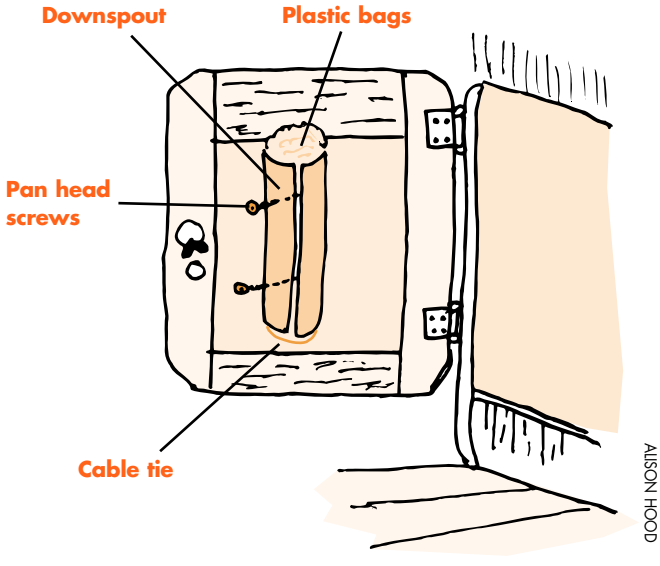
I mount the same stainless hooks to the underside of deck fittings in lockers. The hooks then hang down and are perfect for holding things like a bucket full of cleaning supplies. This saves space for docklines and fenders, items that are used every day.



At least once a year, clean out all lockers. Take an inventory of the stuff you keep on the boat and throw away anything that hasn't been useful in the past season. Just remember that when you see a good deal on some gizmo at a boat show this winter, before purchasing, carefully consider where you're going to stow it.

— Dennis Angle, Beamsville, Ont.

BAG HOLDER



A simple gadget to store plastic bags is made of round or rectangular plastic PVC downspout (the kind used with house gutters). Take a 25cm (10") section or longer depending on mounting location, and cut a narrow vertical slot in the center. Attach the pipe with two pan head stainless-steel screws to the inside of a galley door or other convenient location. Where door panels are too thin to hold screws, glue a hardwood cleat to the door, then mount the downspout. To prevent the bags from dropping out the bottom, drill two holes in each side at the bottom and thread a cable tie through the holes.

— *Sophia Dean, "Via Sophia," Surrey, B.C.*

A SECURE BERTH

For everyday use on any power or sailboat, leecloths will keep bodies and gear from falling out of a bunk when underway in a rough sea.

While there are many variations made of solid wood or canvas, this adaptation is lightweight and easy to make. Constructed of truck tailgate webbing it fastens to the bunk top. When not needed, it packs compactly under the berth cushion.

For each leecloth, you'll need one full-size truck tailgate net plus enough fabric (i.e. Cordura nylon or acrylic) to give a finished height of a least 45.7cm (18"), 8mm (5/16") nylon line, two boat snaps, two pad eyes and aluminum flat bar, 3mm (1/8") thick by 2.54cm (1") wide by the length of the net.

To assemble, stitch the canvas strip to the bottom of the net. Lay the canvas over the berth, stretch slightly, and mark fastener placement. This bottom edge is sandwiched and fastened every 15cm (6") between a piece of aluminum flat bar (sanded smooth to prevent chafe) and the top surface of the bunk. Knot or splice a length of line to the top corners of the net. Hold the line and raise the bunkboard in position, lifting up at a 30° angle or so. Make a mark

where each line touches the ceiling (or a bulkhead) and mount small pad eyes. Cut the line to fit and add a boat snap to each end.

— *John and Nadine Mitchell aboard "Lil Ollie."*

DIY MECHANIC

STERN DRIVE LAY-UP & START-UP

Storage is one of the greatest enemies of a marine engine. Follow these steps to properly lay-up and relaunch your stern drive.

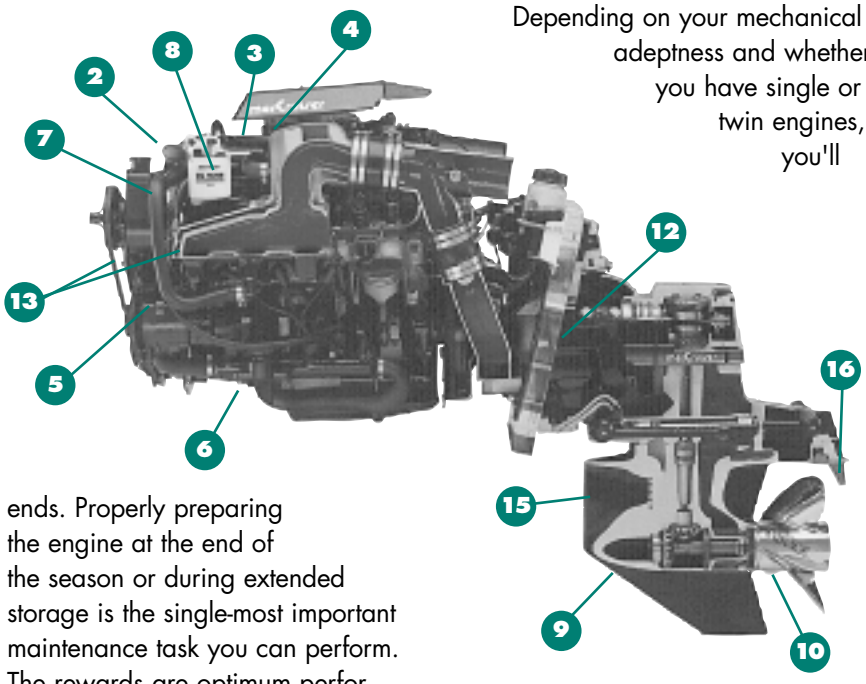
Story by Jim Marotta, photos by Jan Mundy

