FALL 1995

DIY boat owner the MARINE MAINTENANCE MAGAZINE

INSIDE

Features

Gelcoat Blister Repair

How to identify, repair and prevent gelcoat blisters plus a step-by-step demonstration of Peel-Away bottom paint remover.

Cast-Off

Compass adjusting; Multi-use block and tackle.

Engine Troubleshooting

Oil filter wrench; Quick-fix for barnacles; Inboard flush-out valve; Adding a blade or two; Diesel engine troubleshooting.

DIY Projects

DIY Dock box design contest: win a DIY binder; Footlights from nav lights; Cockpit line organizer; Chafing strip for tenders.

Electronics

Plug into AC Power with an inverter.

Powerboat Rigging

Complete guide to installing and operating trim tabs.

Sailboat Rigging

Taking control of your mainsail; Inner forestay for furlers.

Winter Lay-up

A step-by-step guide to preparing your boat for storage PLUS propane system lay-up procedures.

Departments

Refer to DIY 1999 #4 for current specs on Inverter sizing and installation guidelines.

TALKBACK

Need help with a problem? Unable to find information on products or do-it-yourself projects? DIY TALKBACK is a special reader service that makes available to you the resources of marine industry experts covering such topics as boat repair, engines, trailers, electricity, plumbing, electronics, sails, maintenance and more — everything you need to know to keep your boat in safe and "Bristol" condition.

Send your questions today to TALKBACK, DIY Boat Owner, P.O. Box 22473 , Alexandria, VA 22304 or you can email it to info@diy-boat.com. Include your name, boat name and home port.

Q. I will be installing an inverter on my boat. Do I have to ground it and if yes, where and how do I do this? As I plan on installing it in the next week or so, a prompt reply would be appreciated.
Raymond Leduc, Ottawa, ON

A. *Grounding an inverter DC system is always recommended practice. There are two reasons for grounding. The first is a safety precaution in an effort to prevent shock. Secondly, the grounding system will minimize stray current thus reducing any likelihood of corrosion.*

Some inverters, such as Statpower, have the ground and the negative connected internally. If this is the case, then one does not have to run a separate ground.

The newer Trace inverters have the DC side isolated from any input voltages. This allows for either a positive or negative ground. Your boat's system will dictate which ground is used. The ground wire should be run to the battery terminal or to the boat's system ground. The size of grounding wire should be no smaller than the largest current-carrying wire. Your local dealer should be able to supply you with the type of grounding used in your particular inverter.
Spencer Evans, Marine Account Manager, Soltek Solar Energy, Victoria, BC; (800) 727-2135.

Q. I have a 15-year-old Sunfish that is in fine shape except for the red deck. The latter has lost its sheen. Can you suggest any product that would help to restore its original lustre?
William Bateman, Pointe Au Baril, ON

A. *Our Winter issue includes test results of four fiberglass restorers, if you can wait till then.*

Replacing Filters on Universals

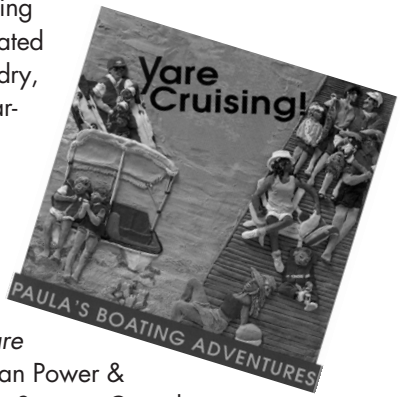
Owners of sailboats equipped with Universal diesel engines take note. Although your engine has a Japanese-made Kubota engine block, be careful if you replace your oil filter with a Kubota-brand oil filter. Some dealers have been selling metric filters as replacements. The oil filter assembly nipple on Universal model #5424 engine (and some other models) is made of aluminum and fits imperial-sized filters only. Steel threads on a metric oil filter will remove the bite on the assembly nipple and your filter can fall off. The result is a black oily mess and if you have not caught it in time, destruction of an expensive engine.
Maurice Turner, Victoria, BC
Maurice publishes a quarterly newsletter for Aloha 10.4 owners. Anyone interested in receiving a copy should write him at: 1386 Oliver St., Victoria, BC V8S 4X2.

TRADE NEWS

It's now Sir Peter and Sir Robin. Peter Blake, the chief of Team New Zealand, whose *Black Magic* won the America's Cup in May and Robin Knox-Johnson, who was the first man to single-handedly circumnavigate the world nonstop (in 1969), were knighted by Queen Elizabeth in June for "their services to yachting."

SAFE BOATING BOOK FOR KIDS

Yare Cruising! is a unique, fully illustrated book designed to teach children about boating. In this 24-page book, children will learn about boat handling, boating safety, rules of the road, navigation, weather tips, preserving the environment and more. Illustrated and created by Anne-Marie Hendry, a marina operator and former cartographer, detailed color illustrations made of three-dimensional plasticine artwork demonstrate practical procedures presented in an easy-to-understand format. The book is written by DIY's own editor, Jan Mundy. *Yare Cruising!* is endorsed by Canadian Power & Sail Squadrons, Royal Life Saving Society, Canadian Yachting Association and others. A price of CDN$6.95 includes taxes, shipping and handling. For additional information or to order copies contact the illustrator at: RR #3, Beaverton, ON L0K 1A0; Tel: (705) 426-7343, Fax: (705) 426-7258.

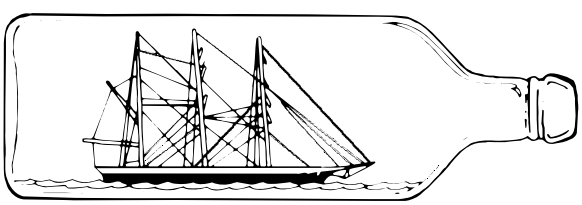


Erratum

On page 45 in the Summer Issue we incorrectly classified the Pro Pal Safety Cell. This unit "complies" with codes established by the Canadian Gas Association and Canadian Coast Guard, it is not approved by the two groups. Further research found that there are, in fact, no standards regulating propane installations in recreational boats in Canada. Insurance companies stipulate that installations must be done by a gas fitter, but as yet there is no marine certification. Boat owners should obtain a complete set of installation guidelines from the coast guard or ask your servicing dealer.

We neglected to mention Epifanes Woodfinish in the article on teak maintenance beginning on page 34. This one-component finish is specially formulated for application on teak.

In our Spring Issue, the price quoted for Epifanes Deck Coating on page 38 was too high. A 1-litre (.88 qt) can retails for CDN$32.90.



TECH TIPS

BUG DEFENSE: There's nothing worse than traveling at high speeds and having your eye skewered by a high-flying critter. Try wearing a ball cap (if you can keep in on your head) that has a nylon mesh liner inside the peak. Pull the liner over your eyes and instantly you have a made-to-measure bug screen.
Anne-Marie Hendry, Beaverton, ON

TEAK TREATMENT: To treat mildewed teak after the chemical cleaning process, mix a solution of one part bleach to three parts water and follow with a clean water rinse.

PLASTIC WAX: Protect Lexan ports and hatch covers by coating them with a commercial car wax, such as Turtle Wax, after each cleaning. Once Lexan crazes, the damage is permanent.

FLOSS FOR SAILS: Waxed dental floss is not only good for your teeth but it doubles as a strong sewing thread for repairing seams and tears in sailcloth or canvas.
Bob York, Oakville, ON

BLOWOUTS: To prevent an explosion when drilling into a hull, be sure the bilge is completely ventilated and free of any gas fumes.

MORE ABOUT ACRYLICS: When installing a vent with a stainless steel deck ring in an acrylic (Plexiglas, Lexan) hatch, overcut the hole by .3cm (1/8"). Heat causes acrylics to expand then crack if hardware is mounted too snug.
Sandy Currie, Oakville, ON

PARTS TO SPARE: We learned a valuable lesson when topping up the tanks before our first run of the season: always carry a spare fuel cap. An overzealous fuel attendant yanked the gas cap off with such force it parted the retaining chain and flew into the water. Dredging the bottom with a huge magnet only netted some rusted old chain. There was a marine store nearby but naturally, the size we needed was out of stock. Fortunately, we were close to home and found another fuel cap buried deep in a tool kit.

VINYL FIX: Carry a repair kit for inflatables on board for when you accidentally slash the vinyl seat cushions. For a quick Band-Aid, duct tape seals vinyl in a pinch.

SHAFT CLAMP: If you're concerned about the propeller shaft parting from the coupling and exiting out the stern (yes, this can happen), install a zinc anode around the shaft inboard of the stuffing box.

FUEL STRAINER: Clean fuel is critical to the continuing good health of your engine. If you suspect that fuel is contaminated use a filter. And when you're without one, use a coffee filter for gasoline and a nylon stocking or pantyhose for diesel. It takes longer but keeps harmful dirt out of the tank.

ODOR EATER: When leaving the boat for extended periods, place high-grade charcoal in plastic trays, punch holes in the top and place in bottom of lockers to absorb odors and moisture.

GAP FILLER: To fill small holes, gouges or splits in wood trim, clean the repair area with acetone, sand and let dry. Fill with dust from the sander mixed with epoxy glue. The dust makes a good match to the wood.

NOISELESS SLUMBER: Things that squeak in the night means getting little shut-eye on overnight cruises. When the sound of a fender rubbing against the hull is driving you mad, pour some liquid detergent (preferrably biodegradable) over it. You also get the added benefit of spot cleaning both fender and hull.
Vicki De Kleer, *Mollyhawk*, Bronte, ON

FISHING STORIES: Here are some tips from a local fisherwoman. I'm not certain if they're legal or environmentally safe but was assured either method guarantees some action. Spray WD-40 or other moisture-displacing lubricant on lures. It's like perfume to fish and hides the "human" smell. Hang colored, triangular-shaped plastic flags from your anchor rode before lowering. Wait one hour. Supposedly, the bright colors and sound waves produced by the streaming flags will attract fish within a mile radius. Any excuse for a party!

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

DIY Tech Tips,
P.O. Box 22473,
Alexandira, VA, 22304
Or E-mail to
diy@diy-boat.com

DIY boat owner

How to Identify, Repair and Prevent the POX

GELCOAT BLISTER REPAIR

More than 30 years ago, the use of fiberglass and resin to build boats revolutionized the marine manufacturing process.

Renown for high strength, durability and presumed low maintenance, fiberglass was deemed to be almost indestructible. In the early 70s, it was rumored that fiberglass boats were being devoured by "polyestermites." Those in the know compared these glass-eating bugs to the teredo worm, the nemesis of wooden boat owners. It was discovered to be a hoax; although perhaps the mites creators forewarned of what we now call osmosis.

AKZO SIKKENS

Osmosis starts with a minuscule air bubble trapped between gelcoat and laminate (1). Moisture penetrates the slightly porous gelcoat, causing the blister to expand (2). Moisture gradually breaks down and dissolves the polyester resin. This watery solution collects in the microscopic voids in the solidified resin, increasing moisture absorption through the gelcoat and creating a highly concentrated, sour-smelling substance. This substance builds up pressure and causes blistering of the gelcoat (3). As a result of the pressure build-up, the gelcoat separates from the laminate. The pressure in the blister continues to grow and eventually, causes the blister to burst (4).

A fiberglass hull is composed of two layers. The base layer, or polyester resin-reinforced fiberglass laminate, is covered by gelcoat, a pigmented polyester resin. All fiberglass laminates are semipermeable, meaning they allow water to pass through the outer layers. Osmosis is the process of moisture seeping into the fiberglass laminate, either through the gelcoat layer or internally from the bilge areas. As moisture migrates into the laminate it fills voids, becomes trapped and creates an acidic blister fluid. Still seeking to diffuse equally throughout the substrate, the water between the laminate and outer surface places pressure on the gelcoat. The resulting blemishes or blisters that form between the laminate and the gelcoat affect the appearance and performance of the boat. As excessive moisture is the culprit, blistering usually only occurs below the waterline.

When blisters are left unchecked they will progressively extend deeper into the laminate and affect the structural integrity of the hull. The term used to describe the chemical reaction between polyester resin laminates and water is hydrolysis. Over time, blister fluids attack the resin in the laminate, severing the chemical bond between the resin and laminate. As it progresses, the bottom becomes spongy and delaminates. Unfortunately, this condition is not reversible but can be repaired once it has started. Any hydrolyzed laminate on a boat must be removed and the bottom relaminated. This usually requires the services of a professional.

Regardless of the quality of construction, osmosis blistering and water absorption into the laminate occur in most boats sooner or later. It's the nature of the beast!

Variations in resins, catalysts, humidity and workmanship in the manufacturing process all determine when and to what extent gelcoat blisters appear.

9 Steps to Blister Repair

1. *Wash and clean area*
2. *Remove bottom paint*
3. *Remove gelcoat*
4. *Expose and clean blister area*
5. *Dry out hull*
6. *Seal repair area*
7. *Fill and fair repair area*
8. *Apply barrier coats*
9. *Apply primer and antifouling paint*

Repair Techniques

Sealing the gelcoat from moisture with an epoxy-based coating helps to prevent osmosis. If your boat develops small and shallow blisters you can repair it yourself. The best time to spot blisters is when the boat is first hauled out of the water. Immediately mark the blisters with a waterproof pen. Blisters may begin to disappear within a few hours but will reabsorb water when the boat is launched.

