SPRING 1996

DIY boat owner

INSIDE

A complete guide to converting your ice box to an efficient marine refrigerator or freezer.

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Restoring Gelcoat

Refer to DIY 1999-#4 for refrigeration troubleshooting and upgrades.

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TALKBACK

ENGINES IN SALT WATER

Q: Regarding your reply to a letter from M. Jarvis in the WINTER '95 issue, most of your comments are correct except your statement, "When leaving the boat shoreside for longer than one week you must drain salt water from the block..." Well, since I have been here in Toronto, I have heard all kinds of comments about what happens to your boat when "poisonous" salt water gets to it. If you are operating in salt water — so what! Drain your engine at the end of the season. There are other potential problems for freshwater boats going to "real" water for a prolonged period — corrosion on boats equipped with brass seacocks rather than bronze, for example. We've used a lot of Yanmar engines in our fishing boats in Newfoundland without any corrosion problems. Periodically, rust collects on the outflow and blocks the cooling jacket. In that situation we flush the engine with an anti-rust agent.
Jim Miller, former Newfoundland boater

A: From Norm Wagner of Land-Sea Power, a Vancouver, B.C.-based Yanmar distributor, comes this reply: If you maintain engine zincs, checking them every two to three months depending on salt content in the water, there's no need to flush out engines with fresh water. Saltwater deposits, however, do build up in engines. Water trapped in the top of the engine evaporates, leaving salt deposits. When the engine is rarely used, say only once a month in waters with a high salt content, deposits build up, blocking passages in the cylinder head, thermostat housing, hoses and other small passageways. It can take upwards of three years before the engine must be stripped down and cleaned. A more serious concern when cruising in tropical waters is microorganisms of coral that pass through the water system and adhere to warm metal. Over time, the coral builds a "reef" inside the engine. There's nothing you can do to prevent this; eventually, the engine will need to be dismantled and the coral chipped off.

COAL TAR UPDATE

Q: In your Gelcoat Blister Repair article (FALL '95), as in all the other articles I've read on the subject, no-one commented on the effectiveness of Cold Tar epoxy coating. On my previous boat, a CS 27, I removed the antifouling and coated the bottom with four coats of VC Cold Tar. When I sold the boat last year, five years after recoating, the blistering was under control and, apart from a touch-up of the steel keel, no further maintenance was required. The bottom is very fair and Cold Tar was easy to apply. Now I have an Aloha 34 and would like to ensure the bottom is well protected. Do you have any information on the effectiveness of various epoxy coating systems? Any suggestions on where I could look for information on Cold Tar?
L. Harrison, Kincardine, Ont.

A: According to Interlux technical support service, Coal Tar has been around for a long time and provides a smooth finish before you apply your normal antifouling. However, drawbacks to Coal Tar include colors bleeding through the final coat, longer drying time and a finish that's less tough after hardening than some of the current antifoulings on the market. For example, Coal Tar can turn a blue antifouling to green and a red one to brown. The product is now sold by Interlux under the name VC Tar and is only recommended for use under VC17 or VC18 coatings. Your local dealer should be able to obtain VC Tar or you can call Interlux at 1-800-Intrlux for the name of

your nearest dealer. Both Micron CSC and Fiberglass Bottomkote perform just as well and are thick enough to provide the smooth finish you are looking for on your hull.

MORE BATTERY MANAGEMENT

Q: On page 36 in your FALL '95 issue, you discuss storing batteries in the winter. A battery should never be winter stored in any other state than fully charged. Freezing is not the only issue: sulfating and the resultant loss of capacity also need to be considered. Also, deep cycling a battery as described on page 5 in the Winter '95 issue never does it any good. What is needed to reverse sulfating is a "conditioning charge," one that intentionally raises voltage to over 14.8 for a controlled period of time. Moreover, during storage, batteries should be kept attached to a charger — one of the modern, sophisticated types that tapers off current to maintenance levels and avoids gassing when the batteries are at full voltage.
Phil Friedman, Pompano Beach, Fla.

A: We agree with you on the freezing issue but turned to the experts for a response on charging. David Surrette, president of Surrette Battery Company, Springhill, Nova Scotia, replies: Your reader states that a battery should always be attached to a charger during winter storage. This is incorrect. Even the more sophisticated marine chargers are normally designed for batteries that are going to be exercised regularly. This usually means a setting of 14 volts on a 12-volt system. This is too high when batteries go for months without being exercised. A setting of 13.1 to 13.2 volts would be required, one usually not found on marine chargers.

John MacDonald of The Battery Sell Co. in Oakville, Ont., recommends that at any time, winter or summer, a battery should only be discharged to 80% of its rate of capacity (1.75 volts per cell). He also adds that a battery will not accept a charge at cold temperatures. Low temperatures also affect the discharge rate: A fully charged battery stored at 26.7C (80F) takes 30 days before it self-discharges 25%; at 10C (50F) it takes 100 days.

RENEWING PLEXIGLASS

Q: The permanent Plexiglas cabin ports on our 1979 Tanzer 8.5 have developed a frosted appearance over the years. We're not sure if it's grime or simply age. We have tried several boat cleaners, but to no avail. Any suggestions?
J. Kerr, Mississauga, Ont.

A: Frosted windows are caused by crazing due mostly to

the use of unsuitable cleaning products and techniques. Household window cleaners, kitchen scouring compounds, solvents (such as teak oils and paints) and even so-called "safe" cleaners used with too much elbow grease will weaken or scratch acrylic surfaces. These scratches create an illusion of frosting or fogging. According to a representative of Warehoused Plastic Sales, Toronto, Ont., there are no chemicals that will remove crazing from acrylic; the windows will have to be replaced. Refer to the article on restoring acrylic plastics in this issue beginning on page 27. Before replacing the windows, however, why not try the sanding method for deep scratches? It might just do the job.

AGING FIBERGLASS

Q: I just bought my first boat, a 1978 Bayliner 24-foot flybridge cruiser that had been stored outside for five years. The white fiberglass is in good condition but very dull and dirty. What steps should I take to clean and paint it?
R. Desjardins, Midnight Sun, *Gatineau, Que.*

A: This is a common problem with aged fiberglass. Dan Neilson of Washbucklers, Inc., an Orillia, Ont.-based company specializing in boat detailing, recommends this simple and quick remedy that won't break the bank. First, wash the boat thoroughly and let it dry. Clean the hull using a compound wax such as Boat Armor Color Restorer, Mirror Glaze #44, Star brite Liquid Rubbing Compound or a similar product. Some products do not require a completely dry surface before cleaning. Finish with a good quality wax.

TECH TIPS

HOLE STOPPER:
When the engine water intake or exhaust hose develops a hole and you don't have any spare hose for wrapping, cover the hole with friction or vinyl electrician's tape, wrapping the tape securely around the hose. Then cut the ends off a drink can and slice down the side of the can to form a sheet. Wrap sheet around taped hose and secure it with hose clamps.
From Phil Friedman, Pompano Beach, FL

SEALANT REMOVAL:
Polyurethane sealants, such as 3M 5200, bond so well to wood and fiberglass that they are difficult to remove even with a sharp knife. These are tough sealants meant for use on fittings that will never be removed. When a knife won't do the job, try piano wire; pull it through the sealant, then sand off what's left. Wear rawhide gloves to protect hands from the sharp wire.
From Daryl Johnson, 3M Marine

SKIN-FREE PAINTS:
To prevent paint skin from forming in a partly full can, raise one edge of the lid just slightly, blow lightly into the can, then close it immediately. You'll be replacing oxygen, which causes skin formation, with carbon dioxide. Do this carefully to prevent splashing paint on your face.
From Charlie Francis, Consolidated Coatings

IF THE WRENCH DOESN'T FIT:
When you need to remove a metric hex head bolt, but your imperial (American) box wrench is slightly too large, cover the bolt head with a cotton cloth and force the box wrench on. If the bolt hasn't seized up due to corrosion, it should turn out.
Phil Friedman, Pompano Beach, FL

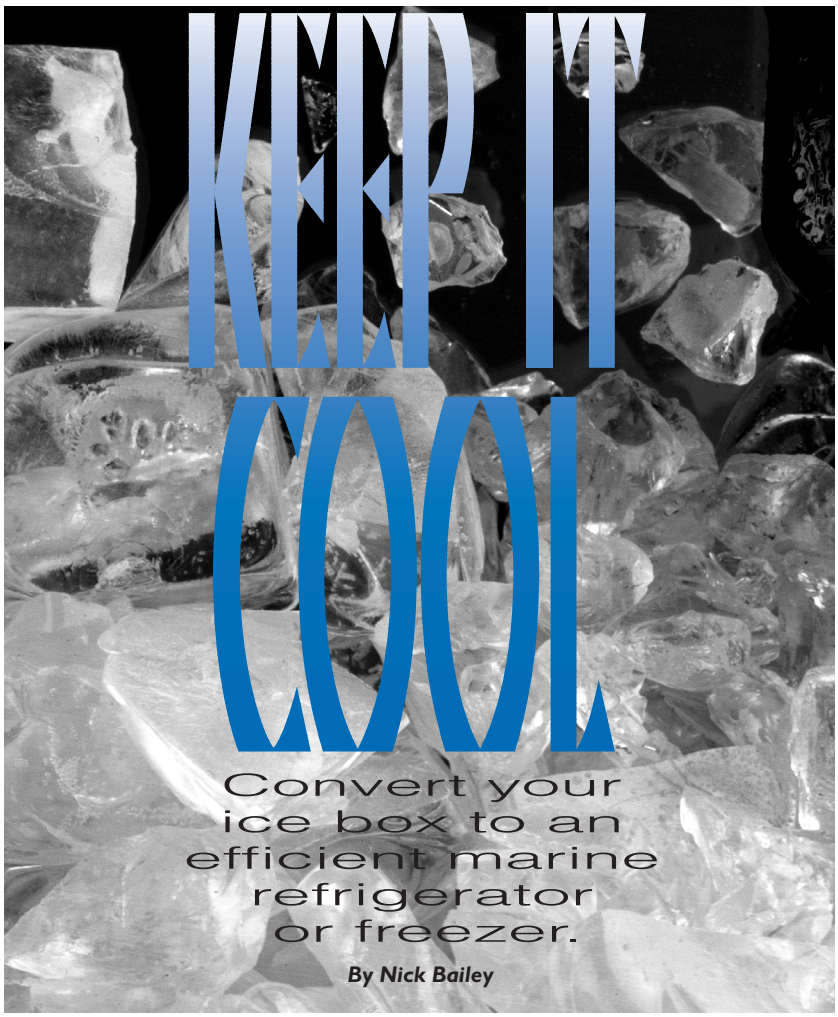
LINE ID:
Now that you've identified the length and size of your dock, anchor and tow lines with leather, plastic or cloth tags, colored thread or marker, designate them specific locations according to their length. For example; hang all 6m (20') dock lines on one hook in a cockpit locker.
Sheilah van Nostrand, Dream Catcher*, Keswick, ON*

SETTING BUNGS:
Set wood bungs in varnish rather than glue. They'll be watertight and a lot easier to remove.

CURE FOR RUBBER RUB OFF:
To prevent rubber bow stops on trailers from transferring black marks to the hull when they're winched tight against the bow, coat them with an acrylic clear coat finish such as Captain Phab Clear Coat. A water-based product, it's available in a glossy or satin finish. As it wears off with use, the bow stop will need to be recoated periodically. Use it also on brass and other metals to prevent corrosion. A light coating sprayed on vinyl striping, serial numbers and graphics protects them when washing or waxing the hull.

FUEL BLOCKAGE:
If after replacing the fuel filter your diesel engine keeps stalling when increasing rpms, inspect the check valve if you have one installed in the fuel intake line. Deposits build up and block fuel flow. Unless the manufacturer requires one in the line, remove it. [Editor's note: check valves are sometimes installed in bilge pump hoses and cockpit scuppers. These clog with debris and should be checked regularly.]
Les Harrison, Kincardine, Ont.

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, Alexandria, VA, 22304 or E-mail to info@diy-boat.com.**



KEEP IT COOL

Convert your ice box to an efficient marine refrigerator or freezer.

By Nick Bailey

So here you are, a cruiser with enough experience to know that the rituals of organizing ice for the ice box are a pain. Last weekend's block is gone by the time you decide to embark on that impromptu midweek evening cruise. Those carefully husbanded last few beverages are now warm and sloshing about in 5cm (2") of smelly, stagnant meltwater along with the label from the skipper's reserve bottle of Chardonnay. Where did this mold come from? Did I really leave a jar of mayo in here too? Yikes! This cheese will definitely have to go. And damn, the gas dock is closed so no fresh ice! Well, the sunset won't wait, so you cast off and head out anyway with fizzy warm ones. Who said yachting was upper crust?

