1998 - #4 (WINTER)

DIY boat owner

the MARINE MAINTENANCE MAGAZINE

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BALLAST

MID-LIFE REFIT

Guest column by Nick Bailey

Boats, like living things, have a natural life span yet despite the forces of nature, this life span can be expanded indefinitely by vigilant maintenance, good coatings and bold intervention when the burden of time and weather makes it necessary.

In the commercial fleets and navies of the world, the first major refit is usually required when the vessel's hull is still sound but economical operation or mission readiness is compromised by age and worn-out equipment. This procedure is often referred to as the "mid-life refit" and is pragmatically viewed as a worthwhile investment. The refit price tag, if not much less than that of the vessel's original construction, is certainly less than the current replacement cost.

The same basic economics hold true for smaller boats. For example, you may own or be looking to purchase a 25-year-old sailboat of good pedigree, about 10.5m (35') in reasonable but dowdy condition. The old Atomic 4 runs but seems anemic, there are soft spots in the deck, the electronics haven't worked in a decade — but it sails so well, has a good hull with (almost) no osmosis and a purchase price of around $1,000 a foot (just like in 1975 when it was new). After installing a new diesel engine, refinishing with polyurethane paint, major deck repairs, new electronics and nice upholstery, you will have invested more than twice that figure (and this is without buying new sails). However, you will have a boat that looks new and works like new at less than half the price of a new one. It may even sail faster than a new boat. The downside is that the resale value will increase but nowhere near enough to offset your costs. In other words, a mid-life refit makes sense if you plan to keep the boat but not if you're thinking of selling it.

To sweeten this equation, a capable do-it-yourselfer can invest sweat instead of cash. Be very cautious, however, not to undertake a big job that is beyond your skills and run the risk of reducing the boat's value if the work is "unprofessional." You may wish to combine your own work with the expertise of a professional shop, compromising on the cost, but resulting in a much better finished product. For example, if you want to paint your deck, most shops will allow you to remove and replace the deck hardware, thus saving hundreds of dollars, but resulting in a professionally painted deck.

As our local fleets age, there will be many lovely but tuckered out boats that offer opportunities for the bargain hunter willing to boldly intervene against the natural forces of decay. Look for them.

Nick Bailey is a DIY columnist and general manager of Bristol Marine, Mississauga, Ontario.

ERROR

Under the heading "Prep Sanding" in the Shoptalk column in the 1998-#3 issue, you should sand, "Cabinet woods like maple...with 320-grit sandpaper..." not 32 grit as printed.

TALKBACK Q&A

Winterizing Water Systems

Q: I have taken it upon myself to winterize the freshwater system in my 9.6m (32') Bayliner Motor Yacht. After draining the system, I added 32L (8gal) of antifreeze to my freshwater tank and there's just a hint of pink in the water running out the hot-water side. This system also uses the engine for heat as well. Please advise winterizing procedures quickly as the temperature is falling.
Robert Strong,
Knight Life II, *Chatham, Ont.*

A: The first thing a pressure-water system does when turned on is fill the hot-water tank. It's a big tank and you'll have to wait a long time with the pump running to get antifreeze to come out the hot-water taps. Most professionals make no attempt to run antifreeze through the hot-water side of the system without draining it and bypassing it. You'll need a bypass hose that links the input to the output of the hot water heater. This takes the hot-water tank out of the system and restores the integrity of the pressure-water system. Drain the hot-water tank, connect your bypass hose, then run antifreeze through the whole system. You should be able to get antifreeze coming out all the taps, both hot and cold. Try to avoid putting antifreeze into the water tanks. It's best to drain the tanks, then use bypass hoses connected directly to the pump. (RV suppliers sell an assembled bypass line that splices into the water line.) This uses less antifreeze and doesn't require flushing the system with fresh water next spring. If you don't have access to the tanks, you may have to pour a few gallons into them. Your engine's heat exchanger is part of the engine circuit and is serviced when winterizing the engine. It's drained separately, then flushed through with antifreeze. Be sure to use storage, not plumbing, antifreeze when winterizing the engine.
– *Nick Bailey*

Installing a Tach

Q: How do I add a tachometer to my Yanmar YSB8?
Eric Eder, Manana, *Sicamous, B.C.*

A: Yanmar manufactured this model from 1976 to 1978 in 8- and 12-hp versions. Unfortunately, they didn't make provisions for a tachometer and installation is somewhat more complicated than for a gasoline engine. According to Ron Cairns of Land-Sea Power, Delta, B.C., the most economical way to install one is to have an A.C. tap installed onto your engine's alternator. From this tap you can install an alternator pulsed tachometer. Any auto-marine alternator-starter repair facility can do this task for you. Datcon manufactures a 0 to 4,000 rpm tach for this purpose, part number 103866, and it comes with an hourmeter. Check with the alternator shop if your alternator has the correct magnetic pole/ratio combinations, as per the following table:

Magnetic poles	Pulley ratio
8	2.7 to 5.3
12	1.8 to 3.5
14	1.6 to 3.0
16	1.4 to 2.6

Once this information is established, and you do install this unit, you'll need a portable strobe-type hand-held tachometer to check rpm and to calibrate, by way of DIN switches, and to set in your actual engine rpm, which runs at maximum 3,200.

Priming Ready-to-Paint Topsides

Q: I am repainting Awlgrip and epoxy repaired cabin sides by rolling and tipping Awlgrip. Should I use 545 or Awl-quik or both primers? I'm thinking of spot priming the repairs with 545, coating all with Awl-quik for surfacing, then priming with two coats of 545 before applying the topcoats. Is this overkill?
Bob Beck,
Island Girl, *Charleston, S.C.*

A: Yes, it's overkill to prime after applying Awl-quik based on techniques perfected in the paint shop at Bristol Marine in Mississauga, Ont. Generally, you need something to seal the repaired surface. Using 545, Bristol spot primes any areas that have gone through the existing top coat and/or have filler. Repriming is not necessary if you are sanding an existing Alwgrip finish in good condition. If the 545 covers the porosity in the filled areas, and it looks good (two coats may be necessary), proceed to sand and topcoat. If you still see sanding marks or porosity showing through, then you'll need to apply a thin layer of the Awl-quik glazing compound applied with a trowel. It's not necessary to prime again with 545.

Marine-to-Auto Engine Replacement

Q: I recently acquired a 1966 6.9m (23') John Allman boat. The

hull is solid but the original 283 ci Chevy block is rusted out. I'm planning to replace this engine with a low mileage, 1976, 350 four-bolt. It looks like a direct replacement. Are there any holes in my plan?
Jay Shipley,
Expense, *Pasadena, Maryland*

A: It sounds like the low mileage 350 is an automotive engine. If so, there is a huge hole in your plan. According to Mark Jacobs, editor of Clymer Publications, marine engines have many modifications that make them suitable for service in a boat in addition to the corrosive marine environment. Because marine engines are frequently operated at or near full throttle for extended periods, special valve springs, lifters, pistons, bearings, camshafts and other components are required for optimum performance and service life. A marine engine operates under conditions comparable to attaching a large trailer to your automobile, then driving uphill, in high gear, all day. Furthermore, engines used in marine applications have special corrosion-resistant cylinder head gaskets and core plugs. The mild steel core plugs used in automotive engines will quickly rust away in a boat. The 350 cid engine will directly replace the 283, but more than likely, will not be long lived in your boat.

Transom Rot

Q: What are the telltale signs of a bad transom? Is there anything to look for, short of the outboard motor falling off?
Ron Breed, Dallas, Texas

A: I presume this is a fiberglass boat and not wood or aluminum. Usually, the transom delaminates, which involves both the fiberglass delaminating from the plywood and the plywood delaminating from itself. Telltale signs include cracks at the corners of the transom at the chines. These cracks seem to radiate into the middle of the transom from the corners. Take a rubber mallet and lightly tap the transom. You should hear a very solid sounding rap. If the fiberglass has delaminated from the wood, you'll hear a dull "thunk" instead. Rap it all over and see if the sound changes from one area to another. You can also gently rock the outboard fore and aft. If the transom flexes visibly, it's probably delaminated. Take out the drain plug and check for water drainage. If the plug hole is wet for hours after the last water has drained from the boat, there may be water saturation of the plywood. This is always accompanied by delamination and rot. Follow the repair procedures in this issue's ShopTalk column on page 7.
— *Wayne Redditt*

Vibrating Tachs

Q: I recently purchased a 1990 Doral Prestancia with twin 4.3 MerCruisers. The tachometers and the synchronizer have adjustment screws on the back. It seems that these screws either move due to vibration or the tachs simply go out of calibration. The previous owner warned me of the problem, and when we checked, the one tach was reading more than 1,000 rpm high and the other was reading 100 low. These adjustments apparently go out of adjustment on a frequent basis. Short of replacing the tachs and synchronizer, is there a cure for the problem?
Gary Young,
Cool Change II, *Beaverton, Ont.*

A: Sometimes erratic engine rpm readout is caused by the addition of outside accessories tapped into the engine wiring harness, radio frequency interference, compasses or a problem with continuity on the tach signal wire. In your case, Steve Auger of Mercury Marine suspects the problem is either related to the instruments or the prior owner. Once calibrated using a digital shop tach, a boat's tachometers should never need readjustment. They may have been adjusted so many times that the plastic detents that lock in the adjustment are stripped, sacrificing the tach's ability to stay in one position. There should be a fair amount of resistance when adjusting the tach settings. Under normal circumstances, the gauges should have been replaced under warranty. Your solution is to purchase new tachs. Synchronizers are generally preset by the factory. After 100 to 200 hours of operation, they may need readjustment, which is done by an adjustment screw. Without knowing the brand, Auger suspects these screws are also worn out.

TECH TIPS

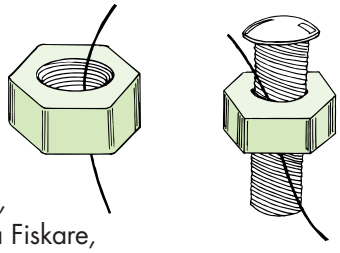
A CLEAR VIEW: When instrument lenses become discolored or so cloudy that you can barely read the gauges, they'll come clean with Meguiar's Fiberglass Restorer, a liquid abrasive polishing compound. Apply a small amount of compound to a wet cloth and rub it on the lens in a circular motion using light hand pressure only. It will eliminate almost all of the surface cloudiness and scratches. Follow with a good-quality wax buffed with an electric buffer — do this with care — and the lens will look like new.
Steve Bell, Off Duty, *Oshawa, Ont.*

SMALL PARTS: Empty 35mm film canisters make great containers for those small spare parts (fuses, split rings, screws, nuts, bolts, etc.). Especially handy are the transparent ones. Many film developing shops give away the empty containers as a means of recycling.
Mel Smith,
Archimedes, *Port Whitby, Ont.*

HYDROMETER KNOW-HOW: A flashlight bracket mounted close to the battery makes a convenient support for your hydrometer. After using, rinse with fresh water, then put a golf tee in the end of the dip tube so that acid does not drip on anything.
George and Sheilah van Nostrand,
Dream Catcher, *en route to the Gulf of Mexico.*

REVERSING THE FLOW: If you damage your propeller when you're away from home port and the only replacement available on short notice is wrong-handed for your transmission (i.e. you need a right-hand prop, but can only get a left-hand one or vice versa), there's a quick solution. Many contemporary transmissions can run indefinitely in reverse with no damage; check the owner's manual for your transmission or call the manufacturer. If yours can do this, install the wrong-handed prop and run with the transmission in reverse until you get home. Be especially careful until the correct prop is installed, as this emergency rig can be disorienting in close quarters and when docking.
Phil Friedman, Port Royal Marine, Pompano Beach, Fla.

EMERGENCY LOCK NUTS: To keep a nut tight if no locknut is available, use monofilament fishing line. Run the line through the nut, tighten the bolt, trim off the line. This will act like a locknut. Use heavier line with larger nuts.



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John Golden,
Lyckliga Fiskare,
Houston, Texas

COVER UPKEEP: To free stuck zippers, lubricate with a graphite pencil or wax candle. For zippers that won't stay closed any longer, spray with a lacquer hair spray, allow to dry and you'll find they work almost as good as new. To make cushions snap on and off with ease, lubricate with a dollop of Vaseline or a spritz of vegetable spray. This also protects snaps temporarily against further corrosion.
Bill Lindsey, Hollywood, Fla.

TYING ANCHOR RODES: Attach plastic cable ties to your anchor rodes and you'll always know how much line is out. Pick a system that's easy to remember. For example: to mark off in 3m (10') increments, use one tie for 3m (10'), two ties for 6m (20'), three ties for 9m (30') and so on. When anchoring, just count the number of ties. Ties are cheap to replace and won't interfere with windlasses.

A CLEANER BURN: Burn Varsol in Primus burners, stove and oil lamps rather than kerosene. It's cheaper, cleaner burning and no worse smelling. When filling, pour it through a filter or connect an in-line gasoline filter to the filler hose.
Yves Gillenas,
Jean du Sud, *Oka, Quebec*

WHAT'S NORMAL?: Ever looked at your engine gauges and needed to know quickly if that temperature, pressure or voltage reading is abnormal? When the engine is up to normal operating temperature, pressures, etc., mark the edge of the bezel adjacent to the pointer position with a dot of paint, nail polish or tape and in future you'll be able to tell at a glance if conditions are changing.
Mel Smith,
Archimedes, *Port Whitby, Ont.*

Disclaimer: DIY boat owner takes no responsibility for any comments appearing in this section.

***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.**

ShopTalk

REPAIRING FIBERGLASS POWERBOAT TRANSOMS

Follow these repair procedures to restore a rotten or delaminated transom to original condition.

By Wayne Redditt

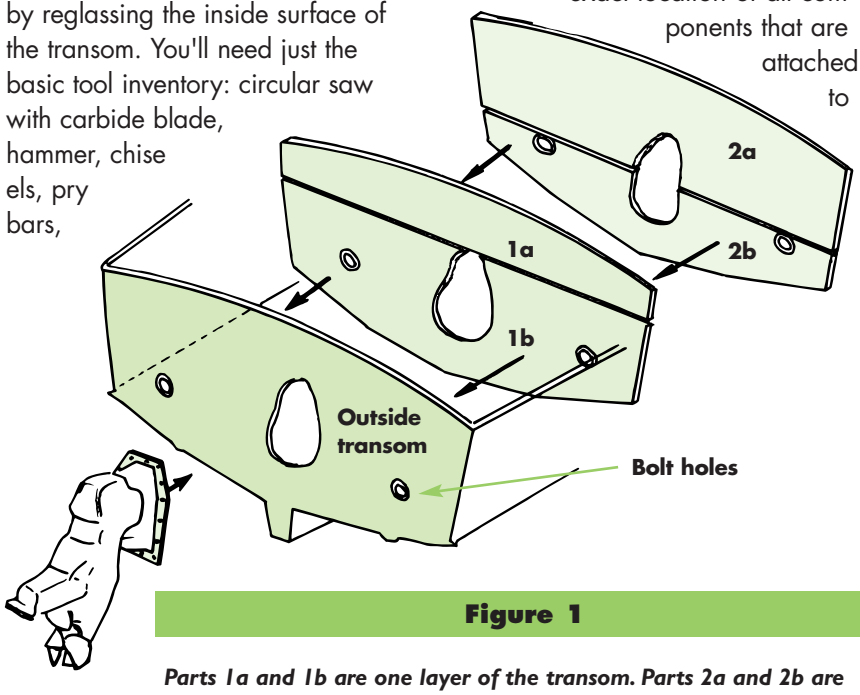
Most fiberglass boats powered by sterndrive or outboard engines will have a plywood-cored transom. It's usually constructed of two layers of 19mm (3/4") plywood, with an inner and outer skin of fiberglass laminated to the wood.

If you suspect your boat's transom is rotten, it's a relatively straightforward, though lengthy job to repair. Moderate woodworking and fiberglassing skills are required, but more importantly, patience and attention to detail are keys to success. All the rotten, delaminated wood must be removed and replaced, followed by reglassing the inside surface of the transom. You'll need just the basic tool inventory: circular saw with carbide blade, hammer, chisels, pry bars, screwdrivers, wrenches and socket sets, jigsaw or reciprocating saw (to cut the hole for the outdrive in the new transom), electric drill and bits, putty knives, rollers, scissors, buckets, stir sticks and cleanup supplies, safety and protective gear.

To confirm the diagnosis of transom rot or delamination, use a small plastic-faced hammer and tap test the laminate. If it sounds hollow instead of firm, you have one or both conditions present.

Repair Strategy

Prior to removing any components, it's wise to draw a "map" of the exact location of all components that are attached to the transom. These include wiring harnesses, transom lights, vents, all mechanical accessories, hoses, pumps, blowers, etc. Taking a photo wouldn't hurt either. It's easier to spend a few minutes at the beginning than ponder the location of these things later.



ANNE-MARIE HENDRY

Figure 1

Parts 1a and 1b are one layer of the transom. Parts 2a and 2b are the second layer. Horizontal cuts are necessary due to confined working space in most boats and are staggered so they don't weaken the finished structure.

The boat must be securely blocked to prevent the hull changing shape as you remove the structural section of the transom. This cannot be overemphasized. The boat will twist if not properly blocked prior to removal of the transom skin. If the new transom is installed into a twisted hull, the change will be permanent and undesirable.

Remove the engine and outdrive. Label all connections for ease of reassembly later. Keep all nuts, bolts and other fasteners together in labeled containers. Remove all items that are attached to the transom and are in the vicinity. You will require clear working space all around the inside portion of the transom in order to remove and replace the wood core. Once you've removed everything, make a cardboard template of the transom shape, marking the placement of all thru-holes, fasteners, etc.