Osmosis may not be evident under several coats of antifouling. Scraping or sanding may reveal bumps or crescent-shaped cracks from the size of a match head to a quarter. Before beginning to remove the antifouling paint, wash and clean the hull area being repaired. Removing all of the surface contaminants — marine growths such as algae, barnacles, sea grass, etc. — is the first thing that needs to be

done. Use an acid-based cleaner to quickly dissolve any growth and grime.

Next, remove the bottom paint from the affected areas using a 24- to 36- grit abrasive. This should take off 60% to 70% of the bottom paint. Some abrasives are specifically designed for this process. They utilize a special coating process to prevent them from loading on soft bottom paints and fairing compounds and give an increased cut rate. Use a finer grit (60 to 100) to remove the remaining coating. Make sure you take the proper safety precautions before sanding. When removing bottom paint or sanding fiberglass and gelcoat always wear protective clothing, gloves and a face respirator. Some manufacturers do not recommend using chemical paint strippers to remove bottom paints. Such products facilitate paint removal but may damage gelcoat or the polyester resin in the laminate. Another option is to use Peel Away, a non-methylene-chloride stripper that removes multiple bottom paint coatings from fiberglass, wood, steel, aluminum (see product demo on page 10).

INTERLUX

Sandblasting removes gelcoat and opens blister cavities but must be done by a competent operator.

Where a bottom has small, isolated blisters it is not necessary to remove the gelcoat. Clean the surface with a dewaxer or solvent wash. Open each blister individually then fill and fair the blister cavities followed by an epoxy coating. Use a countersink bit on a variable-speed drill to open blisters. Wear protective clothing and eye protection (goggles or full face shield). The acidic fluid may be under as much as 200 psi of pressure.

If the bottom is covered with small or large blisters that go into the laminate, you'll need to remove the gelcoat surface down to the fiberglass laminate and at least 5cm (2") above the waterline. This is accom

Continued on page 9

BOTTOM PAINT REMOVAL

Peel-Away is a two-component system that removes multiple coats of antifouling paint from fiberglass, wood, steel, aluminum. Manufactured by Dumond Chemicals, (1501 Broadway, New York, NY 10036; Tel: (212) 869-6350), it contains no methylene chloride and will not harm gelcoat. It's available in two formulations: Peel-Away Marine Safety Strip for most applications and Peel-Away II for boats coated with an epoxy primer or barrier coat. The manufacturer recommends first doing a test patch when the coating type is unknown. It removes up to 10 coats, often in a single application.

Last spring we attended a demonstration conducted by Tom Pollock of Payne Distributors, the Canadian wholesaler. The test boat was an old steel hulk layered with multiple coats of some unknown bottom paint. Applying Peel-Away is similar to wallpapering. A non-sagging paste with a consistency like mayonnaise coats the bottom paint and then is covered with strips of plastic-coated paper. The paper seals the paste and prevents evaporation.

Peel Away's only drawback is time. Depending on the thickness of paint and outside temperature, it takes 12 to 48 hours before you can remove the paper and scrape the surface. While it's more expensive than sandpaper or discs, it's a lot less strenuous and definitely less hazardous to your health. Albeit it's a relatively safe product (contains no solvents), you should wear protective clothing and gloves and work is a well-ventilated area. Optimum working temperature is 15.5 C (60 F); below 7 C (45 F) the product becomes dormant.

Cost to strip a 7.5m (25') boat using the standard Peel-Away product averages $250. Coverage is 40 to 50 square feet per 3.785L (1 US gallon). The list price of CDN$80/ US$50 per gallon includes strips of laminated cloth.

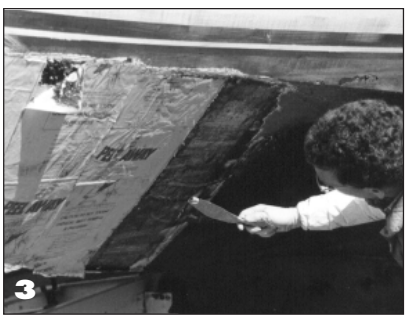
1 Remove any flaking or peeling paint with a wire brush. Apply a thick coating of paste, about .3cm to .5cm (1/8" to 3/16"), with a large brush. Work in .9 sq.m (3 sq. ft.) sections, covering all traces of bottom paint. Protect painted bootstripes with a solvent-resistant striping tape.

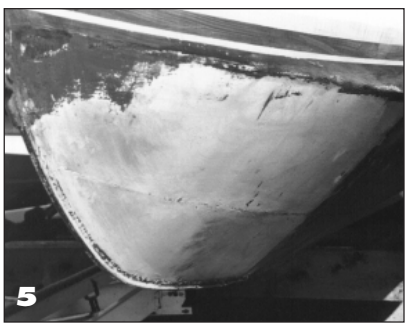
2 Cut laminated cloth into small strips (especially on a windy day) and cover paste with the printed side facing out. Lightly press surface with hand or a roller. Trim edges, allowing about .6cm (1/4") overhang. Wait 12 to 48 hours, depending on the thickness of the coating.

3 Check a small area to test if ready. Slide a large paint scraper under the fabric and ease paste, paint and cloth away from the surface in one piece. Scrape excess paste with putty knife, being careful not to scratch the hull.

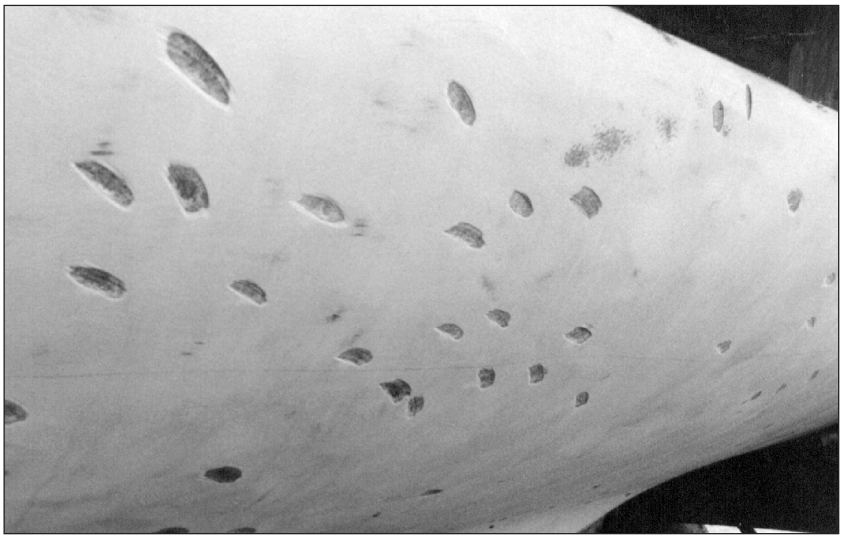
4 Remove all remaining residue with water and a 3M Scotch Brite pad. Do not let the paste dry as it hardens and will require sanding.

5 A single application removed all paint on our test area.





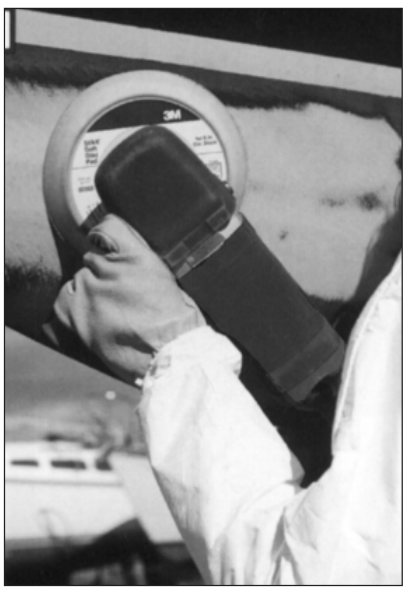
GELCOAT BLISTER REPAIR



JAN MUNDY

Damage can range from a few small blisters to an entire hull dotted with the "pox."

plished by either sandblasting, peeling or grinding. Sandblasting with sand or other mediums will remove the gelcoat and open any blister cavities but must be done by a competent operator — in the wrong hands, sandblasting can blast a hole right through the laminate. It's effective but can embed particles in the laminate and leave a bumpy finish.



3M

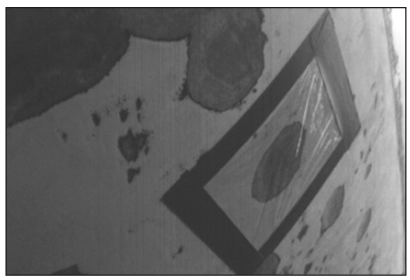
Use a grinder with a foam disc pad to remove bottom paint.

Gelcoat peeling is the most efficient method of removing gelcoat. It leaves a clean, smooth surface, but because it requires expensive hand-held or robotic equipment, must be done by a contractor. Grinding is painstaking slow and messy work but the most common solution for do-it-yourselfers.

Use a grinder fitted with a soft back-up pad and 24- to 36 grit discs and grind until you reach the laminate layer. Hold the grinder at a low angle to avoid gouges. Be careful not to cut into the laminate. Often grinding removes all blistering occurring between the gelcoat and skin coat, the first layer of mat. If you can still see light-colored circles of delamination, you'll need to remove the damaged laminate. Using a 7.6cm (3") 24- or 36- grit grinding disc on a drill attachment, grind out the contaminated laminate area, forming small craters until all signs of delamination are removed. Gougeon Brothers recommend "sounding" the hull with a rubber mallet to detect any laminate degradation. Wet or delaminated areas will sound dull or flat; dry, solid laminate has a sharp sound. If there is evidence of delamination or blistering above the waterline consult a surveyor.

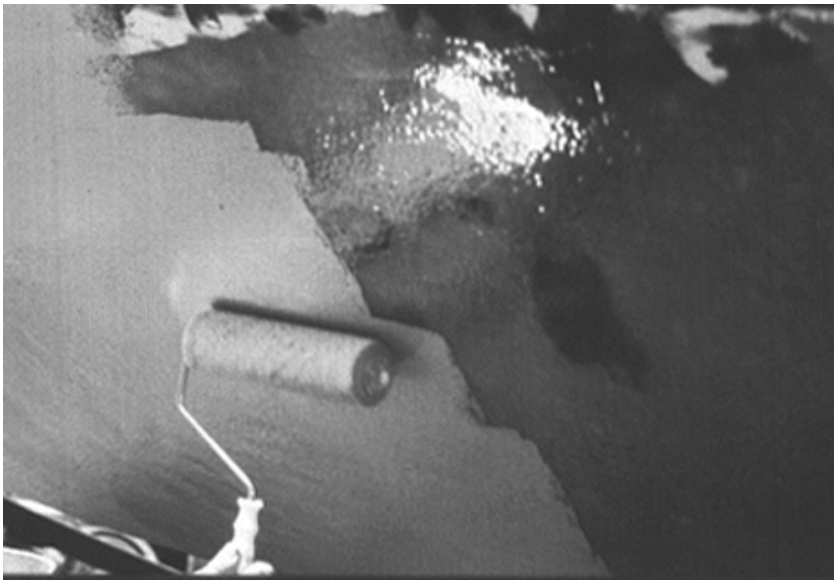
Scrub the area with detergent and flush out with freshwater to remove any contaminants. Allow the area to dry to remove all moisture from the bottom. Drying could take anywhere from two weeks to two months or possibly longer depending on the severity of the blistering. The more blistering, the more water the hull has retained. Removing all of the moisture from the hull prior to repairing and recoating will minimize the possibility of blisters reoccurring. Infrared heat lamps or tenting the hull area with plastic sheeting will speed up the drying process. In the latter case, wrap the bottom in plastic, held in place above the waterline with tape and weighted at the bottom to form a tight seal. Dehumidifiers and small fans to keep the air moving are placed inside the tent. Keep the bilge dry and well ventilated to prevent moisture from entering the laminate from the inside. If the boat is stored inside, use heaters or fans to force dry the surface.

GELCOAT BLISTER REPAIR



INTERLUX

A simple method to determine hull dryness is to tape squares of clear plastic sheet over the surface.



INTERLUX

Multiple coats of Interprotect or other barrier coating are applied after filling the blisters and fairing the surface.

Check the moisture content of the fiberglass laminate with a moisture meter before applying any coating. Test the hull both above and below the waterline in several areas every two to three feet apart. Mark the spots on the hull where you take the readings and every few weeks again check the moisture content. A meter reading of 2% or 3% is recommended. Another method to determine hull dryness is to lay 30.4cm (12") 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. Remove the plastic, wipe the area and plastic dry and repeat until the plastic remains dry.

When thoroughly dry, wash the bottom again with freshwater. Scrub the surface with a 3M Scotch Brite pad to remove any surface contaminates leached out during drying such as glycol, a liquid component of polyester resins that unlike water, does not evaporate. Some manufacturers recommend pressure washing the hull with hot freshwater every three to four weeks during the drying processing to remove all glycol contained in the laminate. When the surface has thoroughly dried, apply a sealer coat to cover the exposed laminate surfaces. These sealers are typically low viscosity epoxy coatings designed to seal voids and pin holes prior to applying a fairing compound and barrier coatings. Follow the manufacturer's directions. Epoxy coatings developed for blister repair include many epoxy resin systems (West Systems, East Epoxy and others), Interlux's Interprotect System and Sikkens Epoxy GP System.