If you own a small cruiser, you probably don't have space for a refrigerator, yet you may not be aware that the luxury of refrigeration may be well within your grasp. As a reader of *DIY* you are no doubt an intrepid sort, possessing at least basic tools, moderate skills, a rudimentary knowledge of 12-volt electrics and plenty of determination. The most popular refrigeration systems are easy to install and within reach of most boaters' pocketbooks.

Let's assume you own a typical mid-size sailboat or powerboat equipped with a built-in ice box insulated with at least 5cm (2") of polyurethane foam all around, including the top and lid. A minimum of 10cm (4") is recommended (see Ice Box Design page 13). You have a 12-volt DC electrical system and inboard auxiliary engine with an alternator. You also have a 110-volt shore power system with an automatic battery charger and, ideally, separate house and engine starting batteries. If this sounds like your boat, you already have the fundamental system prerequisites for adding a 12-volt refrigeration system that can be left running while you are away from the boat.

If you don't have all of the infrastructure listed above, you may be able to run DC refrigeration as long as you can somehow provide the necessary 12-volt power (anywhere from 25 to 100 amp-hours a day). If you decide to drag the bar fridge from your basement on board your boat and plug it in with an extension cord or inverter, that's okay. Just don't leave the dock for long.

FUNDAMENTAL THERMODYNAMICS

All refrigeration systems consist of two separate components: an evaporator unit and a compressor/condenser unit. All that refrigeration does is remove heat from one location — in this case, an insulated ice box — and release it somewhere else. This is accomplished by compressing a refrigerant gas and liquefying it, a process that concentrates heat in the liquid that is then cooled by air or water. The cooled liquid is then pumped to a remote location (the ice box) allowing the liquid to expand and suddenly evaporate within the confines of the evaporator. Gas is then sucked back to the compressor and the process starts again.

The physics of any fluid changing state from a liquid to a gas and vice

versa (evaporation and condensation) dictates that the evaporating fluid will absorb heat from its surroundings. This latent heat is later released when the gas condenses into fluid. Find a gas or fluid that will change state in the right temperature range, then all you need is a mechanical fluid pump and clever plumbing and you've got refrigeration.

How efficiently a given system operates depends on how well the insulated ice box keeps the heat from leaking back in and how well the heat exchanger is able to shed heat at the other end by air or water cooling.

WHAT'S AVAILABLE

The most popular 12-volt ice box refrigeration systems are all based on the Danfoss compressor and "black box" controller. Various refrigeration manufacturers all over the world use these Danish-built components, renowned for their low power consumption, reliability, and ability to operate on a sailboat at 20 degrees of heel. In Canada, the best known manufacturers are E-Z Kold of Bloomfield, Ont., and Nova Kool Mfg. of Burnaby, B.C. In the US, systems by Adler-Barbour (maker of the original ColdMachine) are popular, as are units by Crosby, the Italian-built Frigomatic, and Norcold (whose models operate with a different compressor). Prices range from $1,000 to $2,100.

The Nova Kool system is well known and fitted on thousands of boats. It consists of the typical frosted evaporator, installed in the ice box with room for two ice-cube trays. Compressor, cooling fan and control box all fit on a separate 30cm by 45.7cm by 25.4cm (12"x18"x10") chassis that mounts neatly in a cockpit locker. Nova Kool's Compucold thermostat also yields system and voltage information on an LED readout. All 12-volt systems deliver similar performance. Differences between manufacturers are in the design of condensing coils, fan structure and filters.

Some units, such as those from E-Z Kold, offer a similar frosted evaporator system but its forte is a holdover-plate system. The holdover plate, originally called a Dole plate, is a metal box containing a glycol solution that is frozen by internal evaporator plumbing. Holdover plates have tremendous cold-carrying capacity. This means you can run your fridge when power is available at dockside or while motoring, then shut it off for relatively long periods to conserve power. Holdover plates act in many ways like a permanent renewable block of ice. E-Z Kold custom fabricates these units to suit your ice box dimensions. This holdover-plate system is also thermostatically controlled so that it can be left plugged in at dockside. You will, however, have to rig your own ice-cube trays.

All this holdover-plate technology trickles down from the heavy-duty, engine-driven offshore systems offered by Sea Frost (used on 90% of charter boats in the Caribbean), Grunert, Glacier Bay, Technautics and others. The boat's engine drives the compressor which rapidly cools the ice box or freezer. Such systems use minimal fuel and are not dependent on a boat's battery supply. Most units have two systems: a holdover engine-drive system plus a 110-volt system when plugged into shore. They cool 10 times faster than a comparable 12-volt system and are more efficient. Refrigeration systems are rated in British Thermal Units (BTUs). Engine-driven units average 2,600 BTUs per hour versus 250 BTUs for 12-volt units.

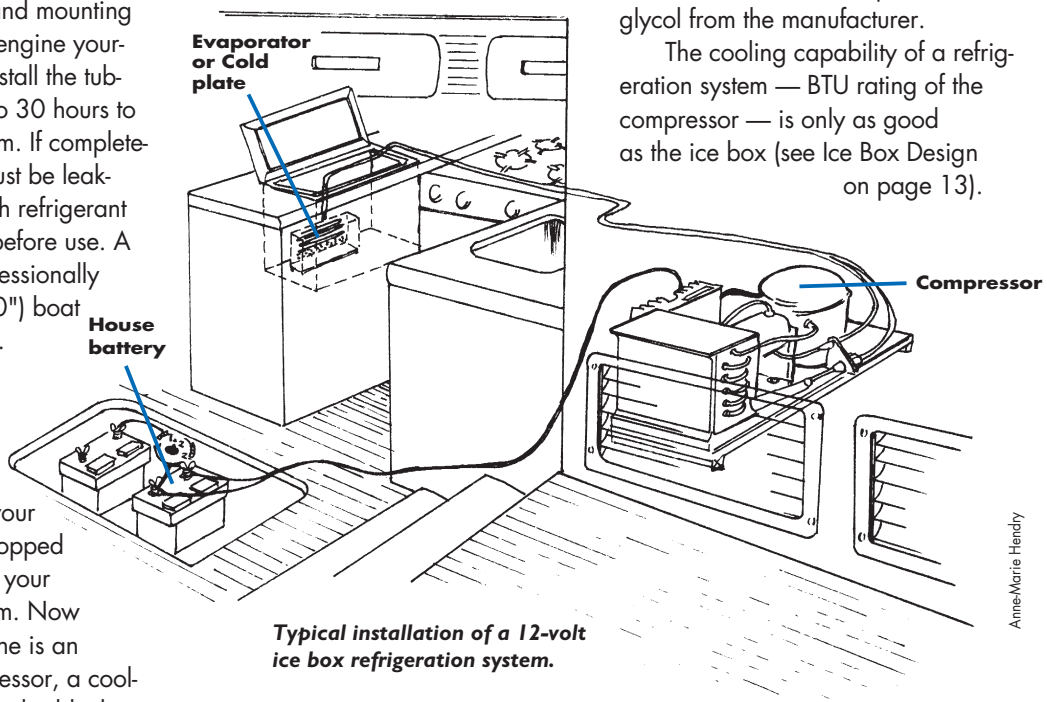
If you are planning extended offshore cruising, these are the top-of-the-line systems but they are expensive. A complete system for a single ice box or two adjacent boxes, starts at CDN$4,000/ US$2,600. Installation is somewhat complex and

if you're in doubt you should contract a professional. You can save money by installing the plate and mounting the compressor on the engine yourself, then have a pro install the tubing. It takes about 20 to 30 hours to install a complete system. If completely owner installed, it must be leak-tested and charged with refrigerant by a certified installer before use. A three-plate system, professionally installed, for a 12m (40") boat averages CDN$6,500.

SET-UP

STEP 1: GETTING READY

So you have checked your ice box dimensions, shopped around and purchased your new refrigeration system. Now unpack the boxes; in one is an assembly with a compressor, a cooling fan (if air cooled) and a black box voltage controller which is actually an inverter, converting AC power from the refrigeration unit to DC. In the other is either your frosted evaporator or a holdover plate that installs in the ice box. This will come with a coil of copper plumbing attached plus a thermostat. Handle this plumbing with care; it is precharged with refrigerant. There will also be installation instructions — follow these religiously! Before cutting any holes, plan the layout carefully and make sure that there is room for all components. Most installations are straightforward and require about a day to complete.



Typical installation of a 12-volt ice box refrigeration system.

STEP 2: ICE BOX SET-UP

If you have a frosted-evaporator-type system, pick a convenient spot in the ice box, fasten the evaporator assembly to the inside of the ice box, drill a hole to feed the copper lines (refrigerant tubes) and connectors through to your compressor location and mount the thermostat. Seal the holes in the ice box by whatever means are convenient (an aerosol polyurethane foam works fine). If you are installing a holdover-plate system, consider subdividing the ice box into a freezer and fridge section, otherwise, the installation is much the same as above. Most units come prefilled with glycol from the manufacturer.

The cooling capability of a refrigeration system — BTU rating of the compressor — is only as good as the ice box (see Ice Box Design on page 13). Insulation thickness and seals on lids or doors affect efficiency. Drains not equipped with a trap or valve funnel enormous amounts of cold air.

STEP 3: COMPRESSOR HOOK-UP

The compressor assembly sits in a tidy self-contained chassis that must

ICE BOX DESIGN KEY TO COOLING EFFICIENCY

The single most important part of a refrigeration system is the design and construction of the ice box. Heat leaking into the box quickly reduces the efficiency of the cooling unit. If you don't have a well-insulated ice box, you're throwing away both money and energy.

Ice boxes should have a minimum of 10cm (4") of polyurethane foam insulation on all sides, including the top which must also be gasketed. (Unfortunately, ice boxes in most production boats built before 1990 have less insulation.) Polyurethane, a closed-cell foam, is 50% more effective than Styrofoam for every inch of insulation. Ice boxes should also have a vapor barrier, such as heavy aluminum foil, sheet metal, epoxy or fiberglass gelcoat (for polyurethane foams only), between the foam and outer frame to prevent insulation from moisture deterioration. All joints and seams must be sealed perfectly to prevent heat leakage; attach strips of neoprene around the lid rim to prevent leakage. Ice boxes that currently can't keep ice from melting in short periods will require frequent cycling of a refrigeration system. If there's room to add additional insulation, glue foam blocks to the outside.

Use the graph on page 14 to check the effectiveness of your existing ice box. As refrigeration systems are rated by BTUs, you'll need to calculate the exact BTU loss of your existing ice box to determine what system to install. Manufacturers and installers can help with the details. They will need to know: type and thickness of insulation; ice box capacity; type of opening; as well as how the boat is used and where it's kept. ***Information provided by David Good, co-owner of Ocean Marine, a Don Mills, Ont.-based service company specializing in outfitting offshore boats.***

be mounted within reach of the copper plumbing from the ice box. A typical location is on a well-secured shelf in a cockpit locker. If you don't have a shelf, you'll have to make one. Remember, the shelf must stay put in a knockdown when all the other stuff in the locker falls on top of it. Locate the compressor within easy reach of the refrigerant lines coming through from the ice box.

STEP 4: COOLING OPTIONS

A cockpit locker usually provides adequate ventilation in northern climates; however, if you cruise in southern climes or in temperatures above 25C (77F), or the compressor is mounted in a poorly ventilated locker, the unit will have to work very hard to shed all that heat removed from the ice box. In some cases, it may operate all day and all night, running your battery flat with a steady draw of 5.5 amps.

A better solution to the cooling problem is water cooling. It's more efficient — water is an eight times better heat exchanger than air — and is a necessity in southern boating areas. Water cooling is accomplished by the installation of a 12-volt water pump and an appropriate thru-hull fitting, to circulate water through a fridge compressor especially adapted for this purpose. Though this system is slightly more complicated, it should present no problems for a competent do-it-yourselfer. You may be tempted to connect the fridge pump to your existing engine seawater cooling intake. Don't do it! This short cut can result in your engine seawater pump sucking air through the fridge pump. The engine then overheats, quits and, well, you know the rest of the story. This turn of events will certainly annoy your insurance company, ruin your whole day/weekend/summer/marriage and create excellent repair opportunities for certain yards.

STEP 5: CONNECTING TUBING

Once the compressor is securely mounted and the copper refrigerant lines have been led neatly through from the ice box, you are now ready to connect evaporator to compressor. Special connector fittings are self-sealing and should screw together with no loss of gas. Both halves of the system are precharged and should now be ready to go. Be careful not to apply any torque to the soldered joint between the copper tubing and the connector ends. Any damage to the tubing joints or evaporator will release refrigerant gas and require professional repair and recharging.