Materials

Spark plugs
Engine oil
Gear oil
Power steering fluid
Storage seal
2-cycle motor oil
Antifreeze
Petroleum jelly
Marine grease
Moisture-displacing lubricant
Fuel stabilizer/water absorber
Fuel-water separating filter
Engine oil filter
Engine fuel filter
SAE 30W motor oil
Owner's Maintenance Manual

Photos were taken with the assistance of Warren Mills, owner of Gannon Narrows Marina, a full-service marina located on the Trent Severn Waterway.

Like cars, marine engines' steering and shifting mechanisms are built to run regularly. Unfortunately, this is impractical for most boaters where boat usage is confined to vacations and spare weekends. Properly preparing the engine at the end of the season or during extended storage is the single-most important maintenance task you can perform. The rewards are optimum performance, increased longevity and greatly reduced expenses over the life of the engine.



Steps to stern-drive lay-up.

Lay-up involves protecting the engine and its components from corrosion, dirt, dormancy and freezing. The following steps provide a general guideline to laying up the most popular stern drives, both carbureted and EFI models. If any steps differ from those in your owner's manual, defer to the manufacturer's instructions. Also, refer to your owner's manual before applying any lubes, oils or additives. Don't omit any steps. If you shortcut the lay-up procedures, you risk costly damage to the engine. If the boat is stored in winter climates, lay-up the engine well in advance of freeze-up. Overnight, sub-zero temperatures can freeze and crack a block, costing thousands of dollars to repair. If your engine is still under warranty, damage caused by freezing is not covered by manufacturers — even some insurance policies don't cover it.

Depending on your mechanical adeptness and whether you have single or twin engines, you'll need to reserve three to six hours to complete the job. If you are in doubt about any lay-up procedure, consult a knowledgeable (and reputable) marine dealer or the manufacturer. If you are completely in doubt, you may want to consider having your engine professionally serviced.

1 PREPLANNING Make a list of what maintenance has been performed and what needs to be done prior to servicing the engine. This serves as your guide to a thorough job now and to an equally thorough commissioning. [Ed: For a recommended maintenance schedule, refer to page 34, DIY 1996-#3 issue.)

TIPS FUEL BOOSTER

Pumping reformulated fuels makes the use of fuel stabilizers truly more important than ever before. To protect your engine from water build-up, detergents and other additives in fuel during the boating season, engine manufacturers recommend adding fuel stabilizer and water absorber with every fill up — never run the engine without it. All pre '87engines and post '87 V-6 engines also require adding a lead substitute with the stabilizer, otherwise the valves may stick.

2 OIL CHANGE Servicing includes changing the engine oil. Acids build-up in the oil during normal engine operation. When left for an extended lay-up period, these acids can pit the bearing surfaces, reducing engine life. Engine oil must be hot prior to draining. Hot oil is easier to siphon

Add 2/3 of the required amount of oil, run the engine for three or four minutes, then check the oil level and fill as necessary.

Water must circulate through the lower unit and engine anytime the engine is operating. Some stern drives contain a built-in flushing nozzle; others use flush ears that clamp over the water intake.

out and heating and agitating the oil suspends dirt and other contaminants that are removed when changing the oil. Run the engine at idle either in the water or if using flush ears, remove the propeller and observe readings on water-pressure gauge or make sure water runs out the water exhaust, until normal operating temperature is reached. Post '85 MerCruisers have a garden hose-size adapter bonded to the dipstick tube to which you thread on an oil change pump with a matching fitting. Remove the oil filter and install a new one. Add 2/3 of the required amount of oil, run the engine for three or four minutes, then check the

One of the best oil change pumps available is the portable Pela, formerly known as the Oil Vac (see DIY 1996-#3 for a product review). Dirty oil is drawn out through the dipstick, draining the crankcase dry in five minutes or less.

oil level and fill as necessary. Some large cruisers have a built-in electric pump on the engine, just flip a switch to pump oil out, or pump in fresh oil. Using a vacuum pump allows you to remove most of the engine oil. TIP: For engines without a hose fitting or electronic pump, insert a short length of trim tab hose, a hard plastic hose about the size of speedometer tubing, into the dipstick tube then attach a vacuum pump.

3 FUEL TREATMENT Remove the boat's fuel source and in a portable tank mix up 1-gal high-octane fuel (the highest available), fuel stabilizer and two-cycle motor oil at a ratio of 24:1 or 1qt to 5gals. Run the engine at idle for five minutes to distribute this "soup" through the fuel system. The alcohol eventually evaporates, leaving detergents and additives suspended in the oil which are then exhausted upon starting the engine after lay-up. You now have two choices: drain the fuel tank or fill it full. [Ed: For complete details and the recommended procedures, see "Warning: Protect Engine From Damaging Fuels" on page 20.]