The surface is now ready for fairing. Fairing is the process of making the surface flat and smooth again. Any surface bumps or dents in the hull will result in a decrease in performance and appearance. Apply the fairing compound to fill the exposed cavities. Use large putty knives and battens to apply a smooth layer of filler. Several thin coats are better than one thick coat. Don't use a polyester fairing compound below the waterline. Epoxy or vinylester work best here. Again, follow the manufacturer's instructions. When dry, sand off high spots, remove dust and refill low spots. Be sure there are no pinholes or glass strands protruding through the filler.

Once the fairing compound material has dried, proceed to sand or "rough shape" with 36-grit sandpaper or disc to knock down the material quickly. Don't sand too

Estimating Coverage

Use the following formulas to calculate the square footage of the underwater area when estimating coverage of epoxy-based coatings and antifouling paints:

For displacement powerboats and full-keel sailboats
Beam + draft x LWL (waterline length) = square footage

Planing powerboats and modified-keel sailboats
Beam + draft x LWL x .75 = square footage

Fin-keel sailboats
Beam + draft x LWL x .50 = square footage

much or you will have to apply more fairing compound to your low spots. Finish sanding with 80 grit followed by 180 grit to refine the surface for painting. Follow manufacturer's instructions for finishing details.

Multiple coats of a recommended epoxy barrier coating followed by a primer and antifouling paint are now applied according to manufacturer's instructions at this time. Wash the hull with the recommended solvent before applying primer.

Prevention

Is osmosis preventable? It's estimated that one in four fiberglass boats will get gelcoat blisters in its lifetime. The obvious answer is yes, there are preventative measures you can take to slow down and delay this occurrence. The first line of defense is your boat's gelcoat. Apply a barrier coating to new hulls before commissioning. Other protective measures such as dry storage, frequent spot repair of defects in the gelcoat and additional hull coatings will help slow down and delay the possibility of blisters forming.

Epoxy coatings applied on a sound, dry hull provide a durable, water-resistant barrier; however no system is foolproof. Even epoxy coatings allow some absorption. The key to a successful repair is to remove all of the damaged laminate, thoroughly dry the hull and correctly apply the barrier coats. To reduce the possibility of blisters reoccurring keep the bilge as dry as possible and the boat well ventilated. Install additional vents to eliminate condensation. Solar-powered vents offer an efficient and affordable means of increasing air flow. Finally, check the barrier coat annually. If scraped and dinged, repair and recoat promptly.

Many thanks to Joe Dardis, 3M Marine Technical Service Specialist for contributions to this article.

DIY Repair Bill

Approximate cost for repairing a 7.8m (26') sailboat covered with small blisters. In this example, sandblasting was not necessary. Prices vary depending on the blister repair product used. Professional yards charge about $100 per foot (LOA) for a complete blister repair. Estimates for DIYers run about $60 per foot.

Dewaxer $50
Fairing compound $200
Epoxy coating $350
Anti-fouling primer (1 coat) $90
Anti-fouling paint (2 coats) $280
Rollers, sandpaper, discs, brushes, solvent $100

TOTAL $1,070

CAST OFF

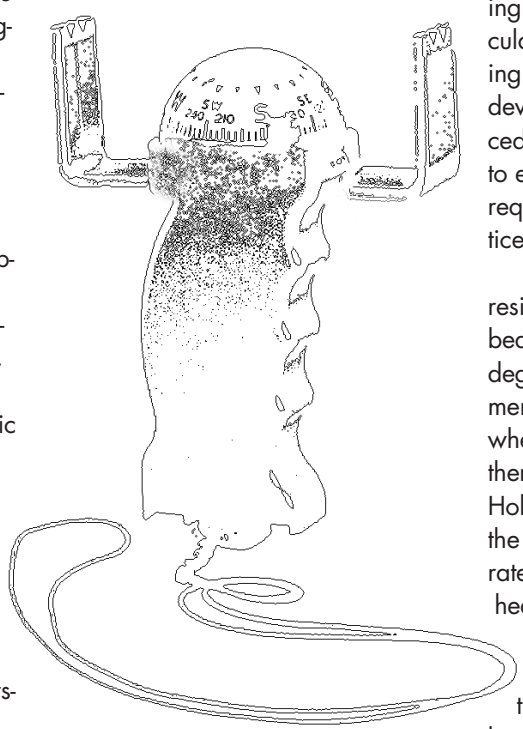
ADJUSTING A COMPASS

Using a hand-bearing compass is simpler than the traditional "swinging" of the compass.

The compass is the single most important navigation instrument on your boat. Although most fiberglass and wood boats do not have any magnetic influence on the compass, lockers and shelves are used to store tools and equipment which are magnetic. Speakers, steel eyeglass frames, engine instruments and controls, electronic wiring, pocket knives, even flashlight batteries can throw a compass off by many degrees.

To adjust your compass and tabulate a deviation table use the following procedure. Store all magnetic-influenced gear in its usual place, put wiper blades (powerboats) in "Off" position and keep all magnetic sources away from the compass. You may need a non-magnetic screwdriver (a dime works well) to adjust the compass set screws. Pick a calm day when wind and current will not set the boat off course. You must first run several east to west and north to south courses to zero-in your compass before compensating. You'll need an independent reference to run the exact reciprocals for reference while doing this. Floating markers, a range ashore or a shadow pin compass work well. (A shadow pin compass is like a pelorus but with a tall center pin that casts a shadow out to the circle of degree marks.)

First run an easterly (90 degree) course using the steering compass. Return on the reciprocal (270 degrees) using the alternate reference. This could be done by using a temporary floating marker or sighting on a range ashore. The return course must be exactly 180 degrees to the original. Note how much the steering compass differs. While still maintaining the reciprocal course, adjust the E-W adjustment screw on the compass (check owner's manual for location) to cancel half the amount of the error. Repeat the run and double check your calculation.



Next run a north course (000 degrees), then the reciprocal (180 degrees). Again note the error and adjust the N-S adjustment screw to cancel half the error. Rerun the course to double check. Go back to recheck the east-west course. Most likely it will need a small additional adjustment since all these adjustments are interactive. Repeat procedure if necessary.

When you have removed as much of the gross deviation as possible, you are ready to make up the deviation table. Professional compass adjusters prefer to use a gyro compass for reference or a number of accurate shore ranges. To do the latter you must use a pelorus, but now you need an extra crew member. While crossing the range and maintaining a constant heading the relative bearing of the range is measured with the pelorus. Calculations are made to correct for ship's heading. The difference between the calculated bearing and the actual bearing as measured on the chart is the deviation on that heading. This procedure is time consuming and prone to error by inexperienced persons. It requires considerable skill and practice, not to mention a pelorus.

An easier way to measure the residual deviation is to use a hand-bearing compass which has one-degree graduations. Have a crew member hold the compass somewhere on the boat's centerline where there is no local magnetic influence. Hold the compass steady, aligning the centerline with the card to accurately measure the boat's magnetic heading. The helmsman steers courses at 15-degree intervals maintaining each heading until the crew notes the corresponding hand-bearing compass reading. It helps if the helmsman calls "mark" or "good" when the steering compass is actually right on course. At that instant the other person records the reading. This process works even when the compasses are swinging either side of the exact heading. Do this check with all equipment and electronics in their normal operating

position when cruising.

As tempting as it might seem, do not use your GPS (if equipped) course over ground (COG) readout. The displayed value is an averaged value indicating the mean course made good between successive positions, not the instantaneous heading of the boat. Your instantaneous heading could be off by five or 10 degrees. The only exception would be if you steer towards a distant mark with a known location entered as a waypoint. The bearing to waypoint from present position can be used for a reference provided you take your readings at the exact instant the compass is pointing directly at the distant mark. For accurate results you must use a mark at least five miles away and high enough to be visible at all times. This method is only suitable for checking specific headings, not for checking every heading at 15-degree intervals.

The next step is to produce a final deviation table. The simplest is to have a three-column table with magnetic course (as read from the head-bearing compass) in column 1, deviation in the center and the compass heading in column 3. The increments could be as little as five degrees or as much as 30 (the test above uses 15-degree increments). A pictorial method is to have two compass roses with lines connecting related points. One rose is the magnetic heading, the other is the boat's heading. If the known magnetic or compass direction falls between two values, use the largest deviation amount. Should you need a more accurate result, both methods demand that you interpolate. There are involved calculations for determining precise magnetic and compass headings that are beyond the scope of this article. Many navigation books refer to a Napier diagram (named after the man who developed it in the 1800s). This is a more simplified chart that converts between magnetic and compass courses without separate tables.
— Arild Jensen

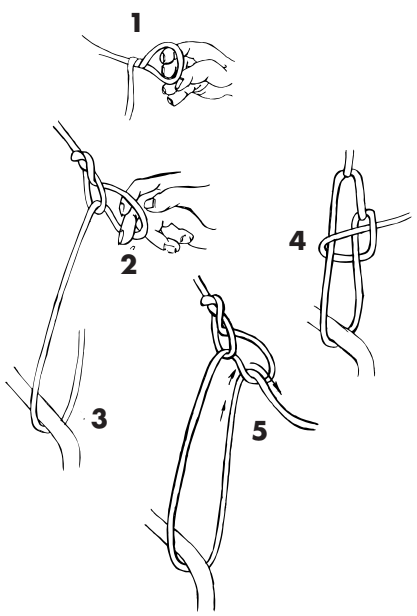
SAMPLE DEVIATION TABLE

Boat's Heading *Magnetic	Deviation	Boat's Heading Compass
359	1W	000
013	2W	015
027	3W	030
040	5W	045
053	7W	060
213	3E	210
229	4E	225
247	7E	240
264	11E	255
285	15E	270
etc.		

*Read from hand-bearing compass
Note: deviation is West if the compass course is greater than the magnetic course.

KNOTTY KNOW-HOW

One of the best knots for securing the dinghy on deck, barber hauling the jib, tying the canoe or cartopper to a roof rack or car bumper, tightening the life lines, or any lines for that matter, is the Trucker's Hitch. It's a mechanical block and tackle which gives a three to one purchase that's easily released, even when wet or under tension. To tie, hold the line in your left hand, form a loop with the fingers of your right-hand and twist the rope counterclockwise two times (**Figure 1**). Holding the twisted line securely with your left hand, make a small loop where the line is twisted in the bitter end (free end) and draw it through the first loop (**Figure 2**). This forms the upper block and tackle. Pass the bitter end under the rack or through an eye, block, cleat or whatever (**Figure 3**). This becomes the lower tackle. Route the line through the upper loop and yank down as hard as you can (**Figure 4**). To increase the pulling power, wrap the bitter end under the support a second time. Draw tight and tie off with a couple of half-hitches (**Figure 5**).



ENGINE TROUBLESHOOTING

EASY FILTER REMOVAL

A standard automotive oil filter wrench does a quick and easy job of removing a water separating fuel filter. This band wrench wraps around the filter and tightens when

you apply pressure. Made of mild steel, it will rust but you'll get a few years of use before one needs replacing. Inexpensive, the wrench is available at most automotive supply stores for $12 or less.

GETTING RID OF BARNACLES

When zebra mussels or barnacles clog your engine water intake there's no need to haul the boat or hire the services of a diver. A more economical alternate costs about $2 in materials and takes less than an hour to complete. First close the seacock and remove the intake hose. Affix a long piece of rigid hose to the seacock. Make sure the hose is long enough to reach well above the waterline or you'll have to man the pumps! Brace the hose with a vertical pipe or wood scrap. Open the seacock and run a stiff wire (coat hanger) or metal rod through the hose and seacock to remove the varmints.

PROPELLERS: ARE MORE BLADES BETTER?

Propeller technology has recently given boaters more choices about blades. Four, five and even six-blade props are becoming popular for their ability to reduce vibration throughout the rpm range.

Four-blade props can improve planing off time and fuel economy in the cruising range. They significantly reduce cavitation in turns and

improve rough-water handling and control. They're very efficient when getting on plane because there are more blades in the water at once. In mid-range throttle, a four-blade is most efficient. A boat can normally pick up 2 to 4 mph as the prop lowers the slip factor. But in high range, they sometimes seem to lose some performance, perhaps because they create additional drag. Generally, a three-blade propeller will allow slightly better top-end speed on most boats.

Five-blade props are well suited for extremely heavy applications. Such props can significantly increase performance and handling over three-blade props on high-mounted motor/drive applications. This often allows owners to improve not only low-end and mid-range performance, but top end as well. As higher engine mounts reduce drag, multi-blade props often allow the use of higher pitches that can let an engine develop more rpm and increase speed.

For water skiing, where engine heights are usually low, multi-blade props produce superior hole shots and minimize speed variations. However, adding more blades can slightly reduce top-end speed.

Information supplied by Mach Performance.