STEP 6: ELECTRICAL HOOK-UP

You will need to provide a DC power supply cable; a minimum 10-gauge multi-strand type is recommended. Check installation instructions for specifics. Connect the fridge positive

wire directly to the house battery using the fridge thermostat as the off-on switch or, alternatively, to a breaker on the main DC distribution panel. Install an in-line fuse in the feed wire. The negative ground connects to whatever negative common is available.

Alternatively, hook up the positive directly to the main panel. This latter option is easier to install and gives you better control — there's no need to mess with connectors on the battery terminals — but, take heed: You'll need larger wires and, when a battery charger is also connected, there's a risk you'll blow the inverter (black box) if the system does not receive pure DC power. Consult a professional installer on this one.

STEP 6: TEST RUN

Recheck your wiring connections, then turn the unit on. It should "gurgle" to life. Now check the ice box. The evaporator should soon get frosty. If it runs but does not cool, you have somehow managed to lose the refrigerant charge. If there is no sign of life, check the fuse in the unit and check to see that adequate voltage is being supplied. If the unit blows fuses continuously, call your dealer.

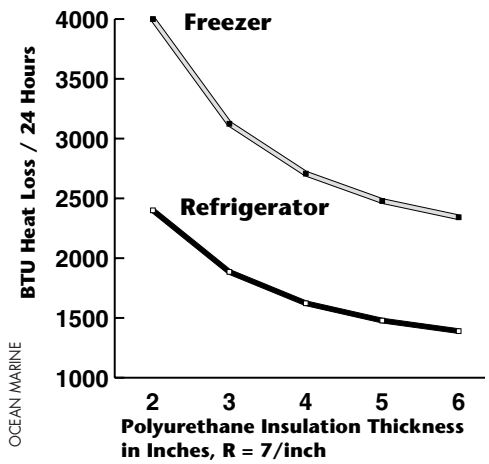
BATTERY MANAGEMENT

Cold beverages and unspoiled foods are dependent on plenty of 12-volt juice. Now that you have an operating fridge, you'll have to learn how to keep it running. Books have been written on the subject of battery management, but, to be brief, the engine starting battery should never be called on to supply power to the fridge. An engine that starts reliably is far more important than cold goodies. If you are using the traditional four-position master switch, which isolates the batteries, make sure you know which battery is for engine cranking and which is for house supply and the fridge. Refrigeration power requirements will exceed other items on board. For example, typical fridge power consumption in one day can be calculated as follows: 5-amp draw multiplied by 24 hours times the typical 50% duty cycle equals 60 amp hours per day.

You should have a good quality house battery capable of deep discharges without damage; 12-volt batteries are surprisingly finicky devices. In addition, a battery should not be discharged past the 50% point if you want it to last. For example, if you have a 100-hour ampere battery (a typical 27 series or larger car battery) you should plan on its usable capacity to be 50-amp hours. Using the consumption rate outlined above, a battery this size will just suffice while cruising if charged once a day. Plan your daily energy budget taking into account your charging capabilities and the amount of power you consume. You may want to invest in high-quality monitoring equipment (Link 2000 or E-Meter), a high-output alternator or three-stage regulators if you plan more than overnight cruises. Remember: Batteries usually don't die; they are murdered.

Nick Bailey has been in the marine service profession for more than 20 years and currently is service manager of Bristol Marine in Mississauga, Ont. He and his wife own and race a wooden Thunderbird that recently underwent a major refit. Articles detailing some of their renovations will appear in upcoming issues.

ICE BOX EFFICIENCY



The amount of BTUs used to keep the ice box cool is directly related to size of the ice box and how well it's insulated. Values are based on a standard box size of six cubic feet, with polyurethane foam insulation (R factor of 7) and an operating temperature difference between the freezer and outside air of 32C (90F); refrigerator is 10C (50F). For example: An ice box with 10 cm (4") of insulation uses 1623 BTUs in 24 hours.

CAST OFF

SAFETY ON BOARD

Pack some know-how into your ditty bag before you take to the high seas.

By Sheilah van Nostrand

As captain of your vessel, it's your responsibility to be knowledgeable of the rules of the road and safety practices, and skilled in piloting and navigation. The safety and well-being of those on your boat, swimmers, waterskiers and anyone who may be affected by your vessel's course and wake depend on it.

For a safe and enjoyable outing on the water, ensure that everyone aboard knows and agrees with your boat's safety rules before leaving the dock. Be aware of the skills and limitations of your crew so you know what you can expect from them in an emergency. Life jackets should be worn at all times by children or non-swimmers, and crew or guests while underway. They should be worn by everyone, including the skipper, in rough water. Take your guests on a tour of the boat, pointing out danger areas such as deck fittings, booms, sheets under load and so on. Discuss the location of essential safety equipment such as the liferaft, fire extinguishers, hand holds, safety rings and other safety gear — and how to use it.

PREPARATION

There is no better way to foster sound boating habits than to involve each person on board including children, as much as they're able to peform pre-cruise routines. Several short written checklists (**Figure 1**), rotated among the crew, will help maintain a high level of alertness. A short conference prior to castoff will let your crew know your plans and unite the team.

As an added precaution, give a relative or friend a pre-departure float plan (**Figure 2**). This should include a full description of the boat: its make, color, size, style, number of engines, fuel capacity, registration number and any distinguishing features; the names, addresses and phone numbers of everyone on board and any known medical problems; a list of safety and survival equipment (PFDs, flares, ground tackle, raft, dinghy, EPIRB, and so on); and marine radio call letters, type and frequencies. Also note trip details such as your point of departure and the date, your anticipated route, destination and expected time of arrival, your expected date of return and an alternate course plan. Supply phone numbers for the marine operator in case there is a need to contact the vessel and the coast guard and local police in case a search is required.

Safety harnesses are not just for sailors! A harness will keep you attached to the boat if you fall or are knocked overboard. Mustang's two-in-one — an inflatable PFD with integral harness — makes good sense.

STAY ON BOARD

Since your primary safety system is the boat itself, it should be well maintained both structurally and mechanically, and outfitted appropriately with approved safety equipment.

We've already said life jackets are important; let's go one step further to safety harnesses. These devices keep boaters (of all ages) on board should they lose their footing and fall. There seems to be some unwritten law that harnesses are only for sailors. But all too often, we read and hear about search parties looking for powerboaters lost overboard. Cruisers and fishermen alike should consider wearing a harness. Singlehanders, power or sail, should wear a harness while on deck,

Figure 1

Create pre-cruise checklists for various areas such as electronics, galley supplies, safety equipment, rigging, navigation, engine room, sails, foul weather gear, safety gear, ground tackle, and so on. Photocopy several of each. Have a business supply store make the lists into pads, or simply staple them together.

Sample Navigation Checklist

ITEM	PRESENT	WORKING
Float plan		
Dividers		
Parallel rules		
Deviation table		
Pens,Pencils, sharpener		
Stop watch		
Calculator		
Range finder		
Binoculars		
Pelorus		
Cruising guides		
GPS		
Loran		
VHF		
Depth finder		
Compass		

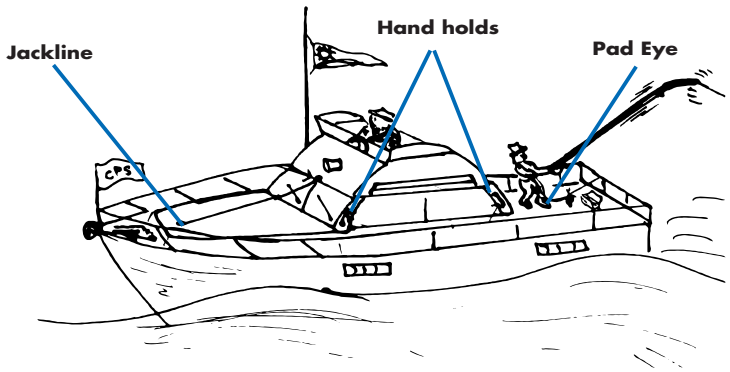


Figure 3: Powerboats are easily rigged with nylon webbing jacklines and secure attachment points for harness tethers. Attach 6mm (1/4") yacht braid at one end to adjust the webbing tension. Stow jacklines away until you need them.

regardless of the sea conditions.

Your harness attaches to a jackline — a length of line or webbing that runs from stem to stern on deck — by means of a tether (**Figure 3**). Small runabouts, cuddies and some express cruisers adapt well to similar rigging methods used on sailboats. Larger cruisers with full cabins and a flybridge could rig a jackline from a secure mounting point on the front of the cabin to a pad eye mounted on the cabin roof or foredeck. Install another single pad eye in the center of the aft cockpit. Pad eyes must be thru-bolted and installed with a backing plate.

A harness could also be hooked to the windward side of the boat to a sturdy thru-bolted fitting (a cleat, winch, or stay), mast or stainless steel eye on toe or grab rails. Lifelines, stanchions and side rails are unsuitable attachment points because they cannot be relied on to take a load. Adjust each harness to fit the person who will wear it, then label it by name for easy identification and stow in a dry, accessible locker.

Figure 2

Sample Float Plan

Boat name and number _____
Names and addresses _____
Boat size and type _____
Color: Hull___ Deck___ Cabin___
Type of engine(s) _____
Other distinguishing features _____
Type of radios _____
Liferaft: Y/N
Tender: Y/N Color ___
Other safety equipment _____
Flares (#)_____ Life jackets (#)____
Other_____
Search-and-Rescue No. _____
Police No. _____

TRIP NO. 1

Date_____
Time _____No. on board____
Leaving from _____
Going to_____
Proposed route_____
ETA_____
Returning date_____
ETA _____
Call Search and Rescue at:
Time_____Date _____

BE SEEN AND HEARD

Visual distress signals, come in several "flavors." Know what is legally required for your vessel but don't limit yourself to only these. A large and varied supply of aids could save you, your crew and your craft.

There are four types of pyrotechnics (flares): A, B, C and D. All have a limited shelf life and each is designed for a specific search condition such as night use, day use, night/day use, observation during air search or from both the ground and air, and so on. Read and comply with instructions.

There are a number of visual distress aids. A large orange flag with a black circle and a black square can be flown from the mast or draped on a cabin roof or deck so it can be seen during an air search. Use a flashlight to transmit an S.O.S. signal, and orange dye markers can be spread over the water surrounding your vessel.

Sound plays a part in rescue missions too. An EPIRB (Emergency Position Indicating Radio Beacon) is an automatic radio transmitter highly recommended for any vessel operating offshore or on the Great Lakes beyond the range of VHF radio — roughly 30km (20 miles) in ideal weather conditions. Class A and B EPIRBs transmit signals on aircraft frequencies for up to 322km (200 miles) for hours or days, depending on the quality of the unit and its battery life. Category I or II 406 EPIRBs transmit a coded message that identifies the sender and position of the vessel to a search-and-rescue satellite, which then forwards the information to the nearest ground station.

At night, you'll have a better chance of being seen in the water if you have a waterproof strobe light. Shown here is the RL-2 from Forespar.

A VHF radio — considered a basic piece of safety equipment — is used to receive weather reports and coast guard warnings as well as to transmit requests for assistance and communicate with rescuers. Each VHF radio requires both an operator's and station licence.

M.O.B. AND OTHER GEAR

There are many throwing devices such as life rings (mandatory on most boats), floating cushions and floating lines on the market. Consider the

strength and dexterity of your crew and the type of boating you usually do before buying. Throwing devices should always be clearly visible and easy to get at. Practise man-overboard sessions under controlled conditions. If you're frequently underway at night, it's a good idea to have a waterproof floating light, preferably a strobe light that automatically activates on contact with water. Attach a light to the life ring and every life jacket.

Approved fire extinguishers should be strategically located near all companionways and other exits, and you should have a type C (for electrical fires) at each helm. Inspect your extinguishers regularly (and date the label) according to type. It is recommended that CO_2 types be weighed annually. And since the dry chemical types tend to cake or pack, frequently shake the cylinders vigorously and periodically strike the base of the cases soundly with a rubber mallet to thoroughly loosen the dry chemical powder.

Ground tackle, too, will be determined by the size of your craft and your cruising habits. One anchor is never considered sufficient and no craft, whether it be a rowboat or a cruiser, should be without ground tackle. For the more adventurous, three anchors provide an efficient combination: a light lunch hook for brief stops in sheltered waters; a working anchor for regular overnight service; and a third, larger storm anchor selected for its superior holding power in extreme weather conditions.