Add two-cycle oil to the fuel with the stabilizer then run the engine to coat the fuel injectors, carburetor, fuel pump, etc.

4 FOGGING On carbureted engines, protecting the cylinder walls and piston rings from rust is done by a technique known as fogging. Remove the flame arrestor and with the engine idling, spray into the carburetors storage seal, a lubricant containing an adhesive propellant (alcohol) that evaporates and leaves a gummy residue that sticks to the cylinder walls. Continue spraying until the engine stalls due to lack of proper fuel mixture. Never use storage seal in fuel-injected engines. Instead, disconnect the boat's fuel supply, remove the fuel-water separating filter and empty the contents.

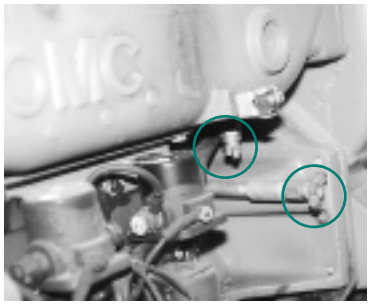
Fogging carbureted engines coats the cylinders with a sticky residue to prevent corrosion.

Fuel-injected engines are "fogged" by putting a 50/50 mix of fuel stabilizer and two-cycle oil into the fuel-water separator.

Fill the filter with a 50/50 mix of fuel stabilizer and two-cycle motor oil. Reinstall the filter, then run engine until it stalls. Remove the fuel-water filter and replace with a new one. If your engine is not equipped with a canister-type fuel-water separating filter, mix up a "soup" of premium fuel, two-cycle motor oil and fuel stabilizer and run it through the engine. The motor oil suspends additives in the fuel and keeps fuel injectors and the fuel pump check valve from sticking.

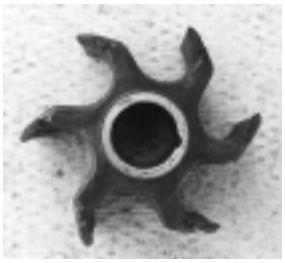
5 POWER STEERING MAINTENANCE With the engine still at operating temperature, remove the reservoir cap and check the fluid level in the power-steering pump. Add an approved fluid if necessary. Don't overfill.

6 RAW-WATER COOLING Remove the drain plugs from the engine block and manifolds. To flush the raw-water cooling circuit, attach flush ears to the water intake and back-wash with freshwater until the water runs clear. This removes corrosive salts, rust flakes and sediment.



Location of manifold and exhaust drain plugs on V-4 OMC Cobra. Check your manual for the exact location. When draining the raw-water system, insure the exhaust manifolds are completely drained. In areas with sub-zero winters, any remaining water will freeze and crack the manifolds.

Drain the raw-water system taking special care to empty all the low spots. Insure the exhaust manifolds are completely drained or they will crack from freezing. To prevent water pockets collecting where temperatures drop below freezing, remove the thermostat housing and pour propylene glycol (PG) antifreeze into the cooling system to prevent ice pockets from forming and cracking the block. Pour until you see pink (or blue) liquid flowing out, let drain, and store empty. All that's left is residual antifreeze that you must recapture when starting the engine after lay-up — don't expel into the water as antifreeze absorbs contaminants during storage. Never use highly toxic ethylene glycol (automotive) antifreeze.



When impeller vanes are cracked or worn or have taken a permanent set as shown, replace the impeller with a new one.

Remove the raw-water pump impeller. Grease the impeller vanes lightly with petroleum jelly and reinstall. Leave the pump cover screws loose to prevent the impeller from sticking to the housing, which would damage the impeller upon initial startup. Remember to tighten screws — add this to your checklist — before launching. A loose cover also prevents grease from contacting the paper gasket that, when tightened, breaks the seal.

Gear oil that is milky white in color or high-performance lube (right) that turns green, is a sure sign of worn prop, input shift shaft or shaft-driven water-pump seals.

7 FRESHWATER COOLING Drain, flush and refill the freshwater cooling circuit — do this only after the engine has cooled. To drain the coolant, remove all engine, heat-exchanger and oil-cooler drain plugs. Your engine will likely have four or eight drain plugs depending on the model. Collect coolant into a sealable container and clean up any spills. Remember, animals and children are attracted to the sweet taste of ethylene glycol antifreeze, a highly toxic solution. Back-flush the freshwater circuit to remove sediment. Replace the coolant with storage antifreeze — when recommissioning, flush out the storage antifreeze and add operating antifreeze. Don't reuse old antifreeze, but do recycle it if possible. [Ed: For a complete review of antifreezes, refer to DIY 1998-#3 issue, page 18.]

8 FILTER REPLACEMENT Most boats should be rigged with at least two fuel filters. The first filter, a fuel-water separating filter, is mounted between the fuel tank and the engine. The second unit is an inline fuel filter mounted on or near the engine. Replace both with new filters.

Separate fuel-water separating filter, changed frequently, keeps the fuel system clean and free of water and other contaminants.