FLUSH-OUT VALVE FOR INBOARDS

Inboard engine systems that operate in salt or brackish water should be

Forespar's Engine Flush Out Valve also facilitates flushing out inboard engines with antifreeze for winter lay-up.

flushed at regular intervals with freshwater to prevent corrosion. Forespar's Engine Flush Out Valve makes this maintenance quick and

easy. Made of Marelon, a glass-reinforced nylon designed for marine use, it comes with a specially designed thru-hull fitting that replaces the existing one. The valve threads into the thru-hull and the barb end connects to the engine intake cooling hose. When the system needs to be flushed out, simply connect a garden hose to the brass female coupler on top of the valve. Turning the valve handle 90 degrees allows freshwater to enter the system. It also works well with antifreeze when flushing the engine for winter storage in cold climates. Available in four sizes from 2.54cm to 5cm (1" to 2") in diameter, prices start at US$84.

DIESEL ENGINE TROUBLESHOOTING

A guide to checking some of the most common problems with diesel inboard engines.

Symptom	Check-over
Engine will not crank over	1/ Starting battery selector switch in off or wrong position. 2/ Engine panel key switch not turned on or malfunctioning. 3/ Battery connections at the engine or battery are loose or corroded. 4/ Low battery power: you'll hear a clicking of the starter solenoid without engaging the starter. 5/ Seized transmission: check lubricant level and color. Black oil is caused by heat and seizure.
Engine cranks but will not start.	1/ Air in the fuel system (see *Bleeding a Diesel Engine,* Spring '95). 2/ Weak battery, faulty starter or bad electrical connections. 3/ Clogged air filter(s), plugged intake or blocked exhaust. 4/ Blocked fuel filter.
Engine runs then shuts down	1/ Check fuel level in tank. 2/ Air in the fuel system. 3/ Contaminated fuel or clogged filters. 4/ Faulty fuel pump. 5/ Clogged fuel tank fitting on top of pickup tube. 6/ Fuel injection cut off due to faulty governor or governor system.
Overheating	1/ Blocked thru-hull intake or water strainer. 2/ Clogged or broken water pump impeller. 3/ Thermostat is stuck closed. 4/ Dirty cooling system: flush with cleaner.
Full load operation impossible	1/ Clogged fuel filter. 2/ Worn fuel pump plunger.
Bad exhaust color	1/ Incorrect fuel injection timing. 2/ Bad fuel. 3/ Faulty injection valve. 4/ Faulty intake and exhaust valve adjustment. 5/ Leaking intake and exhaust valves.
Low engine oil pressure	1/ Leaking lubricating oil. 2/ Clogging oil filter. 3/ Loose oil regulator valve. 4/ Low lubricating oil viscosity. 5/ Excessive gas leaking into crankcase.

DIY PROJECTS

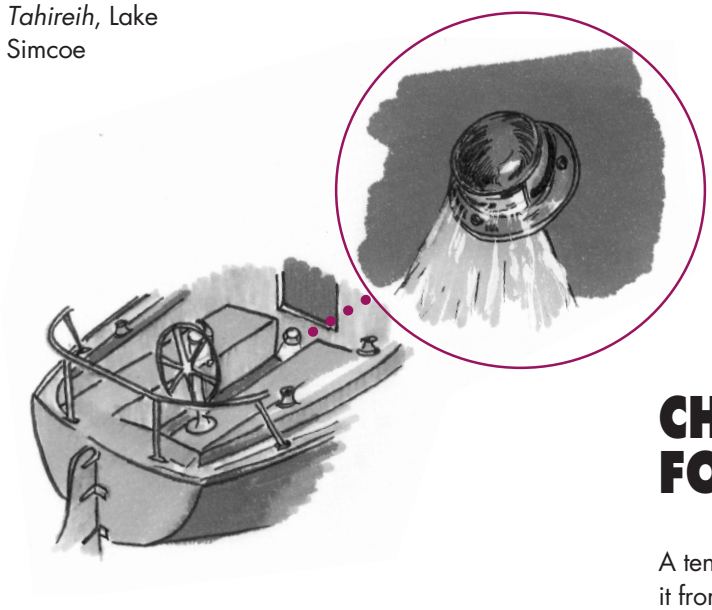
Illustrations by Anne-Marie Hendry

FOOTLIGHTS FROM OLD NAV LIGHTS

If you are planning to upgrade your old navigation lights don't throw them away, recycled them. Thousands of boats were once equipped with round stainless steel dome lights containing a clear, red or green plastic lens. While these are totally inadequate as navigation lights they can serve other uses.

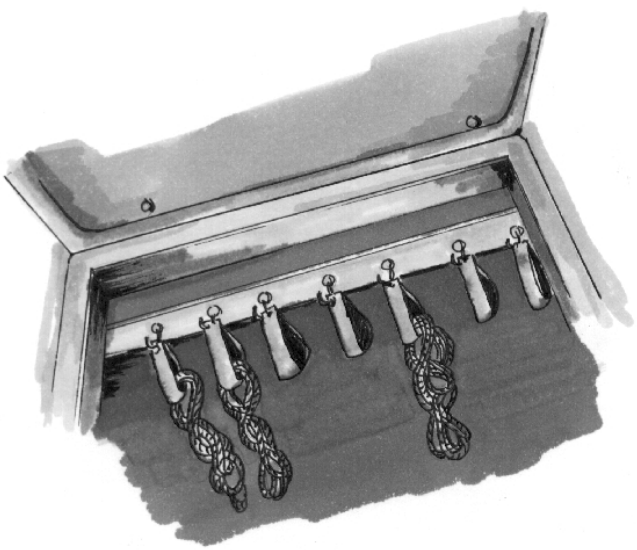
Mounted on a vertical surface such as a cockpit bulkhead or a footwell with the lens opening downwards, they make excellent footlights while blocking any light from going upwards into your eyes. The stainless steel shell protects the lens from falling objects. A white or red lens is preferred; a green lens could be used but it tends to make everyone look seasick. Depending on how many you scrounge, you could even use them in the cabin, on the companionway ladder or in a closet or locker. Using a large drill bit, drill a hole for the bulb and wires. Attach 16-gauge wires to the leads from the light and run the positive wire to your electrical panel and the negative to a terminal block. For easier access from the cockpit, mount a toggle switch inside the cabin near the companionway entrance. Connect wires from the light to this switch, then route wires to the panel and block. Bed the stainless steel fasteners and rubber gasket (included with most lights) in marine sealant to give a watertight fit.

Thanks to Arild Jensen, *Tahireih*, Lake Simcoe



LINE ORGANIZER

Most boats, especially sailboats, have the common problem of finding easily accessible storage for all the many lines on board. One easy solution converts a cockpit locker into organized storage for lines and sheets using cup hooks. Take large brass cup hooks bedded with marine sealant and screw them into the hull. Alternatively, you can glue a wood spacer to the hull then attach the hooks. Space the hooks about 6.3cm (2-1/2") apart. Take a strip of 2.54cm-wide (1") heavy duty leather (cowhide) and cut into 25.4cm (10") lengths. Punch a small hole in each end and slide the ends over the cup hooks, forming a loop. To use, simply remove the top piece of leather, slide it through the line and rehook. The lines lay flat against the hull and use up minimal space. With enough hooks you can stow spare jib sheets and halyards, dock lines, reefing lines, emergency gear such as safety harnesses and tethers, extra block and tackle and any other paraphernalia.



CHAFING STRIP FOR TENDERS

A tender requires some sort of chafing protection to keep it from destroying your boat and protect it from damage against docks. A rubber or plastic rubbing strip glued or tacked on the gunwale will suffice, but a rope chafing band is more traditional and "yachty." A tightly bound rope surrounds the tender just below the gunwale. There are two methods of securing the chafing band to the tender depending on whether or not it carries an outboard motor.

DIY PROJECTS

Materials List

- 3-strand rope 1.58cm to 1.9cm (5/8" or 3/4") diameter
- Tape measure
- Canvas patches
- Prybar
- Fid
- Self-tapping stainless steel screws
- Waxed thread and canvas needles
- Palm (optional)
- Epoxy
- Plexiglas
- Marine polyurethane sealant

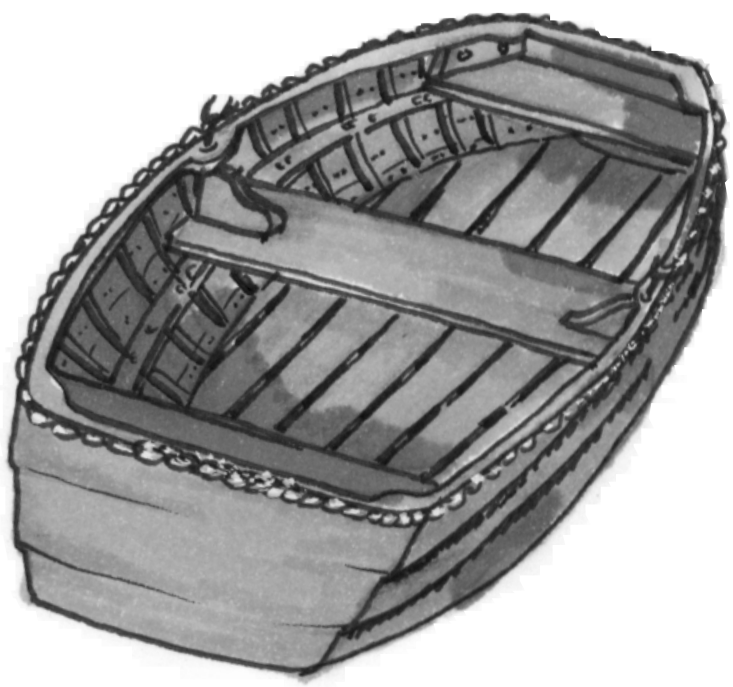
On dinghies without a motor, first measure the hull around the gunwale and add an extra .6m (2") for splicing. Find the center of the rope and secure it to the stem using a self-tapping stainless steel screw. Pull each line to the stern and draw tight. Cushion any sharp edges and transom corners with a scrap of canvas or sailcloth placed under the rope. Overlap both ends of the line, pulling as tight as possible, then mark where they join for splicing. Back off the screw from the stem, remove the line and splice the ends together **(Figure 1)**. If you want a more continuous flow in the line to the transom then you should long splice them. I prefer the extra bulk of a short splice that gives additional chafing protection. Provided you complete the same number of tucks (splicing passes over and under) each side, the rope band will still look uniform. When you complete the splice you will have a continuous loop or bight to secure the band to the tender.

Now refasten the midpoint to the stem with the screw. With the help of a partner, work the line to the stern using a prybar to gently pop the line over the transom. Don't forget the chafing patches over the gunwale. Use a rope fid to open the lay of the rope, then drive a self-tapping stainless steel screw through the line every foot along the length of the hull. Bed all screws in a marine polyurethane sealant. Opening the lay embeds the screw head so it doesn't stand proud and scratch your yacht.

Tenders with an outboard engine will need to keep the transom free. After bending the line around the stern you can either drill through the transom or secure the bitter ends of the line to the transom. In the later case, you'll need to form a Flemish coil or doily with the bitter ends **(Figure 2)**. Work the rope in a circular fashion until it forms a flat mat. To ensure the rope lays flat, work right-hand twisted rope into a clockwise circle and vise versa. Sew the coils together with waxed thread and a heavy duty needle, then epoxy each to a 15cm (6") square piece of clear Plexiglas. Fasten each piece to the hull with a self-tapping stainless steel screw bedded in sealant. Mounting coils to the plastic facilitates removal for cleaning or painting.

Another method for mounting the rope ends is to drill through the transom, just inboard of the corners at the gunwale. Pass the ends through the hole then secure with a figure eight knot. Whip (**Figure 3**) or heat seal any exposed rope ends with an electric hot knife, butane lighter or torch. A variation on this is to pass the rope ends through the drilled holes **(Figure 4).** Form an eye splice in one end, pass the other end through the loop, draw the line taut, then seize the bitter end to its standing part.

Thanks to R. Bruce Macdonald, Victoria, BC



DIY PROJECTS

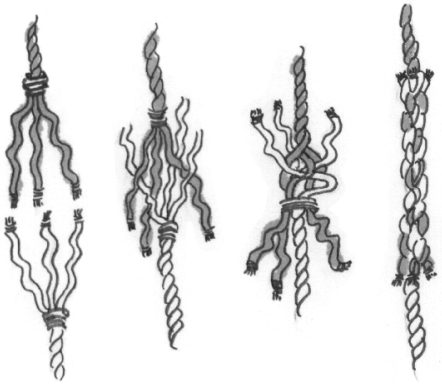


Figure 1

A short splice expands the diameter of the rope, providing better chafe protection. Tape rope ends, then unlay the line about 13cm (5") from the end. Join the ends so that one strand from each line lies between two strands from the other line. Temporarily tape or tie the three strands on one side in place. With one side secured, splice the other three strands as you would for an eye splice. Five or more tucks are recommended. To finish, cut ends leaving a 1.3cm (1/2") tail and fuse with a match or butane lighter. Untie the other side and splice as above. Roll the splice on a flat surface to smooth out. For a more uniform splice, taper the strands with scissors after completing three tucks.

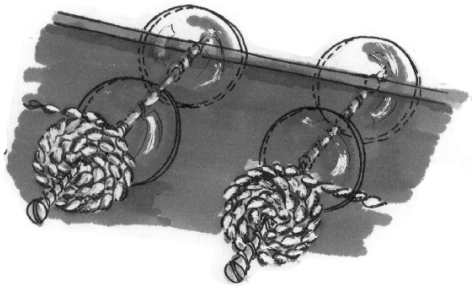


Figure 2

For dinghies equipped with an outboard engine, make a flemish coil with the bitter ends, then glue each to Plexiglas and screw to the transom.