Offshore and Great Lakes travellers know the benefits of stabilizing devices, such as drogues and sea anchors, in extreme weather. A liferaft big enough to carry the largest crew aboard is also a must-have for offshore trips of more than several miles. Similarly, a dinghy doubles as a shuttle from an anchorage to land and as a life-saving flotable if the main ship is sinking. A first-aid kit appropriate for your boat size, the number of passengers and degree of medical expertise, is essential (the topic of first-aid kits will be covered in more detail in a future issue). There are also alarms and detectors that alert you to a wide variety of dangers, from burglars on board to explosive vapors trapped below. A wired float switch can warn of flooding in the bilge. Other detectors indicate dangerous levels of various substances such as gasoline, propane and carbon monoxide.

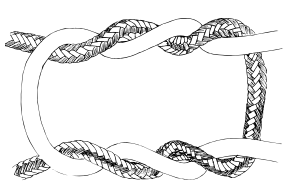
Remember an educated, prepared and conscientious boater is one who, after many years of judiciously inspecting and maintaining their vessel, and following sound safety procedures on the water, gets to gather the grandchildren around and tell happy tales of adventures on the high seas!

Sheilah van Nostrand is a retired registered nurse, freelance writer, Jane-of-all-trades and long-time powerboat enthusiast and member of Canadian Power & Sail Squadrons. She and her mechanic husband George (also a contributor to DIY*) are currently upgrading a 1975 10.2m (34') Tollycraft for long-range cruising.*

KNOTTY KNOW-HOW

Surgeon's Knot

Similar to a reef knot, the surgeon's knot has an extra turn at each stage. This knot is particularly useful for securing cord and small-diameter lines; the extra turns in the first tie prevent the knot from slipping.



ENGINE TROUBLESHOOTING

RECOMMISSIONING DIESEL INBOARDS

When recommissioning a boat after winter storage, or after it has been laid up for extensive maintenance, preparation is needed before you start the diesel engine.

During long-term storage, moisture builds up inside tanks that are partially full; I'll assume that you added fuel conditioner to the fuel tank and then filled it to minimize condensation. If the oil wasn't changed when the boat was hauled out, then drain the crankcase and gearcase and add new stuff. It's a good idea to change the oil on boats stored for six months or more — even when the oil was changed prior to storage — as moisture condensing inside the engine will contaminate the oil.

Engines must be prelubed before starting to prevent damage to moving parts; this step is critical. You can turn the engine over with the hand-operated crank (on smaller engines only) or with the help of the boat's battery. Connect power to the engine, place the shifter in neutral, raise the decompression lever and leave it in the no-compression position, then turn the ignition key to "On." Turn the engine over five to 10 times. The starter spins the cylinder(s), forcing oil to the top of the engine. If the engine stops running, all the oil will drip to the bottom and be bone-dry on top. Stop immediately if you hear any abnormal sounds. If you're turning the engine by hand, check the engine manual for the correct procedure.

If the boat is afloat, you must first disconnect the water supply before prelubing the engine. When there is no exhaust pressure, water pumped into the system will back up into the engine. Now, turn the water on and start the engine. If after a few tries the engine fails to start, turn the water off and try again. Inspect the fuel filter/separator for water contamination after the first run. After running the engine for several minutes, stop it, wait for about 3 minutes, then recheck the oil level. For additional information refer to your engine manual for the recommended procedure for starting a new engine for the first time.

IMPELLER REPLACEMENT

By George van Nostrand

Impellers can be destroyed in minutes when there's a blockage of the water intake by weeds, plastic bags or other foreign objects. Blockage results in overheating which can cause expensive engine damage.

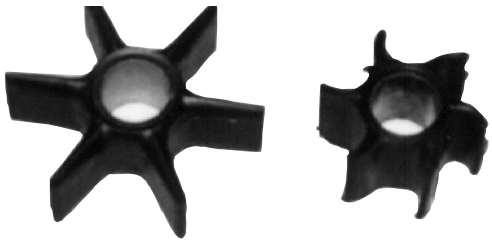
SHEILAH VAN NOSTRAND

Figure 1

Use two screw drivers to pry out the impeller.

Figure 2

Comparing new (left) versus old (right): it's time to replace the impeller when vanes take a permanent set.



Every owner should carry spare impellers, gaskets, O-rings, tools and an engine manual on board, and be able to replace an impeller when it fails. Doing this in an inboard engine is easy; impeller replacement in outboards and stern drives is extremely complex, requiring removal of the gear housing, and is beyond the scope of this discussion.

First, shut off the intake seacock. Remove the drive belt and pump assembly, taking note of and labeling the inlet and outlet hoses as well as the pump ports. Some engines do not require removal of the pump assembly to access the impeller; check your engine manual before continuing. Also note and mark the direction of rotation of the drive pulley. Remove all cover screws and cover plate. Grip the impeller with pliers or pry it out with two screwdrivers **(Figure 1)**. Inspect the impeller for cracks, wear and missing blades ***(Figure 2)***. Pieces from broken blades must be located and removed as they will block the water cir-

culation in the system. If you remove the water pump assembly, hold it on a table or bench, or grip it in a vise, then spin the drive pulley to check for noisy (growling) bearings. If bearing damage is suspected, replacement of the bearing and seal is best done by a marine mechanic as press work may be involved.

MERCURY MARINE

If you suspect a water blockage or the engine overheating alarm sounds, turn engine off immediately. This impeller was run dry for only 30 seconds at 2,000 rpm and shows burned leading edges and two broken vanes.

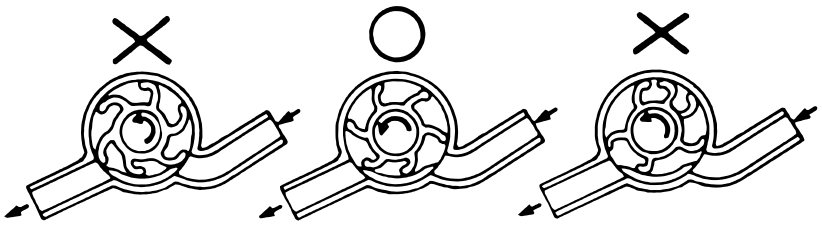


Figure 3

View from the top of the cooling water pump: Blades must be positioned in the opposite direction to that of rotation to avoid premature failure. Some impellers are installed counterclockwise; check rotation on pump assembly or engine manual.

required. As pumps and drives vary, always be sure to follow manufacturer's instructions.

Many stern drive units have the seawater pump in the outdrive gear housing and maintenance requires special tools and training. It's recommended that impeller inspections be done by a qualified marine mechanic and not by the owner or well-meaning friends.

A certified mechanic, George van Nostrand has owned, skippered and delivered powerboats for over 35 years. He and his wife Sheilah are currently upgrading their third, and first fiberglass cruiser, a 1975 10.2m (34') Tollycraft.

ENGINE TROUBLESHOOTING

ENGINE PREVENTION: Oily Warning System

Monitoring engine wear and tear with regular oil analysis can detect early stages of engine failure.

By Phil Friedman

Analyzing crankcase oil allows you to gauge what's happening inside your engine without costly exploratory disassembly. By identifying the presence of foreign substances, chemical, spectrographic and infrared analyses can provide early warning of potential problems.

PROOF POSITIVE

Chemical analysis can disclose the presence of contaminants such as water, antifreeze and raw fuel before their concentration can cause mechanical trouble. The presence of water or antifreeze in your oil, for example, could indicate a head gasket leak that, if left uncorrected, could result in significant bearing damage, as well as accelerated wear of piston rings and cylinder walls. Fuel in your crankcase oil can cause a loss of oil viscosity and, in turn, lead to rapid deterioration of rings, cylinder walls, and other friction surfaces.

As internal parts wear, microscopic metal particles are picked up by the circulating crankcase oil. The level of concentration of these metals in the oil can be determined by spectrographic analysis — or more accurately, atomic absorption spectrophotometry. By comparing these concentration levels to those established by experience for normal wear, technicians can determine whether your engine is wearing at a normal or accelerated rate.

Infrared analysis is used to check the condition of the oil itself and how well various additives are holding up between oil changes. Consequently, it can provide early warning of a need either for more frequent oil changes or corrective repairs, or possibly both.

Under normal circumstances, oil additives maintain their effectiveness between oil changes. However, unusual operating conditions — high sulfur content in fuels or the presence of internal engine problems, for example — can lead to premature depletion of critical additives.

TEST PROCEDURES

Effective oil analysis requires proper sampling techniques and skilled interpretation. Because metals tend to settle out, oil must be sampled when it's hot and has recently circulated through the engine. And you must prevent contamination of the sample by using one of the special sanitary sampling kits provided by engine manufacturers and various independent oil-testing labs.

Unless there are gross amounts of metal in the oil — due, for example, to a completely disintegrated bearing insert — particular levels of trace metals have very limited meaning without a benchmark against which to measure. Consequently, if you want to take

TIPS ENGINE MANUALS

If you don't have one — get one! Engine manuals cost about $40 and are available from specialty book stores, marine dealers or direct from the engine manufacturer. If your engine is an antique, check with your local dealer. Some dealers have old shop copies that they will photocopy for a fee. Also ask your neighbors in the marina; you may find another boat owner with the same engine who has a manual you can photocopy.

advantage of oil analysis, it's critical to keep accurate operating records for your boat's engine(s). Your engine maintenance log should show how many running hours have accumulated and the dates on which you've changed the oil and filters. It's also critical to follow a regular program of oil service and sampling. Beyond that, you need to deal with a testing lab (Shell and Imperial Oil both operate test labs) that has access to compiled data concerning precisely what concentrations of wear metals should be present if wear is within normal limits for your specific engine make and model.

The first step is to find out whether the manufacturer of your engine(s) maintains its own oil analysis program. If not, check out the independent laboratories. Some of these labs maintain extensive databases that include wear information on most major engine makes. Ask your engine manufacturer's tech/service department for a referral.

You might also check out the Oil Analysis Kit produced by Marine Development. It retails for about $25 and is available from most marine accessory supply stores or from the major catalog houses.
The price of the kit, which is for sampling and shipping the oil, includes the cost of the analysis and report at an MDR-contracted lab. It usually takes about two weeks to receive the report.

EARLY DETECTION

The best results are obtained by starting a sampling/analysis program as soon as possible after an engine's initial break-in and by continuing that program at regular intervals, say, just before every other oil change. This establishes a "wear record" for the engine and makes it easier to detect unusual accelerated accumulations of trace metals. Even if your engine(s) is (are) older, you can embark on a program of regular oil service and testing, if the appropriate wear data is available at the lab.

Don't expect miracles. Oil analysis cannot predict catastrophic failures like the sudden fracture of a connecting rod or a valve stem. Such failures are due to internal stresses, strains and defects and, consequently, are not preceded by a detectable release of trace metals.

Regular and systematic oil service (oil and filter changes) goes a long way towards prolonging engine life; but it does not forestall abnormal, or even normal wear and tear. Systematic oil analysis allows you to monitor such wear and tear, and can alert you to developing problems. Just as important, it can tell you that nothing is wrong, and in so doing, help you avoid arbitrarily scheduled and unnecessary overhauls and their associated costs.

ELECTRONICS

GPS ACCURACY DROPS TO 10!

The accuracy of GPS is determined by selective availability, or SA, an operational mode imposed by the U.S. Department of Defense that affects GPS signals. Designed to deny "hostile" forces the tactical advantage of GPS positioning, SA can be changed at any time. Position accuracy of GPS units is currently only to within 100m (328').

The good news for boaters is that effective May 1, 1996, SA will be upgraded. This means that existing GPS units, depending on the model, will be able to find a position within near-earshot range. According to Robert Hudson of Canadian Marconi Company, a built-in unit with a large microprocessor and powerful eight- or 12-channel antenna, will be accurate to about 10m (32.8'). A Differential GPS unit will get within stroking range — an amazing 30cm (1')! With hand-held units accuracy will improve only marginally, anywhere from 10% to 50%, because of less advanced microprocessors. Existing GPS units do not require software upgrades to take advantage of the new rules; just turn your unit on – it's free.

Manufacturers do not expect the selling price of GPS units to increase, but you can count on loran prices to drop. Don't throw away your loran, though. In the event of a "hostile action" (such as war), the defense department will almost certainly degrade SA worldwide, preventing any access to GPS signals.

WIRING HANDBOOK UPDATE

RECALCULATING WIRE SIZE

As a follow-up to our *Wiring Handbook* in the WINTER '95 issue, Dick Rogers of Arbrux Limited, a marine electronics supply and consulting firm in Uxbridge, Ont., sent us this handy formula for calculating wire size exactly to your requirements. Besides factoring in amps, length of wire and acceptable voltage drop, this formula also accounts for operating temperature when calculating wire gauge.