Preparing the Core

Working from the inside of the transom, use a circular saw to remove the fiberglass skin. [In some cases it may be easier to repair the transom from the outside, removing the outside fiberglass skin, but this requires more detailed finishing. — ED.] Set the blade depth so it goes just through the thickness of the outer skin and doesn't cut the core. Carefully cut all around the perimeter as close to the outer edge as you can get (the saw fence determines

this). Use pry bars and wedges (made from wood scraps) to carefully remove the skin. Then remove the plywood, being careful not to damage the outer skin in the process. This is usually a messy job. Wear a respirator, since rotten wood contains a fungus that may cause allergic reactions in some people. Slightly sand the surface of the exposed fiberglass skin to expose clean fiberglass.

After the wood is removed, the exposed laminate is dry and the inside of the boat is cleaned of debris, you must plan the method to replace the plywood. When the boat was built in the factory, the transom was installed prior to the deck being placed onto the hull. You are attempting something that is slightly more difficult. The plywood must be installed in a number of pieces, in order to be able to fit around the deck overhang, engine stringers and cockpit floor. Transfer the shape from the cardboard template onto the plywood you have pur-

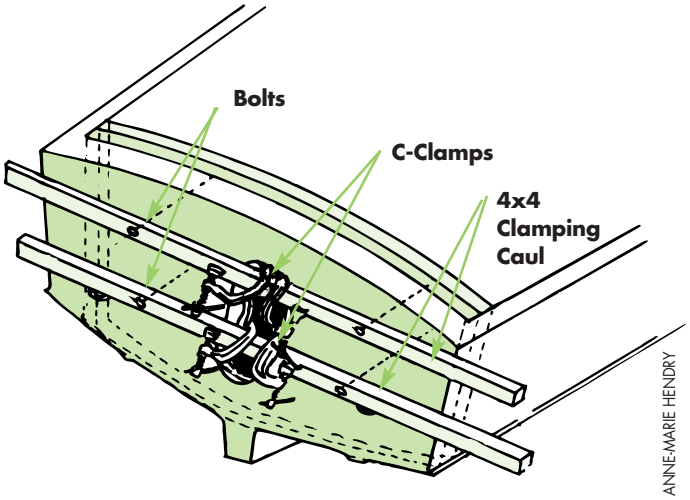


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Figure 2

TIMBER CLAMPING CAULS - When gluing plywood to the outer laminate, place at least two 4x4s across the transom horizontally and thru-bolted. If plywood is precut for outdrive, bolt sections together with C-clamps. This ensures a perfectly flat mounting surface for outdrives.

chased for the job. A word on plywood: Marine grade is expensive but worth its cost; exterior grade G1S (Good One Side) will do if your budget is really tight, but the flaws in the wood make it undesirable for this job.

The pieces you have formed must be staggered at the joint as shown in **Figure 1**. If the butt joints are too close together, they seriously weaken the structure. Dry-fit all pieces before attempting to glue them into place. The clamping strategy must be worked out ahead of time, since there is no time to waste once glue is applied. The usual method of clamping involves drilling bolt holes completely through the plywood, outer fiberglass skin and a clamping caul (**Figure 2**). This caul may be angle iron

or simply a 4x4 timber. The idea is to keep the transom flat while the glue cures. Use bolts with oversize washers or small plywood blocks to hold the sections together and screws to apply pressure while the glue cures. Coat fasteners with auto paste wax or Pam cooking spray to facilitate removal. If you plan to leave any screws (or nails) in place, use ones made of stainless steel or bronze and countersink the heads in the plywood.

Fitting and Finishing

Epoxy resin is used to coat the plywood and exposed fiberglass skin and to bond it all together; polyester resin in used to laminate the layers of fiberglass. First seal all plywood edges with "raw" or unthickened epoxy resin. Now roll on one coat of epoxy on the plywood and the fiberglass surface. Mix up a batch of epoxy thickened to a consistency of mayonnaise with a low-density filler (i.e. a blended microfibers and colloidal silica filler). This filler prevents glue sag and will fill any gaps between the layers. [This is a personal preference as West System recommends using a high-density filler, such as its 403 Microfibers, for this job. — Ed.] Onto the wet epoxy, apply the thickened epoxy with a squeegee or notched trowel. Use this mixture between the layers of plywood and the fiberglass surface and as filler putty around the edges. Apply liberally, so epoxy squeezes out the edges when clamped. Clamp using your cauls, clean up excess epoxy and let fully cure. Once cured, remove the fasteners and fill the holes with slightly thickened epoxy. A plastic syringe makes this job easy.

A new inner fiberglass skin is now laminated over the plywood. Use polyester resin as epoxy doesn't work well with most chopped-strand mat (CSM) fiberglass. Begin with 1-1/2oz CSM. The technique for successfully saturating fiberglass on vertical surfaces involves using short paint rollers with thick-nap roller covers. Lay the CSM over the transom, overlapping the edges and holding in place with masking tape. Dunk your roller into a bucket of catalyzed resin and roll the resin into the CSM. Make sure it's well saturated. A resin-rich laminate is okay for this job. Let it cure slightly (it should not be "wet") before following with a layer of 18oz (or heavier) woven roving. Use the same technique to saturate this layer. Alternate layers until you have a thickness approximating the original laminate. When cured, paint the surface for a finished appearance.

Cut out the drive opening and reinstall the drive, motor and accessories. Whew, big job, but worth the hassle if you love that old boat.

Wayne Redditt teaches boatbuilding, repair and restoration at Georgian College's Marine Technology-Recreation course in Orillia, Ont. Inquiries directed towards this column are welcome. Send your comments or questions via mail, fax or e-mail, attention ShopTalk.

BUYING CANVAS?

Whether you're planning to make your own cushions, dodger, bimini or awning, or use a professional, here's what you need to know when purchasing materials.

Story and Photos by Jan Mundy

Not all canvas is created equal. The differences stem from the design, materials used, construction and options. Suitability, quality, durability and cost all factor into a well-informed canvas purchase when you're buying a new boat or looking to upgrade an older one.

Our quest for information led to Nat Genco, general manager of Genco Marine (416/504-2891), a canvas specialist, sailmaker and chandlery in Toronto, Ont. Founded in 1965 by brother Nick and cousin Nat Sr., the firm is renowned by boaters throughout Canada and the eastern U.S. as a builder of finely crafted awnings, upholstery and dodgers sold under the Natty brand. Nat joined the family business in 1968 and oversees all canvas production. He outfitted then-teenager Tania Abei's boat before she circumnavigated the world, and just recently was commissioned to build the upholstery and a dodger for *Sail* magazine editor Patience Wales' 15.9m (53') Scorpio. The shop stocks myriad upholstery and boat top fabrics, interior headliners and marine carpet.

"When buying a new boat, canvas items are usually part of a package price rather than an option," says Nat. "As a result, you often get equipment that's engineered for the mass market not necessarily for comfort or practicality.

"Knowing what to look for and investing in good construction and well-planned extras," Nat adds, "will pay off in years of useful service."

Cushions

Materials: Nat recommends interior cushions of long-wearing synthetics — Olefin which is a polypropylene, nylon or polyester — preferably treated with a stain repellent, an essential option with kids on board. Cotton fabrics look nicer, but are more expensive and tend to absorb moisture, especially in a saltwater environment. If your budget allows, use ultra-leather in high-traffic areas. It costs about 2.5 times more than a quality nylon but it requires no care, is cool to sit on and breathes. An acrylic-blend fabric (i.e. Sunbrella) is a good choice if it fits into your boat's interior look (it's offered in about 40 hues) and you don't mind the inherent static charge that attracts dirt, pet fur and the like.

Foam is sold by density (determines the quality) and compression (from soft to hard) stated in pounds per cubic foot. The cheapest foam is 1.5-pound density; better is 2.25-pound with a 35-pound compression,

the standard for most bunk or seat foams. Ultracell is a high-resilient, precrushed foam that offers a softer compression in a comparable thickness. Latex foam, sold only in 14cm (5-1/2") thickness, gives the ultimate in sleeping comfort but at a higher price. Foam alone for a 9m (30') boat costs nearly CDN$600, compared to Ultracell at CDN$300.

According to Nat, the best choice for cockpit cushions is a combination of acrylic with a stain-resistant coating or mildew-treated vinyl both with a mesh fabric to eliminate moisture build up: Textilene, an open-weave fiberglass mesh commonly used on lawn furniture; Sheerweave, a 35% fiberglass blend with a PVC coating and a denser mesh; or Ultraweave, a tightly woven fabric commonly used for sunshades.

"As acrylic cushions stain permanently from suntan oils and vinyl doesn't breathe," explains Nat, "use the mesh fabric for only the top, which also keeps the cost down."

You have three choices of foam for cockpit cushions: upholstery foam, which is comfortable but absorbs water; Airex closed-cell flotation foam, which is expensive and shrinks as much as 7%, resulting in loose-fitting fabric; and Ensolite, a 3cm- (1-1/4"-) thick foam typically used in life jackets. While not as soft as Airex, Ensolite is not as costly, shrinks less and, being thinner, is easier to stow.

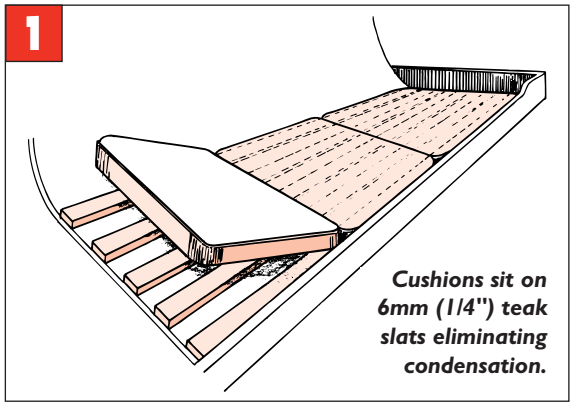
What to Look For: Select fabrics that look good and will last with a soft, high-resilient foam.

"For sleeping, you need a minimum foam thickness of 10cm (4") and more if you have the height," Nat adds, "and where headroom is limited, use a better quality 7.6cm (3") foam with higher compression."

Backrests normally have the same foam as the bunks or seats; upgrading to a super-soft foam will add a lot of comfort.

Zippers with metal sliders corrode in saltwater; choose either zippers with plastic sliders (standard) or optional Velcro closures.

Installation Tips: If you spend a lot of time on board, add some luxury and select the best foam your budget will allow, perhaps using latex for the captain's berth. Musty cushions are a continual onboard problem. Here's a trick from Nat to circulate air and eliminate condensation: Mount either full-length or short strips of 6mm (1/4") teak (**Figure 1**), spaced about 30cm (12") apart, over fiberglass or plywood bunks or seats, and fasten with screws or Velcro if you need access to lockers. Alternatively, use cockpit matting. Either method won't interfere with sleeping comfort.



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Cushions sit on 6mm (1/4") teak slats eliminating condensation.

Upholstery foam purchased for cockpit cushions should be no less than 5cm (2") thick — anything thinner and it won't hold up. Rubberized nonskid material works as well or better than snaps for keeping cockpit cushions in place and you don't have to drill any holes. Lift-The-Dot and turnbuttons aren't a good option as they protrude too far. If you plan to frequently leave your cushions out, try Nat's ultimate hold-down: Sew on a tab with a rope that slides into a track (same set up as a bolt rope on a sail track) mounted to the coaming.

Dodgers & Enclosures

Materials: While you may consider waterproof coated fabrics, such as Sunbrella Plus or TopGun, to be a good choice for dodgers or enclosures, these fabrics don't breathe which creates condensation and ideal conditions for mildew growth. The preferred material is acrylic (i.e. Sunbrella), a breathable, durable, non-fading fabric with a waterproof coating that lasts for about six years before it needs retreating.

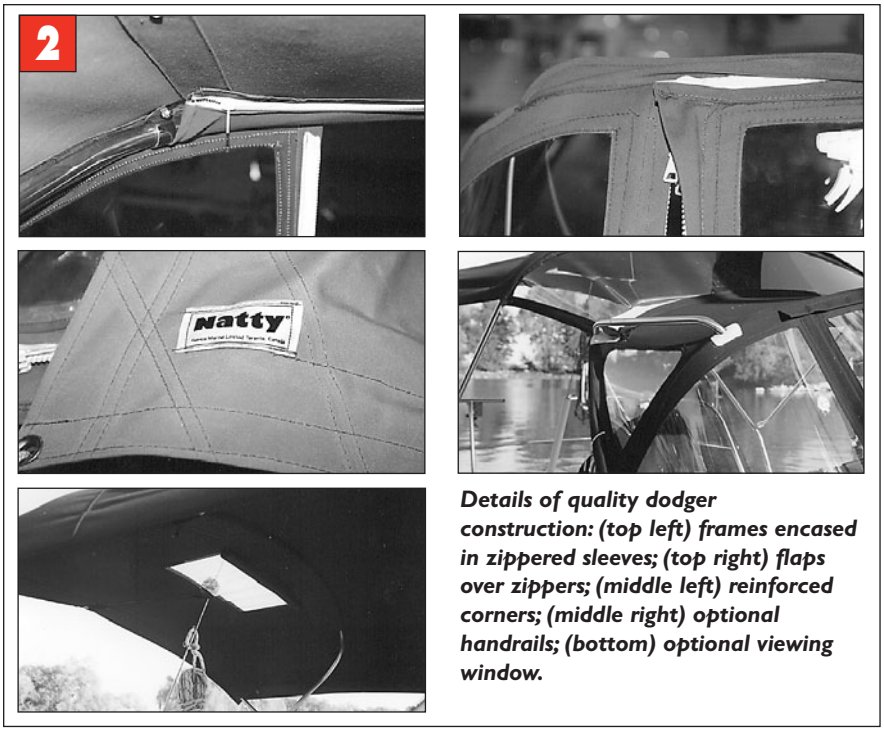
Plastic window options are many and each material has it advantages. The standard for most production canvas is a 20ml UV-treated plastic; a heavier 30ml is better as it creates fewer wrinkles when folded. These "rolled" plastics have a memory — folding them for storage causes permanent creases that distort the material and affect the clarity, especially when wet or viewed in direct sunlight. Optional materials include sheets of laminated plastic and rigid polycarbonate. Sheet plastics include Regalite, available in 30ml and 40ml thickness, and 40ml Strataglass.

"Sheet materials offer better clarity and will last 50% longer than rolled plastics, even if you're careless," Nat says, "but these windows will always curl, no matter how tight they're stretched.

"In a small window, it's minimal," Nat adds, "but on large windows, such as those in powerboat enclosures, the windows always look sloppy."

Distortion-free, rigid polycarbonate windows (i.e. Lexan) offer near-glass clarity but cost nearly twice the price of sheet plastics. Lexan must be handled carefully and kept clean as it scratches easily. Nat doesn't recommend a scratch-resistant coating as the sun turns the finish cloudy. Because polycarbonates don't bend, once the dodger is installed, it's best to leave it up.

What to Look For: For durability and strength, frames should be made of stainless steel, usually 7/8" or 1". Roof frames that attach to the canvas should be encased in a zip-



Details of quality dodger construction: (top left) frames encased in zippered sleeves; (top right) flaps over zippers; (middle left) reinforced corners; (middle right) optional handrails; (bottom) optional viewing window.

pered sleeve (**Figure 2**, top left) or you'll have to disassemble for cleaning or repair. Zippers should always be sewn to a fabric strip which is then sewn to the window; otherwise, when you need to replace the window, you'll also be replacing the zipper. Also, they should always be covered with material overlaps (**Figure 2,** top right).

Your top should be constructed of one material so it all wears and shrinks at the rate. For example, some manufacturers use white vinyl binding to reinforce and finish cutouts and zippers, or to join two pieces. But the binding will shrink and crack, so tops no longer stretch to fit fasteners. Use anti-wick polyester thread to prevent leaks. Substituting Gore-Tex thread means you'll probably never need your canvas restitched but adds about 15% to the overall cost. A polyester thread can last five years or longer so it may be cheaper to service the top rather than spend the extra money upfront, or to use the Gore-Tex just in high-wear areas, such as roof panels and zippers, or when restitching older canvas.

There's only one choice for fasteners, according to Nat, and that's Lift-The-Dot.

"Poor quality control is a problem with turnbuttons," explains Nat,

"while Lift-The-Dot are made to an automotive standard, are more durable and won't pull out of canvas, but are also more expensive."

Handy-to-have options are a roof viewing window and handrails (**Figure 2**), mounted on the aft or side frames, which don't allow folding of the dodger without taking it apart. All-removable windows, another option, facilitate stowing and servicing.

Installation Tips: Keep the fabric taut to prevent water pooling and it will last longer. This is impossible if the frame is flat on top, so rebend the frame with a slight arch.

Awnings & Biminis

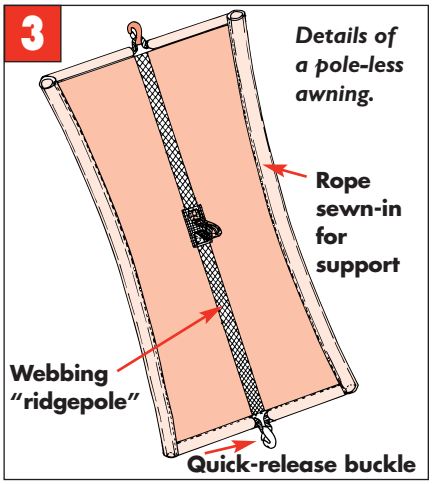
Materials: Synthetic fabrics with water-resistant coatings are your best choice for awnings. Weblon, a polyester-vinyl blend with a white exterior and pearl-gray interior to reduce glare, is heavy, awkward to fold and tends to crack in colder climates. Sunbrella is more durable but expensive. The best all-round fabric is Stamoid, a tightly woven, sun-resistant polyester with a waterproof urethane coating. However, it's expensive: An awning for a 9m (30') boat made of coated polyester costs about CDN$450; built of Stamoid, the price is CDN$900.

What to Look For: Choose light colors, which reflect more light and remain cooler underneath. If glare is a concern, have the awning lined with gray polyester.

Standard awning design has roll-up sides, a support pole at either end and a three-point lift.

"If you decide you don't want sides, have the canvas-maker attach zippers anyway when making the awning," explains Nat, "so you have the option of adding fabric sides or mosquito screening later. Also add sleeves for poles, so you have the option of using them."