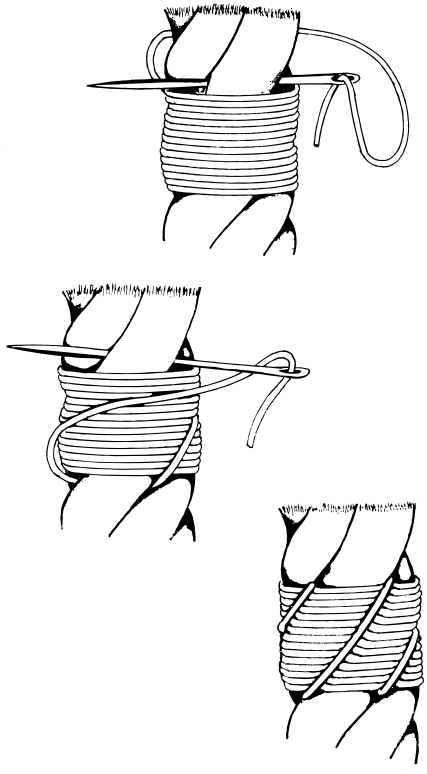


Figure 3

A sailmaker's whipping finishes the rope ends.

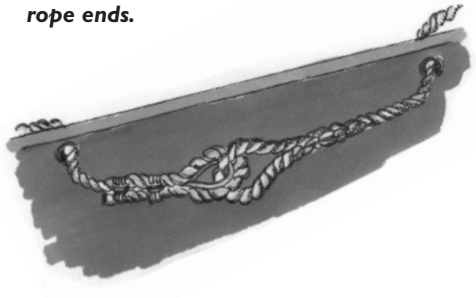


Figure 4

To secure rope ends at the transom, form an eye splice in one end, pass the other end through the splice, draw tight then whip the standing part.

Share a boat-tested project with other DIY readers. If we publish it, we'll send you $25 to $150 depending on the published length.

ELECTRONICS

PLUG INTO AC ENERGY

An inverter lets you add creature comforts on board with very few drawbacks.

When you leave shore, there's no need to leave the comforts and conveniences of landlubbers behind. With an inverter and a beefed-up direct current (DC) system you can operate a hair dryer, power tools, computer, use a toaster, coffee maker, compact microwave, watch TV, recharge your hand-held radio battery or vacuum the cabin sole. On boats without alternating current (AC) system or shore power, an inverter offers an economical way of operating appliances off the battery. On larger cruisers already equipped with a generator, inverters supply immediate AC power for operating light loads without the need to start up the generator.

The key components of any onboard energy system are an inverter, battery charger and bank of batteries. An inverter converts battery-stored DC power to 115- or 120-volt AC energy. The battery charger recharges the batteries from AC power supplied by the engine alternator, generator, solar panel or shore power. Installing an inverter is quite simple and easily accomplished in a few hours. Selecting the proper inverter and upgrading your DC system to handle the additional power load is somewhat more complicated.

Inverter Selection

Inverters are rated in watts according to the continuous power they can produce. Most units have higher start-up (surge) capabilities that deliver large amounts of power for short periods of time. Inverters for onboard use range from 100 to 2,500 watts (larger units are available but not practical for pleasure boats). For runabouts or small weekend cruisers, an inexpensive, portable 150-watt inverter that plugs into a 12-volt receptacle is ideal for powering lights, TV, fans, mixer or other small appliances. To operate a microwave or power tools, an inverter needs to provide more than 600 watts.

Models are available with 12-, 24- or 32-volt DC input and a variety of accessories and options. Most inverters have a display on the front panel showing the voltage status of the DC system. Many manufacturers offer optional remote panels that provide information on battery volts, amps and AC input. Some units such as Vanner Weldon's Bravo line, Dimensions marketed by Arbrux and the Heart Interface EMS and Freedom series are self-charging. These "smart" inverters have a built-in, automatic three-stage battery charger that senses when there is no power consumption and goes into idle mode, drawing minimal current from the batteries. Turn on an AC appliance and the inverter switches into charge mode. Such units extend the life of your batteries and eliminate the cost of buying a separate battery charger. Units not equipped with charging systems monitor battery voltage and shut down if the voltage goes too low or too high.

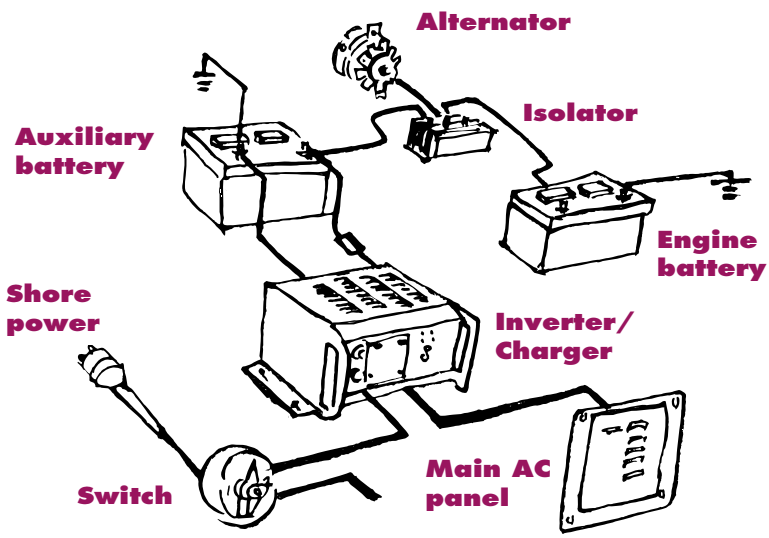


Figure 2

Typical installation with shore power, generator and self-charging inverter powering a single AC panel.

ELECTRONICS

Alarms and LED indicators give advance warning of overheating or overloading. Larger inverters often automatically transfer AC power from the batteries to a generator or shore power when available.

The inverter you choose must be able to handle all the appliances you plan to use. List the appliances that would be running at the same time and determine their continuous power rating and surge requirements in watts (see Figure 1). If you are planning to use large powerful motors with high surge load requirements, you may need a larger inverter than if you were running just lights or small appliances. Total wattage determines the maximum power output of the inverter. Always select a unit slightly larger than your maximum load requirement — once you become accustomed to using electrical appliances on board, it's likely you'll want to add more.

Buy the best unit you can afford and one that meets your power requirements and space limitations. Cost for a basic unit averages $1 per watt. Options such as battery charger, remote control, transfer relay or 24-volt input substantially increase the selling price.

ESTIMATING BATTERY POWER

After determining the power requirements of the AC appliances operated on board, you need to calculate the available capacity of your boat's battery bank (see Figure 1).

For an inverter to operate efficiently, your boat must be equipped with a good battery system and adequate recharging capabilities. Space, weight and budget limitations determine the size, type and number of batteries. The batteries you use affect the performance you can expect from your inverter. The larger the battery capacity, the longer the time between battery recharges. Only use deep-cycle batteries (never starting batteries) which can withstand repeated cycles of heavy discharge and recharge without damage. Deep-cycle batteries are rated in amp-hours. This rating is usually relative to a 20-hour discharge cycle. A 100 amp-hour battery, for example, will provide 5 amps for 20 hours (5 x 20 = 100). If the rate of discharge is higher, the battery will not deliver its full rating. A DC system rated at 200 to 400 amp-hours provides adequate power for a weekend of average use of a microwave, lights, coffee pot, hair dryer, TV and VCR. (See Figure 1 for determining battery amp-hours.)

Depending on the unit, some manufacturers recommend installing a separate bank of wet or gel cell deep-cycle batteries. To create a battery bank, batteries are linked using

Figure 1

Calculating Battery Requirements

To determine the total daily load on a battery, take the power usage including surge loads in watts of all appliances, multiplied by the hours of use between battery charges. If an appliance is rated in amps, multiply volts by amps to obtain watts. For example, a 120-volt appliance rated at 10 amps requires 1,200 watts of power. Convert the total watts to amp/hours by dividing by the DC system voltage (12, 24 or 32) then add the values. Multiply amp/hour value by 1.1 to 1.2 (depending on the inverter) to determine the total battery drain.

Since the number of amp/hours consumed by AC loads before recharging the battery should be no more than 50% of the battery's rated capacity, you'll need about 288 amp/hours (or three 100-amp batteries) to provide the AC power in this example.

Appliance	Total W Rating	Hours of Use Per Day	Total Watts	Amp/hours Use(÷12)
13" TV	80	2	160	13
Stereo	50	2	100	8
VCR	50	2	100	8
Blender	300	1/6	50	4
3/8" drill	500	1/12	42	3
Hand sander	500	1/12	42	3
Ice maker	200	1/6	33	3
Coffee maker	1000	1/6	167	14
Hair dryer	1500	1/6	250	21
Portable vacuum cleaner	1100	1/12	92	8
Compact microwave	750	1/4	187	15

Total amp/hours consumed = 100 (Sum of right column).
Multiply by 1.2 for inverter inefficiency = 120
Recharging requires 120 x 1.2 = 144 amp/hours
(Note: numbers rounded to nearest whole number.)

either parallel or series connections. When batteries are connected in parallel, the voltage of the battery bank is the same as that of each individual battery. When connected in series, the total available voltage is equal to the sum of the voltages of each battery.

To meet increased AC power demands, existing DC systems on most boats are most likely insufficient. When calculating the amp/hour drain on your batteries you probably discovered that your boat's present battery is too small. Operating AC appliances is limited by the amount of DC power you can generate and the boat's recharging capabilities. Increasing the size and number of batteries will help. If the total battery drain between recharges is 144 amp/hours, you will need a minimum battery capacity of 288 amp/hours just to power the inverter, without considering other everyday DC loads (cabin lights, VHF radio, etc.). Sailboats that use the alternator as the main source of charge to the batteries should also consider adding a high-output alternator along with a smart regulator to increase charging rates. Consult with the engine manufacturer when upgrading these components.

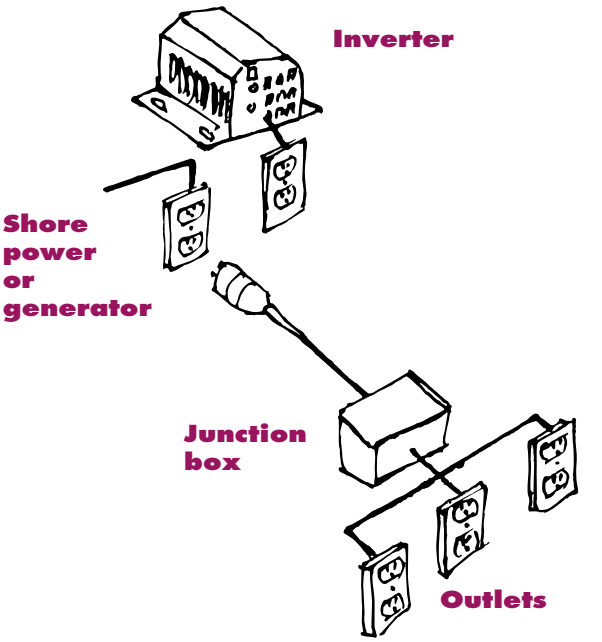


Figure 3

A switching device can be as simple as an AC plug that plugs into the desired AC power source.

Installation

Inverters mount either vertically (bulkhead mount) or horizontally (shelf mount) in a dry location away from water, condensation and excessive heat. Do not install near hatches or exhaust manifolds or in compartments containing batteries or flammable materials. Inverters run hot and need plenty of "breathing" space to prevent overheating. A good rule of thumb is to allow enough room to be able to reach around the unit on all sides. If housed in an enclosed compartment, provide ventilation to allow easy air flow. (Many units are thermally protected, however, and will shut down in excessively high temperatures.)

Place the inverter within easy access to 115- or 120-volt AC system wiring and input wiring from shore power (if equipped). Proper wire and wiring are important to the efficient operation of your inverter. Use only heavy insulated, stranded copper wire (no aluminum) with crimped and soldered lugs. Keep the total DC cable run to under 3m (10') to minimize line voltage loss. It's better to run longer AC wires that are less expensive than DC cables.

Most units come with DC cables that connect to the batteries or a battery switch. Before connecting the cables, make sure the power switch on the unit is in the "off" position. If you are using a battery selector switch set it to the "off" position. Cables must be as short as possible and large enough to handle the required current. The inverter's size and distance from the unit to the batteries determines the correct wire gauge. Run

cables from the battery posts to the positive and negative input terminals on the inverter. Most inverters are not protected against reverse polarity and permanent damage may occur if improperly connected. Tighten all cables to reduce excessive voltage drop and prevent overheated wires and melted insulation.

It's recommended to install an in-line fuse in the positive battery cable to protect against DC wiring short circuits. Install the fuse holder as close to the battery as possible. Use a slow-blow fuse with an amp rating that's sized to allow operation of all your DC-powered equipment. If the battery posts are the terminus for the starter motor, alternator and battery selector switch, you will need to add a negative and positive distribution panel with a single heavy cable leading to each battery post. Separate battery bank from the boat's starting battery with an isolator. This device allows equipment to be operated from an auxiliary battery without danger of discharging the boat's starting battery. When the engine is running, the battery isolator automatically directs the charge from the alternator to the battery requiring the charge.