Temperature affects high-current wires, especially those in the engine room or other hot areas, where the known operating temperature is around 54C (130F). If your intention is to maintain a maximum 3% voltage drop, then you'll need to consider temperature. Using a calculator, punch in the amps, length of wire, acceptable voltage drop for a particular wire run and the factor for temperature. Compare results on the Gauge Code Chart to determine wire size. Here's the formula:

$$\frac{\mathbf{K \times I \times L}}{\mathbf{E \times 1000}} = \mathbf{G}$$

Example:

$$\frac{11.2 \times 36 \times 21}{.6 \times 1000} = 14.11 = \#8$$

E= Allowable voltage drop.
For 12-volt systems and a drop of 3%, use .36; for 10%, use 1.2.
K = A constant for resistance of copper based on temperature.
For 10C (50F) use 10;
up to 40C (105F), use 11.2;
up to 65C (150F), use 12.2;
up to 93C (200F), use 13.3.
I = Current in amps.
L = Wire length from the positive power source back to the negative power source, measured in feet.
G = Gauge code. See chart below.

GAUGE CODE CHART

Gauge Code less than	Use AWG#
2.5	16
4.1	14
6.5	12
10.4	10
16.5	8
26.3	6
41.7	4
66.4	2
83.7	1
106	0
133	00
168	000
212	0000

DIY PROJECTS

RETROFITTING WINDOWS

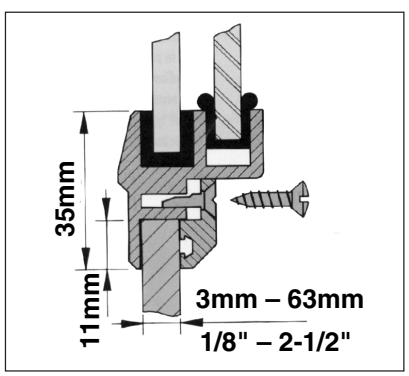
Many boat owners are plagued by leaking windows, portholes or deadlights. (For clarity we'll refer to all the above as windows.) As boats age, window seals deteriorate, vibration and the constant movement of the hull loosen fasteners and consequently, windows begin to leak. You tighten the fasteners a little, then a little more, until you can't tighten them anymore; still the window leaks. On older powerboats, wooden U-channels that hold sliding windows captive eventually rot from water seepage and will disintegrate over time.

CONTROLLING LEAKS

Repairing leaks before they cause structural damage should be your primary goal. Because windows are composed of a glass or plastic insert mounted in a frame that attaches to the hull, windows can leak on two sides: between the glass and frame, and between the hull and frame. When the leak is between the hull and frame, caulking offers a quick fix but it's not the best solution. A bead of silicone around the edge is never fully watertight. When caulking is compressed over large surfaces the excess may squirt out, but there's no guarantee that it forms a continuous seal once cured.

Tape seals made of neoprene are a better remedy but require removal of the window. Carefully remove the window, clean the edge and seal it with a strip of 3mm (1/8"), or thinner, outdoor-grade neoprene (also known as weatherstripping). Double-sided tape works best. Affix it first to the frame, remove the backing, position the frame in the opening and reinstall the screws. Covered by the window flange, tape seals remain soft and flexible. Once the frame is compressed, the window should not leak except perhaps through the screw holes. Tape seals come in different grades; use the best quality you can find.

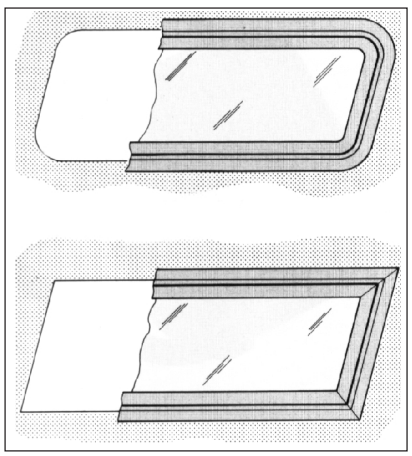
Resealing the join between frame and window is near impossible. Some sailboats built in the late 80s, including C&Cs, Mirages, Tanzers and others, might have window seals (between the plastic window and frame) made of a gray plastic-like material. Unfortunately for the unsuspecting buyer, these seals were of poor quality and deteriorated rapidly, causing windows to leak like sieves. If your boat is so equipped, you have few options. Caulking the frame is a messy job and will never completely stop leaks. Continual tightening of the fasteners, in an effort to stop leaks, may have also bent the frame. (These windows were bargain-basement specials!) On these boats and when windows leak steadily even after resealing with tape, your only option is to replace the windows.



VETUS

Figure 1

Modern fixed and sliding windows, portholes and deadlights are clamped into place, without drilling screws holes into the hull.



VETUS

Figure 2

Aluminum window frames are made in one-piece, bent to shape, with rounded corners (top) or a four-piece section with mitred corners (bottom).

REPLACEMENT MATERIALS

Don't dispair; think of window replacement as an opportunity. You have your choice of materials and design, and are limited only by the shape of the mounting surface. Fixed windows adapt easily to fit most curves, while sliding and half drop windows require two parallel sides (top and bottom) and an absolutely flat, vertical surface. This automatically excludes sailboats because of the excessive camber in their cabin walls.

Boat windows come with two styles of mounts — flange or

DIY PROJECTS

clamped — plus variations on each style. The former has a flange screwed into or through the hull. Most windows produced in North America for sailboats are of the flange type. This is a good system, but as contact with the hull is only at the fasteners, the windows often leaks. A clamped window has an outside flange connected to an inside trim. Flange and trim are clamped together, compressing the window material against the hull and forming a watertight join without drilling into the hull **(Figure 1).** This method requires flat surfaces to maintain an impenetrable seal. Aluminum frames are either mitre cut and made up of four pieces, or bent **(Figure 2)**. Older powerboats usually have mitre-cut frames. A boat's infrastructure gives this frame its rigidity and although it can be made waterproof, it's never as strong as a single-piece bent frame.

Windows are made of tempered glass, Plexiglas and Acrylite acrylic plastic or Lexan polycarbonate plastic.

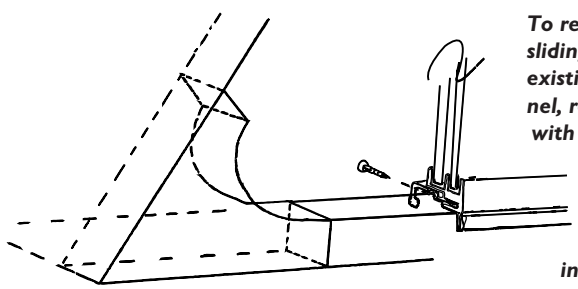
Lexan is stronger than acrylic plastics; tempered glass of the same thickness is the strongest. Glass adds additional weight — it's nearly 50% heavier than Plexiglas of the same thickness — but it won't scratch. Tempered glass is flat and doesn't bend, consequently it cannot conform to long windows with lots of camber.

Replacement prices vary depending on the number of windows and materials used. Replacing six or seven glass windows in a 9m (30') powerboat, for example, will cost $1,800 to $2,200. Clear anodized aluminum frames are standard; black anodizing costs the same but the finish is not guaranteed against wear. Glass is usually offered in clear, blue, green, gray or smoke; acrylics in all colors. Powder-coated frames, color matched to the boat's gelcoat, add about $20 per window, plus an extra start-up cost per color of about $250. As sailboat windows have so many mounting variables, prices are available by quotation only.

A PERFECT FIT

Boat window manufacturers rarely inventory stock windows. Boat windows are not uniform; even among boats of the same model and year, no two windows are exactly alike. Before removing any window, first obtain a quotation for a new one. With the window intact, measure the overall outside dimensions and forward these to the manufacturer for an estimate. When you've agreed on a price, dismantle the window. To design a replacement window, the manufacturer needs to know the hull thickness and exact dimension of the window opening. Measure the length of the top, sides and bottom. Then measure two diagonals, from upper right to lower left, and upper left to lower right corners. Measure the radius of the corners or make a template. Many window manufacturers use CAD systems; when provided with correct measurements they will produce perfectly matched windows.

Figure 3



WILLEM BOON

To retrofit a clamped sliding window to an existing wooden U-channel, replace the channel with a square block 1.9cm to 2.54cm (3/4" to 1") wide and install a wooden block of the correct radius in the corner.

INSTALLATION TIPS

On older powerboats with sliding panels the wooden U-channel structure may need to be rebuilt. Replace with a 1.9cm to 2.54cm (3/4" to 1") square block, glued and screwed in place. In the corners cut a wooden block of the correct radius, waterproof with epoxy, then glue in place **(Figure 3)**.

Leaks can occur with large fixed plastic windows that are mounted incorrectly. Plastics are susceptible to temperature variations. In areas with drastic temperature changes between summer and winter, acrylic plastic expands by nearly 1% of its length. After a few seasons, large windows on sailboats reveal major leaks. Manufacturers recommend that you use clamp mounts with a frame slightly larger than the total contraction and expansion. Flange mounts fastened with screws will crack acrylics, unless you have slotted screw holes to accommodate movement of the acrylic. A high-quality window, installed correctly and properly maintained (see *Care of Plastics* below) will deliver years of trouble-free use.

Many thanks to Willem Boon of Bomon, a Quebec-based window manufacturer, for assistance with this article.

CARE OF PLASTICS

Plexiglas and Acrylite acrylic plastic and Lexan polycarbonate plastic hatch covers, portholes, companionway doors, windshields and windows have excellent durability and resistance to breaking. Acrylics retain their appearance for a very long time if precautions are taken not to scratch them or subject them to high temperatures. The same precautions must also be taken with Lexan, but it does not have the superior ultraviolet qualities of acrylic plastic. Follow these easy steps to ensure that your boat's plastic glazing will maintain its crystal clarity for years.

CLEANING

Clean plastic surfaces with a good quality plastic cleaner, mild soap or detergent and plenty of lukewarm water. Use a clean, soft cloth or foam polishing pad and apply only light pressure. Rinse with clear water and dry by blotting with a damp cloth or chamois. Remove grease, oil or tar using a good grade naphtha or kerosene. Immediately wash the surface to remove any oily film left behind by solvents. Do not use household window cleaners, kitchen scouring compounds or solvents such as acetone, gasoline, benzene, carbon tetrachloride or lacquer thinner. Keep teak oil, varnish and other solvent-based solutions from coming into contact with plastics.

POLISHING

Polish acrylic or Lexan with a quality cleaner and polish. There are a variety of products on the market, such as Warehouse Plastic Sales' 210 Cleaner and Polish. Apply a light coating on the surface, then wipe and buff dry with a clean cloth. Static electricity attracts dust to plastics. Cleaners such as Plexus from B.T.I. Chemical or Davies Klear-to-Sea contain an anti-static compound that repels static and dust. 3M Marine recommends using a rubbing compound followed by 3M Imperial Glaze.

DIY PROJECTS

REMOVING FINE SCRATCHES AND OXIDATION

Fine scratches are easily removed with plastic compounds such as 210 Plus Scratch Remover, Star brite's Plastic Scratch Remover, 3M's Imperial Microfinishing Compound, Mequiar's Plastic Cleaner and others. Some products may require a second application on badly scratched surfaces. Many are three-in-one products that clean, restore and leave a protective coating on the surface in one application. Single-purpose scratch removers must be overcoated with a polish to restore shine and clarity.

To recondition deeply scratched plastics, wet sand in two different directions.

SANDING

Hand sanding is an acceptable practice for reconditioning deeply scratched plastics. Before sanding, determine the type of plastic you are working on. If you're unsure, do a scratch test. Find an inconspicuous section of plastic, such as a corner or area under a removable trim piece. Run a corner of a screwdriver blade over the plastic. If you hear a scraping sound, or the blade jumps across the surface, you're working on acrylic plastic. If you don't hear anything or the blade moves smoothly across the surface, the product is Lexan.

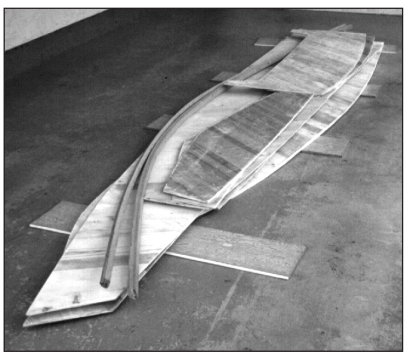
Reconditioning requires sanding the surface in two directions. 3M Marine recommends the following procedures: First, wet sand the entire surface in one direction only. On acrylics, use a sanding block and 320- grit paper for light scratches and 600-grit to remove deep scratches. Sanding Lexan is only effective on light scratches and should be done with 1200-grit paper; scratches produced by coarser abrasives cannot be removed from Lexan. When you're finished, all sanding scratches should be going in the same direction. Now, using a finer-grit wet paper, sand in a direction perpendicular (this is called cross-sanding) to your first sanding marks until all the coarse scratches have been eliminated. Follow with 3M's Imperial Microfinishing Compound and Glaze which is available in either machine- or hand-applied formulas.