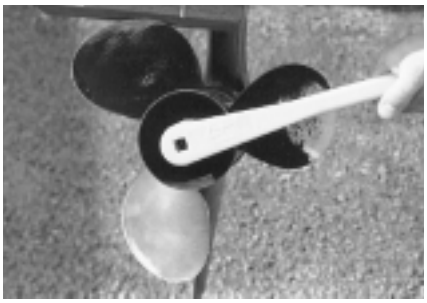
9 GEARCASE SERVICING Drain and fill the gearcase oil every 100 hours, and always before extended storage. Otherwise, corrosive acids and other contaminants will damage bearings and the gear set. Even worse, water-diluted gear oil remaining in the lower unit can freeze and crack the housing.

Put the lower unit in the down position, remove the oil plug and washer and drain the oil.

SELOC

Remove the upper oil plug, then fill the lower unit from the bottom hole until the lubricant just starts flowing from the upper fluid level plug. This ensures there are no air bubbles and the gearcase is full. Reinsert the lower plug, then the upper plug and washers (replace if worn). Store the lower unit in the down position to avoid water pooling in the prop hub.

10 PROP INSPECTION Inspect propeller for chips, dents, etc. and service as needed. A damaged prop causes cavitation and reduces the life of the gearcase and powerhead. Using a prop wrench, remove the propeller and check for line, rope or weeds wrapped around the hub. Lubricate the shaft before reinstalling.



11 STEERING Lubricate control cables with grease fittings while the steering cable is fully retracted into the cable housing. Don't lubricate cables without grease fittings (i.e. Teflon lined). Lubricate all steering and throttle-shift components with SAE 30W motor oil. It's important to keep these cables well lubricated to prevent corrosion from forming inside the casing and replacing of cables.

Apply grease to the grease nipples and spline on the universal joint with a marine waterproof grease.

TIPS MONITOR ENGINE ANTIFREEZE

Engine coolant must be checked twice annually to monitor any contamination. Using an antifreeze tester, check the coolant mixture. Record this number in your maintenance records. In the fall, test the coolant again. If the engine is sound, the readings will be identical. If the value decreases, seawater is getting into the antifreeze.

TIPS STABILIZER OR WATER ABSORBER

Gasoline treatments designed to protect internal fuel system components from corrosion, prevent gum and varnish build-up, and remove water, come in various disguises. Some one-step products stabilize the fuel and remove water; look for products containing methyl hydrate. Other products treat the fuel but not the water. This means you need to add both a stabilizer and a water absorber, which emulsifies the water in the fuel so it passes through the fuel system without stalling the engine. Most are highly concentrated solutions: depending on the brand, a 355ml (12oz) bottle treats up to 60gals of fuel.

12 GREASE POINTS Grease all drive train components, such as the gimbal bearing and engine coupler, with a marine waterproof grease. The gimbal housing normally has several grease nipples, as well as the tilt-trim mechanism. Spray a moisture-displacing lubricant over the entire powerhead.

13 VISUAL INSPECTION Inspect water, fuel, vent, tank fill and other hoses for signs of softening, cracking or bulging, especially those exposed to high heat. Check hose clamps for tightness and corrosion, and replace as necessary. Inspect drive belts for signs of slipping, burning or cracking and replace any that show signs of wear.

Check tension on all belts.

Carefully inspect coolant hoses for signs of softening, cracking or bulging.

14 ELECTRICS First disconnect the negative battery cable, then the positive cable. Unattended, a battery naturally discharges over a period of several weeks. The electrolyte in a discharged battery can freeze at 7°C (44°F), so if leaving on board, keep batteries fully

DIY MECHANIC

An inexpensive, pocket-sized hydrometer reads battery voltage by measuring the specific gravity of the electrolyte.

charged, or move them to a warmer storage area. Small automatic trickle chargers, such as the Battery Tender manufactured by Deltran, will keep batteries charged without overcharging. Treat battery and cable terminals with petroleum jelly, silicone grease or a heavy-duty corrosion inhibitor. Lightly coat the alternator and starter with a moisture-displacing lubricant.

15 VISUAL INSPECTION Hose down the lower unit, removing all dirt and salt residue. Check for any areas where paint has exposed metal. Clean, prime and repaint the area to prevent rust. Don't paint the sacrificial anodes. Protect all external surfaces of the engine with a spray-on, wax-based corrosion inhibitor.

16 ANODE REPLACEMENT Stern drives have at least one zinc anode attached to the outdrive. Other anodes may be mounted on the

Check anode on outdrive and on the engine, if equipped.

engine. Replace any anode that is less than half its original size.

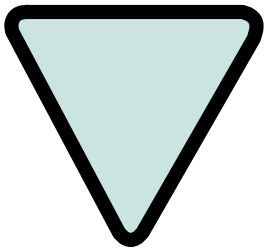
17 LET IT BREATHE Sealing all openings to the engine (air inlet, breathers, exhaust) traps moisture and corrodes parts. Also, explosive vapors can accumulate in the engine compartment creating a potential fire hazard. A good source of air is to remove a hose or two from seacocks (just remember to reinstall before launch) or install a deck-mounted solar exhaust vent. To discourage rodents from moving in, fill engine vents with steel wool or fiberglass insulation.