Awnings for smaller boats with no stowage for poles, are cut with scalloped sides for tension and a rope sewn in the edge for support (**Figure 3**). To keep the center taut, a strip of 2.5cm (1") nylon webbing is sewn down the center with a quick-release buckle at either end to fasten with line to the mast and backstay or topping lift. A zippered doorway on awnings without poles is a good addition.



ANNE-MARIE HENDRY

DIY boat owner

DC ELECTRICAL SYSTEMS

Are you contemplating a major overhaul of your boat's electrical system? Here's how to design an efficient trouble-free DC system and the proper techniques for installing electrical cables and circuits.

By Kevin Jeffrey

A circuit is a path that, if followed completely, leads back to the starting place. Here we are concerned with marine electrical circuits that provide a reliable path for direct current (DC). While there are definite rules to follow when wiring a new boat or rewiring an existing one, the DC portion of the electrical system can be set up in a variety of ways. With some creative thinking, proper circuit components, and good wiring techniques, you can take the best advantage of battery-supplied electricity on board.

In DC circuits an electrical potential, or voltage, drives the electrical current. Charging sources create the necessary voltage to drive current into the batteries and, in turn, the batteries serve as a voltage source for operating all DC loads on board, including inverters that, in turn, provide AC power. A boat has both charging circuits and load circuits, yet all DC circuits must include the batteries. Individual batteries can be connected in a variety of ways to give you the system voltage and total battery capacity you require for house loads and engine starting (see **Figures 1** and **2** for sample schematics and refer to DIY 1997-#3 and 1997-#4 issues for setting up batteries).

A DC system has a positive and negative side to each circuit. The positive side originates at the positive terminal of the voltage source and goes to the positive distribution point (if provided), then on to individual loads. The negative side of the circuit provides a return path back to the voltage source. The flow of electricity is determined by the electrical resistance of the loads. For example, engine starters, freezers and large inverters have relatively little electrical resistance compared to lights and navigation instruments and, there-

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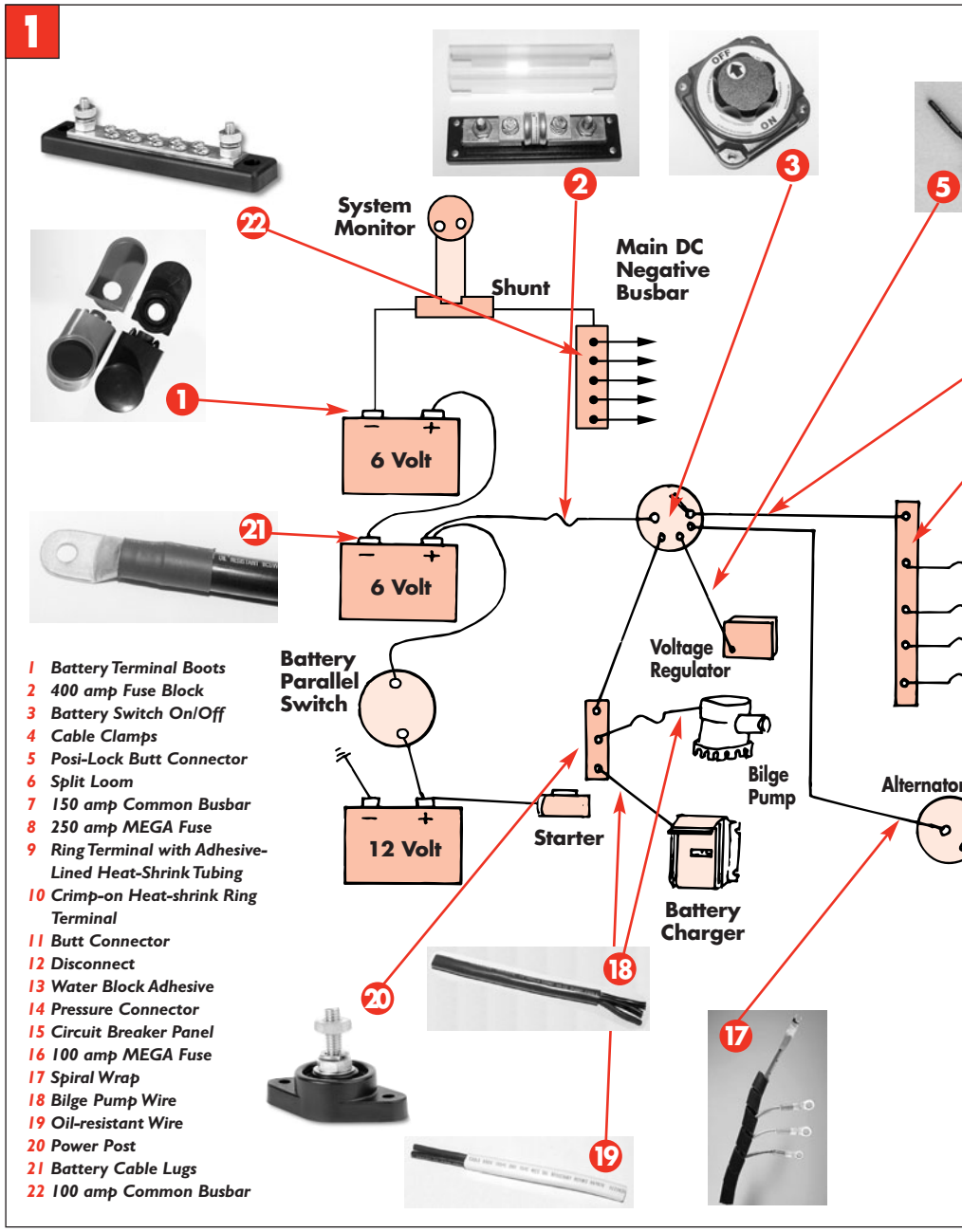


ANNE-MARIE HENDRY

fore, allow much more current to flow.

Sample Circuits

DC marine electrical circuits fall into two categories — main circuits and branch or subsidiary circuits. Main circuits originate from the batteries and provide current directly to large appliance loads or to distribution points housing multiple branch circuits. While the methods of routing and controlling these circuits may vary, the wiring techniques for the best safety and efficiency remain the same.

Shown in **Figures 1 and 2** are three sample schematics depicting main and branch DC circuits commonly found on boats. Keep in mind that components in a DC system can be arranged in a variety of ways.

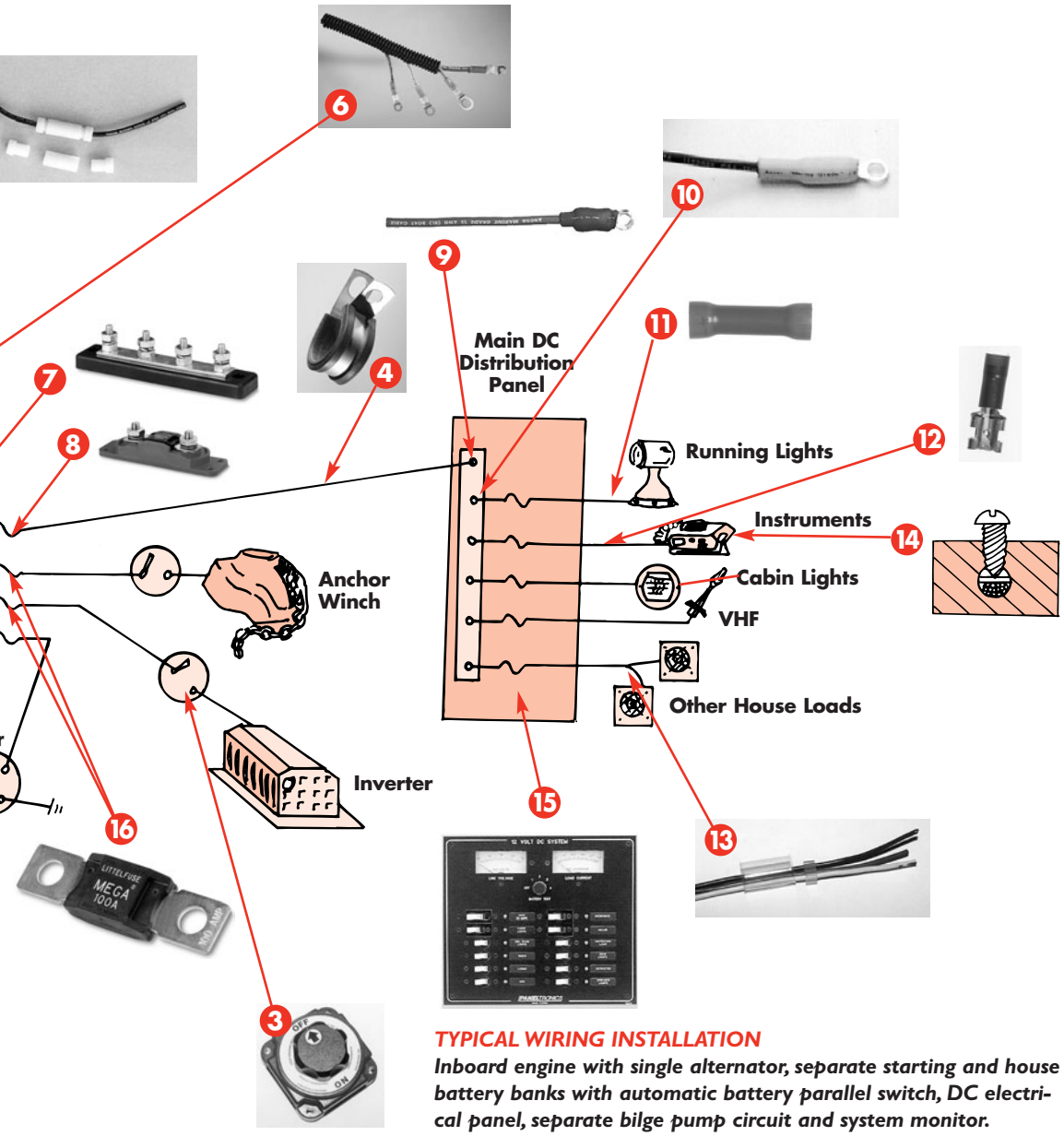
Codes for Conductors

Wire conductors carry the current from the voltage source to the loads. Other circuit components to consider include connectors to join conductors to electrical equipment or two or more wires together, distribution posts or busbars to conveniently join groups of positive or negative wires, manual or automatic switches to control current flow, diodes to prevent reverse current flow, and meters and monitors to help make electricity visible.

Wire conductors provide the supply and return path from the voltage source to the various electrical loads. DC wiring is selected for the type of job it must do, and is sized according to how much current it's expected to safely carry and the allowable voltage drop over its length of run. Conductors from 8 AWG (American Wire Gauge) to 4/0 AWG, usually referred to as cable, is used for positive and negative conductors where high current is expected, such as battery banks, large high-output alternators, starter motors, and large inverters and chargers. Marine cable should meet the same standards as other conductors on board.

Wire and cable conductors are insulated for safety and should be installed to make certain electricity stays in its intended path. If the electrical load is bypassed due to an accidental "short" circuit, resulting high current can cause serious damage and possibly a fire unless proper current protection devices — fuses **(Figure 1, #8)** and circuit breakers — for each circuit are in place.

The integrity of a DC circuit is only as good as the individual components and connections. Selecting the proper conductor type and size is a good place to start. Even though high-quality conductors



TYPICAL WIRING INSTALLATION

Inboard engine with single alternator, separate starting and house battery banks with automatic battery parallel switch, DC electrical panel, separate bilge pump circuit and system monitor.

made to AWG standards are more expensive for a given size, they can actually save you money over the long term. AWG wires are up to 12% larger than the same size SAE wire used for "surface vehicles," so in many applications a smaller gauge AWG wire can stay within the voltage drop limits recommended by American Boat & Yacht Council (ABYC) and other marine standards (**Tables B and C** on page 20).

Wire conductors in a marine installation face harsh conditions, and must adhere to the following criteria:

1. ABYC standards state that "Conductors shall be at least 16 AWG (except 18 AWG may be used as internal wiring in panelboards), and shall have a minimum rating of 50 volts."

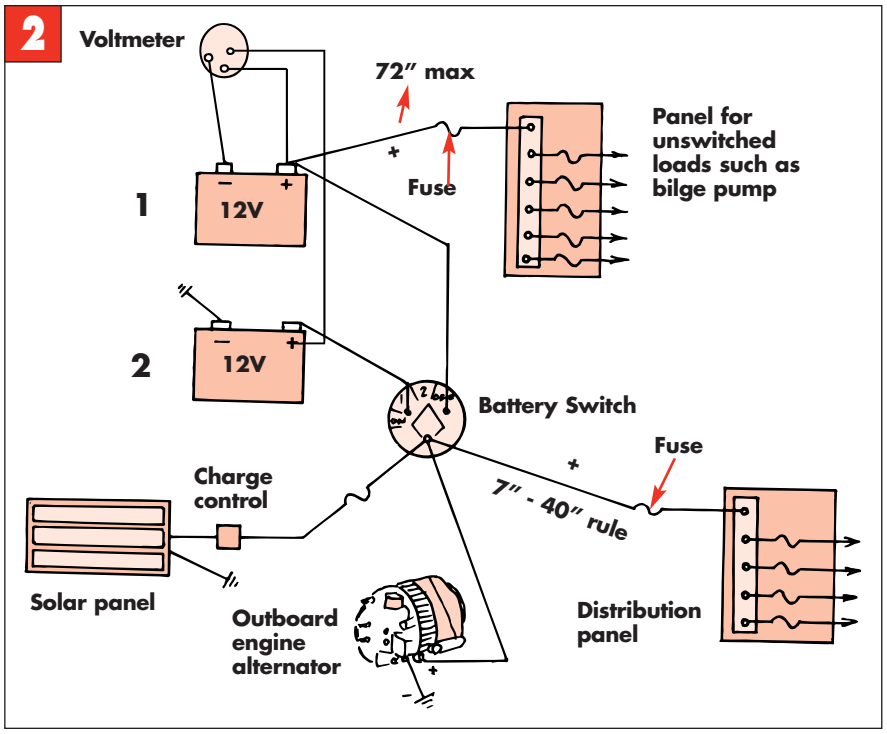
2. Wire with multiple strands (**Table D** on page 24) has a better ability to cope with repeated flexing without breaking, and it makes for a much more reliable crimp connection since the strands mold more completely to the terminal barrel. Solid wire or wire with only Type 1 stranding is not recommended for marine use. ABYC standards state that "Conductors with at least Type 2 stranding shall be used for general purpose boat wiring. Conductors with Type 3 stranding (many more strands per wire size) shall be used for any wiring where frequent flexing is involved in normal use." Also look for wire with tinned copper strands, since it offers the maximum protection against corrosion and electrolysis.

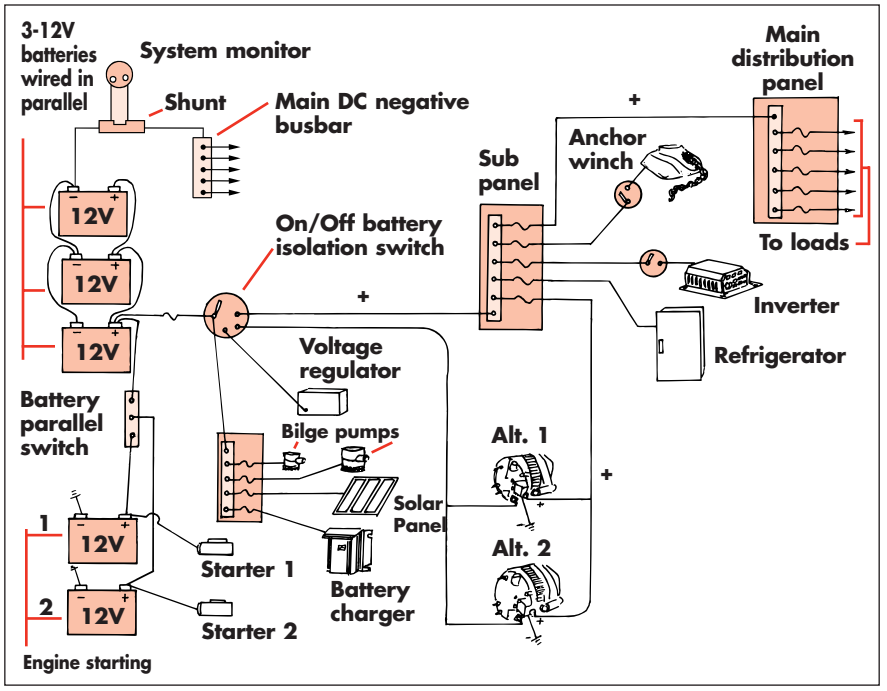
3. The wire insulation should be able to withstand the maximum ambient conditions: temperature; moisture; contact with saltwater, oil, boat fuel, battery acid or other chemicals; exposure to sunlight.

What to look for: A commonly available conductor such as UL 1426 boat cable meets most ambient conditions found on board **(Figure 1, #19)**.

4. The ampacity (ability to carry current) of the conductor and its insulation should be sufficient to avoid overheating. The ampacity rating is independent of conductor length of run and voltage drop.

What to look for: Refer to **Table D** ampacity ratings for marine conductors under 50 volts. These values are the safe amperages which the conductor can carry on a continuous basis. They do not apply to intermittent starting loads such as motor





ANNEMARIE HENDRY

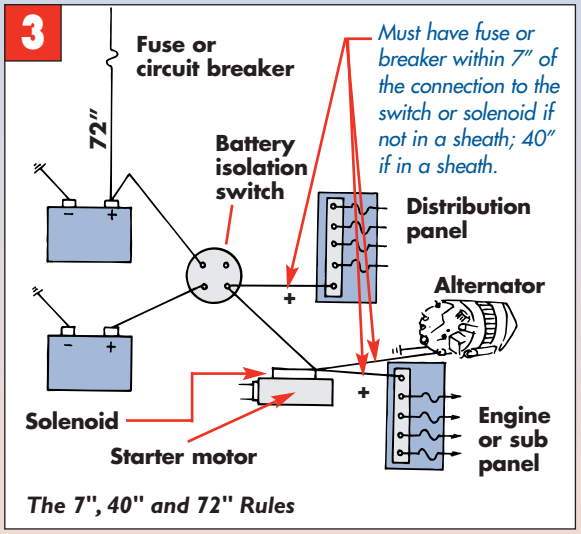
***SAMPLE BOAT SCHEMATICS** (Top) Single engine with alternator, two batteries with manual battery switch, simple DC electrical panel, separate bilge pump circuit, voltmeter (battery condition meter) and solar panel.*

(Bottom): Dual inboard engines with alternators, two starting and one house battery bank with automatic parallel switch, multiple renewable charging sources, DC electrical panel, separate dual bilge pump circuits, system monitor, inverter, anchor winch and refrigeration.