With information supplied by Warehouse Plastic Sales and 3M Marine.

BUILD A BOAT FROM A KIT

For the many *DIY* readers who requested information on building small runabouts or dinghies, SuperKits from Wood River Enterprises in Chilliwack, B.C., produces affordable, seaworthy kit boats. It takes less than 20 hours, using only pliers and a screwdriver, to complete the 15-footer, one of three models available. Better yet, have the kids build the boat while you work on the mother ship.

We discovered these kits at the Vancouver boat show. For less than CDN$1,000, you can be on the water in your own creation. Hulls are constructed of preformed panels made of a wood-epoxy composite. This material is lighter than aluminum with a greater strength-to-weight ratio than steel. Hull sections are pre-shaped using a vacuum molding system developed by Wood River. This results in full-length, solid wood and epoxy panels, 10mm (5/16") thick, with built-in compound curves. Panels are cut to length, drilled and coated with epoxy. Boats are assembled using a modified stitch-and-glue method that Wood River calls SST (Stitch-Tack-Tape). Since the epoxy is impervious to rot or mildew, there's no need to fiberglass the hull. Except for a regular coat of paint, the hull is as maintenance-free as a fiberglass boat.



Kit comes ready-to-build — just add pliers, screwdriver and...water.

SuperKits are available in two runabout models: a 3.67m (12') StarFisher (CDN$795)and 4.32m (14'2") SportFisher 95 (CDN$895). The smaller model has a beam of 1.53m (5'), and can carry three people and a 10-hp outboard. The beamy SportFisher is 1.88m (5'2") wide, can carry up to 490kg (1,080lb) and outboards up to 30 hp. Both models have under-seat stowage compartments for life jackets, fishing rods, tackle and other gear; the SportFisher also has a forward casting platform. Modified-V hulls and a fine entry suggests the boats will row well, while the deep freeboard and a wide transom

After the panels are stitched together with wire, craft glue is applied to hold the panels in place.

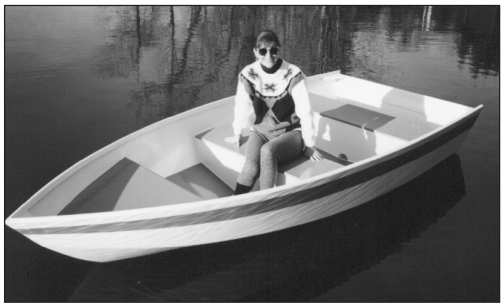
increase stability and comfort in rough water. The self-flotation properties of wood make these boats extremely safe. As we went to press, the company was putting the finishing touches on a tender. This 7-footer will weigh about 20.25kg (45lb), take eight hours or less to build and sell for under $400.

Kits arrive ready-to-build. Bottom

Wire "tacks" are removed and a fillet of thickened epoxy is laid over the seams. Epoxy saturated-fiberglass tape is then laid over fillets. Non-toxic, water-based epoxy makes cleanup easy.

and side panels and transom are precut and drilled. Gunwales and rub rails are cut to length and beveled. Other components include: a building jig, seat assemblies, storage compartments, wire, glue gun and sticks, epoxy, fiberglass tape, sandpaper, brushes, scraper, measuring cups, fillet sticks and fasteners. You'll need to supply two sawhorses to support the jig, Styrofoam for positive flotation (required with outboards over 9.9 hp), a bow eye, transom handles, paint, trailer and outboard motor. The manufacturer claims that if you need a saw, you can return the kit for a full refund!

Building is easy — components fit together much like lacing a shoe. After setting up the jig, which takes about 30 minutes, the bottom panels are stitched together by threading wire (supplied) into predrilled holes, then twisting the wire to fasten. Continue stitching, adding side panels and transom. Seat assemblies are placed in position, then everything is tacked in place with the glue gun. Wires are removed, seams are filleted with thickened epoxy, covered with epoxy saturated fiberglass tape, then coated with epoxy. The epoxy is water-soluble (no solvents), so cleanup is easy with water.



Less than 13 hours later and our proud builder shows off her prize.

Next, turn the hull over, fill the seams with epoxy and cover them with tape. It takes about 14 hours plus drying time to get to this stage. A light sanding followed by three coats of a marine enamel or polyurethane and your boat is ready to launch.

DIY PROJECTS

CHAFE GUARDS FOR LINES

Dock, spring and fender lines must be protected from abrasion from chocks, rails, stanchions, docks, piers, pilings, trees and rocks. There are commercial chafe guards available on the market, but true-blue DIYers can make their own — it's easy and less expensive.

EQUIPMENT

To make these chafe guards, you'll need leather; a leather punch (a $10 item available at hardware, hobby and craft stores or tack shops); scissors or a utility knife and metal guide (ruler or square); shoe laces (preferably round) or a leather thong for sewing.

Leather is flexible, durable, resistant to water and sun and tolerates the abrasive action of the working line on its interior surface. Purchase thick leather (moose or elk) from a hobby or craft store. Manufacturers of leather goods such as shoes, boots and coats often sell scraps, or you can check out some second-hand stores for used coats, moccasins or boots with leather uppers. Rubber garden hose is a substitute for leather but it's less flexible and you're confined to the "one size fits all" inside diameter of the hose. Keep a piece or two of hose on board for quick repairs.

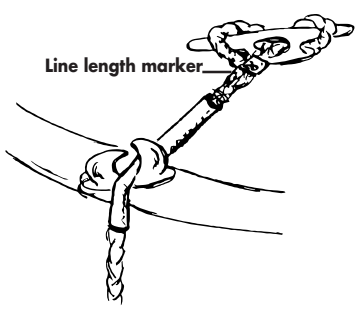
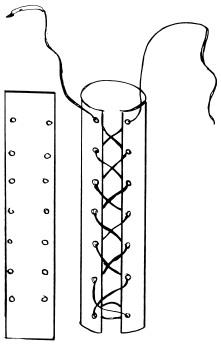


Figure 3: Secure chafe guard with a surgeon's knot or sew to line.



SHEILAH VAN NOSTRAND

Figure 1 & 2

ASSEMBLY

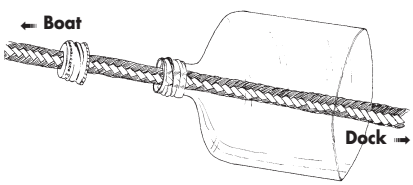
Cut a rectangular piece of leather long enough to allow for oblique protection, 30cm (12") or more, and sufficiently wide to wrap around the designated line so the guard slides freely. Punch holes spaced about 2.54cm (1") apart on both long sides but not too close to the edge (**Figure 1**). Lace the sides together with criss-cross stitches as if you were tying a shoe, allowing extra length on the ends to secure the guard to the dock, spring or fender line (**Figure 2**).

Make a permanent chock guard for designated docklines (**Figure 3**). Make up two or more extra-long guards for times when two guards are needed on the same line: when a single line doubles as a fore-and-aft spring, for example, or when you're tying off to a piling or rock. Use left-over scraps to sew a band of leather at or near the join of each eye splice. Then inscribe the length of each line with a permanent marking pen.

Secure the guard by wrapping the laces around the line two or three times, then tie off with a granny knot and bow (again just like your shoes) for temporary placements. For permanent chafe guards on dock lines, secure with a surgeon's knot (see page 17) or sew the guard to the line with waxed thread. *Sheilah van Nostrand*

RODENT GUARD

In response to an inquiry in our last issue from a reader seeking a means to stop unwanted four-legged trespassers, we received this nifty idea. The Rodent Guard attaches to dock lines and is simple to make. Cut a 500-ml (12 oz) plastic soda bottle in half, remove the cap and drill a hole in it slightly smaller than the diameter of your dock lines. To assemble, squeeze the line through the cap and bottle, slide cap to desired location on the line and screw bottle in place. Providing the cap fits snugly on the line, it will hold the bottle in position.
Robert Houston, Victoria, BC.



ANNE-MARIE HENDRY

PROJECTS WANTED

If you would like to share one of your own boat-tested projects, send your articles to DIY PROJECTS via mail, fax or e-mail. Include a brief explanation and photos and/or sketches (don't worry, we'll redraw the art). Also, please include your mailing address and a daytime phone number or e-mail address. If we publish your project, we'll send you between $25 and $150, depending on the published length.

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

E-mail: info@diy-boat.com

POWERBOAT RIGGING

STEERING CABLE REPLACEMENT

TOOL BAG

- **Socket set**
- **Pliers**
- **Adjustable wrench**
- **Side-cutting pliers**
- **Rags**
- **Marine-grade lubricant**
- **Penetrating oil**
- **Moisture-displacing lubricant**

When a boat is new, the steering wheel is easily turned with one finger while the engine is in neutral or idle, but over time the system deteriorates and steering effort increases.

Steering on a boat is controlled by a cable, usually a steel inner cable that slides in a lubricated plastic jacket or tube. One end attaches to a transom mount, the other to a helm unit under the dash. Cables fail for many reasons, including lack of regular lubrication (see Cable Maintenance on page 33), corrosion, salt water, dirt, incorrect installation and old age. Sometimes the cause of stiff cable operation is a build up of old grease on the cable core and engine tilt tube. Removing the grease can help restore near-normal operation. When moisture and dirt migrate past the seals, the inner cable becomes corroded. Eventually, it becomes too stiff to operate safely and must be replaced.

The following are general guidelines for replacing steering cables. It's imperative that you follow the installation instructions for your specific brand before starting. If you're without a manual, contact your dealer or cable manufacturer to obtain a copy.

ORDERING INFO

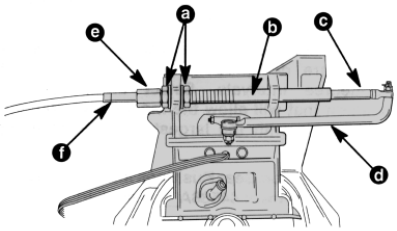
The first step is to order a replacement cable. Cables come in myriad sizes and types and dealers have limited stock. You'll find the cable manufacturer's identification numbers on the old cable, usually stamped on the outer plastic jacket within a foot or so of the end near the engine. The number includes a part number and cable length in inches or feet. If the cable is old, the part number will not be current. When in doubt, remove the cable (follow the instructions below) and take it to your dealer.

Cables are sold separately or as complete kits, packaged with preassembled helm, bezel and cable.

Replacement cables are available from Acco, DetMar, Mercury's Quicksilver division, Morse and Teleflex. Cables cost CDN$150/US$100 or less, depending on length and brand; a complete kit, packaged with preassembled helm, bezel and cable, may run as high as CDN$650/US$450.

STERN DRIVES

Cable replacement in a stern drive setup is the easiest — after you've located the cable identification numbers, that is. Often, finding these numbers requires standing on your head in a dark engine compartment and twisting your body under the back deck, only to discover the numbers have partially worn off or are hidden behind the power steering unit. Complete removal of the cable may be your only solution.



Mercury Marine Quicksilver Division

Sample attachment of cable to MerCruiser stern drive unit without power steering: a, attaching nuts; b, cable guide tube; c, steering cable end; d, steering arm; e, steering cable coupler nut; f, steering cable.

To detach the cable from the steering arm, remove the clevis pin held by a cotter pin. The pin is located behind the engine and access is poor. On older boats there may be a nut secured with a cotter pin or a locking nut instead of a clevis pin. Use the correct-size socket on a ratchet or open-end wrench. Loosen the steering cable coupler nut with a wrench. After undoing both, turn the steering wheel to port (counter-clockwise) to retract the cable end into the plastic jacket. (Check your manual; some systems require a full-lock turn to starboard.)

Use side-cutting pliers to remove all cable ties holding the cable in position against the hull. The cable must be slack so the end can be withdrawn from the cable attachment behind the engine. (Some boats have molded-in tunnels that the cable feeds through.) On smaller boats, space is limited between the hull and centerline of the engine. Working

POWERBOAT RIGGING

the cable out of the attachment involves trying to find enough working space around the battery and various electrical wires. The cable is often less flexible due to corrosion inside the plastic jacket which makes the job more difficult. If you need someone to curse during this process, remember that the cable was originally installed in the boat, prior to fitting the deck, when there was still lots of light and nothing for the installers to bang their head on!

The next step is to disconnect the cable at the helm. There are two main helm styles, rotary or rack, located behind the steering wheel. Rotary helms use a large-toothed disc inside a housing to drive the cable; rack systems use a rack-and-pinion gear to move the cable. The rotary helm comes off by undoing the large nut and withdrawing the cable end while turning the steering wheel. Rack systems have a long flat box with four attachment bolts. Undo these four bolts only — a larger nut in the middle holds the steering wheel. Even if you are only replacing the cable and not the helm, it's a good idea to disassemble the helm and inspect for wear.