With smaller inverters, such as Statpower's Prowatt series, appliances plug directly into standard AC receptacles on the unit. These units are ideal for small boats with confined spaces and minimal AC demands such as powering a small TV or computer. Larger inverters with chargers are wired directly to the boat's existing AC wiring or an AC control panel. Before working on AC wiring always disconnect DC power from the inverter. Also, disconnect any other AC power source such as a generator or shore power. Electrical shocks from AC power can be fatal.

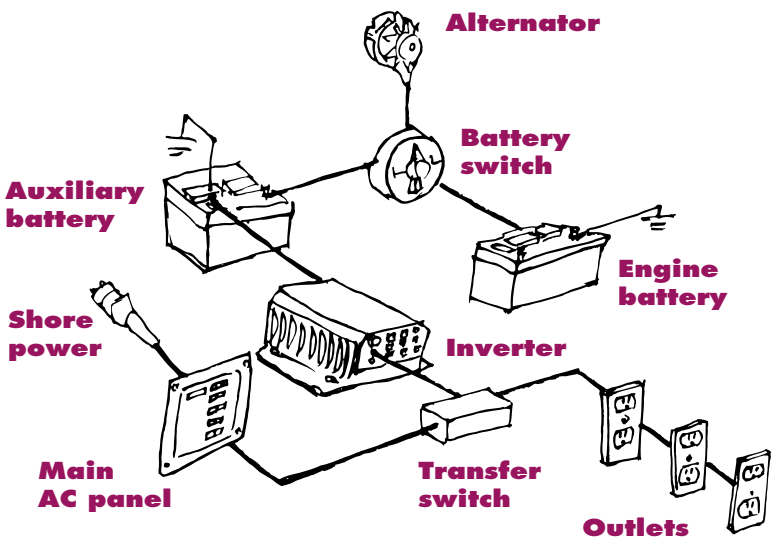


Figure 4

Installation with inverter and an automatic transfer switch.

Determining Recharging Times

To calculate the amount of time you can use only one appliance before it becomes necessary to recharge the batteries, first determine the wattage of the appliance. For example, a 100-watt TV attached to an inverter powered by a 200 amp-hour, 12-volt battery bank will draw about 10 amps whenever it is on (divide the running wattage by 10). Since batteries should only be discharged about 50%, the TV can run for 10 hours before recharging is necessary (assuming the batteries were fully charged). The formula is: 1/2 the battery capacity of 200 amp-hours divided by 10 amps (current draw of the TV) equals 10 hours. Use the same method to calculate time before recharging on 24-volt systems except divide the wattage of the appliance by 20. For 32-volt systems, divide by 27.

Modern AC wiring systems have three conductors: hot (black wire), neutral (white wire) and ground (green or bare wire). Screws on terminals are typically color-coded brass for hot, silver for neutral and green for ground. Use multi-strand, marine-grade, tinned wire; household type, solid-core wire has no place on a boat. It's important to maintain correct wiring polarity, otherwise you risk permanent damage to the inverter. Do not install the inverter to another AC power source (generator, shore power) at the same

time, even when your inverter is equipped with an AC sensing and transfer function.

On boats equipped with other AC power sources, you must install a manual (Figure 3) or automatic (Figure 4) switching device so that only one power source connects to the AC distribution panel at any time. Available from many marine stores, they are commonly used to transfer between the generator and shore power. Do not attempt your own AC wiring unless you have the knowledge and experience to do a safe job. Follow the manufacturer's instructions carefully. It's a good idea to have an authorized electronics dealer check the installation when completed.

Lastly, ground the inverter to the boat's grounding system. With the installation completed, turn the battery selector switch (if using) to select one of the batteries and switch on the inverter. Check the meters and indicators on the unit or optional remote panel. Voltage should read 12 to 13 volts, depending on the battery voltage. Test the system by plugging in a low power load, such as a 100-watt lamp.

Operating tips

When operating an inverter, always use appliances that are within the unit's wattage handling capacity. If the in-line fuse or circuit breaker blows when you turn the appliance on, the high start-up surge requirement exceeds the inverter's rating. Never replace a blown fuse with one of higher value. When operating several appliances, turn each on separately to reduce the start-up load on the inverter. The output power of an inverter is not exactly the same as household power. Slight differences may cause oddities: some appliances with complex electronic controls may buzz or not work at all under inverter power. Microwaves take longer to cook and dimmer switches won't dim. Inverters sometimes interfere with radio and TV reception and may cause a hum on audio systems.

An inverter easily handles light AC loads for extended periods or intermittent heavier loads such as cooking veggies in the microwave. If you find you need to run your engine all day just to recharge the batteries, then use your generator. Power-hungry appliances like air conditioners and refrigerators are best left to the gen sets. On installations that combine an inverter and generator, save the latter for heavy duty continuous loads that also provide power for a battery charger or a self-charging inverter. At all other times or when the main engine is running, use the inverter to supply AC power without the noise, vibration, fumes or maintenance costs (gas, oil or spark plugs) of a generator.

POWERBOAT
RIGGING

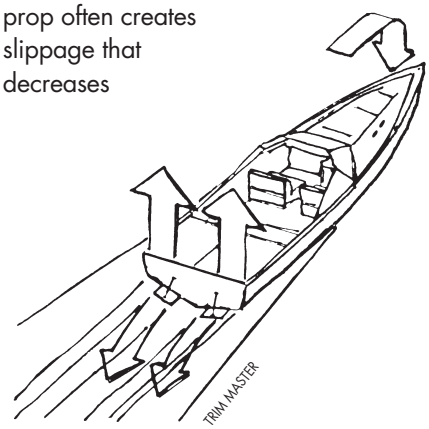
TOOLS

Hole saw or jigsaw
Assorted screwdrivers
Drill and assorted bits
Wrench or socket set
Wire cutter and stripper
Marine sealant
Tape measure
Straight edge
Masking tape
Plastic electrical hangers

TRIMMING FOR MAXIMUM PERFORMANCE

No matter what size or style of boat you own — 4.5m (15') runabout to a 18m (60') cruiser, outboard, stern drive or inboard — a pair of adjustable afterplanes or trim tabs makes a noticeable difference in performance. A boat equipped with trim tabs planes faster and at slower speeds. Trim tabs also correct listing, regardless of weight distribution or sea conditions. They improve the running attitude of your boat, reduce porpoising when traveling at speed in smooth water and hull pounding when running in rough seas. With the simple flick of a control switch you can correct a bow-high condition or adjust hull trim when carrying additional passengers and loads.

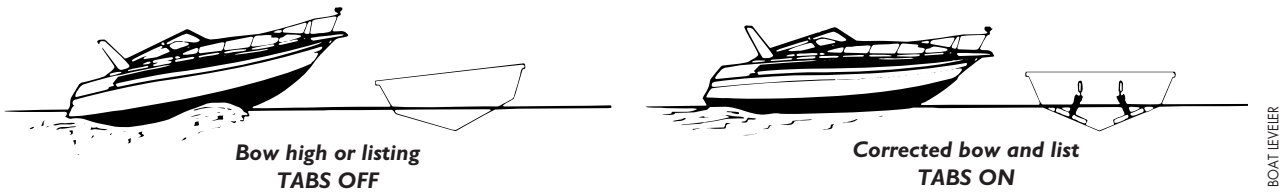
Trim tabs mount on the transom and are driven by a hydraulic motor and pump unit attached to the inside of the transom that drives hydraulic cylinders on each tab. Dual switches at the helm control the up or down positioning of each tab simultaneously or individually. As trim tabs are driven into position by the cylinders, water is deflected underneath the tabs, creating an upward pressure on the planes. This pressure raises the stern and lowers the bow. This reduces engine strain, pounding and drag and increases visibility. Less drag and engine laboring mean increased performance, higher speeds and increased fuel economy. Lifting the stern decreases wake, providing a smoother and safer ride for skiers and "bobbers." Trim tabs also enhance propeller performance. An untrimmed prop often creates slippage that decreases speed and performance. Adding trim tabs allows the propeller to deliver maximum thrust, propelling the boat in a straightforward motion through the water.



As trim tabs are lowered, water is deflected underneath, creating an upward pressure that raises the stern and lowers the bow.

Selection

Bennett Marine, Boat Leveler (Insta-Trim), Hynautics and Trim Master all offer a variety of trim tabs to fit stern drive, inboard or outboard single and twin engine installations. Most suppliers offer specialized tabs for sport boats (running 40 mph to over 60 mph) and bass boats.
Made of stainless steel, trim tabs come with 12-, 24- or 32-volt power



kits. Boat Leveler tabs come with easy-to-install color-coded wiring in two lengths with quick connect fittings and standard rocker-type controls; an electronic tab locator is optional. Trim Master tabs are sold as complete sets or individual components. If you're retrofitting an existing system, all Trim Master components, including switches, power units and cylinders, are adaptable to existing electric or hydraulic trim tab systems by other manufacturers.

"Trim tabs trim the hull while power trim on the outdrive adjusts the prop."

Size selection varies based on engine configuration and horsepower, weight distribution, type of boat and use. Many older cruisers have tabs that are much too small and do nothing more than correct for list. Larger and/or slower boats require larger trim tabs than smaller, faster boats. Use the manufacturer's general sizing recommendations as a general guide when purchasing trim tabs. You should choose at least 2.54cm (1") of trim tab per size for every 30.5cm (12") of boat. A 6.6m (22') boat, for example, requires 61cm by 22.8cm (24" by 9") trim tabs. Tab widths or chord length (fore and aft measurement) are available in 20cm (8") to 30.5cm (12"); lengths are based on boat length. (Custom sizes are available too.) For heavy boats or boats with twin engines and limited transom space, the larger 30.5cm (12") chord is recommended.

POWERBOAT RIGGING

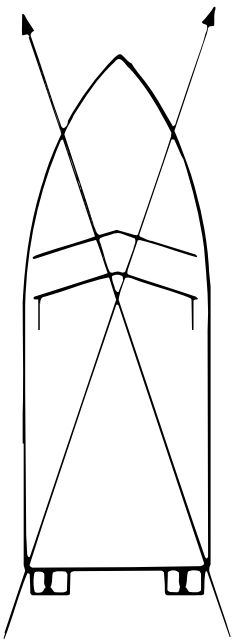
Before buying, double-check the size by measuring the transom. Measure in a straight line along the bottom, disregarding the strakes. The outboard edge of the trim tab is installed 7.6cm to 10cm (3" to 4") from the chine. For boats with single stern drive or outboard engine, the trim tab length should extend to a minimum of 20.3cm (8") from the centerline. Boats with twins measure the length to the center of each lower unit. On inboard-powered boats, the inboard edge of the trim tab extends to the centerline of the transom. Select the longest tab available to ensure maximum efficiency.

Prices start at CDN $665/ US$450 for a complete system that fits 4.5m to 6m (15' to 20') boats up to CDN $1,150/ US$795 for a 65-footer. (Low-priced, non-adjustable models are available but are much less effective.) Helm controls range from standard toggle or rocker-type switches to more expensive optional electronic controls with LCD and LED readouts that add $200 or more to the price tag. Warranties range from one year to lifetime (Trim Master) depending on the brand.

Installation

Trim tabs are packaged with power units, hydraulic cylinders and lines, brackets, switches, mounting hardware and all wiring. Trim Master also includes a bottle of biodegradable hydraulic fluid with every set. Installation requires a few standard tools and three to four hours of labor. Pre-wired units packaged with a wiring harness reduce installation time and facilitate routing wires from the transom to the dashboard. Most manufacturers supply a set of templates for accurate drilling of holes along with complete step-by-step instructions.

General mounting instructions follow; however, you should carefully follow instructions included with your tabs as they vary between brands. First, position tabs the recommended distance (check owner's manual) from the chine and the centerline. Tabs mount as low as possible (check manufacturer's specifications) on the transom without extending below the hull. Use a straight edge placed under the center of the trim tab and the hull bottom to set tab height and trailing edge as specified in the installation instructions. Curved transoms require adding shims to give a level mounting surface. Check that the upper mounting of the hydraulic cylinder does not interfere with any obstructions inside the transom. (Dual cylinders are standard on larger tabs.) If the transom is inaccessible due to the fuel tank or flotation, or if there is inadequate room inside the transom to connect the hydraulic lines, contact the manufacturer.



BENNETT MARINE

Trim tabs operate in reverse order.