CIRCUIT PROTECTION DEVICES

All marine DC circuits, with the exception of starter motor cranking circuits, should be protected by circuit protection devices (CPD), such as circuit breakers or fuses. As shown below, main battery circuits must adhere to the 7", 40" and 72" rules. Main feeds connected directly to a battery must have a CPD within 72" of the battery. Main feeds connected to a battery switch or starter motor solenoid switch must have a CPD within 7" of the connection if unsheathed or within 40" of the connection if in a sheath.

All branch circuits should also be protected by CPDs. **Figure 2**, bottom (shown on page 16) shows the levels of circuit protection recommended for a boat with a single house bank system and multiple sub-main circuits. While your electrical system may not be this complex, the basic principles of circuit protection can be applied to any boat.



The 7", 40" and 72" Rules

CPDs should be sized according to the expected load in the circuit: have a DC voltage rating of not less than the nominal system voltage; and have an appropriate ampere interrupting capacity based on battery capacity. Contact your electrical equipment supplier for help sizing and selecting CPDs.

start currents. Wiring in and passing through engine spaces must be able to operate at higher ambient temperatures.

5. The wire should be of sufficient size so that the voltage drop over the length of run not impair the load's ability to function.

What to look for: Voltage drop is a function of expected amperage (current) and length of run; increased amperage and longer runs require larger wire size. Conductors used for electronic equipment, navigation lights or other circuits where voltage drop should be kept to a minimum shall be sized for a voltage drop not to exceed 3% (**Table B** on page

WIRE ID

Every UL-listed wire, including UL 1426 Boat Cable, is required to be identified with the manufacturer's trade name as well as an "E" number — a PIN for the particular company or plant that made the wire. The term "Marine Grade" on an electrical product is a trademark of a particular manufacturer. The term "Boat Cable" or "BC" means the wire has passed a rigorous test by an independent testing laboratory to ensure it meets the UL 1426 standard for heat, cold, flexing and resistance to acid and water. It does not imply corrosion or oil resistance. Corrosion resistance is a function of tinned conductors and only those conductors specifically marked "oil resistant" are in fact so rated.

Other markings on the insulation of wire or cable describe the conductor or cable type and how it's rated. Unmarked conductors are not recommended by ABYC and may be disallowed by marine surveyors for insurance purposes. Listed below are some sample markings and what they describe:

Marine Grade	Manufacturer's trade name
2 con	Two separate conductors within an outer sheath
12 AWG	Conductor size is 12 American Wire Gauge
(UL) boat cable	Conductor conforms to UL 1426 standards for wire specially designed for boats
50V	Conductor's maximum voltage rating
105C dry, 75C wet	Insulation's maximum temperature rating
Oil resistant	Insulation is resistant to damage from oils
BC5W2	Qualifies this wire as boat cable with 105°C dry and 75°C wet temperature rating
E67078	Number assigned to manufacturer by UL
LL22035	Wire lot number
CSA	Conductor conforms to Canadian Standards Association (CSA)
AWM	Meets CSA standards for "Appliance Wiring Material"
II	CSA two-conductor wire with external jacket

20). Conductors used for general lighting and other circuits where voltage drop is not critical may be sized for a voltage drop of 10% (**Table C** on page 20). (See Ancor Marine's web site www.ancorproducts.com for a quick wire calculator.)

6. There should be a means to easily identify a conductor's function in an electrical system.

What to look for: **Table E** on page 26 shows the recommended color code for DC conductors used for general, engine and accessory wiring purposes on boats. ABYC standards state "Color coding may be accomplished by colored sleeving (i.e. colored heat shrink tubing) or color application (such as colored plastic tape) to wiring at termination points."

Getting Connected

Wire connectors come in a variety of designs as shown in **Figure 1** on page 14. Solderless crimp-on ring (**#10**) and captive spade terminals are the most commonly used terminals, but they must be installed properly (See "Wiring Runs and Connections" on page 24). It's important to realize that crimping is a system, in which the wire, connector, crimping tool and installation technique must be matched to create a good electrical connection.

Other accepted terminals include friction connectors (**#5, #12**) — male and female components that pull apart — and pressure connec-

WIRING STANDARDS

A condensed version of ABYC standards regarding wire connectors is as follows:

▲ All connections shall be protected from the weather or in weatherproof enclosures. Connections exposed to immersion shall be watertight.

▲ Wiring connections shall be made without damage to the conductors.

▲ Metals used for terminal studs, nuts and washers shall be corrosion resistant and galvanically compatible with conductor and terminal lug.

▲ Terminal connectors shall be the ring or captive spade types with one exception: Friction-type connectors may be used if the voltage drop from terminal to terminal does not exceed 50 millivolts for a 20-amp current flow, and the connection does not separate if subjected to a six-pound tensile force along the axial direction of the connector for one minute.

▲ Ring and captive spade-type terminal connectors shall be the same nominal size as the stud to which they are mounted.

▲ In pressure-type connectors, a means must be provided to prevent the pressure screw from bearing directly on the conductor strands (see recommended type in Figure 1, #14).

▲ Twist-on connectors (wire nuts) and terminals where solder provides the only mechanical connection are not recommended in marine applications, although solder can be the sole connection in battery lugs provided that the solder contact length is not less than 1.5 times the diameter of the conductor.

tors (**#14**) — wires are joined and held together with pressure from a bolt or set screw — provided these types of connectors meet certain standards outlined below.

Crimp-on butt connectors (**#11**) are available if needed to splice two conductors in the middle of a wire run. Some controls and monitoring devices are supplied with wire pigtails; for this gear you'll need to use crimp-on butt connectors, or friction connectors that allow for easy disconnect and removal.

Wire connectors are available as: 1) non-insulated, 2) with an insulated barrel, 3) with an insulated barrel with additional insulation grip (on connectors made to be double-crimped — one crimp on the barrel for electrical contact and one on the insulation for added strain relief), and 4) as fully insulated disconnects (when connected, no bare metal is visible).

Terminals for connecting battery cable from 8 AWG to 4/0 AWG are available as heavy-duty lugs (**#21**), similar to ring terminals used for smaller wire, and

DC ELECTRICAL SYSTEMS

heavy-duty butt connectors. For heavy-duty applications, lugs are available with a thicker wall for higher strength and less heat, a wider pad for better contact and a longer barrel for more crimp area.

Protective sleeves that insulate the metal shank of terminal connections are recommended. The best way to comply is to use short sections of adhesive-lined heat-shrink tubing. When heated they form a tight, moisture-resistant seal over the terminal shank. Not only do adhesive-lined sleeves seal out moisture, they also provide additional strain relief between connector and wire. Terminals from 22 AWG to 10 AWG with preformed adhesive-lined heat-shrink are also available, making installation convenient for the DIYer. In areas where moisture is a concern, seal multiple wires with Water Block Adhesive (**#13**) from Ancor Marine, a combination of heat-shrink adhesive with preformed wire channels and a clear outer section of heat-shrink tubing.

Power Distribution Points

It's best to make all wiring connections at equipment termination points, instead of joining conductors in the middle of a run — additional connections increase the potential for problems down the road. Convenient termination points are found at batteries, distribution posts and blocks, electric panels **(Figure 1, #15)**, loads, switches, controls and other devices in the circuit.

Battery switches isolate the batteries from the charging sources or electrical loads, but they can also serve as a convenient power distribution point. For example, on systems with a separate engine starting bank

TABLE B: AWG CONDUCTOR SIZES FOR 3% VOLTAGE DROP AT 12 VOLTS

LENGTH* \ CURRENT (amps)**	5	10	15	20	25	30	40	50	60	70	80	90	100
10'	18	14	12	12	10	10	8	8	6	6	6	4	4
15'	16	12	10	10	8	8	6	6	4	4	4	2	2
20'	14	12	10	8	8	6	6	4	4	4	2	2	2
25'	14	10	8	8	6	6	4	4	2	2	2	1	1
30'	12	10	8	6	6	4	4	2	2	2	1	1/0	1/0
40'	12	8	6	6	4	4	2	2	1	1/0	1/0	2/0	2/0
50'	10	8	6	4	4	2	2	1	1/0	1/0	2/0	3/0	3/0
60'	10	6	6	4	2	2	1	1/0	2/0	2/0	3/0	3/0	4/0
70'	10	6	4	2	2	2	1/0	2/0	2/0	3/0	3/0	4/0	4/0
80'	8	6	4	2	2	1	1/0	2/0	3/0	3/0	4/0		
90'	8	4	4	2	1	1/0	2/0	3/0	3/0	4/0			
100'	8	4	2	2	1	1/0	2/0	3/0	4/0	4/0			

Use this table for any critical applications: bilge pumps, navigation lights, electronic, etc. The next larger conductor should be used when length falls between two conductor sizes. For determining conductor size in 24-volt and 32-volt systems see "Formula For Sizing Conductors" on page 21.
**Length of wire from the positive power source (battery, panelboard or switchboard) to electrical device and back to the negative power source in feet.*
*** Total current on circuit in amps. Where there is a variance between the voltage drop and the ampacity (Table D on page 24), use the larger wire size.*

SOURCE: ANCOR MARINE

TABLE C: AWG CONDUCTOR SIZES FOR 10% VOLTAGE DROP AT 12 VOLTS

LENGTH* \ CURRENT (amps)**	5	10	15	20	25	30	40	50	60	70	80	90	100
10'	18	18	18	16	16	14	14	12	10	8	8	6	6
15'	18	18	16	16	14	14	12	12	10	8	8	6	6
20'	18	16	16	14	12	12	10	10	8	8	8	6	6
25'	18	16	14	12	12	10	10	8	8	8	6	6	6
30'	18	16	14	12	10	10	8	8	8	6	6	6	4
40'	16	14	12	10	10	8	8	6	6	6	4	4	4
50'	16	12	10	10	8	8	6	6	4	4	4	4	2
60'	16	12	10	8	8	8	6	4	4	4	2	2	2
70'	14	12	10	8	8	6	6	4	4	2	2	2	2
80'	14	10	8	8	6	6	4	4	2	2	2	2	1
90'	14	10	8	8	6	6	4	4	2	2	2	1	1
100'	12	10	8	6	6	4	4	2	2	2	1	1	1/0

Use this table for any non-critical applications: cabin lights, stereo, etc. The next larger conductor should be used when length falls between two conductor sizes. For determining conductor size in 24-volt and 32-volt systems see "Formula For Sizing Conductors" on page 21.
**Length of wire from the battery to electrical equipment and back in feet.*
*** Total current on circuit in amps. Where there is a variance between the voltage drop and the ampacity (Table D on page 24), use the larger wire size.*

SOURCE: ANCOR MARINE

and a simple ON/OFF disconnect switch **(Figure 1, #3)** for a single house bank the switch terminal closest to the positive post of the batteries can be used for connecting the positive leads of bilge pumps and renewable chargers that you don't want to accidentally disconnect with the other loads. For systems with dual battery banks for either house loads or engine starting **(Figure 2, top)**, the common positive terminal on a 1-2-BOTH-OFF switch can be used to connect the positive feeds to the starter circuit and the load distribution panel, as well as the positive leads from renewable chargers.

Multiple conductors can be joined in a circuit by using a power distribution post, busbar or splicer block. Distribution posts are used for large battery cable to branch out from a central positive connection, or to consolidate a number of negative return cables, allowing you to take one large cable to the engine block. These posts are available with 1/4", 5/16" or 3/8" diameter studs **Figure 1, #20)**. Busbars **(Figure 1, #7)** and splicer blocks perform the same function as distribution posts, only they offer multiple connection points. Branch circuits for large loads, such as windlass, large inverter, or refrigeration are often distributed through a separate heavy-duty busbar as shown in **Figure 2**, bottom. Make sure that all branch circuits on board are protected with appropriately sized fuses **(Figure 1, #16)** or circuit breakers.

Most branch load circuits on a boat are connected inside a DC distribution panel. Marine panels typi-

FORMULA FOR SIZING CONDUCTORS

Use this formula for calculating conductor sizes not included in Table B or C:

$$CM = \frac{K \times I \times L}{E}$$

- CM = Circular mil area of conductors as found in Table D on page 24
- K = 10.75 (constant representing the mil-foot resistance of copper)
- I = Current in amps
- L = Total length in feet from power panel to negative panel
- E = Voltage drop at load in volts (either 3% or 10% drop, and 12V, 24V or 32V)

For example:

$$CM = \frac{10.75 \times 10\text{amps} \times 27' = 4{,}031}{.72 \text{ (3\% of 24 volts)}}$$

Table D shows that 14 AWG is the correct conductor size to use.

DC ELECTRICAL SYSTEMS

cally have a positive busbar and disconnects, and fuses or circuit breakers for each branch, and may also include additional circuit switching or monitoring functions.

Setting Up The Circuits

First, create a rough system schematic of how the electrical components and circuits will be arranged on your boat. Using the schematic as a guide, determine where the components will be placed on board; make sure major components are readily accessible. Next, select and purchase the appropriate electrical gear and mount it securely in the desired locations.

Once the major components are in place, choose wire paths that are practical and aesthetically pleasing, and that keep wires away from excessive heat, moisture or sharp objects. Wires and connections that must pass through bilge areas must be watertight. Route conductors as far away from exhaust pipes and other heat sources as possible. ABYC recommends a minimum 5cm (2") clearance from wet exhaust components and minimum 22.8cm (9") clearance from dry exhaust components. Wire runs should avoid obvious chafe points such as steering cable or linkages and engine shafts or throttle connections. Try to allow for future access to all wiring connections.

Select the wire size, type and length of run for each application. Remember that in addition to using markers, adhering to standard wire color codes helps identify a conductor's function in an electrical system (**Table E** on page 26). Using wires with multiple conductors encased in an outer sheath where possible is a handy way to keep wiring runs tidy.

Cut/Strip/Crimp Tool (top); Wire and Cable Cutter (bottom).

5 Marine Prep Pen

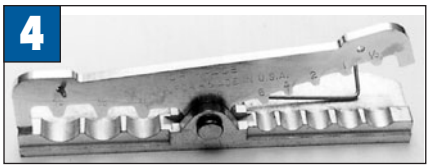
Cable Tie Gun

Specialty cables are available for bilge pumps (**Figure 1**, **#18** with two or three color-coded conductors 18-14 AWG, water-resistant jacket), masts (five color-coded conductors 14 AWG, round sheath) and other applications.

Now choose the types of terminals and connectors that work best for your system, and the necessary wiring tools for the job.

The Right Tools for the Job

There are specialty tools available that can simplify wiring installations and help boaters comply with industry standards. Although sophisticated gear is available for professionals and DIYers tackling large projects, most boaters can get the job done with relatively inexpensive wiring tools and accessories. If it doesn't seem worth even the modest expense to purchase specialty tools to make a few cable connections, cables made to order with the appropriate connectors can often be purchased from



Heavy Duty Lug Crimper

Mini butane torch.

Wire Marker Dispenser (top); Write-On Indentification Tubing (bottom).

marine power suppliers. On the other hand, once you own a complete set of wiring tools and are proficient at using them, you may be able to earn money by helping other boaters with their wiring needs.

Cut, Strip, & Crimp Tools

The first thing to look for is a good-quality combination wire cutter, stripper and crimper that can handle wire down to 10 AWG. Ancor supplies a model (#701008, US$25/CDN$39) that includes needle-nose pliers for pulling and looping wire, cushioned grips, cutting blades, wire stripping and single crimping stations for 22 AWG to 10 AWG, and the ability to cut up to 10-24 machine screws commonly found in electrical systems (**Figure 3, top**). Professional quality single- or double-crimping tools are

available for those who need or can afford them. Some professional models have a ratchet mechanism that won't release until a proper crimp is made.

Battery cable needs to be cut with a heavy-duty tool such as the Wire and Cable Cutter (**Figure 3, bottom**), from Ancor Marine (US$50/CDN$77) rated for 22 AWG to 2/0 AWG non-ferrous wire and cable. With some elbow grease and patience you can even cut 4/0 cable with this device. Crimping large cable lugs can be an easy task for the DIYer with the reasonably priced Heavy Duty Lug Crimper (US$44), which crimps 6-4/0 AWG lugs and 6-3/0 terminals (**Figure 4**). Lug crimpers with compound lever action are available for a price justified only by professionals.

Wire & Terminal Cleaning Tools

It helps to have a convenient way to clean wire terminals and connection points prior to crimping or soldering. A small wire brush will work fine, but the Marine Prep Pen from Ancor (US$14/CDN$22) makes this job much easier (**Figure 5**). Held like a pen, this device has 20,000 retractable glass fibers that can scrub away marine corrosion and rust in hard-to-reach places.

Solder and Heat-Shrink Tools

Most DIYers use crimp-on type mechanical wire connections, but occasionally the need arises for solder connections. While any good quality soldering iron works well for small gauge wire, a compact butane torch offers more flexibility. A mini butane torch (about US$17) has a focused flame that can be used for soldering large or small wire and, if used with a little care, installing heat-shrink tubing (**Figure 6**). It can also be used for plumbing and other jobs on board requiring a small yet intense heat source.

Special heat guns are available that use hot air (much hotter than the average blow-dryer) to shrink the tubing rather than an open flame, avoiding discolored tubing and accidental scorching. Entry-level models start around US$80.