Now you're ready to extract the old cable, being careful of other cables or wires that may interfere with the steering cable. Some cables have a decorative cover that must be removed before you can proceed. To save time, tape the new cable to the old, then feed it through to the helm. Be careful not to bend the new cable when threading it through the boat.

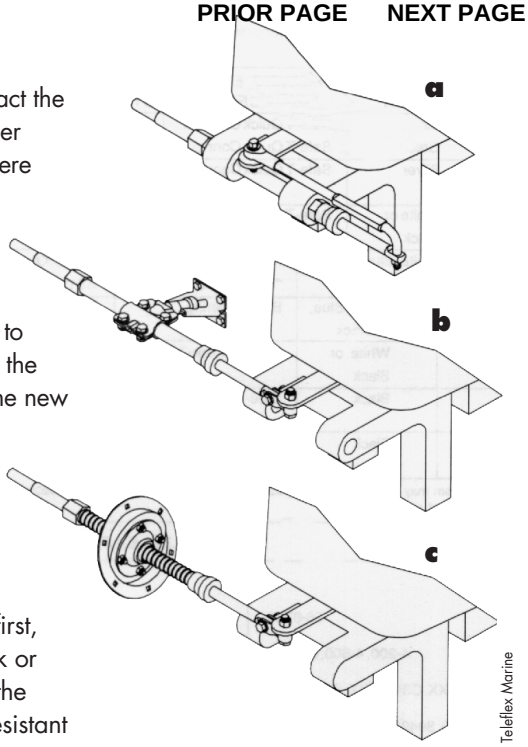
INSTALLING NEW CABLE

Hook up the dashboard end first, attaching the cable to the rack or rotary helm. Liberally grease the inner cable core with water-resistant grease. It may be necessary to center the steering wheel — equal number of turns right and left. Refer to the installation manual for precise instructions. The cable is designed with a specific minimum bend radius, so don't try to bend it more than it will easily go. Bolt the helm to the dash (if necessary) and mount the steering wheel.

To attach the cable to the engine end, center the engine outdrive and adjust the cable attachment so the pin or bolt slides through both the cable end and steering arm easily. Tighten the cable coupler nut, but not too tight; check the torque rating in your manual. Reinstall the cable boots (if equipped). Use cable ties to reattach all wires and hoses to the new steering cable. Don't apply too much force or you'll pinch the hoses.

OUTBOARD INSTALLATION

Replacement of outboard cables is similar to that of stern drive steering systems except for the attachment of the cable at the engine end; it feeds through the engine mount tilt tube and a large nut threads onto the tube. Loosen the locking nut that holds the cable to the engine tilt tube.



Steering cable-to-engine mounts for outboards: (a) Tilt tube mounting is the most popular; (b) Transom-support mounting is generally used for older boats without tilt tubes; (c) Splashwell mounting.

If dirt or corrosion has found its way into the space between the tilt tube and the steering cable housing, the cable may be difficult to remove. Try heating the cables with a heat gun and pound them lightly. If cables still refuse to budge, contact your local dealer who may know some other tricks of the trade. After pulling the cable out of the tube, you must clean the tilt tube to make room for the new cable housing. Soaking it with a grease-cutting cleaner should loosen the deposits. Next, wipe it with a cleaning cloth: Tie a small strip of cloth to the middle of a longer cord, insert it in the tube and pull it back and forth. For stubborn situations, T & R Marine makes a special tilt tube cleaning brush. Available from dealers for about $25, it's a steel brush on an 20.3cm (8") shaft that runs off an electric drill.

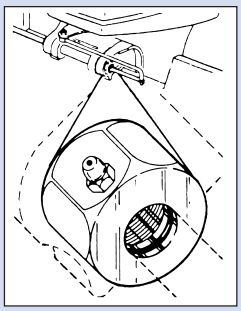
You may also have to loosen the engine-mount bolts to provide enough working space to remove the cable from the tilt tubes without

MEASURING CABLES

Measuring for a new cable is easy to do. Measure from the center of the wheel to the gunwale. Add the distance from the dash to transom plus the distance from gunwale to center of the transom. On outboardengines with tilt tube mounting, add another 15.2cm (6”). For trasom or splashwell hookups, subtract 15.2cm (6”). Some cable manufacturers measure differently, so check with your dealer before your place your order.

CABLE MAINTENANCE

Lack of maintenance is the key cause of steering cable failure. Inspect steering systems at least every 50 hours of operation or 60 days, whichever comes first. Saltwater boaters should check every 25 hours or 30 days. Look for bent rod ends, swelling under the outer jacket, cracked or cut jacket or jacket separation. Remove cable end from engine tilt



A Steersman Steering Guard mounted on the engine cable end lubricates and seals the systems.

tube and coat with grease to prevent corrosion. For cables with grease fittings (such as Quicksilver Ride Guide), lubricate cables as follows: Fully retract the core of the cable and lubricate the engine end of the steering cable through the grease fitting with the recommended lubricant. For cables without grease fittings, remove the old grease, wipe clean and reapply. On all cable systems, lubricate the exposed portion of the steering cable end. Apply SAE 30W engine oil or equivalent to all pivot points. Grease fittings make lubrication easy. If your cable isn't equipped with grease fittings, consider installing a Steersman Steering Guard cable-grease adapter. Available in sizes to fit most outboard models, it easily attaches without tools to the engine end of the cable. For the name of your local dealer contact the manufacturer, Worldwide Marine, Box 273043, Houston, TX 77277; Tel: (713) 666-6486, U.S. only (800) 747-5976; Fax: (713) 666-0788.

kinking it. When reinstalling the engine end of the new cable, rotate the wheel to starboard to expose the ram (the solid piece at the end of the inner core). Apply a heavy coating of marine-grade grease, then slide the cable through the tilt tube and reconnect it to the engine's steering arm. Refasten the engine bolts (if they were loosened) using a marine-grade polysulfide sealant under the bolt heads to prevent water from seeping into the transom and causing rot.

Other comon methods of cable attachment involve a bracket attached to the transom beside the engine or an opening in the splash-well through which the cable feeds. The ram attaches to the engine bracket, usually with a self-locking nut. Manufacturers use many different attachments and support methods but most are a variation of the above.

INBOARD HOOK-UP

On an inboard configuration, where the cable is connected to one or more rudders, the most likely hook-up is similar to the outboard set-up described above. A bracket securing the cable outer tube attaches to the transom and the ram is bolted to the rudder arm. A second rudder would be attached to the first with an adjustable link.

FINAL TEST

Before running the boat on the water, check the overall operation of the steering system. Turn the steering wheel full-lock to port, then to starboard. Check your installation manual for fine-tuning details.

Now you're ready for a test ride. The new cable should make you feel like you have power steering. Friction-free steering makes the boat easier to control and safer, and may even improve your boat handling, especially when you're maneuvering into a slip.

Many thanks to Ken Hendry, co-owner of Hendry's Trent Talbot Marina, for assistance with this article.

SAILBOAT RIGGING

SERVICING YOUR WINCHES

TOOL BAG

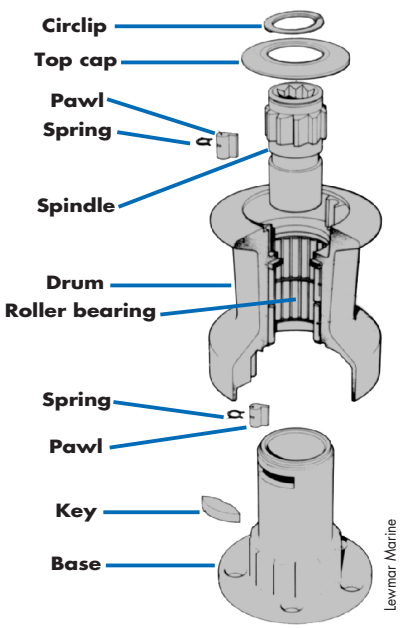
- **Assorted screwdrivers**
- **Cotton rags**
- **Degreaser**
- **Light machine oil**
- **Winch grease**

To ensure that winches function effectively and safely, dismantle, clean and lubricate them at least once a season. Under heavy use, such as racing, saltwater cruising or charter service, winches should be cleaned three or more times a year. Cleaning minimizes friction, reduces corrosion and offers a great chance to inspect for worn or broken parts.

Before performing any winch maintenance, obtain a service manual from your dealer or contact the manufacturer for one. If the winch is old and you're unable to acquire a manual for it, sketch the disassembly, noting each separate piece, as you take the winch apart. Winch manufacturers also offer service kits containing spare circlips, pawls, springs and other parts that may be lost during dismantling.

The following disassembly instructions provide general guidelines for cleaning and greasing winches sized for a 8.1m (27') boat. Instructions marked "**NST**" are for a Lewmar single-speed #8 winch; **ST** refers to an Andersen 28 ST, a two-speed self-tailing winch. Winch disassembly procedures vary with the model and manufacturer. Refer to your manual before beginning.

A note about grease: Always use a specially formulated winch grease when lubricating winches, never a general-purpose marine grease.



Lewmar #8, a typical single-speed winch.

HOW TO LUBRICATE A WINCH

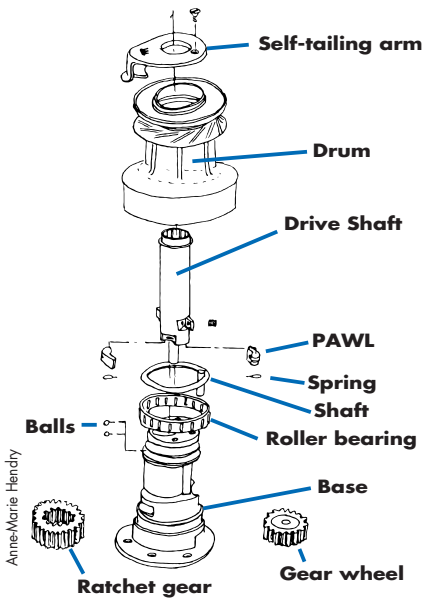
Step 1

Lay rags, newspaper or plastic on the deck to provide a clean working area. If the winch is spar-mounted, tape a bucket directly underneath to catch parts.

Step 2

NST: Remove the circlip using a small slot screwdriver and lightly pry up one edge in a circular motion, lifting slightly outward.

ST: Remove screw(s) on top of the drum or unscrew the top cap. Some older models have a slotted lock screw on top which must be removed prior to removing the 5cm (2") diameter indented lock ring.



Schematic of the Andersen 28 ST.

Step 3

NST: Remove the cover plate and lift the drum away from the base. Watch for bearings that could fall out. If the drum refuses to budge, don't force it. The pawls could be catching the drum, you have not removed all fasteners or the winch is corroded. Where corrosion is the problem, call a rigger to finish the job.

ST: Lift and remove the self-tailing arm, holding it with your thumb so that it doesn't drop overboard. Remove the drum.

Step 4

NST: Hold each spring by its pawl (located in drum) and remove.

ST: Insert a winch handle and remove the main spindle (drive shaft) while turning the gear wheel and ratchet gear.

Step 5

NST: Remove drum roller bearings. Pull out the retaining key and remove the spindle.
ST: Remove the ratchet gear. Remove the shaft, turning and tilting to lift it off the center base. Remove the gear wheel. To release the roller bearing, carefully insert a small screwdriver between the bearing and base.

Step 6

ST: Remove balls with a small screwdriver. Do not remove the plastic ring above the balls. Remove lower pawls and springs.

Step 7

Clean all parts with a degreaser. Use a toothbrush dipped in a degreaser to clean gear teeth and pawl traps or ball track inside the drum. Let dry.

Step 8

Inspect components for wear and tear and replace any damaged parts, such as pawls with rounded edges, worn springs, broken bearings, worn spacers or worn drive nuts. Look for cracked bases, housings or drums.

Step 9

Lightly grease the drive shaft and all gear teeth, bushings, roller bearings, shafts, balls, pawls and springs. Use a soft brush (small glue brush) and a dab of winch grease. Do not grease pawls or springs. Instead, lubricate them with light machine oil. Use the grease sparingly; too much only collects dirt and induces friction.

Step 10

Reassemble in reverse order. Be careful to align the pawls and springs correctly. When sliding the drum on, you may need to squeeze the pawls. Self-tailing arms must be correctly aligned to the sheet angle. When everything is reassembled, rotate the drum. It should spin effortlessly and you should hear the distinct telltale click of the pawls.

Lewmar Marine

MAINTENANCE

Bottom Paints 101

Trying to keep the "hairy beard" from growing on your boat's bottom can be a challenge, but understanding how bottom paints work and the variables that affect performance is a good starting point.