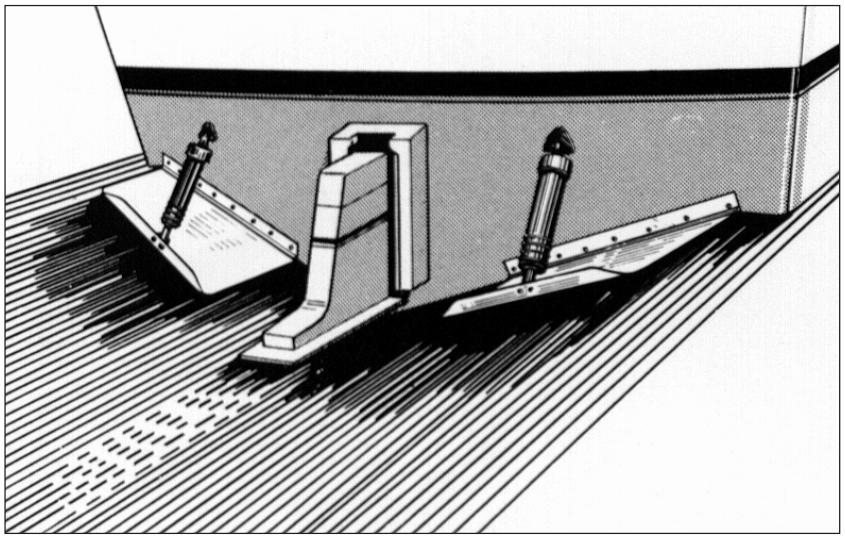
Carefully measure the location of the trim tabs on the transom. Before drilling, ventilate the bilge and make sure it is free of gas fumes to prevent an untimely explosion. Drill pilot holes and dry fit the tabs. Drill the correct size hole, apply marine epoxy or sealant around all holes and coat screws, then fasten tabs to transom. Position the upper mount of the hydraulic cylinder on the transom. Drill small pilot holes, check the fit, then fasten the cylinder mount.

Next mount the hydraulic power unit on a bulkhead in a dry location (these units don't like to get wet). Run lines, cut to length and connect fittings. Using a hole saw (or jig saw) cut a hole in the dashboard for the switch. When wiring is complete, move each tab switch and check operation of both tabs. Work tabs in the full down and up position two or three times to purge the cylinders and lines of all air. Place tabs in full down position and check for leaks. Support the wiring harness and hydraulic tubing with plastic hangers. A spacing of less than 45.7cm (18") apart is recommended.

Trim tab maintenance includes regular checks of fluid levels and wires for loose or corroded connections. Manufacturers recommend applying an epoxy metal primer followed by two coats of antifouling paint to the tabs and cylinders to discourage marine growth. Saltwater users may need to attach a zinc anode to the top of each trim tab to deter electrolysis. (Boat Leveler

brand tabs are guaranteed against electrolysis.)

On The Water



Relaunch your boat and conduct sea trials on flat water with the boat lightly loaded. Slowly push down the throttle and move both tab switches in the "Bow Down" position. When learning how to use trim tabs, operate the switches in short, half-second bursts, allowing time for the boat to respond to tab adjustments to avoid overtrimming. When overtrimmed the bow plows, reducing manoeuverability. If overtrimming occurs as the boat gains speed, retract the tabs by pressing "Bow Up."

Running at speed, set the throttle at cruising speed and adjust the tabs to obtain the boat's best running attitude. In an untrimmed condition, the bow spray is far aft on the hull, the stern wake is high and there's a roostertail. When trimmed, the bow spray is further forward, the wake is diminished, the roostertail is smaller and farther behind the boat. Laboring of the engine is also reduced and rpms increase without touching the throttle. Be careful not to overtrim at higher speeds as the bow will lower quickly and "dig in," causing the boat to veer sharply. Never move one tab significantly farther down than the other while underway or an undesirable listing may occur. Once the hull is properly trimmed, observe the bow in relation to the horizon and note the helm settings. Under normal operating conditions use the same tab settings to reproduce the same ideal attitude. For engines equipped with power trim, position the propeller parallel to the waterflow, then fine-tune with the trim tabs if necessary. You can adjust tabs separately to align the bow to the proper attitude but never simultaneously activate one tab up and the other tab down.

To correct a listing condition resulting from wind, propeller torque or unequal distribution of passengers or gear, adjust each trim tab independently. Trim the boat fore and aft before correcting for list. If the port bow is high, push the left-side switch on the helm control in the "Bow Down" direction and the port bow lowers. Watch the boat's attitude to the water and do not overtrim. To lower the starboard bow, push the right-side control in the "Bow Down" direction.

When running in choppy or heavy seas, press "Bow Down" and the bow will cut through the waves, offering a drier, more comfortable ride. In a following sea, place tabs all the way up for maximum rudder control. To correct porpoising, press "Bow Down" in half-second bursts. Only a slight amount of trim tab deflection should diminish this condition.

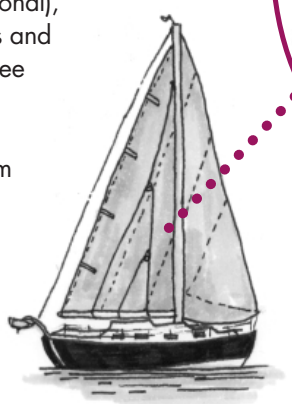
Whether you use your boat for fishing, performance boating or cruising, adding a pair of trim tabs will increase your boat's performance and provide a safe, comfortable and economical ride.

SAILBOAT RIGGING

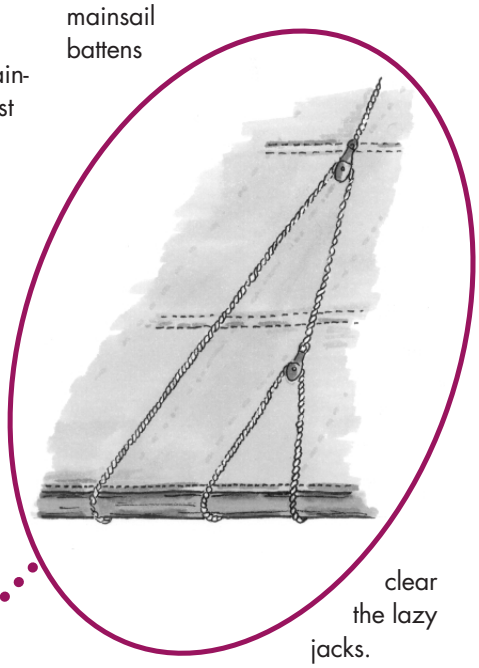
MAINSAIL CONTROL

If you sail shorthanded, lazy jacks help to control and harness the mainsail when dousing or reefing — just release the halyard and the sail flakes on top of the boom. Fully adjustable, they also double as a backup topping lift when needed.

Pre-packaged kits are available but you can easily make your own. All you need is .6cm (1/4") diameter line of the required length, eyestraps, swivel blocks or rings (both optional), two cleats and two or three fairleads. Leading down from two blocks or eyestraps on either side of the mast are two control lines. Intersecting each line are two or three lines that wrap under the boom to form a cradle. These joining lines are tied directly to the control lines or fastened to small stainless steel rings or swivel blocks. The "jacks" are double-ended, passing through fairleads mounted on the underside of the boom, then attached to the control line on the opposite side. The bitter end fastens to a cleat mounted on the boom. Alternatively, you can run the two control lines down either side of the mast to a cleat(s) at the gooseneck or mast step.



When hoisting, let off the lazy jacks and once the main is set, take up the excess line leaving a bit of slack. Watch carefully that the mainsail battens clear the lazy jacks. Keeping the boat head to weather will help. To douse, release the mainsheet, take up the topping lift and tighten the lazy jacks.



Lazy jacks have a tendency to chafe mainsail seams. Slackening them when underway, especially when sailing off the wind, will reduce chafe.

REMOVABLE INNER FORESTAY

Boats equipped with furling systems often compromise sail shape and performance for convenience when using the system for reefing. Manufacturers suggest furling a large genoa to at least 60% of its total area. This means that a 135% reefs to a 90% jib. But when you furl even the best-cut sail, you end up with a fuller shape with little control over luff and sheet tension. A better solution is to install a removable inner forestay. Working or storm jibs are hanked on this stay when needed. When not required, it stows neatly out of the way.

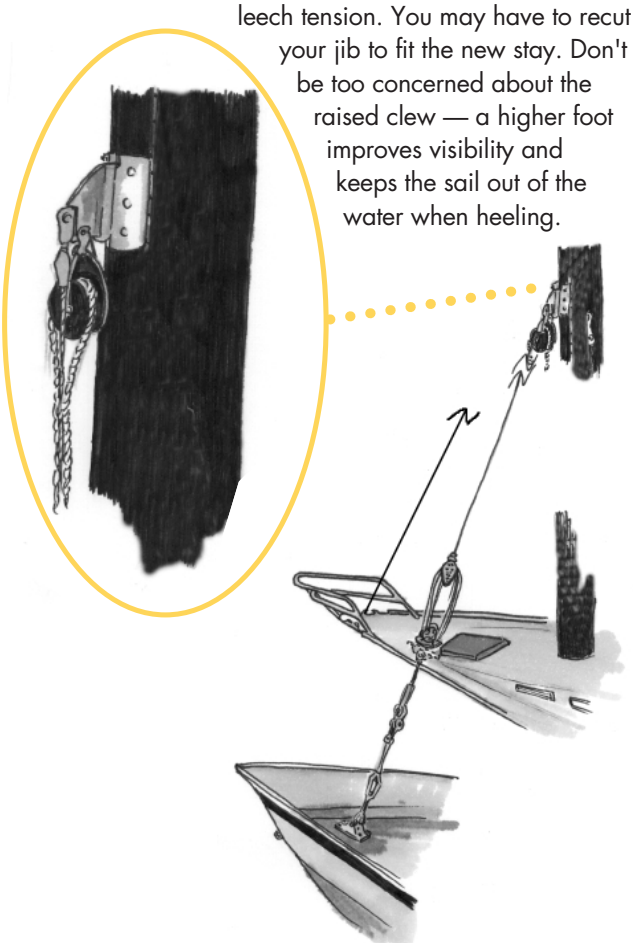
Installation requires a length of stainless steel wire, two terminal ends, mast fitting, swivel block and extra halyard, two fiddle blocks and line, heavy duty deck padeye and backing plate plus additional reinforcing as necessary (see below).

Have a metal fabricator fashion a stainless steel mast fitting, bent to the shape of your mast, with holes for attaching the halyard block and stay. A wide base fitting will evenly distribute the loads around the mast. It may look bulky, but it works better than a hook-in T terminal fitted into a backing plate that may stress the wire if not perfectly aligned. To equalize the increased loading on the mast, install the inner stay just below the upper shrouds on masthead rigs or at the same height as the running backstays. If it's located well below the masthead, you may need to add running backstays to counteract the load. The stay should run as parallel as possible to the forestay: the distance off at the mast measured between the two stays should be equal at deck level. This is not always possible; more often, the stay mounts .6m (2') below the masthead and .9m (30") from the forestay on deck. Measure and cut the stay, remembering to subtract the length of the terminal fittings and lower block and tackle, allowing a .8m (32") span between blocks. The lower block on the four-part tackle needs a snap shackle that fastens

to the deck padeye. When not in use, the inner stay should stow neatly against the base of the mast or clips on the rail. You'll have to experiment to get the stay length just right. The lower block is also fitted with a cam cleat or you can run the standing end aft to a cleat near the cockpit. Terminate the ends of the rigging wire with swage fittings (requires services of a professional rigger) or bolt-on Norseman or Sta-Lok terminals that are easily assembled by hand.

Attach the block and tackle to the stay, draw it down to the deck and determine where to mount the heavy duty padeye. The inner stay puts tremendous force on fiberglass decks that may lift if not properly reinforced. Strengthen decks with a stainless steel or aluminum backing plate mounted directly underneath the padeye. If the deck still lifts when under load, you'll need to assemble a tie rod or wire that attaches to a padeye mounted to a block glassed to the hull.

To use, furl the genoa, hank the jib on to the stay. Run jib sheets through lead blocks that are positioned farther forward to obtain the correct foot and leech tension. You may have to recut your jib to fit the new stay. Don't be too concerned about the raised clew — a higher foot improves visibility and keeps the sail out of the water when heeling.



For boaters who are landlubbers in the winter, here's a step-by-step guide to preparing your boat for hibernation.

When the season draws to a close for many boaters in the northern climes, an annual rite of passage commences with the weekend (or two) ritual of preparing your boat for winter storage. Investing some time and effort now will make next year's launch a lot easier.

Before you haul out, check boat covers and frames, mast supports, cradle or trailer, and lubricate and repair as necessary. Pour fuel additives into tanks before your last trip so the conditioned fuel runs through lines and filters. Additives prevent and remove gum and varnish deposits, remove moisture in fuel systems and prevent carburetor icing and fuel line freezing. The following information is provided as a basic guide to end-of-season maintenance. Different mechanical systems have their own quirks, so read your owner's manuals for specific instructions.

EXTERIOR

❑ Pressure wash bottom, Immediately after hauling out, check the hull for gelcoat blistering (see page 7). Also check for zebra mussels. If you find some, check water intakes on the engine, head and sink. Use an acid-based cleaner to remove heavy buildup of algae and scum from unpainted hulls. Wear protective clothing when working with such solutions.

❑ Protect gelcoat or painted hulls with marine wax or polish. Buff the wax now because some waxes harden if left on and require much labor to remove.

❑ Remove fenders (PVC lasts longer if stored indoors) and clean them. Check docklines for wear and replace as needed. Remove all antennas. Clean vinyl seat cushions and treat with light coat of vinyl protectant to prevent drying and cracking.

❑ Inspect brightwork and repair any damage, applying at least two coats of varnish or oil to protect wood from winter's dryness.

❑ If you store your boat outside, keep your boat clean and dry with a snug-fitting canvas cover, polyethylene tarp or shrink wrap. Covers must have adequate ventilation and a means of access. If "tenting" your boat with a tarp, leave a .6m (2') opening at the bow and stern.