Wire Markers, Cable Ties and Mounts

Maintaining neat, well-secured and marked wiring runs lends a measure of safety and professionalism to your installation. Plastic cable ties hold multiple conductors securely. Cable ties are available in assorted colors in standard and releasable (for changing or adding wires) models. You can purchase cable tie mounts that attach ties to a wall or bulkhead with a single screw, or you can purchase special cable ties that have a mounting eye at one end. Cable clamps (**Figure 1, #4**), available in either nylon or cushioned steel, wrap around one or more wires and provide a single-screw

attachment point. Wire ties can be pulled tight with a pair of pliers, although you might be inclined to purchase an inexpensive cable tie gun (US$22/CDN$34) that rapidly tightens cable ties to the proper tension (**Figure 7**).

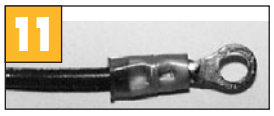
In most instances wires and what they are used for can be identified by color, but in complex wiring installations it's best to mark each wire to avoid confusion. One convenient way to do this is with the Wire Marker Dispenser (US$57/CDN$87). This device (**Figure 8, top**) holds 10 rolls of adhesive-backed stickers, individually marked 0 through 9, that peel off in 1-1/4" strips. Select a wire, assign it a number, and attach strips with that number at easy access points; with markers you'll always be able to trace wire runs.

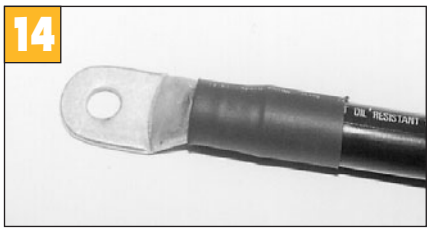
Although some boaters mark wires with a pen and strips of tape, a better method is to use small sections of heat-shrinkable Write-On Identification Tubing from Ancor (**Figure 8, bottom**). Available in 6mm (1/4") and 12mm (1/2"), this product consists of 10 7.6cm (3") sections of white heat-shrink tubing held by polyester strips and cost less than US$20. It can be marked with a pen, or fed through most typewriters or printers for the professional touch. Once heated the tubing shrinks to fit securely around the wire and the marking becomes permanent.

Wiring Runs and Connections

Once you have wire, connectors and tools on hand, you're ready to set up the wiring runs. Using color-coded wire and markers, install the conductors between pieces of electrical equipment.

Wiring is easy when you follow the strip, terminal crimp and heat-shrink sleeve installation technique for wire to 10 AWG as provided by Ancor Marine.





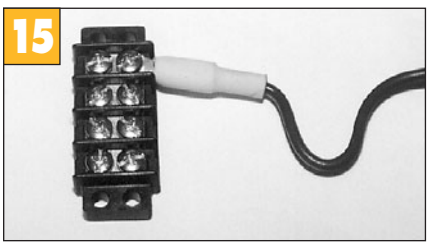


TABLE D: CONDUCTOR RATINGS

AWG	AWG CM	Minimum Number of Strands		Ampacity in Engine Space[3]	
		TYPE 2[1]	TYPE 3[2]	OUTSIDE	INSIDE
18	1,600	16	—	20	17
16	2,600	19	26	25	21
14	4,100	19	41	35	31
12	6,500	19	65	45	38
10	10,500	19	105	60	51
8	16,800	19	168	80	68
6	26,600	37	266	120	102
4	42,000	49	420	160	136
2	66,500	127	665	210	178
1	83,690	127	836	245	208
0	105,600	127	1064	285	242
2/0	133,100	127	1323	330	280
3/0	167,800	259	1666	385	327
4/0	211,600	418	2107	445	378

[1] Conductors with Type 2 stranding used for general purpose boat wiring.
[2] Conductors with Type 3 stranding used where frequent flexing occurs.
[3] Ampacity values for cables in circuits under 50 volts based on an ambient temperature of 50°C (122°F) and are independent of conductor length of run. See Tables B and C for specifics. Where there is a variance, use the larger wire size.

SOURCE: 1998 ABYC

1. Select the correct terminal. Make sure the wire range of the terminal is compatible with the actual wire size.

2. To insure a good connection, make certain the terminals and wire strands are free from oxidation and corrosion.

3. Using the correct wire strip die on your cut, strip and crimp tool, strip the correct amount of insulation off the wire, exposing the conductor (**Figure 9**).

4. Place the terminal (shown is an adhesive-lined, heat-shrink ring terminal) in the proper cavity of the crimp tool and insert the stripped wire. Make sure the strands do not extend into the contact area.

5. Center the crimp to ensure even pressure and squeeze the handles of the tool (**Figure 10**). An adequate amount of pressure must be applied so oxides on the inside of the terminal are broken down, but not so much pressure that the overall terminal shape is distorted.

6. Crimp the insulation grip sleeve if using a double crimp terminal (**Figure 11**).

7. Check the finished crimp to see that the wire is held firmly in place.

8. Heat connector until insulation shrinks and seals the wire and adhesive flows freely (**Figure 12**).

The technique is the same for larger cable. After cutting it with a cable cutter, stripping the insulation can be done with a sharp utility knife set at the depth of wire insulation and used with care to avoid cutting fingers or individual wire strands. Special battery cable strippers that attach to the cable and cut with a quick circular motion can make the job safer and easier, but a utility knife works fine for making up a few cables. Place the cable lug into the proper cavity of the Power Crimper and insert the cable (**Figure 13**). Strike with a hammer or squeeze with a vice. Since cable lugs are uninsulated, they must be sealed with

heat-shrink tubing or an equivalent type of protection (**Figure 14**). Adhesive-lined heat-shrink tubing also seals and supports the lug.

Sometimes it's more convenient to install end connectors before running the wires, but first make sure the connector will fit through wire chases and thru-holes in bulkheads. Use added wire protecting at all potential chafe points. Allow some excess wiring at all termination points to provide tension relief, to form drip loops for condensation (**Figure 15**) and for future wiring repairs. Follow ABYC standards by making sure all wires are supported with cable tie mounts or anchors at least every 45.7cm (18"). Exceptions: Battery cables within 92.4cm (36") of a battery terminal and cables attached to an outboard motor.

Fasten multiple wires together with cable ties frequently to keep runs neat. In areas where additional abrasion resistance is desired, wires can be encased in plastic spiral wrap (**Figure 1, #17**) or split loom casing (**Figure 1, #6**). With these products, individual wires can enter or exit the wiring harness as needed. Make notes of all wire locations to prevent future fastener penetrations.

Install the appropriate connectors and install wires at preselected termination points. Make sure the terminal surface is free of dirt, oil or corrosion. Tighten all connection fasteners; when the system is completed, double-check all connection points for tightness.

A thin coating of moisture-displacing spray can keep connection points corrosion-free. Battery terminals should be coated with CRC Terminal Protector or similar product to form a corrosion-resistant barrier.

Troubleshooting Electrical Circuits

Most electrical problems are the result of poor connections, accidental wire penetrations or chafing, or the use of substandard components that fail. By using high-quality components and good wiring techniques, you'll save yourself many headaches down the line. If you do encounter a problem in a circuit, first check all connections, including at switches and circuit protection devices, for corrosion and tightness. If everything seems okay, begin checking the continuity of the circuit with a multimeter or test lamp. Start at the battery positive terminal and work your way toward the loads. Do the same for the negative run. Continuity will be disrupted at the source of the problem. Isolate the problem area and repair or replace electrical components or wire as necessary.

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

TABLE E: SAMPLE WIRE COLOR CODE

COLOR	ITEM	WIRE USE
Black or yellow	Ground	Negative mains
Blue, dark	Cabin & instrument lights	Fuse or switch to lights
Blue, light	Oil pressure	Oil pressure sender to gauge
Brown w/yellow stripe or yellow*	Bilge blowers	Fuse or switch to blowers
Gray, dark	Navigation lights Tachometer	Fuse or switch to lights Tachometer sender to gauge
Green or green w/yellow stripe	Bonding systems	Grounding conductors
Brown	Generator armature Alternator charge light Pumps	Generator armature to regulator Generator terminal or alternator Auxiliary terminal to regulator Fuse or switch to pumps
Orange	Accessory feed	Ammeter to alternator or generator output and accessory fuses or switches
Pink	Fuel gauge	Fuel gauge sender to gauge
Purple	Ignition Instrument feed	Ignition switch to coil and electrical instruments Distribution panel to electric instruments
Red	Main power feeds	Positive Conductors
Tan	Water temperature	Water temperature sender to gauge
Yellow w/ red stripe	Starting circuit	Starting switch to solenoid

**If yellow is used for negative, blower must be brown with yellow stripe.*

SOURCE 1998 ABYC

WORKING WITH EPOXY

How to prepare bonding surfaces, mix and apply epoxy glue, coat and fillet — the basic steps for building or repairing most anything on your boat.

Story and photos by Jan Mundy

WHAT YOU NEED

Epoxy resin
Slow- and fast-cure hardener
Adhesive and fairing fillers
Solvent
Mixing pots, Stir sticks
Paint rollers & tray
Cheap glue brushes in sizes 12mm - 7.6cm (1/2" - 3")
Foil (or non-printed plastic bags)
Putty knives, various sizes
Small plastic bags
C-Clamps, pipe clamps
Heavy-duty stapler & staplers
Wax paper & Paper towels
Low-nap foam rollers with solvent-resistant core
Dust mask & Goggles
Disposable latex gloves
Sander and sandpaper
3M Scotch Brite pad

I wouldn't call myself an expert with epoxy but having applied well over 50 gallons building and repairing boats and hundreds of other things, I have a lot of user experience.

A few tools and supplies, and some woodworking experience are all you need to complete the procedures outlined below. The techniques for gluing, coating and filleting are generic and apply to many brands of epoxy but you'll need to carefully follow the manufacturer's instructions when mixing and adding fillers.

For our demonstration we used Epiglass, a product developed in New Zealand and recently marketed in North America by Interlux. We've been testing this epoxy for the past year and its advantages are many: a low viscosity resin, it flows better when coating, laminating or sheathing and performs better in lower temperatures; and phenol-free and low-odor hardeners are safer and more pleasant to use. Like MAS and some other epoxies, Epiglass cures with little or no amine blush, a waxy by-product that appears on cured epoxy surfaces. When coating or laminating, blush-free epoxies require little or no preparation between applications.

Many users develop severe skin irritations when using epoxy resins. Protect hands with rubber gloves or a barrier cream (I use both), wear goggles and protective clothing. Always wear a dust mask when sanding cured epoxy or when adding fillers — fine fiber particles form a toxic cloud. It's also recommended that you don't eat, drink or smoke when working with epoxy.

Epoxies will adhere to most properly prepared surfaces, except PVCs and other plastics. Humidity, air temperature, proper surface preparation and application are also critical when working with epoxy resin. Too humid air, a contaminated or too cold work surface, or over- or undercatalyzed mix can reduce bond strength and the epoxy's effectiveness as a moisture barrier. For best results, epoxy should always be applied at room temperature and never below 10°C (50°F), unless specified. As epoxy resins have no UV protection, cover all exposed areas with varnish or paint.

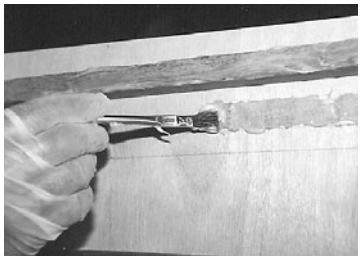
Mixing

◆ Mixing the glue to the proper resin-to-hardener ratio is critical. Precalibrated mixing pumps make the task easier. Always mix small batches at a time and use a slow-cure hardener to increase the working time when applying in hot temperatures or gluing, coating or laminating large areas. Thoroughly mix the resin and hardener together for at least a minute before adding fillers. (I keep a stopwatch in the shop just to time the mix.)

Gluing

◆ Add the appropriate filler. Colloidal silica is used for most general gluing. It can be used alone or mixed with other fillers to improve sanding and smoothness. Use microfibers when bonding wood or a brown-toned wood filler when gluing naturally finished wood. Microballons and glass microbeads are easily sanded and used for fairing putties. Begin adding the filler in small batches (I use a coffee measurer) until the desired consistency is reached.

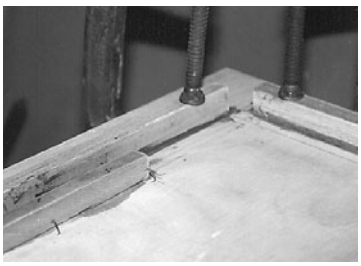
◆ Bonded joints offer superior holding power compared to mechanically fastened joints. A perfect joint is not required; gaps up to 3mm (1/8") shouldn't affect the structural integrity of the bond. Bonding requires a moderately thickened batch. This mixture should have the consistency of mayonnaise; it clings to vertical surfaces but peaks formed by dipping a stir stick in the thickened epoxy will fall over. The thicker the gap, the thicker the glue required. When bonding large, flat panels, the mixture should be slightly thinner with the consistency of ketchup.



◆ Sand bonding surfaces with 120-grit paper if necessary to remove any contaminants then decrease with the appropriate solvent. A two-step glue joint offers the best adhesion and prevents resin-starved joints. The first step is to "wet-out" the bonding surfaces with an application of unthickened (no fillers) resin-hardener mixture, then apply thickened epoxy with a glue brush to both bonding surfaces. When bonding non-structural joints, you can omit the first step.

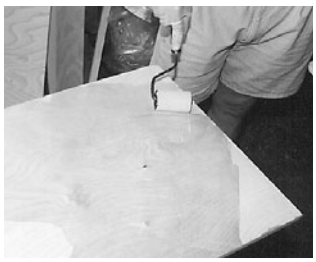
◆ Use staples, small copper nails, clamps, wedges or jigs to hold the pieces in place until the glue sets. If the job requires a lot of staples (i.e. planking on a cold-molded hull), cut plastic garden edging into 2.5cm- (1"-) wide strips and staple through it. After the glue has cured, you just pull the plastic to remove the staples. When clamping, apply just enough pressure until a small amount squeezes out the joint. Too much pressure and you'll squeeze out the epoxy mixture, leaving gaps and weakening the joint.

Remove excess epoxy with a putty knife, then wipe clean with solvent and paper towels rather than rags, which can contaminate the surface. Once cured, any residue is easily removed with a wood file, block plane or cabinet scraper.



Coating

The object of coating wood surfaces is to provide an effective moisture barrier and a smooth surface for overcoating with a UV-resistant varnish or paint. Before starting any coating job, check the humidity. Many epoxies are extremely humidity sensitive, which isn't so critical when gluing as the joint isn't open to moisture, but a potential problem when coating. If the hygrometer reads more than 70%, it's better to postpone the job. Both the epoxy and surface to be coated should be at room temperature to minimize air bubbles and maximize penetration into the wood. Be sure to use foam rollers with solvent-resistant cores or they'll quickly disintegrate. For coating small areas, I prefer using small rollers created by cutting a 23cm (9") roller into thirds with a hacksaw.



◆ Thoroughly mix resin with hardener and pour into a roller tray covered with foil. Load the roller with the resin mixture, roll out the excess, then roll randomly over the surface, vigorously rolling in several directions and loading the roller with epoxy as needed to apply an even thin coat. Make sure you have no dry spots. Work quickly and if the epoxy begins to thicken ("kick off") when coating large areas, discard it and the foil tray cover, mix a new batch and apply with a fresh roller.

◆ Remove the air bubbles by "tipping" with a foam or bristle brush wiped lightly over the surface in even strokes. Apply two coats wet-on-wet, recoating when the resin is just slightly tacky, then let fully cure. Remove the amine blush (if not blush-free) by washing the surface using soap and warm water with a 3M Scotch Brite Pad. Before the water evaporates, dry the surface with paper towels and sand any remaining glossy areas with 120-grit paper (I prefer wet sanding). Let the surface dry thoroughly, then apply a final coat of unthickened epoxy. If desired, add a small amount of powdered pigment, up to 5% by weight, to change the color of the epoxy as a base coat when painting. After curing, wash again, if necessary, sand and prepare the surface for final painting. Two coats are sufficient for most non-exposed interior surfaces; three or more coats are needed for exterior surfaces. The more coats you apply, the better the moisture resistance.

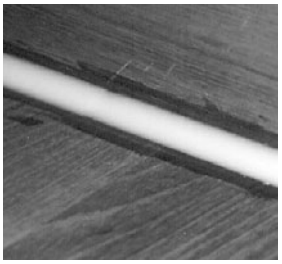
Constructing a Fillet

Use fillets to reinforce joints, bond panels together or to form a rounded, nicely curved joint when coating or laminating. Filleting is simple to do but perfecting the technique takes some skill and best practiced on some scraps.

◆ After thoroughly mixing resin with hardener, add enough filler to make a mixture as thick as peanut butter so it will cling to vertical surfaces; peaks in the mixture should stand up. If you have lots to do, use a slow-curing epoxy. I prefer a 50:50 mixture of colloidal silica and microfibers — you get fillets that aren't dry, don't sag, are glass smooth and require little sanding. For fillets on naturally finished wood surfaces, use a wood filler — the brown color blends nicely. Mix small batches at a time to prevent an untimely cure before completing the fillet.

Half fill a small, heavy-duty bag (such as a freezer bag), with the thickened mixture, then nick the end off one corner at a 45° angle. The opening depends on the desired fillet size: for making fillets on 12mm (1/2") plywood, cut a 6mm (1/4") opening. Apply a bead of epoxy, doing a small section at a time, putting a generous amount on the joint. Too little epoxy and you'll have gaps and have to reapply.

◆ To form the fillet, pass the rounded edge of a stir stick held at an angle over the mixture to remove excess and form a smooth concave. You may have to reshape the end of the stick to match the joint radius. Depending on the temperature and the time elapsed, you can return the excess epoxy to the bag or discard it. I usually discard it rather than risk having it kick off before I get a chance to shape the fillet. Never add used epoxy to a new mix as the heat will dramatically decrease the working time. Carefully remove any excess on both sides of the fillet with a putty knife.