Most bottom paints today use copper or cuprous oxide as a biocide, replacing tributyl tin (TBT) paints in the late 80s. (Canada has stricter environmental regulations governing antifouling paints than the U.S., so some brands mentioned in this article may not be available in Canada.) A higher cuprous oxide content (it ranges from 20% to 75%), does not necessarily mean you'll get better wear or antifouling protection. Paint performance varies, depending on local fouling conditions, pollution levels, paint film thickness (with some paints) and the operating speed of your boat.

There are three types of bottom paints: soft, hard and ablative. Soft bottom paints, such as Interlux Bottomkote, work by sloughing off or wearing away. These paints must be reapplied annually and work best when used on slow-moving boats.

Hard bottom paints include the epoxies, vinyls and chlorinated rubbers. These products leach copper out through the paint film to deliver one-season protection on high-speed boats, or on slow-moving boats when they're scrubbed occasionally to remove slime. Interlux Fiberglas Bottomkote and Viny-Lux, Nautical America's Cup, Pacific Sailor Vinco, Pettit Neptune and Trinidad, Sikkens Vinyl and Woolsey Premium Performance are some examples of hard paints, as are Teflon-based paints from Pacific Sailor and VC Systems.

Ablative-type copolymer antifoulings are self-polishing, which means that they have a controlled constant release of cuprous oxide that slowly dissolves in water to expose new, active antifouling that protects the bottom for two or more years. Boat speed, turbulence and paint film thickness determine how long the paint will last. Ablatives include Awlgrip Gold Label, Gloucester Super Sea Jacket, Interlux Micron and Micron CFC, Jotun Valspar Hydroclean 60A1000, KL-990 Super Epoxycop and others. These paints perform equally well on fast or slow boats, and unlike soft or hard coatings, boats can be hauled out for extended periods of time with no loss of antifouling protection.

Non-copper coatings include Interlux Tri-Lux II, a TBT-free antifouling for aluminum boats and outdrives. Pettit Alumacoat II contains TBT and is sold strictly for coating aluminum. Interlux Aquarius is a water-based, non-toxic, one-year bottom paint. (Gloucester, Pettit and Woolsey also all make one.) A soft ablative coating, it contains less than 3% VOCs, or Volatile Organic Compounds, the air-polluting solvents used in conventional paints. And since it's water based, cleanup with soap and water is easy.

An alternative to painting is a "permanent" antifouling treatment. Perma-Hull Global Enterprises, based in Sidney, B.C., manufactures Perma-Hull, a patented, multi-year coating suitable for all hulls including wood and metal. It's a smooth, hard yet flexible, 100% solids epoxy adhesive coating (no VOCs) that also provides osmosis protection. Application is completed in three coats: After the hull is sanded with 80-grit paper, the first coat of epoxy adhesive is rolled or sprayed, followed by two top coats of mixed epoxy and pure copper granules (with an 85% copper content). Three coats provide a thickness of about 9 mils and, on a 8.1m (27') boat, take about one hour to

apply in 20C (68F) temperatures. A regular scrubbing is all that's required to remove any slime build-up and maintain the antifouling protection. Reapplying two top coats every five years renews the coating.

To find out which antifouling works best in your area, we suggest you tour your local marina or boatyard, talk to your neighbors and, while you're catching up on the latest scores, ask them about their bottoms — hull bottoms that is.

BREATHE EASY

Many marine cleaners and paints are highly toxic products. Most users wear gloves, goggles or a face shield and protective clothing, but how many boaters wear a respirator when sanding or painting? To learn more about respirators, we turned to 3M Marine, one of the leaders in respirator design.

Not all respirators are created equal. One designed for protection against sanding dust, for example, may not be adequate when you're painting. Most marine and hardware stores sell the typical cheap dust mask, a gauze-like fabric pad held in place by a thin elastic band secured to the pad with staples. While this mask is fine

Bottom paints are highly toxic -- always wear protective clothing including gloves, a respirator and goggles or a face shield when cleaning, sanding or painting.

for filtering non-toxic dust, it is completely inadequate for sanding most marine coatings.

Respirators are rated according to NIOSH/MSHA approvals, an industry standard that grades the contaminants and concentration levels to which workers are exposed. Chemical and paint manufacturers often refer to this coding in the cautionary statements on their labels. If a product's label fails to indicate the appropriate respirator, ask your dealer for assistance.

Bottom Paints 101

3M Marine

3M Marine's 5211 respirator provides protection against possible cancer-causing contaminants found in most bottom paints.

Protection from gelcoat, fiberglass, wood and epoxy sanding dust requires a respirator with a NIOSH/MSHA approval rating of TC21C-132 (a 3M Marine 8710 Dust/Mist respirator, for example). If you're applying bottom paints or two-part epoxies, whether by brush, roller or spray, you'll need a more heavy duty respirator with an approval rating of TC-23C-860, such as 3M Marine's 5211 gas and vapor respirator. Equipped with two charcoal cartridges, it filters out all potential cancer-causing contaminants. NIOSH/MSHA-approved respirators suitable for marine applications range in price from $16 to $35. Replacement filters cost about $5 a pair.

To ensure maximum protection, it is important that the respirator fit properly. Facial hair (beards, even stubble) can breach the seal and render it totally ineffective against toxic dust or vapors. In addition, respirators restrict oxygen intake by as much as 20%, so you should take a "fresh-air" break every 20 to 30 minutes. People who suffer from asthma, bronchitis or heart problems are advised not to undertake projects requiring respirators. If you can smell the product you're using while wearing the respirator, it's time to replace the filter. Disposable respirators with self-contained filters must be replaced frequently to ensure maximum oxygen flow and protection. Cartridge filters should be replaced at least annually.

REMOVING BOTTOM PAINTS

Planning on removing your bottom paint sometime in the future? Scraping, sanding and grinding are the traditional methods but they're painstakingly slow and messy. Chemical strippers work a lot faster to remove multiple layers but are still no cakewalk. Sandblasting gets to the bare gelcoat fast, but damages the surface resulting in hours of filling, fairing and recoating with epoxy.

The Armex Accustrip process may be the answer. It uses water-soluble Arm & Hammer baking soda forced through a patented, mobile blasting machine. Originally developed for industrial markets, Armex can quickly remove a fine film of dirt or grease, or bottom paint on boats, without damaging the substrate. It takes about 4 hours for a licensed professional to strip an 11.4m (38') boat and costs $800 or less. All you have to do now is decide whether to spend four weekends scraping or forgo next winter's vacation for a bottom blasting. Check with your marina for the name of nearest Armex Accustrip contractor in your area.

Restoring Gelcoat

Gelcoat, the exterior finish on fiberglass boats, is a porous mix of polyester resin and pigment that must be sealed from the damaging effects of ultra-violet (UV) rays, salt, dirt and weather. With proper care, gelcoat can remain in like-new condition for many years. Neglect it, however, and UV light quickly breaks down the gelcoat, causing it to become more porous, resins in the gelcoat then oxidize and the surface becomes faded and dull.

The telltale white powdery coating on oxidized gelcoat is known as chalking. Obviously, if your boat is white, oxidation will be barely noticeable. (I suppose that's why so many manufacturers build white boats.) If your boat is any color other than white, however, a plum red for example, chalking can turn it to a drab, pastel pink. The method you use to remove the chalking will

TIPS SIGNAL CODE FOR PAINTS

Like a bar of soap, ablative bottom paints slowly dissolve in water until, after three or more years, there's no paint left. When applying an ablative paint, use one color for the first coat, followed by successive coats in a different color. When the first coat begins to show through, you have a year or two before you must reapply.

depend on the severity of the oxidation.

DAMAGE CONTROL

When gelcoat is oxidized to the point of chalking, all that's needed is a thorough washing with a non-abrasive soap, followed by a "sunscreen" to seal and protect the surface and bring up the shine. One or more coats of wax or polish twice each season, especially on brightly colored hulls, should be sufficient.

Choose a wax or polish that has a UV inhibitor. Avoid using products that contain silicone if you're planning to paint the gelcoat sometime in the future. Polishes are easier to apply than waxes: they clean and protect in one easy step and require much less elbow grease. Never use a car wax or polish; most are silicone based and don't have the pore-filling capability of marine products.

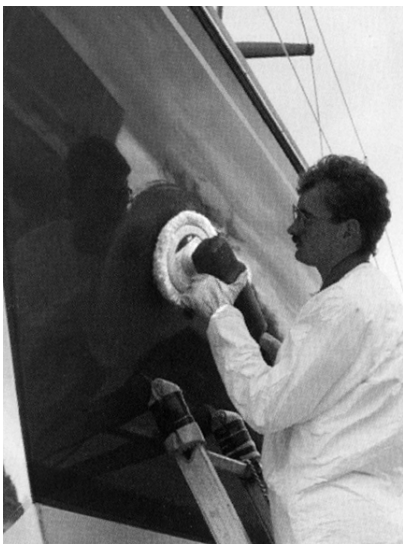
If the gelcoat still appears dull after you've waxed or polished it, you can restore the finish by compounding the surface. This strips away a fine layer of gelcoat and exposes a fresh surface. (Gelcoat is between 20 and 30 mils thick when new and compounding removes about 12 mils or less.) Use a fiberglass rubbing compound worked into the gelcoat with an electric oscillating buffer and buffing pad. (Don't use a circular buffer which gives a dazzling shine but leaves swirl marks.) Remember to wear protective eye goggles or a face shield. The exposed surface will not be as UV-resistant as the original and, immediately after buffing, must be protected with a wax or polish. Heavily oxidized — badly chalked — surfaces may require wet sanding. Start with 320-grit sandpaper and use lots of water. Change to finer paper, using 450, then 600-grit to work out the sanding marks. Finish the job with 1200-grit before applying a rubbing compound, followed by a wax or polish.

If the hull still looks faded after compounding and waxing or polishing, consider applying a restorer.

Restoring Gelcoat

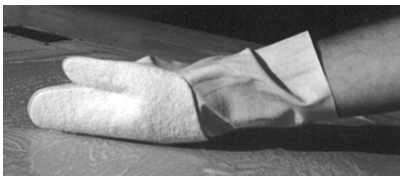
These are petroleum-based mixtures that rejuvenate faded gelcoat by changing the oxidized resin from white to clear. (Wiping a rag soaked in acetone on the hull will give you an idea of how your boat will look after applying a color restorer.)

Apply the color restorer by hand — don't use a buffer as color restorers get sticky when heated. You may need several applications to achieve enough color and gloss, then you can seal the surface with a wax or polish. Restorers are available from 3M Marine, Boat Armor, Boat Life, Iosso, Mequiar's, Star brite and others. If you use a one-step product that combines a restorer with a wax, we recommend that you also apply an additional coat of wax for added UV protection.



3M Marine

An oscillating buffer with a sheep's wool pad makes waxing easier — and you'll get better results.



For those tough cleaning jobs, keep a Duramitt in your maintenance kit. It's a one-size-fits-all rubber mitt, with a scouring pad on the palm for more scrubbing power, that protects your hands from harsh cleaners. The mitt comes with either a sponge or two grades of scouring pads. Edgewater Products of Portland, Oregon includes the mitt with its TSRW gelcoat restoration kit (see page 41), but also sells it separately for about $6.

A trick used by boat detailers to restore the color on badly oxidized boats is to "feed" the gelcoat with an oil, such as 303 Protectant. Let the oil soak in for a day and follow with a color restorer and sealer wax. Penetrol, an oil-based paint additive, can be used to restore color, but it's not recommended for use on saltwater boats as the finish may turn hazy. Other products that can be used for the same purpose include transmission and mineral oil. But never use any oils or products that contain silicone or Teflon on non-skid or you'll end up with a skating rink!

When sanding, compounding, application of a color restorer and waxing or polishing still fails to restore the color and gloss, you can paint, or consider the less-expensive option of overcoating with an acrylic gelcoat restorer. (See Product Demos on page 41)

GELCOAT REPAIRS

Minor gelcoat scratches, gouges and cracks are easily fixed with a gelcoat repair kit, available from Gelcote International or Seacare. Kits sell for $34 or less and include all the materials you need to complete the job.

The kits are easy to use; the difficulty is in matching the old gelcoat color. Start off with white, your base color, then add just a pinhead amount of one or more secondary colors. (A good basic understanding of color combinations will help.) Make a note of the color quantities you add for use in future repairs. Smear a small amount of colored gelcoat on the sanded surface, near the repair area. Let it sit for a few minutes to allow the solvents to evaporate, then check the color variation. Wear gloves and continue color testing until you have a close match. When you are completely satisfied with the color, add the hardener. Wipe off test smears with acetone or lacquer thinner.

Stow your gelcoat repair kit in a sealed container and not in your car or boat, unless you like the smell of polyester resin. It will last longer than the shelf life if you store it in a fridge.