INTERIOR

❑ Clean the boat inside and out with plenty of fresh water and a biodegradable cleaner, rinsing away all sand and grit.
Remove the hull drain plug (if equipped) or pump out bilge water. Allow the boat to dry thoroughly. Pour non-toxic antifreeze into the bilge and pump some through the bilge pump.

❑ Winterize air conditioner and refrigeration systems.

❑ Remove all items that may rust, rot or freeze plus all personal gear and any loose equipment such as life jackets, cushions, bedding, canvas tops, curtains, dock lines, charts or books that may absorb moisture and mildew while in storage.

❑ Remove all foodstuffs and clean the icebox or refrigerator with baking soda and water. Clean appliances. Empty kettle.

❑ To guard against mildew, wash interior cabinets, countertops, bunk tops and lockers with a 50 to 50 mix of vinegar and water.

❑ Slightly open lockers, hatches and floorboards to increase ventilation, reduce condensation and hopefully, guard against mildew.

❑ Check fire extinguishers and recharge if needed. Weigh Halon extinguishers to check charge.

CONTROL MILDEW

Mildew forms when the air outside is cooler than the air inside. This creates condensation and the resulting dampness produces mold spores that feast on damp surfaces. To control mildew you need to eliminate or reduce condensation and moisture. This is impractical in the winter, considering that your boat, wrapped under a tarp, baking under the hot sun, provides the ideal environment for mildew. To help prevent mildew growth, invest in a $20 dehumidifier. It comes with crystals that remove moisture from cabin air and keep the boat dry.

ELECTRICAL

❑ Remove all portable electronics. It's not necessary to remove fixed electronics but storing them indoors in a dry location will prolong their life and they won't be stolen.

❑ Remove dry cell batteries from flashlights, radios etc.

BATTERY STORAGE

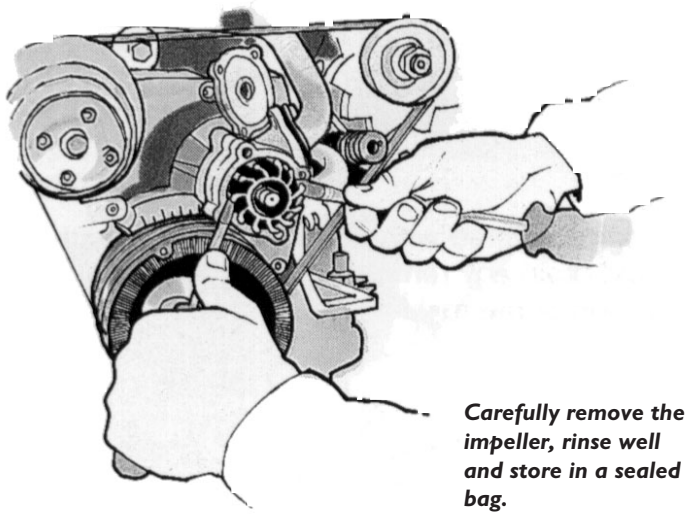
❑ Disconnect and clean battery terminals and casing. Check that electrolyte levels are 1.2cm (1/2") above top of separators. Fully charge battery and store in a cool, dry location. A battery can be left on the boat without risk of freezing, provided it is at least three-quarters charged. If stored on board, check the charge every 30 days.

PLUMBING

❑ Clean freshwater tanks with baking soda and water. Let dry and leave open inspection ports to reduce moisture buildup. Pump non-toxic antifreeze through the system until it exits at the sink to prevent freezing.
❑ Drain all sumps and pumps and pour antifreeze down sink and shower drains.
❑ Descale and clean head and holding tank with Head-O-Matic Shock Treat or other similar product. Pump out the tank, add the recommended solution, fill with fresh water and let cure for 15 or so minutes then empty. Add a lubricant (Sea Lube, Head Lube or other) to the head to lubricate O-rings, pump shaft, pistons and valves and prevent corrosion. Winterize the head by flushing a small amount of non-toxic plumbing antifreeze through the system.
❑ Check aluminum holding tanks for corrosion. Fluids seep under the welds inside the tank, causing pitting and in time will rust through. Any tank that's eight years or older should be inspected thoroughly.
❑ Open all seacocks. Removing hoses from seacocks is a good way to ventilate the cabin when under cover. Lastly, pour a small amount of antifreeze down cockpit drains.

ENGINES Outboards & I/Os

Before winterizing your engine, read the owner's manual and carefully follow the instructions.
❑ Attach a flushing device and run the engine long enough to completely flush the engine's cooling system.
❑ Spray a recommended fogging oil through the carburetor intake while engine is running.
❑ Drain the cooling system on stern-drive-powered rigs.
❑ Remove the air cleaner and spray an anti-corrosion protectant onto the carburetor and any other metal parts to prevent rusting.
❑ Remove filling and vent plugs from the lower unit and fill to the specified level with the recommended gear case lubricant.
❑ Lubricate all grease fittings, inspect zinc anodes, including the one located inside the exhaust passage, for corrosion.
❑ Touch up any scratches or bare spots on the lower unit or drive leg



VOLVO PENTA

Carefully remove the impeller, rinse well and store in a sealed bag.

- Clean the outboard cowling and lower unit of the outboard or stern drive and apply a light coat of wax.
- Examine the engine for worn wiring or electrical connections, loose components or brittle fuel hoses.
- Inspect and clean fuel line screens and replace all fuel filters. Lubricate to the O-ring on base of filter before installing.
- Change engine and drive oil and top off power trim and steering fluid reservoirs (if equipped).
- Add the recommended amount of fuel stabilizer to the gas tank.
- Clean and lightly spray a moisture-displacing lubricant or Engine Protector over all external metal parts to prevent corrosion.
- Remove the prop and check for bent blades, damaged hubs or nicks along leading and trailing edges. Minor nicks are easily filed; major damage requires the services of a prop specialist. Remove any fishing line from the prop shaft, grease the shaft and replace the prop. Make sure the lock nut is on tight and the cotter pin interlocks the nut crown.

TIPS Put a block of wood between the prop and the ventilation plate to prevent rotation as you loosen the prop lock nut. A prop wrench simplifies this job.

TIPS Get the oil up to engine temperature (71 C/160 F) and it drains faster. Run the engine to circulate the new oil.

ENGINES
Diesel Inboards

- Top up fuel tanks to eliminate condensation.
- Change oil and fuel filters.
- Open water intake seacock (if closed) and drain cock on the engine to remove water, then close. Remove hose from the water intake and place in a bucket containing a 50 to 50 mix of non-toxic antifreeze and water. With engine in neutral, start the motor and run until antifreeze exits at the exhaust thru-hull. Stop the engine and open the drain cock.
- Remove the water filter and clean.
- Drain the fuel/water separator.

Continued on page 35

Propane System Safety

By Robert Houston

Liquefied petroleum gas (LPG) or propane is a source of on-board cooking and heating that is clean, inexpensive, readily available, easy to transport and lights easily. But there are also hazards associated with the use of propane. It's invisible, highly explosive, heavier than air and hard to remove from a boat's bilge. These hazards can be reduced to near zero by installing your system correctly, inspecting, testing at regular intervals and replacing defective components immediately.

The National Fire Protection Association Standards for Propane (NFPA 302-6.5) provides guidelines in great detail on required codes and standards for equipment and installation. Summarized, the key points are:

- Use only approved materials.
- Use only approved marine appliances.
- Protect piping and hose from abuse and abrasion.
- Piping must be visible for inspection.
- Provide a leak test arrangement.

In addition to the above, the entire system must be installed and tested per applicable codes and regulations. (The price of a qualified professional for installation is a sound investment.) Like any powerful tool, treat propane with respect. Convenient and clean, this high-energy fuel can be safely used by boaters who understand and handle it with proper caution.

Follow these guidelines below to test and check the individual components of a safe propane system every time it is used and prior to winter lay-up. (Note: If your system has just been installed pressure test with air to prove all connections.) These instructions assume your system is fitted with a pressure gauge. A should-have option, it mounts on the high pressure side of the regulator. Inexpensive, a gauge reading 0 to 300 psi costs about $22.

Daily Use

Prior to starting your system, test it. If your system is installed correctly this test will prove the regulator, supply hose and tube and valve at appliance (see Figure 1).

1. Make sure the valve at the appliance is closed and connections are tight.
2. Open tank locker and check fittings at tank.
3. Open tank valve until tank pressure registers on pressure gauge.
4. Close tank valve and monitor pressure. If it drops, vent cabin space and check connections using soapy water (do not use soap with ammonia) or a leak detector and repair leak before using system.
5. Never use open flame to check for leaks.
6. If there's no drop in pressure, system is okay to use.
7. Open tank valve and continue with intended use.
8. Close and latch tank locker.
9. Always close tank valve when not using system or boat is unattended.

Winter Lay-up

As there are many system set-up configurations, here are some general guidelines for preparing your propane system for the winter. If your boat is laid-up in the water (such as on the West Coast) and will be unattended for long periods of time, close the tank valve and disconnect the regulator. If tank is left on board, always check for gas leaks before starting any electrical appliances.

1. Clean your burners (per manufacturer's guidelines) then coat them lightly with cooking oil to prevent corrosion.
2. Cover burners and venturi openings with aluminum foil to prevent small insects (spiders) from entering small openings during storage. Remove aluminum foil before using.
3. Disconnect propane tank from supply line and install protective plug in tank opening.
4. Cover threaded portion of regulator

ROBERT HOUSTON

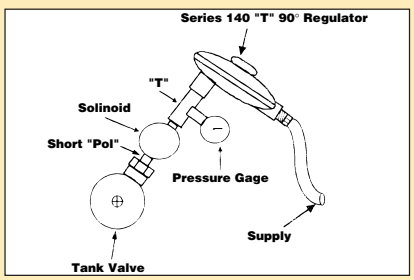


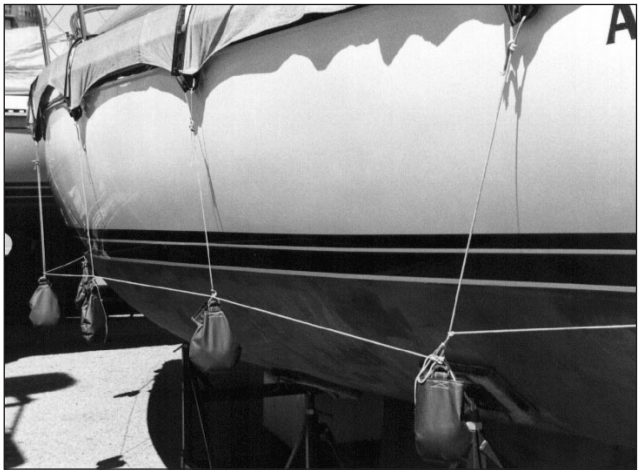
Figure 1: Typical pressure gauge installation for propane systems.

to protect thread and prevent dirt or insects from getting into openings.
5. Visually check safety blow-off valve on tank for dirt or other restrictive material that may impede the operation of the valve.
6. Thoroughly check surface of hose for wear, cracks or hardening.
7. Cover brass fittings with a light coat of cooking oil or Vaseline to prevent corrosion.
8. Inspect tank surface, especially bottom for excessive rust and, if excessive, have the tank inspected by your local propane dealer.
9. If you do not have an approved locker on board that has flow-through venting, store your tank ashore in a protected, well-ventilated area.

Robert Houston is president of Pro Pal Manufacturing, Victoria, BC.

Winter LAY-UP

- Slacken all belts.
- Remove the water pump impeller, inspect, bag and place where you can easily find it next year (try taping to the engine).
- Grease ends of throttle, gear and stop cables. Spray all moving parts (cables, linkages, winches, etc.) with a Teflon-based lubricant.



Bags or jugs filled with water or sand hold covers secure during lay-up.

- Close or plug thru-hulls to prevent air and moisture from entering.
- Inspect the propeller and send in for repair if necessary.

TRAILERABLES

Check that the boat is resting equally on all bunks or rollers to prevent unwanted hooks or hollows caused by improper storage. To reduce the load on the tires and trailer suspension, jack up the trailer until tires clear the ground, then support the frame with jack stands placed on either side of the wheel axle. Loosen trailer tie-down straps to ease pressure on the bottom of the boat. Touch up rust spots on the trailer.

MASTS

First and foremost unstep your mast. Leaving it up subjects the deck, hull and rigging to considerable stress that over time (four to five winters) causes web-like cracks and crazing in gelcoat. Remove spreaders, masthead instruments and antennae. Run a soft cloth along shrouds to check for snags. Wash running rigging and furling gear (if equipped). Never store a painted mast wrapped in plastic. While it protects it from dirt and rain, Danny Klacko of Klacko Spars says the heat from the sun blisters the paint off faster than any chemical stripper.

SAILS

Lay sails out on a flat, clean surface and check all seams, batten pockets, luff tape, slugs or slides for chafe and wear. To remove salt and surface dirt, hose your sails off with fresh water and dry thoroughly. Fold and store sails off the boat in a warm, dry locker. Inspect mainsail and jib covers for tears and chafe and repair as necessary.

TO DO LIST

Make a list of all the items that need to be repaired, cleaned or replaced so you won't forget in the spring.