◆ If you applied enough epoxy, the fillet looks smooth in one pass. If there are gaps, apply more thickened epoxy and again smooth the joint. When fully cured, scrape or sand off any excess epoxy, then sand the wood (and fillets) with 120-grit paper. Apply two or more coats of unthickened resin-hardener mixture over the fillets, then paint or varnish to protect the epoxy from UV.

DIY PROJECTS

BOAT REFIT '98

BOAT IMPROVEMENT PROJECTS & UPGRADES

Illustrations by Anne-Marie Hendry

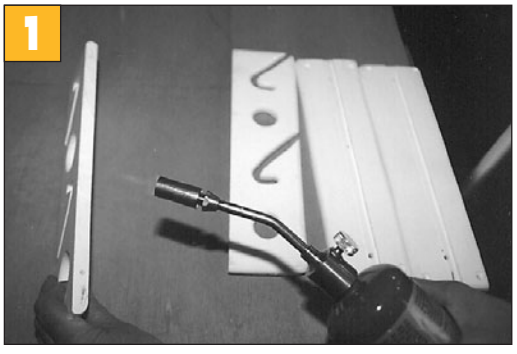
The winter months can find you aboard your boat even if the weather precludes taking it out or it's carefully tucked away for winter's slumber. With an ultra-compact electric heater, even the largest cabin can be a warm and dry place to work.

This year's selection of DIY projects will brighten up your boat and make life on board a little more comfortable — just the excuse you need. There's something worthwhile in here for every boater, no matter what type of skills you have or what you like to do. You'll find solutions for equipment storage, interior modifications, rigging upgrades, performance flaws, safety add-ons and a mishmash of odds and ends. There's also an excellent introductory project for building with DecoLite composite panels and more ideas for building with StarBoard. As with all DIY projects, we've given the most common methods for building these items but, just like opinions, ours are not the only ones.
(Please note that hardware used in these projects are provided as a guideline and are by no means the only products to buy.)

BUILDING WITH STARBOARD

In case you haven't noticed from the various projects that have appeared in past Boat Refit issues of *DIY*, I really like King StarBoard. This durable, UV-stabilized polymer can't be beat for building myriad items: fiddles, spray deflectors, cockpit and shower grates, storage racks, folding seats, swim platforms, rod holders, splashwell, rub rails, nameboards — anything that's usually made of hardwood, normally teak. King StarBoard is totally maintenance-free — it won't delaminate, rot or splinter and requires no painting. Easy to work with using basic woodworking tools and techniques, it's comparably priced to teak and saves a lot of time in finishing work.

Refer to the *DIY* Winter '96 issue for complete step-by-step construction methods for marking, cutting, shaping, drilling, fastening and gluing. StarBoard bonds to fiberglass, aluminum, steel, wood, plywood and itself with StarBond, a specially-formulated two-part urethane adhesive dispensed from a custom cartridge-type gun. It's a three-component system: dispensing gun (US$50/CDN$87) holds glue cartridges (US$19/CDN$31) and single-use static mixing nozzle (US$1.50/CDN$2.40). When doing small jobs, save the mixing nozzle: squirt out some glue on a piece of plastic and mix thoroughly until colors are well-blended and



Flame-treating surfaces to be glued with StarBond.

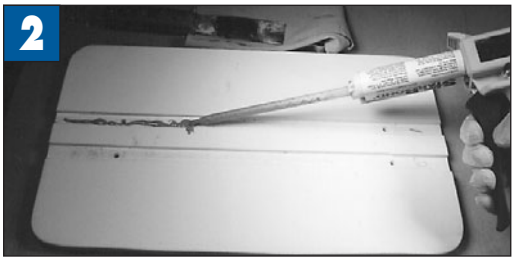
the mixture is an ivory-white.

Proper surface preparation is critical when gluing. Lightly sand StarBoard bonding surfaces with 120-grit paper, clean with solvent (acetone, Toluene or alcohol), then flame-treat with a propane torch. Practice this technique on a some scrap before treating your finished piece. Working in a well-ventilated area, hold the torch so the flame is approximately 2.5cm to 5cm (1" to 2") away and the blue (oxidizing) portion of the flame is on the StarBoard bonding surface (**Figure 1**). Pass the flame over the surface at a rate of 30cm (12") per three seconds. Don't scorch the surface — there should be no visible difference in the treated surface. Ideally, flame-treating should be performed within four hours of bonding. When bonding StarBoard to plywood make sure the wood is dry and clean; fiberglass and steel require a light sanding with 120-grit paper then wiped with acetone, Toluene or alcohol; and aluminum or steel requires removal of surface oxidation and primed.

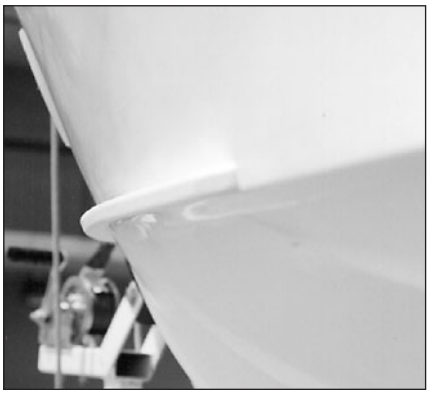
To glue, place the two cartridges in the gun and attach the static mixer. Discard the first amount of adhesive ejected out the mixer until the mixture is a consistent ivory-white. Apply an even coat of StarBond to each bonding surface (**Figure 2**), about 8 to 12 mils thick. Spread evenly with a putty knife. Join the two faces and clamp using moderate pressure but not so much that the glue squeezes out the edges. The optimum thickness of cured adhesive is 15 to 20 mils. Clean up any spilled adhesive with acetone.

Depending on the temperature, working time is about 10 minutes, clamps can be removed in six hours, and it reaches a full cure in 24 hours. Because I don't like to rely entirely on a glued joint, it's good practice to use a lap, rabbeted or similar joint along with mechanical fasteners that can double as clamps to hold the joint firmly until the glue sets.

A note on maintenance: Be careful when using teak oil around StarBoard as oils can cause permanent unsightly stains.



Dispensing gun simplifies application of StarBond adhesive.



Spray deflector made of King StarBoard mounted at the chine prevents water from spraying upwards onto the deck.

We keep finding more uses for King StarBoard and shown here are three more. One practical application of StarBoard is spray deflectors (**Figure 3**). These produce a dramatic difference on "wet" runabouts and cruisers, deflecting the spray downwards, and off the deck. Essentially that's the purpose of a chine, but often it's too narrow and requires an add-on piece.

Strong and durable deflectors made of StarBoard won't require any maintenance or painting, and blend in nicely with the hull. They are mounted on or just above the chine of a hard-chined boat, or on a boat that doesn't have a chine placed at a height that deflects the spray. Length is normally one-third of the boat, measured at the chine. For example: 1.8m (6') deflectors were installed on the 6m (20') Raymond Hunt-designed '60s-something runabout shown in **Figure 3**. These were milled from white, 3cm- (1-1/4"-) thick StarBoard, cut wide enough so they don't look out of place but not too narrow or they'll be ineffective.

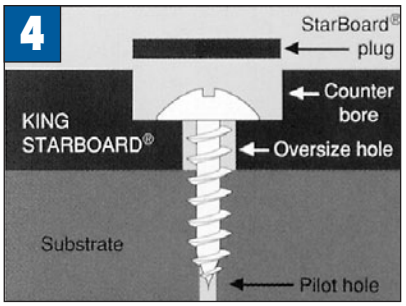
Make a pattern for each side of the hull; it's likely the hull contours are different. StarBoard is best cut with a table saw or radial saw operating at 1,275 rpm and using a carbide blade that has 50 to 70 teeth. Router the outside edges with a 1/2-round carbide bit. Lay deflectors in position and check the fit. Drill holes for 6mm (1/4") screws from the inside hull if you have access; otherwise, predrill the StarBoard, drilling slightly oversized holes (in the StarBoard only) to allow for contraction and expansion and counterbore the heads for a StarBoard plug (**Figure 4**). Prep

the mating surfaces, removing any wax from the hull with acetone. You'll need to seal the fastener holes in the fiberglass. Some professional builders bed screws in 3M Marine 5200 polyurethane sealant, but its ability to adhere to StarBoard is uncertain. But it will stick to fiberglass and StarBoard doesn't absorb water, so use either a polyurethane or polysulfide sealant. We don't recommend gluing on deflectors with StarBond, in case you need to replace or reposition them.

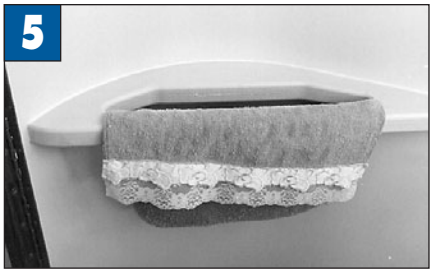
The towel rack (**Figure 5**) mounts onto any flat or curved surface and can be cut to fit towels of any size. Use a jigsaw to cut to the desired shape. To make the cutout, drill 9mm (3/8") holes in all corners, inside the cutting line, then cut between the holes with a jigsaw. Router all edges with a 1/2-round carbide bit and sand smooth with 120-grit paper. Flame-treat the back edge and prep the bonding surface and apply StarBond glue. (See above for application instructions.) You may have to devise some innovative means of clamping until the glue sets — masking tape works great in a pinch.

A StarBoard shower grate (**Figure 6**) is easy to clean and won't mildew or warp. Use your existing grate as a template or make a cardboard one. The grate should fit with a 3mm (1/8") or so gap on all edges. After cutting from 12mm (1/2") material, mark the placement of the 2.5cm (1") diameter holes on the wrong side, arranging them so they are symmetrical, then drill with a holesaw. Router all edges and cutouts with a 1/2-round carbide bit. Smooth edges with a sander and 120-grit paper, if necessary. A desirable modification is the addition of a couple turn-buttons (see *DIY*, Fall '96, Page 18) to secure the grate in rough seas.

— JM



To allow for contraction and expansion, drill oversized holes for pan-head wood screws and seal with a StarBoard plug and counterbore the heads for a StarBoard plug.



Simple-to-make towel rack.

Maintenance-free StarBoard shower grate.

WOODWORKING

FOLD-AND-TURN TABLE

Simple-to-make table is just one of the many uses of lightweight composite panels.

Lightweight table made of 12mm (1/2") DecoLite with fiber-reinforced wood veneer folds against bulkhead.

The drop-leaf table shown in **Figure 7** was built by Bruckmann Manufacturing, Oakville, Ont., a 32-year-old boatshop that built the custom yachts designed by C&C Yachts during the "Golden Years" of sailboat building. The shop, now under the ownership of Mark Bruckmann, specializes in custom building and restoration of all manner of power and sail vessels. Recent boats include the Mark Ellis-designed *Legacy* motoryacht, now built by Freedom Yachts, the custom 14m (47') daysailer, *Volunteer*, and B-28 police boats.

The table was built for *Red Jacket*, an elegant 1966 vintage custom C&C 11.7m (39') sailboat owned by Paul Phelan, CEO of Cara Operations. Racing rules demanded that the boat have a table but the owner didn't want to add any needless weight. Built of DecoLite from Baltek, the table meets both decorative and functional needs.

DecoLite panels are the ideal material to build both new or refit interior bulkheads, doors, built-in furniture and cabinetry for boat interiors. Strong and lightweight, structural panels have end-grain balsa core sandwiched between a choice of fiberglass-reinforced skins: teak, ash and other hardwood veneers or fiberglass 1208. Available in standard 12mm (1/2"), 19mm (3/4") and 2.5cm (1") thickness and custom sizes up to 7.6cm (3") thick, DecoLite is nearly half the weight of equally sized plywood and moderately stiffer and stronger. Substituting DecoLite for plywood can cut the weight of a boat's interior nearly in half. Reducing weight means less mass for your engine or sails to push, which results in improved top-end speed and reduced fuel consumption. Other benefits include good sound and thermal insulation, positive flotation and moisture resistance.

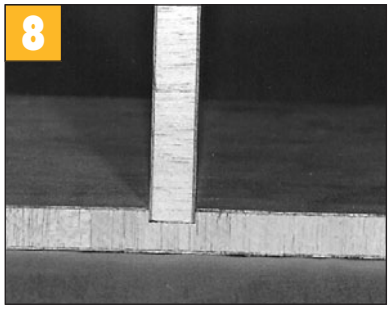
Traditional woodworking techniques apply to DecoLite. Panels are joined together a using a dado joint (**Figure 8**), a butt joint with glued-on wood cleats (**Figure 9**) or fiberglass tape glued over the joint. For the advanced woodworker, a biscuit joint and joiner (**Figure 10**) are used to join panels. As balsa has little compression strength, it's replaced with plywood or solid fiberglass or hardwood splines (**Figure 11**) where there are fasteners, cutouts for hoses or wires, or other openings. Alternatively, reinforce edges without removing the core with backing plates concealed on the underside. It's a simpler and faster method but limited to certain applications. All exposed edges must be coated with epoxy resin to

seal out moisture, or finished with either veneer banding or wood trim.

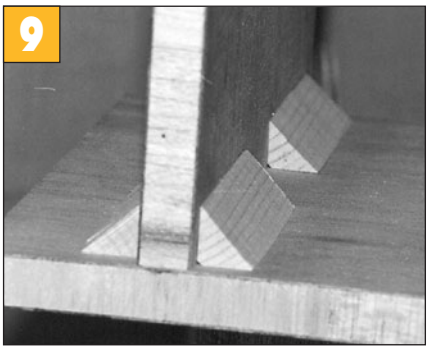
Simple to build, *Red Jacket*'s table measures 46cm (18") wide and 1.5m (5') fully extended and fits easily into any available space. Piano hinge joins the two panels together and the table to a custom swing-out bracket that positions the table when opened at a height of 81cm (32") between the bunks. When folded, the table lies against the bulkhead and is held securely with wooden turnbuttons.

Before you begin building, measure the space where you want the table. Plan a table height that will serve your exact need; for example, on a level with a berth.

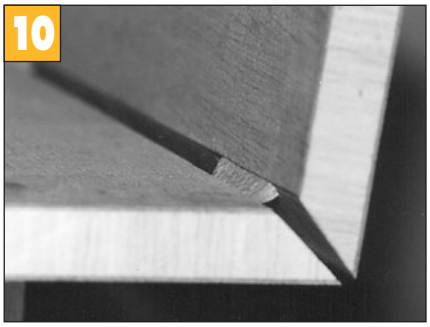
Cut two 12mm (1/2") DecoLite panels of equal width and length to dimensions to suit your installation. Radius the outside corners on the two ends. To reinforce the ends, remove the core by cutting a groove approximately 2.5cm (1") deep. This can be done with either a dado saw blade on a table saw (**Figure 12**) or router. To preserve skin integrity, leave a small amount of balsa against the inside faces of



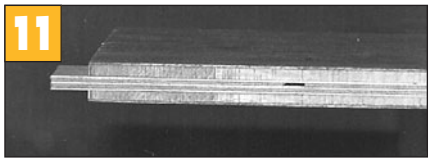
Sample dado joint.



Butt joint with glue blocks.



Mitred corner with biscuit joint.



BALTEK CORPORATION

Reinforcing spline inserted after removing core.

Removing the balsa core, which is replaced with a reinforcing spline

the skins. If using a router, the straight bit size for 12mm (1/2") panels is 5/16"; 9/16" for 19mm (3/4") panels. Make a trial cut on scrap to check the size before proceeding to cut the dadoes. Mill a piece of mahogany to fit the groove and set it in flush with slightly thickened epoxy resin (**Figure 13**), clamped until the glue sets. The spline should be snug but not a force fit and any gaps will be hidden by the veneer banding. Attach a piano hinge to the reinforced edges where the two pieces join and the inboard end with wood screws and glue (**Figure 14**). (Note edge spline in place in Figure 14.) Cover all exposed edges with iron-on hardwood veneer edge banding (**Figure 15**). Sand then varnish or paint. Bruckmann stained the table to match the boat's teak interior (the panel was ash faced), followed with three or more coats of varnish.

Cut a hardwood leg to support the table. You'll need a bracket to fasten the leg to both the underside of the table and the cabin sole. The teak table leg (**Figure 7**) has pins in each end that fit into a stainless-steel bracket flush-mounted to the underside of the table and one mounted to the cabin sole. The custom swing arm is fashioned from aluminum tubing and fits into delrin-lined brackets.

Mahogany spline is cut to fit the groove then set flush with slightly thickened epoxy resin.

At a cost of nearly US$4.77 per square foot for a 12mm (1/2") 4'x8' panel in quantities of one to six panels plus shipping, DecoLite is about three times the price of similar-sized Brunyzeel plywood or twice the cost of teak boat ply. (The 19mm (3/4") retails for US$5.12 per square foot, the 2.5cm (1") for US$5.49.) It's not cheap and you could build with plywood, but the weight savings will likely pay off in the long run.

Piano hinge is fastened to the reinforced edges.

Iron-on veneer banding gets applied to all exposed edges.

For information on building with DecoLite or where to purchase Baltek products contact Baltek Corporation, Marine Dept., P.O. Box 195, Northville, NJ 07647-2492; Tel: 201/767-1400, Fax: 201/387-6631, Email: baltek-corp@aol.com.
— JM

TIPS WOOD SPLINES

To join two pieces of DecoLite or reinforce edges for fasteners, Baltek recommends using splines cut from quality plywood, fiberglass strips or any thin sheet material. Rout out the core along the panel edges leaving a small amount of balsa against the inside faces of the skins so as to avoid destroying the glass reinforcement and skin integrity. Glue using a standard woodworking adhesive and clamp, distributing even pressure from both sides to insure a good bond of the skins to the spline.