18 POST YOUR LIST Place your checklist in a visible spot to remind you of the storage steps that have been performed and what maintenance needs to be done prior to relaunching. This is especially important if you have left the raw-water pump cover bolts loose or removed any hoses. ⚓

About the author: Jim Marotta is managing editor of Seloc Marine Manuals.

RELAUNCH GUIDE

If you correctly prepared your engine for storage, very little needs to be done for launching. First, check your list and reattach, replace or tighten any components. Check gear oil level — some mechanics prefer to again change the oil; it should be up but don't take anything for granted. Top up the fuel tanks if left nearly empty (see "Warning" on page 20). If tanks were filled in the fall, add an octane booster. Replace spark plugs and air cleaner. Lastly, check all fluid levels and go boating.



MECHANIC'S CODE

▼ Observe all applicable safety precautions when working around fuel.

▼ Always work in a well-ventilated area whenever servicing the fuel system.

▼ Don't allow fuel spray or vapors to come in contact with a spark or open flame.

▼ Keep a dry chemical fire extinguisher near the work area.

▼ Always keep fuel in a container specifically designed for fuel storage.

▼ Always properly seal fuel containers to avoid the possibility of fire or explosion.

▼ Never run the engine dry — just a few seconds without water will severely damage the water-pump impeller.

▼ After attaching flush ears, carefully monitor the water- pressure gauge to insure water is being drawn into the lower unit.

▼ Always remove the propeller when using flush ears.

▼ Never open, service or drain the cooling system when hot.

▼ Engine coolant is highly toxic. Collect in sealable containers and clean up any spills.

▼ Never wear loose clothing when working on an engine.

STEP-BY-STEP BLISTER REPAIR

Epoxy resins are the most widely used for repairing osmotic blisters. Here's everything you need to know to ensure a successful job, including a summary of material costs, daily scheduling, reasons for failure and prevention tips.

Story and photos by Jim Shotwell

My boat buddy, Melvin Howard, a retired Baltimore City police officer, called with the bad news. During a routine bottom cleaning of his '78 Irwin 37 center-cockpit sloop the diver discovered blisters, lots of them. After much consideration I decided to do the repair job for him to insure it was done to the highest standards, not to mention saving him money. The one condition: he was to assist me. The going rate for gelcoat blister repair on the upper western shore of Chesapeake Bay, where *Princess II* is berthed, often exceeds $100 per foot of boat length.

Much has been written about the causes of gelcoat blisters (Ed: Refer to DIY 1995-#3, 1996-#3 and 1998-#3 issues, and "Fact Versus Fiction" on page 40). *Princess II* had last been hauled and surveyed in '94 and showed no signs of blisters. It's believed that boats that stay in the water year-round are more prone to blistering than those that are hauled and stored on the hard for part of the year. Was this the cause of the problem? Maybe, but that was of little concern as our only objective was to return the structural integrity to the hull.

I've built wood-epoxy boats for more than a decade and chose MAS Epoxies from Phoenix Resins for this job because of the success I've experienced with the product and the company's technical support. The repair procedures outlined below are easily adapted to most epoxy systems — East, Epiglass, System 3, West and others — and involve sandblasting, drying the hull, filling, fairing and recoating the bottom according to the manufacturer's instructions.

Step 1 The Site

We needed a site that allowed owner do-it-yourself projects, had the travel lift capabilities, space to work and a management philosophy based on teamwork. Marinas willing to co-operate with DIYers are becoming scarce. Last October we moved the boat to Bowley's Marina at the mouth of Middle River in upper Chesapeake Bay. It was hauled, power washed and blocked in the sandblast area. A 500-slip facility with a 30-ton Travelift, a large work yard, a sandblast area and friendly knowledgeable staff, Bowley's is boatyard heaven.

Step 2 Sandblasting and Sanding

Antifouling paint must be removed and the blisters opened to allow them to dry out before repairs can begin. *Princess II* was sandblasted for three reasons: to remove the bottom paint; to open the blisters; and to "tooth up" the gelcoat in preparation for the epoxy coating. Sanding and grinding or chemical stripping and sanding will also get the job done, but are more labor intensive and consequently more costly. Sandblasting opened the blisters and created the toothed surface we needed; it's best left to someone who specializes in the process. After blasting, we carefully sanded the waterline and under the jack stand pads with a random orbital sander.

After sandblasting, the extent of Princess II's blistering became obvious.

Step 3 Drying Out

Before filling the blister voids the hull had to be dry, so we left Princess II to passively dry over winter. It's possible to push the drying time by many methods, such as tenting the hull area with plastic sheeting and/or heating with infrared heat lamps, but the time-honored method of patience is still the best and most cost effective. [Ed: Refer to DIY 1996-#3, page 44, for instructions on how to build a mini boatshed.] Keep the bilge dry and well ventilated to prevent moisture from entering the laminate from the inside (see "Fact Versus Fiction" on page 40).

Before applying any blister repair coating, check the moisture content of the fiberglass laminate. If you have any doubts as to the dryness of the hull, call in a surveyor. When readings are questionable, the only truly accurate means to

determine the exact moisture content is to remove a hull core sample and send it to a lab for testing. Another method to determine hull dryness is to lay 30.4cm (1') squares of clear plastic sheet over the surface and seal all edges with tape. Leave for at least 24 hours. If condensation forms, the hull requires further drying.

Step 4 Washdown

In the spring we washed the bottom with a stiff brush and water to remove the contaminants that came to the surface in the drying process.

Princess II's ***owner removes contaminants from the drying process with a stiff brush.***

The author uses a clean rag and denatured alcohol to remove the last of the contaminants.

After the hull dries, a denatured alcohol (methyl hydrate) wipe down follows in preparation for the initial coat of epoxy. Use plenty of clean rags and change your rag often.

Step 5
Wetting Out the Hull

First tape the waterline to prevent the initial coat of unthickened epoxy from fouling the boot-top stripe. I use 3M Long-Mask for most taping operations in my shop. When doing epoxy work, I recommend removing the tape at the end of each day or use the two-tape method (see "Masking Epoxy" on page 42).

An initial coat of epoxy resin and slow hardener, unthickened, is applied to the bottom to facilitate

BLISTERS: FACT VS. FICTION

Blistering most often occurs between the gelcoat and the outer skin mat layer, some occurs between this mat layer and the structural laminate. (Blisters rarely form in structural laminates of roving layers.) Fibers in the thick mat layer (outer skin) that are not completely saturated with resin (polyester or vinylester) or resin that was not properly catalyzed during the original building creates void spots or air bubbles. Water migration through the laminate collects in these voids and initiates the blistering process. Most boats have some resin-starved mat, sections of dry, uncoated fibers in the outer laminate. The quality of the fiberglass lay-up work plays a major role in blister occurrence and prevention.

Not all blister repair jobs fail, but many do. The main reasons barrier coatings fail are preparation and application of the coating, and poor construction. According to Interlux assistant marketing manager Jim Seidel, failures are most frequently caused by not properly drying the hull prior to coating. A wet hull will continue to blister under the epoxy. Poor surface preparation, things such as leaving the antifouling paint on or not sanding properly always lead to a poor result. Other reasons for reblistering include improper mixing or incomplete curing, filler material that was not correctly mixed or catalyzed reasons or not applying enough epoxy to gain a proper barrier, usually 10 mils or more.

"The mistake most people make here is thinking that there is a magic number of coats," said Seidel. "Since there is not a good definition of what a coat is, you must figure out how much material it will take to put the proper amount on the bottom and then apply all of it.

"If it's three coats or ten coats it is the amount of material that counts," continued Seidel.

Even when correctly applied, it's likely that no repair filler or coating can fully prevent repeat blistering in a hull that has large areas of voids and unsaturated fibers in the outer skin mat layer. While a coating may last for many years, voids must be removed before you can completely eliminate the blistering process under the barrier coating. This is both painstaking and costly, a repair most owners sidestep.

There are some measures you can take to retard the blistering process. Besides water permeating an exterior coating, there are numerous ways water can get into a laminate, such as thru-hull fittings or water in the bilge. Be sure all thru-hulls are well sealed, recaulk any leaking deck fittings. Hulls absorb a great deal of water from the interior. Keep the bilge dry, particularly areas that are not gelcoated or painted.

— Jan Mundy

Use 3M 2090 Long-Mask for a crisp mating line and two tapes when working with epoxy (see "Masking Epoxy" on page 42).

bonding of the epoxy filler. Mix small amounts of unthickened epoxy — start with three pumps each of resin and hardener — until you get a feel for how much you can apply during its pot life.

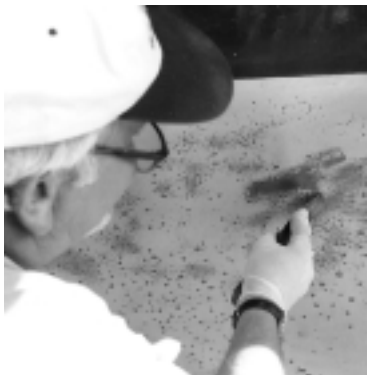
Roll on then tip off, then continue tipping until the coating is tacky to prevent sags or runs and eliminate much of the sanding.

It's important that each blister void is completely coated with this resin mixture. First roll on the epoxy, rolling in two directions, fore and aft, then up and down. Have a helper follow with a small glue brush, dabbing epoxy into any uncoated voids. Now, "tip off" the resin, smoothing the surface with a disposable foam brush. If necessary, tip the resin a second time to insure you don't have any runs or sags. It's much less time consuming to maintain a uniform coating while the epoxy is still "green" than sand out any flaws after it cures. When the foam brush starts to drag on the surface the epoxy has cured enough not to sag. It's best to section off the hull for coating: air and surface temperatures will determine the size of the working area that you can complete without the epoxy curing prematurely. Before the epoxy is fully cured, remove the masking tape.

Step 6 Filling the Blister Voids

To rebuild the surface and fill the voids left by the blisters we mixed resin and fast hardener for about one minute, then added a premixed blend of 75% phenolic microballoons and 25% milled fibers stirred to a peanut butter-like consistency.

Add enough filler so the thickened epoxy doesn't drip off the mixing stick.



Use a plastic squeegee or a putty knife to fill the voids. Apply pressure to force in the filler. The objective is to fill voids as flush with the outside of the gelcoat as possible to limit the amount of sanding or refilling.