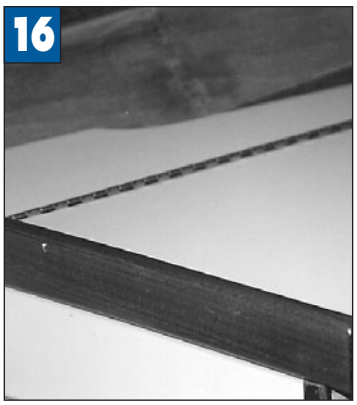
ADDING FIDDLE RAILS

Tools & Materials

Drill & bits
Hacksaw
File
Small block plane
Sandpaper
Brazing rod, 3mm (1/8") or wood dowel, 6mm (1/4")
Carbon paper
Mahogany, teak, maple or other hardwood, 2.5cm to 6cm (1" to 2-1/2") square
Quick-setting glue
Varnish and brush

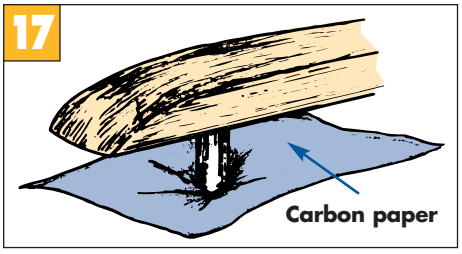
Fiddle rails are unique to boats in that they are necessary to keep the contents of shelves in place, to keep loose objects on the dining table and countertops and in general to prevent all these small items from establishing their own trajectories in response to the boat's motion. If you find that your vessel is under-equipped with these rails, the one I describe here will allow you to correct this deficiency. It's functional and is made of an odd length of scrap hardwood (**Figure 16**).

There are really only two tricks to fitting a fiddle rail to a countertop or shelf: drilling the pin mount holes squarely into the rail and accurately locating the receiving hole on the countertop. Following the illustrations, you'll see how I dealt with these two problems.



A basic fiddle rail.

Step 1 Drill your pin holes into a square or rectangular piece of wood that has been cut to the required length. Space the holes about 61cm (24") apart. With a drill press it's easy to remain perpendicular to the surface you are drilling into, but even with a hand drill you can achieve a high degree of accuracy by drilling the holes before shaping the rail. A piece of tape around the bit or a drill stop will act as a depth gauge to help keep the holes from

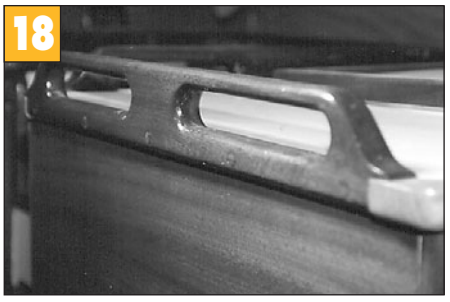


Slide carbon paper under the rail to mark the exact pin placement.

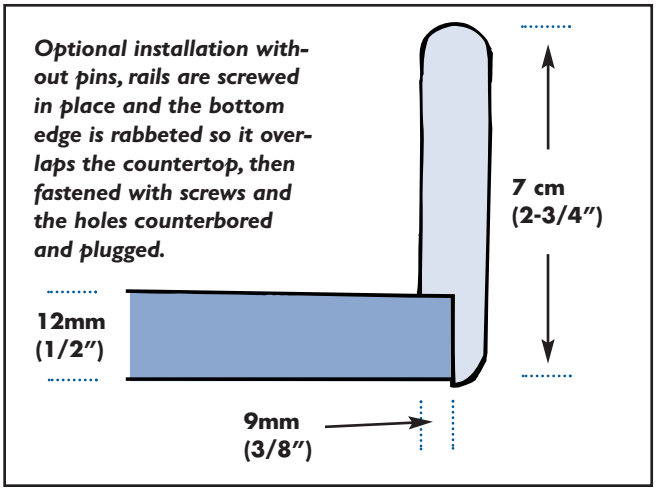
being exposed when you cut the rail to shape in step 2. Drill the holes for a snug fit and a little deeper than the length of the pins to allow room for the glue.

Step 2 Shape the rail, bearing in mind the perpendicular face will be the inner side. Don't cut too close to the pin holes or they will be exposed. If you do cut into the upper end of a pin hole, just carve a short plug from the scrap and epoxy it in place from the top. Once it's sanded and varnished, it will be fairly inconspicuous.

Step 3 Pins are installed using brass rod (brazing rod from a welders' supply or hardware store) or hardwood dowel. Round the exposed end but don't glue them in just yet.



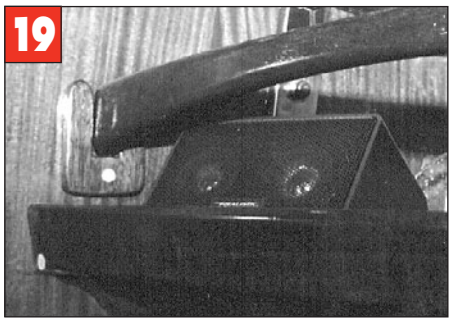
Cut handholds in rails mounted in the galley, chart table or anywhere an extra hand grab is needed. To make a handhold, drill 2.5cm (1") diameter holes, about 15cm (6") apart and up 2.8cm (1-1/8") from the lower edge, then cut out the stock and round the edges. Space cutouts at least 5cm (2") apart.



Step 4 Mark the location on the counter for your pin holes. I did this by placing a sheet of carbon paper under each end of the rail and pressing lightly (**Figure 17**). This will leave two faint marks. This is where you will drill.

Step 5 Drill the counter carefully, keeping the drill perpendicular and using light pressure to avoid chipping the countertop. Watch your depth and use a drill bit that is slightly larger than the pins to ease fitting and removing the rail.

Step 6 Check the fit by starting the rail pins into the countertop and feeling for binding that would indicate a misalignment between the pins and holes. If there is a problem you can either drill one or both counter holes a little more oversized or, if you were off a significant amount, you can remove one of the pins from the rail, glue a wood plug in the hole and redrill the rail. Should redrilling be necessary, clamp the rail's vertical face to a wood block to allow more control as it's being drilled. To mark the underside of the rail,



Shelf rail slides into a U-shaped bracket mounted on a bulkhead. Cut the slot slightly wider than the rail thickness for a tight, rattle-free fit. Mounting screws are countersunk and plugged for a professional finish.

insert the good pin into the countertop, set the other pin into it's hole in the counter and put a piece of carbon paper face up against the rail. Rather than trying to center a point, swing an arc across the width of the rail bottom and locate the center when you redrill.

Step 7 Varnish the rail once you are happy with the fit and have glued in the pins.

You can also make rails with handholds (**Figure 18**) that are screwed to the countertop or rails for a shelf that slide into a U-shaped bracket (**Figure 19**). There you have it, the basic Fiddle Rail. May it keep lunch out of your lap.

— Ryc Rienks, Mai Tardis II, Marine Puerto Vallarta, Jalisco, Mexico.

BUILD AN OVERHEAD SHELF

There never seems to be enough storage spaces on board, particularly when you're in port and need regularly used items near at hand. One simple solution is to build a hanging shelf (**Figure 20 and 21**). Many builders now incorporate this style of shelf (the photos where taken in a Hunter sailboat) and it's easily built. Supported by a 22mm (7/8") stainless-steel rod, it's mounted either to the cabin ceiling or to the underside of the shelf if placed above a countertop. The rod ends fit into a standard round-base rail fitting (i.e. Taco part #F14-0039-1) on the ceiling and a bracket to the shelf, or inserted into two rail fittings on a countertop mounting.

The bottom is cut from 19mm (3/4") plywood or 12mm (1/2") Starboard, and the sides are 19mm x 10cm (3/4" x 4") hardwood. Overall dimensions are determined by the available space and mounting restrictions. First determine how the outboard end is to be support-

Hanging shelf with overhead support.

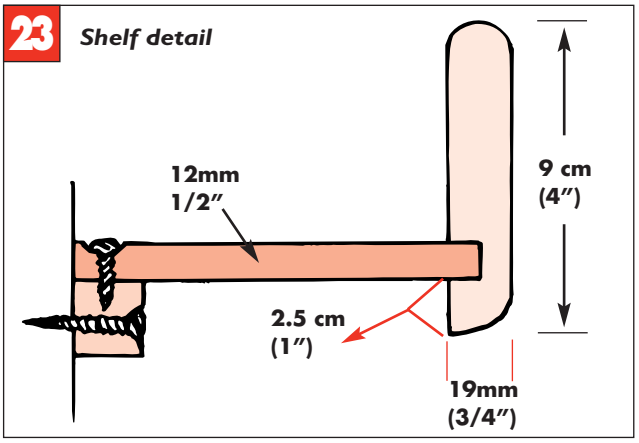
DIY PROJECTS

ed. **Figure 20** shows it resting on the top ledge of a cupboard or locker. If this isn't possible, glue and screw cleat stock to the cabin side or mount a custom bracket

Hanging shelf with countertop support.

(**Figure 22**). Cut the sides to the proper length from 10cm (4") stock, router all edges with a 3/8" radius bit and miter the corners. Dado or router a groove for the shelf as in **Figure 23**. Clamp the pieces together without glue to be sure of the fit. Disassemble, then apply glue to the sides and clamp it together. (You may want to use screws to hold the sides together until the glue dries, then plug the holes.) Finish wooden sides with oil or varnish, attach the shelf to the cabin side, mount the rail bases, cut the rod to length, assemble the hardware and you're done. *— JM*

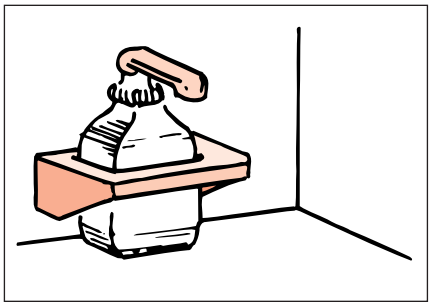
A custom bracket supports the table in lieu of a cleat or cupboard support.

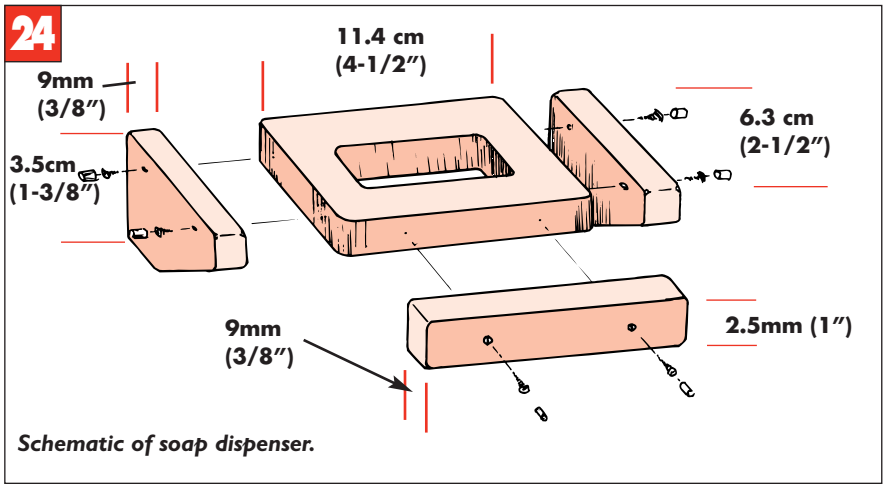


SOAP DISPENSER HOLDER

Soap in a dispenser can be very useful on board when placed in a specially-designed holder. **Figure 24** provides some sample measurements; actual cutting dimensions will depend upon the type of dispenser. The inside dimensions of the holder need only be about 12mm (1/2") larger than the outside measurements of the dispenser. Made of solid or plywood, finished with paint, varnish or Starboard, the holder can be installed in the head or galley to hold a container of dish soap.

— Sophia Dean,
Via Sophia, Oakville, Ont.





Schematic of soap dispenser.

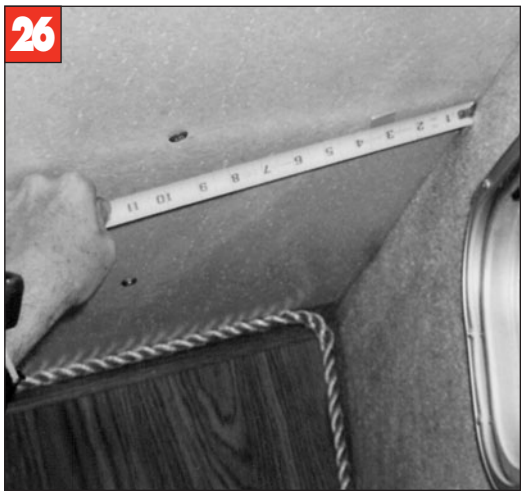
ODDS & ENDS

CUSTOM WINDOW SHADES

The berth on our motor vessel was not equipped with curtains so a small hand towel had to suffice. It may seem silly to spend months living aboard with a hand towel wedged into the window frame, but that is how we managed. I finally purchased some mini-blinds for $5 each and eventually got around to installing them. Available in widths over 30.4cm (12"), blinds are easily custom-cut to any window size.

To make the installation symmetrical and set out from the hull flare, I hung a plumb bob (you can make one from a carbine hook attached to nylon cord) from the overhead (**Figure 25**). The blinds were to hang from the overhead as I couldn't attach them to the inside of the hull. I found that the blind would hang free of the hull if I set it inboard 10cm (4"). Coming out in line with both ends of the port, I added at least 3.8cm (1-1/2") on each side for overlap (**Figure 26**). I marked the ends with masking tape.

Locating the spot.



Marking placement of the ends.

Next, I held the blind assembly up to the taped marks to check for centering. The port is a slide-opening style and so the center was easy to find. I marked the end locations with masking tape (**Figure 27**).

Checking alignment.

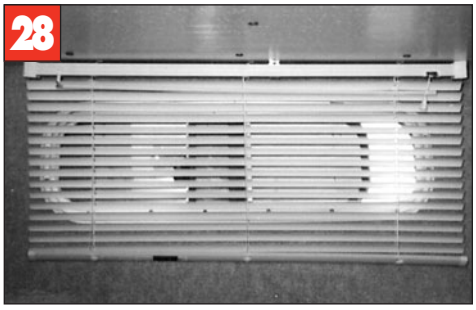
The supporting end caps were mounted with two screws each. I hung the first one with only one screw to allow for possible adjustment. Placing the blind assembly in the mounted end caps, I held a second cap in place to check position. I held both end caps pressed firmly to the end of the blind assembly and this proved to be too exuberant. A little end play, say 3mm (1/8") or so did not compromise the mounting. The second cap was screwed to the overhead with one screw, just as the first was. Again, I slipped the blind assembly into the mounts to check alignment. All was well, so I installed the second screw at each end.

The middle support arm was the last piece to go on, though if I were to do this again, I would mount this piece first. I wound up taping the arm in place, removing the blind and then putting in the screws. Fortunately it didn't shift enough to cause an alignment problem.

The final steps involved screwing in the lock screws, installing the stop plates and removing the excess slats. To shorten a blind, gently twist the bottom caps off with a screwdriver. Untie the knot on the end of the left cord and pull it out of the bottom slat. Do the same with the other lift cords. Make a mental note of the path the cords take as they pass from slat to slat on alternating sides of each rung. Gently pull cords through slats to be removed. Thread the cord through the holes in the bottom rail and pull out the slack. Knot the cord ends and replace the caps.

When you need a new look, paint a design on your blinds using

acrylic paint or cover with fabric or wallpaper. Wash slats with an ammonia-and-water solution to remove any grease or dirt and towel dry. Take blind apart, placing slats on a flat surface in the proper sequence. Cut an equal number of material strips, cutting each slightly oversize. Apply contact or fabric cement to each slat, lay strips over and smooth into place. Let dry overnight. Remove excess material and cut cord holes. Reassemble blinds, starting at the top, and attach bottom rail (**Figure 28**).

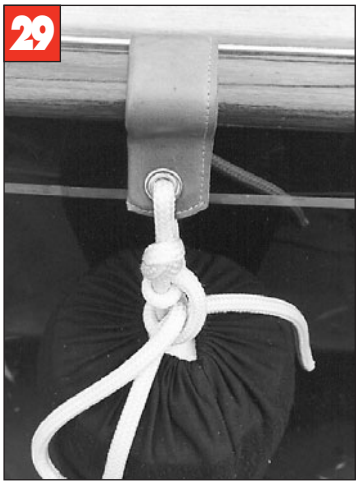


Made-to-measure completed blind.

— *Ryc Rienks*, Mai Tardis II,
Marine Puerto Vallarta, Jalisco, Mexico.

FENDER HOOKS

Here's an ultra-attractive and functional method to secure fenders to rails or gunwales. The one shown in the photo (**Figure 29**) belongs to *Volunteer*, a Mark Ellis-designed custom-built daysailer, but they're easy to make. Take a 5cm (2") wide, 12.7cm (5") long piece of metal and bend one end into the proper shape so it hooks freely over the rail and you have clearance for the material. (You may want to have a metal supplier do this for you.) Cut canvas or medium-weight suede leather twice the width of the hook, adding 5cm (2") to the length plus 6cm (1/4") or more on all edges. Wrap the material around the hook, leaving the extra length at the bottom, turn under the edges and hand-stitch for a secure fit. Punch a brass

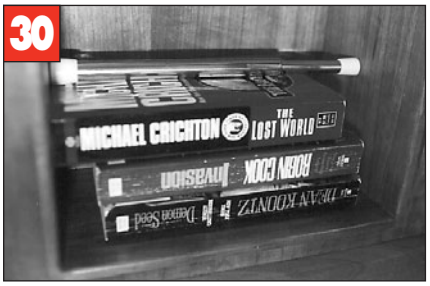


Custom hook hangs fenders from gunwale or rail.

DIY PROJECTS

grommet in the bottom, add a line and hang your fender hook in place.
— *JM*

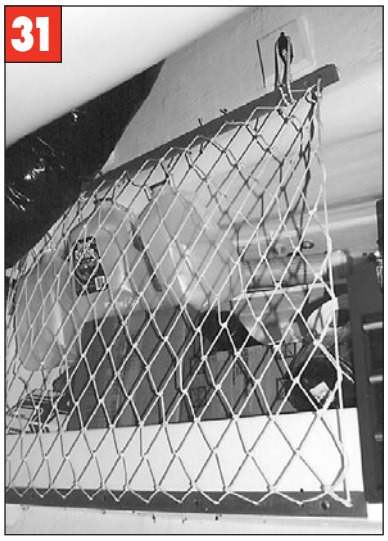
KEEPING THINGS IN PLACE



Inexpensive curtain rods keep gear in its place.