Step 7 Fairing

Always wear a respirator with an organic vapor cartridge when sanding epoxy.

After the epoxy filler has cured to a hard state, 24 to 48 hours at 25°C (77°F), sand the surface with a random orbital sander and 40-grit paper. Epoxy is hard stuff and with a little care you will end up with a very fair bottom. Take your time until you get the hang of it, but most importantly, keep the sander

TIPS — MASKING EPOXY

If you want a crisp mating line, always tape with 3M 2090 Long-Mask and use two tapes; one permanent, one spare. Epoxy resins don't adversely affect the acrylic adhesive in this tape when wet, but curing generates heat and when fully cured the tape slivers where epoxy has overlapped the tape and becomes part of the lay-up. Rather than remove the tape before it cures, losing your line and recreating it another day, first tape the line, then apply a second tape directly over. When you're done for the day, remove only the top tape. Continue laying a second tape over the first and removing it as needed.

Get Your Ducks in a Row Before Buying or Selling a Boat

Once you've decided you're ready for a new boat, you don't want anything to slow down the process. So before the wheeling and dealing begins, make sure to have all your loose ends tied up neatly.

BoatU.S. Members have access to a number of valuable online services such as FREE estimates of the fair market value of your boat as well as FREE insurance quotes and affordable financing.

We will also handle the cumbersome details of your transaction such as escrow, settlement and documentation services at BoatUS.com. These services are available only to BoatU.S. Members and are well worth checking out!

Visit the Boat Buyer Services page at BoatUS.com *Today!*

It's a one-stop source of information that can help the process of buying or selling a boat go as smoothly and quickly as possible.

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SAFETY TIPS – ALWAYS!

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

flat to the surface and moving. Rinse the sanding residue from the boat with freshwater and allow to dry thoroughly. It may be necessary to refill some of the voids prior to the final sanding; spot fill any depressions with a putty knife.

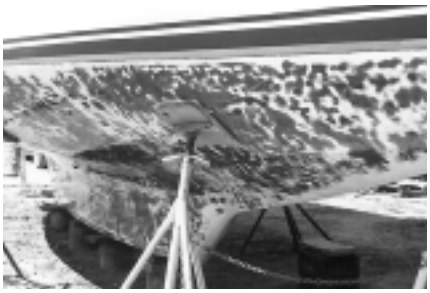
When this application has hardened, about 24 to 48 hours at 25°C (77°F), sand the entire bottom using 80-grit paper, rinse and allow to dry overnight. After this final sanding the bottom was once again sound, fair and smooth.

Step 8 Apply Barrier Coats

The water barrier consists of five coats of epoxy and slow hardener, each applied about 3-plus mils thick, building a total thickness of 15 to 20 mils (a thick gelcoat is about 30 mils, a thin one 20 mils). If time allows and you have extra material, apply more coats to gain a thicker film. We applied all five coats to the starboard hull on one day, and on the port side the next day. Coats were applied "green on green," and always within the 24- to 48-hour recoat window. [Ed: Recoating times and mixing ratios vary with the brand of epoxy you're using; carefully follow instructions provided by the manufacturer.]

With a two-person team, roll and tip in opposite directions. Satisfied with the final finish, the boat was left to cure for seven days, and was then ready for bottom painting.

When recoating



Not a single run or sag in the finished barrier coat.

with MAS resins, use this rule of thumb: If you can leave a thumbnail imprint in the surface, you can recoat without washing (to remove the blush) or sanding. Apply each barrier coat with a solvent-resistant foam roller, rolling in two directions then "levelling" with a foam brush. This results in an even surface mil thickness. Tip off each coat in the opposite direction of the last. Remember to carefully observe each coat and tip again if needed. Pay extra attention to the final coat on each side.

Step 9 Preparing for Relaunch

The barrier coat system described is compatible with all bottom-painting systems. [Ed: For complete step-by-step bottom-painting instructions see DIY 1999-#1 issue.] I always prime epoxy, both new construction and repairs, with Interlux 404/414 Epoxy Barrier Coat, a two-part epoxy primer for above or below the waterline. It offers a high build, bright-white sanding surface for epoxy systems. On *Princess II*'s new bottom it also doubles as the signal coat to warn future sandblasters of the barrier layer underneath.

About the author: Jim Shotwell builds wood-epoxy boats in his shop in Pennsylvania and teaches wooden boatbuilding at the WoodenBoat School in Brooklin, Maine. His book "Building The Sunrise Dinghy" is available soon from Tiller Publishing.

DIY REPAIR BILL

TIME, MATERIALS, COST

This type of project is controlled by the work to be accomplished in a given day rather than the clock. Some days we worked 12 hours, others only six. This is the breakdown in hours per task.