Items tossed onto shelves have a tendency to move around a lot and these projectiles can be dangerous. A quick fix to keep things in place is to use rubber-tipped spring rods (**Figure 30**), sold for window curtains. They're reasonably priced and easily installed and readjusted as needed. Mount them horizontally or vertically to support books or other gear, or as dividers for wide compartments.
— *JM*

REMOVABLE CARGO NET



Custom cargo net.

Many boats have storage areas in the engine compartment or cockpit lockers that are great for stowing things when in port, but lack a means of restraining the contents, making them totally unfit when underway. A custom cargo net (**Figure 31**) secures the load, is easy to install, allows good ventilation and lets you quickly remove items when needed.

Make your own netting or purchase premade nets; perhaps one sold for car trunks or lifeline netting may fit the bill, depending on the depth of the shelf. Cut two 2.5cm x 6mm (1" x 1/4") strips of hardwood. Lay the net over the strips, pulling the ends tight, then drill holes in the center of each, the diameter of the net cord plus some extra, equally spaced to match the ends of the net. In one strip, drill holes for screws spaced about every 25cm (10"). This is the bottom strip. Thread the net ends through the holes and tie off. Install the net in position on your boat, securely fasten the bottom strip and mount hooks for shock cord just above the corners. When you need to add or remove something, simply unhook the top.
— *JM*

STERN ANCHOR MOUNT

Most stern anchors are buried in a cockpit locker, well out of easy reach until needed, which means they're not accessible in an emergency. Usually, this is because no other mounting alternative exists. The stern anchor mount shown in **Figure 32** is a very slick design. It's easy to build, well-engineered, functional — it mounts the anchor above deck yet away from body contact — and somewhat attractive, if you don't mind the anchor hanging off the transom. The bracket attaches to the top rail of the stern pulpit and extends down to the transom

Stern anchor mounted within arm's reach when you need it most.

using standard rail and anchor hardware available at many chandleries.

Top detail.

To make it, you'll need a piece of 2.5cm (1") O.D. stainless-steel tube, 10cm (4") longer than the stock length of your stern anchor; two heavy-duty stainless-steel rail fittings, one with a flat base (Taco #F13-0230-1), the other with a curved base for rail mounting (Taco #F13-0240-1); two stainless-steel 2.5cm (1") I.D. eye ends with a hex head screw (Taco #F12-0105); and a custom-made aluminum bracket (shown in **Figure 34**) to secure the bottom of the anchor and bolt to a stanchion mount anchor bracket (Windline #PM-2). Depending on the anchor design the custom bracket may not be necessary. Wire ties and a short length of 2.5cm (1") I.D. hose complete the materials list.

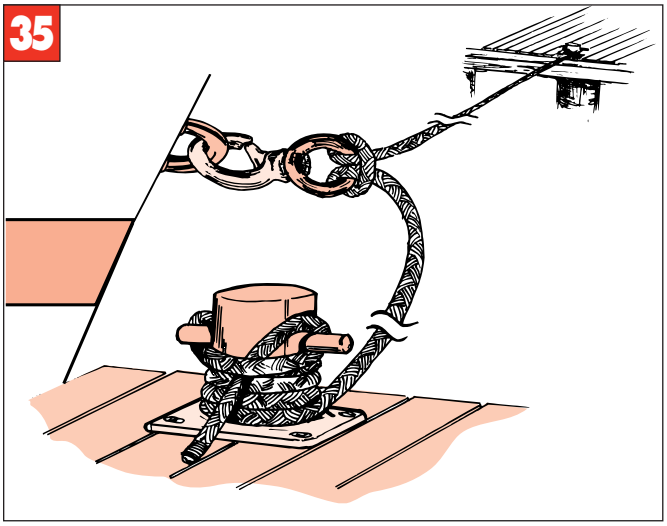
Bottom detail.

To assemble, bolt the rail-mount fitting to the underside of the top pulpit rail (**Figure 33**). Attach an eye end and insert the tube; slide on the other eye end and rail fitting. Mark the bolt holes on the transom for the lower rail fitting. It's best to dry-fit the entire assembly before drilling and mounting the top and bottom fittings to be sure the anchor, when mounted, avoids any obstructions such as antennas, ladders, etc. Also, double-check that the tube length is the correct length for the anchor shaft. Drill the transom; if you have access to the hull from inside, thru-bolt the rail fitting, otherwise mount it with screws (**Figure 34**). Attach the bottom eye end, tighten the hex screws on both ends, bolt the stanchion anchor mount to the tube, then attach the custom bracket (if used).

DIY PROJECTS

To prevent the top shaft of the anchor from chafing the mount, vertically slit the short length of hose, wrap it around the tube at the top (**Figure 33**) and secure with cable ties. Now mount the anchor and clamp the top with a cable tie or line passed through the shackle (**Figure 33**).
— JM

TWO-WAY BOAT TETHER



ANNE-MARIE HENDRY

Double dockline secures a powerboat from its bow eye.

A double dockline attached to a boat's bow eye is a simple and secure means to tie up powerboats lacking adequate bow cleats (**Figure 35**). It consists of a single dockline with its center fastened with a cow hitch to a carbine hook.

You'll need about 9m (30') of 11mm (7/16") or 16mm (5/8)" diameter braided nylon rope. Attach the line to the hook as shown in Figure 35. To tie the cow hitch, mark the center point in the line. Insert one end into the carbine hook, pulling the line through to the center mark. Pass the end over the standing part and insert into the hook from underneath. Cross over and insert the end through the bight parallel to the standing part. Pull both ends to tighten. It's a secure knot provided the tension on the two ends is equal. To use, simply snap the hook on the bow eye and secure the ends to the dock.
— JM

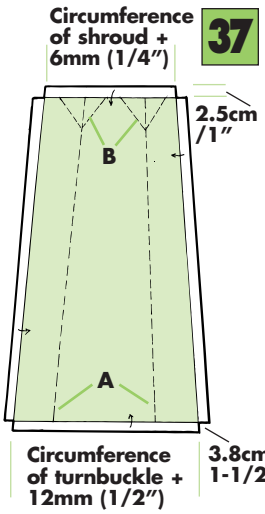
SEWING PROJECT

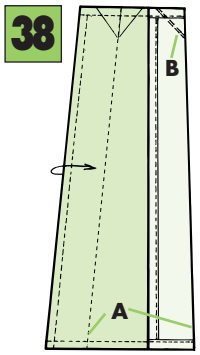
TURNBUCKLE BOOTS

Turnbuckles should be covered to protect sails and sheets from chafe and protect legs from sharp cotter pins. The simplest method is to tape the buckles with rigging tape, which uses rolls of tape, or cover the turnbuckles with short sections of PVC tubing of a large enough diameter to fit over the turnbuckle. These are cheap and easy to make, but they have a tendency to catch flogging sheets and ride up the shroud. For a more traditional look, without the expense of leather, make some fabric covers (**Figure 36**).

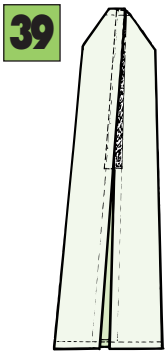
Simple-to-make turnbuckle boots.

Made of acrylic or treated cotton duck and fastened with hook-and-loop (Velcro) tape, they are easy to install or remove for servicing the turnbuckles or when derigging. Make a paper pattern following the measurements shown in **Figure 37**. The length of the boot should cover the turnbuckle and extend a few inches above the rigging screw. The top can be cut square or tapered for a tight fit around the shroud. Allow a 2.54cm (1") seam allowance on the top and bottom edges and an extra 3.8cm (1-1/2") on the front edges. Also add 19mm (3/4") to the right front for the overlap. With pattern in hand, purchase enough fabric to make boots for all your turnbuckles. You'll also need 19mm- (3/4"-) wide hook-and-loop tape, one set per boot, of the appropriate length. While you're at it, purchase extra to make covers for lifeline turnbuckles or backstay adjusters.





Turn edges under then fold along dotted lines (A) and stitch darts (B).



Hook-and-loop tape fastens edges together.

To sew, first snip the corners to the fold line to reduce bulk (**Figure 37**), fold under 19mm (3/4") on the front edges, then fold again, crease with scissors or a ruler, and machine baste along the folded edge. Turn under a 12mm (1/2") double-folded hem on the top and bottom edges and stitch close to the folded edge. With right sides together, fold along dotted lines (A). Stitch along the two dart lines (B) on the top edge (**Figure 38**), then stitch again. Trim close to stitching line. Sew loop tape (**Figure 39**) to the right side of the left front edge and the hook piece to the wrong side of the right edge and you're done. ***— JM***

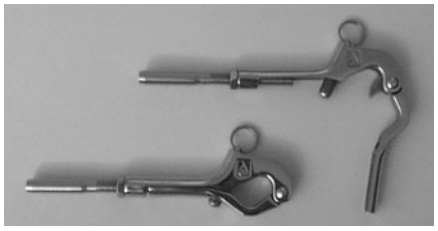
DOCKSIDE New Products

LOW-AMP BULB REPLACEMENT

Energy-efficient 12-volt LED Clusters consist of seven light-emitting diodes bundled together in a standard single- or double-contact bayonet socket. Rated for more than 100,000 hours of use, they consume just .068 amps and generate very little heat. At a foot away, the light intensity is comparable to a 10-watt incandescent bulb but the beam from an LED Cluster spreads at a 60° angle and the light draws 12 times less current. Available in white (US$59.95), or red and amber (US$25.95) for night-time use. For the name of your nearest distributor, contact: Davis Instruments, 3465 Diablo Ave., Hayward, CA 94545; Tel: (510) 732-9229, Fax (510) 732-9188.

Write #301 on Product Info Card

EASY-RELEASE GATE HOOK



Form follows function with the new "Over Center" gate hook from Johnson Marine. This cast no-load hook releases more easily than conventional designs while under load. The plunger pin is retained for security. Hooks sell for under US$46 depending on the model. Fittings are hand-crimped using the custom Johnson Hand Crimp tool. For the name of your nearest dealer contact: Johnson Marine, Box L, East Haddam Industrial Park, East Haddam, CT 06423; Tel: 860/873-8697, Fax: 860/873-8589.

Write #302 on Product Info Card

ELECTRONIC PLOTTING COMES OF AGE

Shop Tested

Test by navigator emeritus Vicki deKleer: For the less technically inclined, Yoeman's "Mouse for Maps" is an electronic chart plotter used with paper charts that can interface with GPS, radar, autopilot, even computers. There are units for chart table use, or for small boats without nav stations, fully-contained portable units, including the Sport XL (US$699). This unit plugs into

any 12-volt power or can be permanently wired to the boat's power supply and GPS. A 7.6cm- (3"-) thick nylon pack contains a rigid "operations" board that doubles as a laptop table, and a back pouch stores two cables, one navigation mouse and workbook. A plastic overlay on the front, secured with Velcro, houses the charts. Built into the board is the brain center, an electronic grid. When a chart already entered into memory (it comes with a sample chart for demonstration purposes) is laid over the grid it reads the precise location of the boat as the puck moves over the chart. Being skeptical of the electronics, I compared positions, courses and distances between waypoints with the unit in demo mode against the same data on a different chart of the same area. Results were identical, the difference being that Yoeman displayed the data instantly. Parallel rules and a pencil were slower and in rough sea conditions, more subject to error. Yeoman proved that the whole is indeed greater than the sum of its parts — far superior to a GPS and chart working independently of each other.

A most useful feature is the ability to guide the mouse to your boat's exact location. It reads standard Mercator or Gnomonic marine charts and it has a memory for 999 of them. To enter a new chart, there are several steps and although the learning curve is fairly short, it's best done prior to departure. Once recorded, however, charts are permanently ready for use. Three position points must be marked and their latitude and longitude listed for each quadrant entered into memory. Current BBA Chart Kits from Maine to Gulf of Mexico and some Admiralty charts are preprogrammed into memory. Positions are marked on the plastic with erasable markers through a "plot spot" on the mouse. Following red indicator lights on the mouse shows you the boat's position, then simply click and drag to your next position and instantly read range and bearing. It's most useful in the cockpit when navigating crowded waterways where you can see your position, check range and bearings and arrival times, and visually cross-reference with the navigation aids or landmarks. Its bulky size may make it awkward to use and to stow, but with the plug-in cable, it can be transported to another boat, car or used at home connected to a converter. This unit works best with BBA Chart Kits; most standard (large-scale, small-area) charts need to be fold-

ed in four to fit the plastic overlay, leaving undesirable permanent creases. A carrying strap (included) fastens onto the bottom, rather than the top; be sure the Velcro closures are secured when carrying or you'll lose the chart overboard. If you overstuff the overlay, it will tear and replacements cost US$30. Before purchasing, it's a good idea to check with Yoeman for compatibility with your GPS, loran, radar and other onboard equipment. For dealer locations, contact: Yoeman, 222 Severn Ave., Annapolis, MD 21403; Tel: 410/263-7335, Fax: 410/263-8318.

Write #303 on Product Info Card

EFFORTLESS BOARDING

Shop Tested

Left: Folded straight up-down ladder; Right: Folded Stowaway.

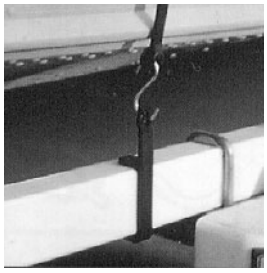
Boarding a boat from the water or a dinghy with a standard "straight" up-down ladder can be a challenge, especially with the typical not-cheap PVC boarding ladder that collapses, just as you're balancing to do a belly roll into the boat, pinching toes and bruising shins. Many children and adults, even those with some athletic ability, find it difficult to pull their mass into a boat and lending a hand means yanking and dragging them over the gunwale (more bruises). All this changes with the Stowaway "stairway." Its angled design lets you walk up or walk down the ladder just like navigating stairs. Super tough, it's constructed of high-tensile anodized aluminum and stainless steel with nonslip PVC-covered steps. Various designs for gunwale, deck, transom, swim platform or pulpit mounting suit most boats and support up to 182kg (400lb). Mounted-on brackets

have quick-release pins allowing removal for storage, and ladders fold flat into a compact package that fits neatly into a locker. Optional quick-release mounting brackets allow mounting in alternate locations. Cushioned standoffs adjust vertically and horizontally to fit any hull to keep the ladder at a comfortable climbing angle. But such comfort comes at a premium: "stairways" start at US$302/CDN$499. If you use your boat for watersports, save your money and buy one. Your family and friends will thank you for it. For the name of your nearest dealer contact: Wesbar, P. O. Box 577, West Bend, WI 53095; Tel: 414/334-2381, Fax: 414/677- 4737.

Write #304 on Product Info Card

ANCHORS FOR COVERS

Shop Tested



Covering a boat can be a time-consuming job, particularly when you don't have sufficient tiedown points. Cov-R-Clips from M&K Industries are an inexpensive gadget that snaps onto a trailer frame giving a permanent yet removable tiedown point wherever one is needed — without modifying the trailer or the cover. They're great for securing the cover to the frame aside wheel fenders, especially on tandem trailers, below the transom or the trailer tongue. Made of durable nylon-composite, they won't crack in extreme cold. Two sizes fit 7.6cm (3") and 10cm (4") trailer frames and many boat lifts. A pack of four sells for under US$13 under the M&K and Taylor Made brands. Available at many marine and outdoor chain stores and chandleries.

Write #305 on Product Info Card

Disclaimer: Until the performance of a specific product is tested by our staff, DIY boat owner is not accountable for any products appearing in this section. Product testing is conducted on a continuing basis with reports appearing regularly.

DIY boat owner

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Good Boatkeeping

Story by David and Zora Aiken, illustrations by David Aiken

BUILD A CURVED LOCKER

Easy bending technique produces a handsome rounded-front locker.

Here's a way to build a locker with a rounded front. This one was made as a vanity for the head sink, but the same construction method can be used in any place where space is limited and a square-cornered locker won't fit.

First, make a bendable pattern using corrugated cardboard. If the locker is to fit in a spot where the hull curves up, be sure to cut the correct shape for the bottom. Cut two pieces of 12mm (1/2") or 19mm (3/4") plywood, one for the top of the locker, the other for the shelf. Cut a piece of 3mm (1/8") mahogany doorskin to the shape of the pattern. Bend it around the front of the plywood pieces (first around the top piece, then around the shelf) and tack it in place with staples, finishing nails or whatever will allow you to remove the shelf later without too much effort.

Apply fiberglass to the outside of the doorskin with clear resin, followed by two or three more coats to fill the weave. Rather than paint the locker, add pigment to the last coat. We used mat rather than cloth because we wanted a textured surface. When the resin dries, carefully remove the plywood shelf to allow access to the entire inner surface. The doorskin will still be somewhat flexible. Turn the doorskin face down (curve up). Prop it up as necessary so it will retain the desired curve as you fiberglass the inside and strengthen the section where the door will be cut. Note: If the locker is not meant to be used with a sink, it's not necessary to fiberglass the inside surface. To stiffen the door area, add some wood strips to the inside surface: Cut 6mm (1/4") wood into strips about 12mm (1/2") wide and long enough to extend a few inches above and below the length of the planned door.

Thicken some epoxy resin with colloidal silica, and glue the wood strips in place vertically side-by-side along the curve where the door will be. Fill gaps between the strips with more thickened resin. When dry, the locker front will be stiff enough to hold its shape when the door is cut. Attach pieces of 1"x2" cleat stock to the bulkhead at appropriate places so the shelf can be put in place and the locker installed. Trim off a small portion of the front of the shelf to make room for the added thickness of the wood strips. Once the locker is in position, hinge the door and add a turnbutton closure.

About the authors: David and Zora Aiken are the authors of "Good Boatkeeping" and "Good Cruising," published by International Marine. The Aikens currently live aboard a 1963 10.5m (35') Chris-Craft sloop, Atelier, *berthed in Grasonville, Maryland.*