Description	Hours
Sand the waterline and wash the bottom	5-1/2
Wetting out the hull	15-1/2
Filling the blister voids (two applications)	75
Fairing (sanding twice)	43
Application of the barrier coat	40-1/2
Total	179-1/2

Order materials well in advance to allow control of the cost and insure availability. Epoxy resin covers approximately 500 square feet per gallon at 3mils of thickness. For coverage purposes, add the total amount of resin plus the total amount of hardener used at the appropriate mixing ratio. To determine the area of a boat's bottom from the waterline to the keel, use this basic formula:

LOA X BEAM X .85 = AREA OF BOTTOM SURFACE

The Irwin 37 required the following materials:

4 gal	Low-viscosity resin
1-1/2 gal	Slow hardener
1/2 gal	Fast epoxy hardener and accelerator
1	Calibrated resin pump
2	Calibrated hardener pump
1-1/2 gal	Phenolic microballoons
2 qt	Milled fibers (chopped fiberglass, 3/8" long)

Note: Resin-hardener mixing ratio of MAS epoxy is 2:1

Material costs may vary according to your location and availability of suppliers. Prices are in U.S. funds.

Epoxy resin and fillers	$505
Masking tape (3M Long-Mask)	13
Sandpaper	57
3" foam and 1/2" glue brushes	27
Roller covers	65
Denatured alcohol	15
Disposable gloves	24
Mixing sticks and pots	18
Paint tray and liners	9
Subtotal	$721
Sandblasting $10 per boat length foot	$370
Total	$1,091

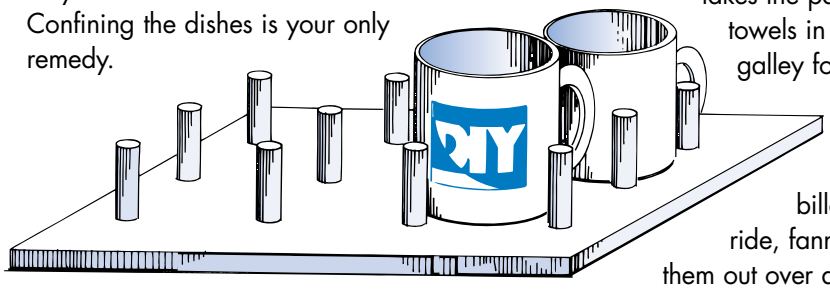
Good Boatkeeping

KEEP IT SIMPLE STORAGE

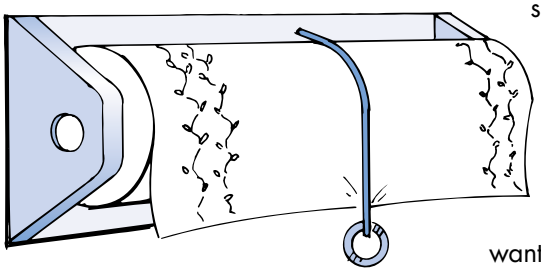
Storage solutions are welcome on any size boat. Here are three simple ideas that solve common problems.

By David and Zora Aiken

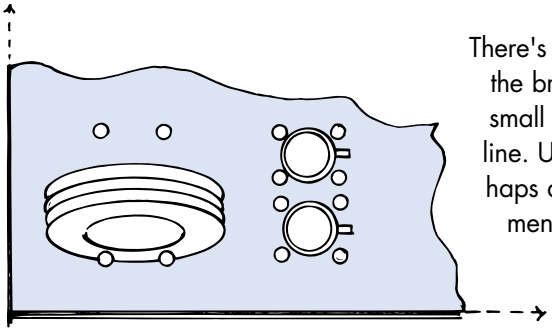
The boat is at anchor. Wind and current rock the boat ever so gently, which should lull you to sleep, except you can't tune out the clanking of the dishes that are sliding ever so regularly with each oscillation. Confining the dishes is your only remedy.



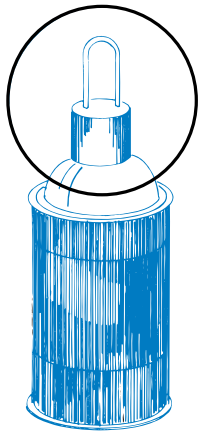
Cut a piece of plywood (or King StarBoard) about 9mm (3/8") thick to fit a locker shelf. Place the dishes and mugs in a practical arrangement atop your new shelf and mark the contours. Drill a series of holes outside your marks, about three or four around each stack of dishes and mugs. Insert and glue (use 3M 4200 or 3M 5200 if using StarBoard) in place short pieces of dowel. Now when the boat rocks, the dishes can't roll.



The boat is once again at anchor, or tied to a dock. A gentle breeze wafts through the hatch and takes the paper towels in the galley for a billowy ride, fanning them out over a stove burner that might be lit. There's a very simple solution to foil the breeze and prevent a fire. Tie a small weight to one end of a short line. Use a big brass washer or perhaps a decorative key chain attachment. Attach the other end to the back of the paper towel holder. The weighted line rests on top of the towel roll and prevents an unroll. This gizmo can prevent toilet paper from unrolling as well.



You're doing some routine maintenance on some mechanical device and you want to spray some lubricant into a not very accessible spot. But you can't find the handy red straw applicator that is sold with the can. If you planned ahead, this wouldn't happen. Poke a couple of tiny holes, slightly larger in diameter than the straw, into the can cap. Bend the straw and push the ends into the holes in the cap. Just don't lose the cap.



About the authors: David and Zora Aiken are the authors of "Good Boatkeeping" and "Good Cruising" published by International Marine. The Aikens currently live aboard "Atelier," berthed in Grasonville, Maryland.